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MINERALS YEARBOOK

1954

Volume I of Three Volumes

METALS AND MINERALS
(EXCEPT FUELS)

Prepared by the staff of the
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FOREWORD

MINERALS YEARBOOK 1954, published in three volumes, includes data collected for the 1954 Census of Minerals Industry. All data collected in cooperation with Bureau of the Census are noted in either text or footnotes in the commodity chapters. Unless otherwise stated, the data were collected by the Bureau of Mines. When final Census data become available, differences in totals will be reconciled.

Volume I includes chapters on mineral commodities, both metals and nonmetals, but exclusive of the mineral fuels. Included also are a chapter reviewing these mineral industries, a statistical summary, and chapters on mining technology, metallurgical technology, and employment and injuries.

Volume II includes chapters on each mineral-fuel commodity, as well as chapters reviewing the industry as a whole, a statistical summary, and an employment and injury presentation.

Volume III is 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 and another presenting employment and injury data.

The data presented in the Minerals Yearbook are based largely upon information obtained from 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*.

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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 Territorial 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: Conservation and Survey Division.
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.
South Carolina: Department of Geology, Mineralogy and Geography.
South Dakota: State Geological Survey.
Tennessee: Tennessee Department of Conservation.
Texas: Bureau of Economic Geology.
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 and Natural History 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, Anita C. Going, Helen E. Tice, and Anne 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.

CONTENTS

Review of the Mineral Industries[1]

(Metals and Nonmetals Except Fuels)

By Gabriel F. Cazell[2]

UNDER the impact of a general decline in the overall national economy, 1954 was a year of reduced activity in the metals and nonfuel minerals. Net new supply and consumption were lower than in 1953 and about equal, as stocks showed no significant overall change. Although the demand for basic minerals in the United States was lower in 1954 than in 1953, the domestic mining industry increased its share of the market at the expense of foreign producers. In addition, the domestic industry shared a larger portion of world markets, with a substantial increase in exports. The domestic production of minerals was only slightly lower in 1954 than in 1953 in spite of the relatively poor year for iron ore, copper, lead, and zinc; almost all ferroalloys and about half of the nonmetallics improved their position substantially.

Prices of minerals were about the same or slightly higher in 1954, with costs also at about the 1953 level. Activity in mining was lower in the second half of the year; activity in smelting and refining was low in the first half but much improved in the second half. Investment in new plant and equipment was more cautious and fell below 1953. The relatively good position of the domestic mineral industry, in spite of a lower demand for its products, can be seen in the 11-percent rise in the price of common stock of mining firms. Investments in mining and smelting industries in foreign countries continued to increase, as did earnings based on them. In the first full year of central direction of defense materials activity by the Office of Defense Mobilization (ODM), both productive capacity and supplies of most strategic materials were increased.

The President's Cabinet Committee on Minerals Policy was established October 26, 1953. As a result of special attention given to the market conditions in the lead and zinc industry, the Committee recommeded that the National Strategic Stockpile be expanded to improve the prices of those metals. In its report dated November 30, 1954, the Committee recommended expansion of fact finding, exploration, and research in the minerals area, and changes in the mineral tax structure to stimulate production. However, the broadening of the stockpile function to include maintenance at proper levels of the domestic component of the mobilization base was probably the most far-reaching effect of the Committee's report. This, in turn, gave

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

[2] Assistant chief economist, assisted by Anne T. Sheehan, general economist.

rise to another significant conceptual development during the year—the advent of the three-phase stockpile philosophy based on minimum, long-term, and supplemental objectives.

On the world scene the total range of mineral prices changed little from 1953; production of a majority of minerals increased moderately during the year.

DOMESTIC PRODUCTION

Value of Mineral Production.—Respective increases and decreases in the metals and nonmetals approximately offset each other in 1954; as a result, the overall value of production of nonfuel minerals, shown in table 1, was virtually the same as in 1953. The nonmetallics were up 13 percent, the metals down 17 percent over 1953. With addition of the fuels, the value of the total mineral production in the continental United States was about 2 percent below 1953. The value of nonfuel minerals was 55 percent greater than the comparable value in 1949, 30 percent greater than in 1950, and 9 percent above 1952. The decline in iron-ore production (which accounted for over 50 percent of the decrease in metal value) was the largest single factor in the leveling off of the total value of nonfuel minerals between 1953 and 1954.

TABLE 1.—Value of mineral production in continental United States, 1949–54, by mineral group

(Million dollars)

Mineral group	1949	1950	1951	1952	1953	1954	Change in 1954 from 1953 (percent)
Metals and nonmetals except fuels:							
Nonmetallic minerals except fuels	1,559	[1] 1,822	[1] 2,079	[1] 2,163	2,337	2,641	+13
Metals	1,101	1,351	[1] 1,671	[1] 1,614	1,796	1,486	−17
Total	2,660	[1] 3,173	[1] 3,750	[1] 3,777	4,133	4,127	0
Mineral fuels	7,920	8,689	9,779	9,615	10,249	10,008	−2
Grand total	10,580	[1] 11,862	[1] 13,529	[1] 13,392	14,382	14,135	−2

[1] Revised figure.

Volume of Production.—The index of physical volume of mined and concentrated metal, stone, and earth minerals, computed by the Federal Reserve Board, declined 11 percent from 1953 to 106 percent of the 1947–49 base. This was slightly lower than the 1950 level. Each component of the index—iron ore, copper mining, lead mining, zinc mining, and stone and earth minerals—declined from 1953. As indicated above, the largest decline was in iron ore, as the index fell from 128 to 84, or 34 percent. The nonferrous mining index fell 10 percent; the index of stone and earth minerals, on the other hand, dropped less than 1 percent.

The index of production of pig iron and steel fell from 138 in 1953 to 108 in 1954, the lowest level since 1949. The production of nonferrous metals—primary and secondary—remained at the 1953 figure of 136. The output of stone and clay products (including cement) and fertilizer, fairly representative of manufacturing in the nonmetallic minerals, was also virtually the same as in 1953. The weighted average of the 4 mineral and metal indexes shown in table 2 fell from 134 in 1953 to 117 in 1954, a decrease of 13 percent or slightly above the 1951 level for this aggregate.

TABLE 2.—Indexes of physical volume of metal and mineral mining, production of metals, production of nonmetallic products, and industrial production, 1948–54 [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
1948	104	106	103	105	104
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

[1] Source: Federal Reserve Bulletin, December 1953, p. 1302, July 1955, pp. 804–807, and March 1956, pp. 272–275. 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 author employing Federal Reserve indexes and weights.

Within the year, unadjusted steel production continued the 1953 monthly decline through the first 7 months of 1954, then rose steadily in the last 5 months. Pig-iron production continued the 1953 monthly decline for the first four months, remained low (about 95 percent of the 1947–49 base) through September, then rose steadily in the last 3 months. Primary nonferrous metal production was stable at about 1953 levels through the first 6 months, fell in the third quarter, then rose in the last quarter to well above 1953, as copper, lead, zinc, and aluminum production rose in the latter half.

Whereas refined metal production rose during the latter part of the year after a decline in the first half, the situation was generally reversed in metal and mineral mining. The combined index of metal, stone, and earth minerals rose in the first 6 months and fell in the last 6. The heavy declines in iron ore more than offset the last half gains in copper mining; as a result, the combined metal-mining index declined steadily in the last 6 months; although the monthly declines were smaller, stone and earth minerals production also fell during the last 6 months. Thus, while the primary metal production index fell in the first half and rose in the second the metal-mining index rose during the first half and fell during the second.

MINING FIRMS

As reported in the 1953 Review of the Mineral Industries, approximately 38,300 mining and quarrying firms (including fuels) were in operation on December 31, 1953; this remains the latest date covered by an estimate. Additional information on the survival experience and prospects of survival in mining and quarrying has appeared however and is partly summarized in table 3. In the 1947–54 period 79 percent of such firms survived the first 6 months of operation, and about 55 percent survived the first 18 months. Only one-third survived the first 3.5 years, but after that age was reached, the rate of attrition among the remaining was much lower. Survival percentages for mining and quarrying were close to but higher than the average percentages for all industries and in this respect are consistent with other survival statistics. It is also shown that for firms in the mining and quarrying category which reached 1 year of age, 74 percent survived an additional year. For firms reaching 5 years of age, 89 percent survived an additional year. The age distribution of mining and quarrying firms in operation on December 31, 1954, indicates that 80 percent have been in operation 1.5 years or longer, 63 percent 4.5 years or longer, and 40 percent 10.5 years or longer. The comparable figure for 10.5 years or longer for all industries was 31 percent. In addition, the median age for mining and quarrying firms was shown to be 7.5 years in 1954, or 2.5 years higher than the 1948 median age of 5.0 years, higher in both years than the median age for all industries.

TABLE 3.—Life expectancy and age distribution of mining and quarrying firms on the basis of 1947–54 experience [1]

Age (years)	Firms surviving to specified age (percent)	Age (years)	Firms of specified age surviving at least 1 additional year (percent)	Age (years)	Firms in operation Dec. 31, 1954 (cumulative percent)
0.5	79	0	67	0 or more	100
1.5	55	1	74	0.5 or more	89
2.5	42	2	79	1.5 or more	80
3.5	34	3	84	2.5 or more	73
4.5	30	4	87	3.5 or more	68
5.5	26	5	89	4.5 or more	63
6.5	24	6	91	5.5 or more	59
7.5	22	7	93	6.5 or more	54
8.5	20	8	94	7.5 or more	50
9.5	19	9	95	8.5 or more	46
10.5	18			9.5 or more	43
				10.5 or more	40

[1] U. S. Department of Commerce, Office of Business Economics, Survey of Current Business: Vol. 35, No. 12, December 1955, pp. 18–19.

NET NEW SUPPLY

The net new supply [3] of minerals and metals fell sharply in 1954. Reduced activity in domestic mining and milling and secondary production, and in the purchases from foreign suppliers, caused net decreases in new supply in the principal minerals ranging from 1 percent in the boron minerals and compounds to 41 percent in mica. Of the 31 minerals listed in table 4, only 9 showed increases from 1953. Molybdenum, nickel, and aluminum were the only metals that increased significantly; five major nonmetallics—bromine, clays, gypsum, phosphate rock, and potash—increased within a range of 1 and 13 percent. The net new supply figures summarize the general decrease in activity in the minerals segment of the economy in 1954.

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

Sources of New Supply.—Of considerable interest is the way in which the supply components shared the reduced net new supply required in 1954. The domestic industry either held its 1953 share or increased it in all but two commodities, and in all but one instance (cobalt) increasing shares on the part of the domestic industry were achieved at the expense of foreign suppliers. The most favorable domestic gains between 1953 and 1954 were in chromite, from 3 percent to 9 percent of gross new supply; in tungsten ore and concentrate, from 25 percent to 35 percent; and in mercury, from 15 percent to 22 percent. The only significant foreign supply gain was in iron equivalent. The significant foreign supply losses were in the commodities in which the domestic component gained, but also in lead (from 41 percent to 37 percent) and in antimony (from 36 to 30 percent). Absolute decreases in imports can be seen in table 5.

It is also of interest to note that not only did the domestic component increase its share of a declining total market for mineral commodities, but it also increased its export business. Although somewhat apparent from percentage figures, the increased export business is better seen by comparing actual export figures. Of the 20 minerals exported, 16 increased. Percentage changes in exports were as follows (the significance of percentage increases can be judged by referring to the percentages exports are of gross new supply):

Commodity:	*Change in exports, 1953–54 (percent)*	Commodity—Continued	*Change in exports, 1953–54 (percent)*
Iron	−25	Platinum	−4
Molybdenum	+84	Asbestos	−33
Tungsten	+186	Boron	+48
Copper	+98	Bromine	+67
Lead	−67	Clays	+9
Zinc	+9	Mica	+609
Aluminum	+471	Phosphate rock	+13
Antimony	+83	Potash	+35
Cadmium	+1, 413	Salt	+53
Mercury	+63	Talc and allied minerals	+4

Sources of Imports.—The sources of United States imports by areas of the world are shown in table 5. There were no conclusive gains or losses in any one area in 1954; gains in some minerals were approximately offset by losses in others in each of the Free World areas. Changes of 5 percent or more in imports from Canada and Mexico were in zinc (up 9 percent), cadmium (up 19 percent), titanium concentrate (down 10 percent), and barite (down 14 percent). Similar changes in the East and South Pacific area were in iron equivalent (down 5 percent), tungsten (up 13 percent), and antimony (down 19 percent). The larger changes in the Other Western Hemisphere area were in iron equivalent (up 11 percent), tungsten (down 6 percent), and aluminum equivalent (up 9 percent). Large changes were more numerous in the Other Free World area: Iron equivalent (down 11 percent), tungsten (down 6 percent), lead (up 5 percent), zinc (down 11 percent), aluminum equivalent (down 6 percent), antimony (up 13 percent), cadmium (down 15 percent), titanium concentrate (up 10 percent), and barite (up 14 percent).

TABLE 4.—Net new supply of principal minerals in the United States and components of gross new supply,[1] 1953–54

(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	
	1953	1954	Change from 1953 (percent)	Primary shipments [2]		Secondary production [3]		Imports [4]			
				1953	1954	1953	1954	1953	1954	1953	1954
Ferrous ores, scrap, and metals:											
Iron (equivalent) [5]	[6] 113,870	85,260	−25	61	53	[7] 31	[7] 33	8	14	2	2
Manganese	1,924	1,167	−39	11	15	-------	-------	[8] 89	[8] 85	([9])	([9])
Chromite (Cr_2O_3 content)	966	671	−31	3	9	-------	-------	97	91	([9])	([9])
Cobalt (content) ... thousand pounds	20,553	19,873	−3	9	11	[10] 7	[10] 4	84	85	-------	-------
Molybdenum (content) ... do	46,376	51,204	+10	100	100	-------	-------	-------	([9])	14	21
Nickel (content)	125	139	+11	1	2	4	3	95	95	-------	-------
Tungsten ore and concentrate (W content) ... short tons	18,600	18,600	0	25	35	-------	-------	75	65	([9])	([9])
Other metallic ores, scrap, and metals:											
Copper (content)	1,910	1,621	−15	46	46	21	22	33	32	5	12
Lead (content)	1,315	1,187	−10	26	27	33	36	41	37	([9])	([9])
Zinc (recoverable content)	1,260	1,057	−16	43	43	5	7	52	50	2	2
Aluminum (equivalent) [11]	1,733	1,903	+10	[12] 20	[12] 24	5	3	[13] 75	[13] 73	([9])	2
Tin (content) ... thousand long tons	130	105	−19	([9])	([9])	15	16	85	84	([9])	([9])
Antimony (recoverable content)	33	30	−9	6	7	58	63	[14] 36	[14] 30	([9])	([9])
Cadium (content) [15] ... short tons	[6] 5,621	4,479	−20	34	38	1	1	65	61	1	10
Magnesium (content)	99	71	−28	[16] 92	[16] 95	6	4	2	1	3	4
Mercury ... 76-pound flasks	97,184	82,623	−15	[16] 15	[16] 22	-------	-------	85	78	1	1
Platinum-group metals ... thousand troy ounces	[6] 699	667	−5	4	4	[17] 9	[17] 9	87	87	4	4
Titanium concentrates: Ilmenite and slag (TiO_2 content)	442	445	+1	58	61	-------	-------	42	39	([9])	-------
Nonmetallic minerals:											
Asbestos	744	724	−3	7	7	-------	-------	93	93	([18] [9])	([18] [9])
Barite, crude	1,279	1,200	−6	74	74	-------	-------	26	26	-------	-------
Boron minerals and compounds ... (gross weight)	576	573	−1	100	100	-------	-------	([9])	([9])	19	26
Bromine and bromine in compounds ... million pounds	161	182	+13	100	100	-------	-------	-------	-------	2	3
Clays	42,283	42,891	+1	100	100	-------	-------	([9])	([9])	1	1
Fluorspar, finished	677	538	−21	47	46	-------	-------	53	54	([9])	([9])
Gypsum, crude	11,477	12,311	+7	[19] 72	[19] 73	-------	-------	28	27	-------	-------
Mica (except scrap) ... thousand pounds	14,469	8,596	−41	6	7	-------	-------	94	93	([9])	4
Phosphate rock (P_2O_5 content) ... thousand long tons	3,319	3,383	+2	99	99	-------	-------	1	1	17	19
Potash (K_2O equivalent)	[6] 1,817	1,971	+8	93	94	-------	-------	7	6	3	3
Salt, common	20,677	20,160	−3	99	99	-------	-------	1	1	1	2
Sulfur (content)	5,049	4,797	−5	[20] 99	[20] 100	-------	-------	1	([9])	20	26
Talc and allied minerals	598	571	−5	96	96	-------	-------	4	4	4	4

[1] Net new supply is the sum of primary shipments, secondary production, and imports, minus exports. Gross new supply is the total before the 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 between 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 otherwise indicated.
[5] Includes iron ore, pig iron, and scrap.
[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 82 percent of bauxite production (rather than shipments) and imports, and 91 percent of alumina imports, both converted to estimated aluminum equivalent in 1953, 85 and 91 percent in 1954. 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, which are 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. Secondary includes both old and new scrap.
[16] Primary production of metal.
[17] Recovery from both old and new scrap.
[18] Exports of foreign merchandise (that is, reexports) have also been deducted.
[19] Primary production, excluding byproduct.
[20] For pyrites, includes sulfur content for production.

TABLE 5.—Percentage distribution of imports of principal minerals consumed in the United States, 1953–54, by country groups of origin [1]

Commodity	Total (thousand short tons unless otherwise stated)		Percent from—									
			Canada and Mexico		East and South Pacific [2]		Other Western Hemisphere		Other Free World		U. S. S. R. bloc	
	1953	1954	1953	1954	1953	1954	1953	1954	1953	1954	1953	1954
Ferrous ores, scrap, and metals:												
Iron (equivalent) [3]	[4] 8,850	12,200	20	25	27	22	26	37	27	16	------	------
Manganese (content) [5]	1,709	1,021	5	4	2	2	14	15	79	79	------	------
Chromite (Cr_2O_3 content)	943	609	------	------	5	3	3	2	92	95	------	------
Cobalt (content) thousand pounds	17,240	16,865	5	7	------	------	------	------	95	93	------	------
Molybdenum (content) do	------	154	------	100	------	------	------	------	------	------	------	------
Nickel (content)	119	132	80	81	([8])	------	12	10	8	9	------	------
Tungsten ore and concentrate (W content) short tons	14,030	12,094	10	9	17	30	12	6	61	55	------	------
Other metallic ores, scrap, and metals:												
Copper (content)	664	595	25	23	49	52	3	3	23	22	------	------
Lead (content) [5]	547	438	43	39	36	35	1	1	20	25	------	------
Zinc (recoverable content) [5]	671	543	64	73	17	19	1	1	18	7	------	------
Aluminum (equivalent) [9]	1,309	1,418	18	15	([8])	------	75	84	7	1	------	------
Tin (content) thousand long tons	111	88	([8])	([8])	17	14	------	------	83	86	------	------
Antimony (recoverable content) [10]	11	8	22	28	51	32	([8])	------	27	40	------	------
Cadmium (content) [11] short tons	1,710	943	69	87	5	2	------	------	26	11	------	------
Magnesium (content)	2	1	([7])	([7])	------	------	------	------	([7])	([7])	------	------
Mercury 76-pound flasks	83,390	64,960	16	14	([8])	------	------	------	84	86	------	------
Platinum-group metals thousand troy ounces	[4] 634	602	35	38	([8])	([8])	6	7	54	54	5	1
Titanium concentrates: Ilmenite and slag (TiO_2 content)	184	174	53	43	([8])	------	------	------	47	57	------	------
Nonmetallic minerals:												
Asbestos	692	678	94	95	([8])	([8])	([8])	([8])	6	5	([8])	([8])
Barite, crude	335	317	80	66	------	------	2	2	18	32	------	------
Boron minerals and compounds gross weight	([6])	([6])	------	([7])	------	------	------	------	([7])	([7])	------	------
Bromine and bromine in compounds thousand pounds	1	------	------	------	([7])	------	------	------	([7])	------	------	------
Clays	149	165	3	3	([8])	------	([8])	------	97	97	------	------
Fluorspar, finished	[4] 360	293	59	58	------	------	------	------	41	42	------	------
Gypsum, crude	3,184	3,368	98	94	------	------	2	6	------	------	------	------
Mica (except scrap) thousand pounds	13,670	8,250	2	2	([8])	------	17	21	81	77	------	------
Phosphate rock (P_2O_5 content) thousand long tons	33	40	([7])	([7])	------	([7])	([7])	([7])	([7])	------	------	------
Potash (K_2O equivalent)	[4] 134	119	([8])	------	1	2	([8])	------	76	75	23	------
Salt, common	137	161	2	1	------	------	98	99	------	------	------	------
Sulfur (content) thousand long tons	92	23	100	([7])	------	------	------	------	([8])	([7])	------	------
Talc and allied minerals	23	22	([7])	([7])	------	------	([7])	------	([7])	([7])	------	------

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

FOREIGN TRADE

Value.—Matching the decrease in physical volume of imports shown in table 4, the value of metallic and nonmetallic (except fuel) imports was lower than in 1953. Value changes in imports of individual commodities can be seen in table 6, as well as totals for crude metallic minerals, metals (unwrought), and crude nonmetallic minerals (except fuels). Metal imports were down the most, 21 percent lower than in 1953, the crude metallic minerals were 5 percent

TABLE 6.—Value of minerals and metals imported and exported by the United States, 1952–54, by commodity groups and commodities, in thousand dollars [1]

[U. S. Department of Commerce]

SITC No.[2]	Group and commodity	Imports for consumption [3]			Exports of domestic merchandise [4]		
		1952	1953	1954	1952	1953	1954
	CRUDE METALLIC MINERALS [5]						
281-01	Iron ore and concentrate	82,903	[6] 96,842	119,459	37,404	[6] 32,422	24,784
282-01	Iron and steel scrap	5,401	[6] 5,870	5,949	12,500	11,219	51,612
	Ores of nonferrous metals and concentrates:						
283-07	Manganese	67,758	[6] 105,673	77,030	504	552	592
283-11	Tungsten	57,062	[6] 91,602	76,251	46	31	111
283-06	Tin	65,287	[6] 83,713	41,725	--------	--------	--------
283-01	Copper	60,463	[6] 59,939	69,142	495	290	1,309
283-08	Chromium	38,595	[6] 56,102	34,197	73	56	50
283-05	Zinc	113,785	49,714	54,328	899	759	--------
283-03	Bauxite (aluminum ore) and concentrate	23,194	29,585	36,289	845	886	666
283-04	Lead	33,253	15,391	48,306	288	269	25
*283-19	Columbium	2,369	[6] 6,891	14,191	--------	--------	1
283-02	Nickel	4,995	5,794	5,358	--------	--------	--------
*283-19	Titanium:						
	Ilmenite	2,478	5,464	4,993	} 111	[6] 110	78
	Rutile	1,729	1,791	1,323	}		
*283-19	Cobalt	5,668	4,952	5,576	--------	--------	--------
*283-19	Molybdenum	41	--------	180	6,792	7,308	13,989
*283-19	Other	7,548	[6] 9,134	7,489	531	152	107
	Nonferrous metal scrap:						
284-01	Aluminum	2,592	8,072	4,675	164	1,476	12,985
	Old and scrap copper	2,582	4,018	2,081	3,937	17,199	40,234
	Old brass and bronze and clippings	3,765	3,737	1,568	[7] 2,360	[7 6] 13,066	[7] 38,469
	Other, not elsewhere included	8,110	5,536	4,990	2,441	3,130	7,040
285-02	Platinum-group metals	11,275	11,827	13,643	--------	1	2
	Total crude metallic minerals	600,853	[6] 661,647	628,743	69,390	[6] 88,926	192,054
	METALS (UNWROUGHT) [5 8]						
681-01	Pig iron and sponge iron	20,976	27,958	15,156	752	1,145	872
681-02	Ferroalloys:						
	Ferromanganese	14,759	27,181	10,903	475	389	615
	Ferrochromium	4,851	10,398	3,502	519	286	996
	Other	1,978	2,812	2,142	6,802	2,708	1,780
682-01	Copper	333,870	362,079	277,981	121,596	[6] 70,117	130,625
687-01	Tin	232,692	[6] 187,613	142,504	581	298	467
684-01	Aluminum	43,505	115,761	83,573	519	937	1,691
683-01	Nickel (including scrap)	89,450	[6] 102,750	124,454	6,527	9,674	--------
685-01	Lead	167,505	[6] 97,449	70,376	733	490	208
686-01	Zinc	36,220	50,282	33,987	24,715	[6] 4,774	5,532
689-01	{Cobalt metal	27,304	33,225	35,391	(9)	(9)	(9)
	{Mercury	12,547	13,569	10,784	86	106	183
	{Other nonferrous base metals	11,334	12,726	9,917	4,599	[6] 3,860	8,103
671-02	Platinum-group metals, including unworked and partly worked	14,259	27,620	21,641	1,689	1,531	2,955
	Total metals	1,011,250	[6] 1,071,423	842,311	169,593	[6] 96,315	154,027
	Total metals and metallic minerals	1,612,103	[6] 1,733,070	1,471,054	238,983	[6] 185,241	346,081

See footnotes at end of table.

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TABLE 6.—Value of minerals and metals imported and exported by the United States, 1952–54, by commodity groups and commodities, in thousand dollars[1]—Con.

[U. S. Department of Commerce]

SITC No.[2]	Group and commodity	Imports for consumption[3]			Exports of domestic merchandise[4]		
		1952	1953	1954	1952	1953	1954
	CRUDE NONMETALLIC MINERALS (EXCEPT FUELS)						
	Diamonds:						
*672-01	Gems, rough or uncut	52,193	[6] 57,289	60,001	165	415	410
*272-07	Industrial	51,910	[6] 49,598	48,841	21	14	63
	Total diamonds	104,103	[6] 106,887	108,842	186	429	473
272-12	Asbestos, crude, washed or ground	61,596	[6] 59,754	55,857	2,550	540	276
271-02	Sodium nitrate	27,631	23,268	26,818	528	1,126	1,210
272-13	Mica, unmanufactured (including scrap)	14,271	[6] 14,700	8,335	41	28	79
*272-14	Fluorspar	10,527	[6] 11,245	8,962	48	49	50
272-11	Stone for industrial uses, except dimension	4,242	5,370	5,807	517	694	762
272-06	Sulfur	106	51	58	35,966	[6] 36,573	52,524
271-03	Phosphates, natural, ground or unground	2,332	2,545	3,081	12,404	18,368	21,169
272-04	Clays	1,917	2,195	2,485	7,014	7,031	8,350
(10)	Other nonmetallic minerals (except fuels)	17,295	[6] 17,298	19,357	17,091	19,390	19,635
	Total crude nonmetallic minerals (except fuels)	244,020	[6] 243,313	239,602	76,345	[6] 84,228	104,528
	Grand total, minerals and metals (except fuels)	1,856,123	[6] 1,976,383	1,710,656	315,328	[6] 269,469	450,609

[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; these 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 instances, 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 instances be in accord with usual Bureau of Mines practice as followed in individual commodity chapters in this Minerals Yearbook. In a few instances, 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 warehouses 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 those for the other years due to 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 that 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 of SITC Nos. 271-04; 272-01, 272-02, 272-03, 272-05, 272-08, 272-15, 272-16, and 272-19; and those parts of Nos. 672-01, 292-07, and 292-14 not shown separately above.

lower, and the crude nonmetallics (excluding fuels) were about 1 percent lower. The overall total was 13 percent lower than 1953 and 8 percent lower than 1952.

The increase in exports referred to in physical terms above can also be seen in value terms. Exports of crude metallics were up 119 percent over 1953, exports of metals were up 60 percent, and total exports were 68 percent higher than in 1953. In 1954 exports were one-fourth of the value of roughly comparable imports; in 1953 the ratio was about one-seventh.

Tariffs.[4]—The Report to the President and the Congress of the Commission on Foreign Economic Policy was submitted January 23, 1954. The Commission, under the chairmanship of Clarence B. Randall, was established August 7, 1953,

> to examine, study, and report on the subjects of international trade and its enlargement consistent with a sound domestic economy, our foreign economic policy, and the trade aspects of our national security and total foreign policy; and to recommend appropriate policies, measures, and practices.[5]

The Commission made several recommendations of specific interest to the mineral industries. These recommendations concerned the instability of raw-material prices, foreign investment policy, and tariff policy. It was the opinion of a majority of the Commission that commodity agreements or unilateral buffer stock actions would not solve the problem of price instability and would impair economic adjustments and freedom of individual initiative. Actions that would make constructive contributions toward greater stability of world prices were enumerated as: (1) Reduction by the United States and other countries of trade barriers, (2) encouragement of diversification by foreign investment in the one- or few-product countries, (3) avoidance of disruptive actions by the United States in its stockpile and commodity control programs, (4) consultation to improve knowledge of world supply and demand, and (5) policies that would temper fluctuations of the United States economy.[6]

The Commission believed that the most effective contribution the United States could make to help the development of raw materials in scarce supply would be to follow policies favorable to investment abroad and to permit easy access of these materials to the United States markets by low tariffs. If security considerations dictate a domestic source of these raw materials, such a source, in the opinion of the Commission, should be maintained by direct means, and tariffs and import restrictions should be determined on economic grounds.[7]

President Eisenhower, in a message to Congress on March 30, 1954, endorsed the recommendations concerning price instability and foreign investment in strong terms. He further stated:

> The Commission also recommended that domestic sources for raw materials required for military purposes should be assured by direct means and not by tariffs and import quotas. I believe that normally this is sound.[8]

Because of insufficient time for full hearings on the President's message and on the Randall Commission Report, a 1-year extension of the trade agreements program without significant change, was voted and was signed by the President July 1, 1954. (Public Law 464, 83d Cong., 2d sess.)

The President's Cabinet Committee on Minerals Policy, whose report was made public November 30, 1954, did not specifically refer

4 Prepared by William A. Vogely, general economist.
5 Public Law 215, 83d Cong., 1st sess., title III, sec. 309 (a).
6 Commission on Foreign Economic Policy, Report to the President and the Congress: January 1954, pp. 35-36.
7 Work cited in footnote 6, pp. 40-41.
8 President of the United States, Foreign Economic Policy of the United States, message, Mar. 30, 1954, House Document 360, 83d Cong., 2d sess., pp. 6, 7.

to tariff policy. It did recommend that, when domestic production of a mineral is insufficient to serve mobilization needs, a "comprehensive program involving the best use of all the various existing authorities of the Government should be developed" to achieve the needed level of domestic production.[9]

The United States Tariff Commission completed its concurrent investigations of the lead and zinc industries under section 332 of the Tariff Act of 1930 and section 7 (escape-clause) of the Trade Agreements Extension Act of 1951 in April and May, respectively. The report of the investigation under section 332 (United States Tariff Commission, Lead and Zinc Industries, Report 192, second series) contains no specific recommendations, as its purpose was purely fact-finding. The Report to the President on May 21, 1954 (United States Tariff Commission, Lead and Zinc, Report to the President on Escape-Clause Investigation 27, May 1954) on the escape-clause investigation, was unanimous in finding serious injury to the unmanufactured lead and the zinc industry as a result in part of customs treatment reflecting tariff concessions under The General Agreement on Tariffs and Trade (GATT). Five of the six commissioners recommended that the tariff be raised to 50 percent above the rates existing on January 1, 1945 (an increase of 140 percent on unmanufactured lead and 200 percent on zinc), while one of the commissioners recommended a return to the statutory rates (an increase of 100 percent and 150 percent, respectively). On July 19, 1954, the President announced that he was deferring action on the Commission's recommendations, and on August 20, 1954, he rejected the recommendations, with the statement that a stockpiling program would give immediate assistance to the industry.[10]

At the Ninth Session of the Contracting Parties in Geneva, GATT was reaffirmed, and the assured life of the tariff concessions granted under the Agreement was extended to December 31, 1957.[11]

The year saw increasing liberalization of trade controls by the European Iron and Steel Community, the most significant for the minerals industries being the dropping of exchange restrictions on the importation of United States coal to West Germany.[12]

CONSUMPTION AND STOCKS

Reported Consumption.—Reported consumption of all but four major metals and minerals for which such data are collected fell rather sharply from 1953. As indicated in table 7, except for tin, which declined 3 percent, the decreases ranged from 9 percent for lead to 48 percent for tungsten concentrate. Consumption of chromite, cobalt, and mica declined over 30 percent; manganese ore, molybdenum, refined copper, antimony, mercury, and fluorspar declined between 15 and 22 percent. Only bauxite, the platinum-group metals, titanium concentrate, and crude barite showed consumption increases over 1953.

[9] Report of the President's Cabinet Committee on Minerals Policy, Nov. 30, 1954, p. 11.
[10] U. S. Tariff Commission, Operation of the Trade Agreements Program: 8th Rep., July 1954–June 1955, p. 197.
[11] Work cited in footnote 10, pp. 16–17.
[12] International Monetary Fund, Sixth Annual Report on Exchange Restrictions: 1955, pp. 157, 163.

Apparent Consumption.—For mineral commodities on which consumption data are not collected, apparent consumption is presented in table 8. Except for cadmium, which declined 22 percent, all other commodities shown are nonmetallics. Bromine and its compounds, and potash showed increases of 14 and 9 percent, respectively; other increases were under 5 percent. Asbestos, the boron minerals and compounds, salt, and sulfur showed small decreases.

TABLE 7.—Reported consumption of principal metals and minerals in the United States, 1953–54

(Thousand short tons, unless otherwise stated)

Commodity	1953	1954	Change from 1953 (percent)
Iron ore ---- thousand long tons, gross weight	122,125	94,229	−23
Manganese ore ---- gross weight	2,196	1,713	−22
Chromite ---- do	1,336	914	−32
Cobalt ---- thousand pounds	10,748	7,350	−32
Molybdenum, primary products (shipments to domestic destinations) thousand pounds, Mo content	29,595	23,717	−20
Nickel, exclusive of scrap ---- short tons	105,681	94,222	−11
Tungsten concentrate ---- thousand pounds, W content	7,734	4,037	−48
Copper, refined	1,494	1,255	−16
Lead	1,202	1,095	−9
Zinc, slab	986	884	−10
Bauxite ---- thousand long tons, dried equivalent	5,628	6,428	+14
Tin ---- long tons	85,640	82,891	−3
Magnesium, primary ---- short tons	[1] 46,843	39,218	−16
Antimony, primary ---- do	14,300	12,180	−15
Mercury ---- 76-pound flasks	52,259	42,796	−18
Platinum-group metals (sales to consumers) ---- thousand troy ounces	533	582	+9
Titanium concentrates (ilmenite and slag) short tons, estimated TiO_2 content	[1] 407,072	424,248	+4
Barite, crude	1,149	1,216	+6
Fluorspar, finished	587	480	−18
Mica, splittings ---- thousand pounds	10,346	6,733	−35

[1] Revised figure.

TABLE 8.—Apparent consumption of metals and minerals in the United States, 1953–54

(Thousand short tons, unless otherwise stated)

Commodity	1953	1954	Change from 1953 (percent)
Cadmium,[1] primary ---- thousand pounds, Cd content	[2] 9,570	7,499	−22
Asbestos, all grades [1]	[2] 744	724	−3
Boron minerals and compounds ---- gross weight	576	573	−1
Bromine and bromine in compounds ---- thousand pounds	160,700	182,400	+14
Clays	42,280	42,890	+1
Gypsum, crude	11,640	12,180	+5
Phosphate rock ---- thousand long tons, P_2O_5 content	3,319	[3] 3,375	+2
Potash ---- K_2O equivalent	[2] 1,816	1,971	+9
Salt	20,680	20,160	−3
Sulfur ---- thousand long tons, S content	5,049	4,910	−3
Talc and allied minerals [1]	[2] 563	571	+1

[1] Adjustments, if any, are not made for National Strategic Stockpile acquisitions.
[2] Revised figure.
[3] P_2O_5 content estimated at 31 percent.

Sales and Orders.[13]—Seasonally adjusted sales of primary metal manufacturing were quite stable during 1954, moving gradually upward. This was in contrast to adjusted sales for all manufacturing,

[13] Survey of Current Business, vol. 35, various issues.

which declined rather consistently the first 10 months before turning upward in the last 2 months. Sales in primary metal-manufacturing ended the year 5 percent higher than in December 1953, those in stone, clay, and glass products rose gradually to 10 percent above December 1953, while sales in all manufacturing, though falling the first 10 months, ended the year at about the December 1953 level.

New orders (adjusted) in primary metal-manufacturing started the year at a fairly low level, remained low for the first 5 months, and then began a rise which carried by December to 34 percent above December 1953. As in the case of sales, new orders in primary metal-manufacturing rose much higher than new orders in all manufacturing, which closed the year 12 percent above December 1953. Unfilled orders (unadjusted) fell throughout the year for all manufacturing; in primary metal manufacturing the decline was halted in September and rose markedly in the last 3 months, although closing the year 26 percent lower than in December 1953 compared with 20 percent lower for all manufacturing.

Physical Stocks of Mineral Manufacturers, Consumers, and Dealers.—Movements in physical stocks of minerals and metals were mixed during 1954. Thus, for minerals as a whole, the higher level reached in 1953 was not noticeably reduced in 1954, as increases and decreases in items shown in table 9 were divided about evenly. Stocks of several major metals were reduced, however: aluminum stocks at producers and consumers were down 46 percent and 32 percent,

TABLE 9.—Selected physical stocks of mineral commodities of mineral manufacturers, consumers, and dealers in the United States, at end of year, 1951–54[1]

Commodity and type of stock	1951	1952	1953	1954 Quantity	1954 Change from 1953 (percent)
Aluminum (short tons):					
Primary, at reduction plants	8,130	7,270	[2] 39,300	21,100	−46
Purchased aluminum scrap, consumers (gross weight)	12,600	20,300	27,000	18,462	−32
Arsenic, producers' stocks ... thousand short tons	4.8	11.3	10.8	12.5	+16
Bauxite, at consumers (thousand long tons) dried equivalent[3]	1,046	1,921	[2] 2,103	2,401	+14
Bismuth, consumers' and dealers' stocks ... thousand pounds	195.4	211.5	166.7	252.8	+52
Cadmium, metal and compounds, producers and distributors (Cd content) ... thousand pounds	1,448	2,186	3,815	5,329	+40
Cement, at mills ... million barrels	18.2	16.0	19.4	16.7	−14
Chromite, at consumers' plants (thousand short tons):					
Metallurgical	305	364	608	804	+32
Refractory	247	270	260	257	−1
Chemical	85	120	148	206	+39
Total	637	754	1,016	1,267	+25
Copper (thousand short tons):					
At primary smelting and refining plants (Cu content):					
Refined	35	26	49	25	−49
Blister and material in process	182	185	223	189	−15
In fabricators' hands, refined, including in process and primary fabricated shapes (Cu content)	280	331	381	361	−5
Purchased copper scrap, consumers (gross weight)	66	107	130	108	−17
Ferrous scrap and pig iron, at consumers' plants (thousand short tons):					
Total scrap	4,370	6,900	7,150	7,349	+3
Pig iron	1,750	1,970	2,800	2,536	−9
Total	6,120	8,870	9,950	9,885	−1

See footnotes at end of table.

TABLE 9.—Selected physical stocks of minerals commodities of mineral manufacturers, consumers, and dealers in the United States, at end of year, 1951–54 [1]—Con.

Commodity and type of stock	1951	1952	1953	1954 Quantity	1954 Change from 1953 (percent)
Fluorspar (thousand short tons):					
At consumers' plants	169.1	252.2	227.5	143.8	−37
Importers	2.8	31.4	15.5	26.1	+68
Iron ore (thousand long tons):					
At consumers' plants	40,950	43,130	45,270	42,190	−7
On Lake Erie docks	6,400	6,120	7,670	6,590	−14
Total	47,350	49,250	52,940	48,780	−8
Lead (thousand short tons, Pb content):					
At smelters and refineries:					
Refined pig lead	18.5	31.4	65.0	77.9	+20
Antimonial lead	6.8	12.2	[2] 14.4	13.3	−8
In base bullion, including in process at and in transit to refineries	31.0	40.4	47.5	47.1	−1
In ore, matte, and in process at smelters	67.8	65.8	67.7	62.1	−8
Total	124.1	149.8	[2] 194.6	200.4	+3
Consumers' stocks:					
Refined	56.7	80.9	[2] 74.8	80.7	+8
Antimonial	28.2	20.3	[2] 14.6	17.1	+17
In unmelted white metal scrap, percentage metals, copper-base scrap, and drosses, residues, etc	17.9	21.3	[3] 22.8	24.4	+7
Total	102.8	122.5	[2] 112.2	122.2	+9
Manganese ore and ferromanganese, at plants including bonded warehouses (thousand short tons, gross weight):					
Ore	546	1,249	[4] 1,692	[4] 1,579	−7
Ferromanganese (excludes producers' stocks)	149	143	137	175	+28
Mercury, in hands of consumers and dealers thousand 76-pound flasks	29.1	33.7	25.9	22.1	−15
Molybdenum primary products, producers' stocks (thousand pounds, Mo content)	3,040	3,370	3,890	3,430	−12
Nickel, consumers' plants:					
Metal [5] thousand pounds, Ni content	8,570	10,460	13,210	14,655	+11
In other forms, exclusive of scrap [5] do	3,260	6,000	7,500	3,626	−52
Total [5] do	11,830	16,460	20,710	18,281	−12
Purchased nickel scrap short tons, gross weight	1,150	1,360	1,190	1,627	+37
Platinum-group metals, all forms, held by refiners, importers and dealers (thousand troy ounces):					
Platinum	139.0	130.1	138.8	135.6	−2
Palladium	138.1	116.8	110.2	86.8	−21
Iridium, osmium, rhodium, and ruthenium	36.8	35.5	32.0	34.2	+7
Total	313.9	282.4	281.0	256.6	−9
Tin, consumers' plants (long tons):					
Pig tin, virgin, (includes in transit in United States, at other warehouses and held by jobbers)	11,100	12,900	[2] 13,680	12,162	−11
In process (tin content)	10,700	11,300	[2] 10,845	11,164	+3
Purchased tin scrap (gross weight)	1,340	1,150	960	560	−42
Titanium concentrate, consumers and distributors thousand short tons, estimated TiO_2 content	316	334	355	370	+4
Tungsten concentrate, consumers and dealers thousand pounds, W content	4,040	2,820	4,340	3,913	−10
Zinc (thousand short tons):					
Slab:					
At primary smelters and secondary distilling plants	22.0	85.0	179.9	124.0	−31
At consumers' plants	50.6	92.3	86.0	95.8	+11
Purchased zinc scrap, at consumers plants gross weight	17.2	22.8	25.2	34.6	+37

[1] Stocks in the National Strategic Stockpile, Reconstruction Finance Corporation stocks of tin, and Government-held nonstrategic stockpiles of bauxite are not included.
[2] Revised figure.
[3] Estimated, using conversion factor of 0.85 for crude and 1.00 for processed.
[4] Excludes small tonnages of dealers' stocks.
[5] Includes amounts in transit to consumers' plants.

respectively; both copper stocks in their various forms and iron ore were down significantly from 1953, and much of the zinc stocks accumulated in 1953 at primary smelters and secondary distilling plants was liquidated in 1954.

Value of Inventories of Primary Metal Manufacturing.[14]—Seasonally adjusted inventories for all primary metal manufacturing (including several industries not ordinarily considered part of mineral manufacturing) were about 6 percent lower in December 1954 than in December 1953, with an upturn in the last quarter partly offsetting the downward trend of the first 9 months. A similar upturn took place in stone, clay, and glass products and in all manufacturing inventories, but was much less pronounced.

Mine Stocks.—Stocks at mines or in the hands of primary producers reacted somewhat differently from those in the hands of manufacturers, dealers, and consumers; increased business activity in the last half of the year aided in reducing the latter in the case of many metals and minerals. The increased business activity did not come soon enough, however, to aid in the reduction of mine stocks. Two minerals—mercury and molybdenum—ended the year with lower mine stocks, but all others increased over year end 1953 levels. This is particularly significant in view of the fact that all minerals shown in table 10, except gypsum and sulfur, had substantially heavier mine stocks in 1953 than in 1952.

TABLE 10.—Stocks of minerals at mines or in hands of primary producers 1953–54

Commodity and unit	1953	1954	Change from 1953 (percent)
Antimony ore and concentrate......short tons, content..	200	200	0
Bauxite (thousand long tons):			
Crude..........	759	964	+27
Processed (dried, calcined, and activated)..........	44	6	−86
Iron ore..........thousand long tons..	5,706	7,079	+24
Mercury..........flasks..	1,121	186	−83
Molybdenum concentrate..........thousand pounds Mo..	10,294	4,942	−52
Titanium concentrates (short tons, TiO_2 content):			
Ilmenite..........	24,010	30,677	+28
Rutile..........	611	709	+16
Tungsten concentrate..........thousand pounds W content..	363	458	+26
Fluorspar, finished..........short tons..	31,896	33,513	+5
Gypsum, crude..........thousand short tons..	1,529	1,664	+9
Phosphate rock..........thousand long tons, P_2O_5 content..	806	1,043	+29
Potassium salts..........thousand short tons, gross weight..	471	524	+11
Sulfur (thousand long tons):			
Frasch..........	3,022	3,228	+7
Recovered..........	107	109	+2

Stocks in Bonded Warehouses.—Stocks of metals and minerals in bonded warehouses, as estimated from general imports and imports for consumption data, showed the same general mixed reaction as did physical stocks in the hands of manufacturers, dealers, and consumers. Eight of the minerals shown in table 11 decreased, seven increased. Changes in manganese, tungsten, lead, zinc, mercury, and fluorspar amounted to 2 to 4 percent of their net new supply; the most

[14] Survey of Current Business, vol. 35, various issues.

significant change was in mica, which amounted to 14 percent of net new supply for 1954. All other changes were relatively small, representing less than 0.5 percent of net new supply.

TABLE 11.—Estimated changes in stocks of selected minerals in custom bonded warehouses, Jan. 1, 1954–Dec. 31, 1954 [1]

(Short tons, unless otherwise stated)

	Estimated stock change	
	Component	Class
Manganese (content)		−32,540
Manganese ore, Battery grade	−756	
Manganese ore, Metallugrical grade	−32,768	
Ferromanganese and manganese-silicon	+984	
Nickel (content)		+9
Nickel alloy and metal, including scrap	+9	
Tungsten ore and concentrate (W content)		−619
Copper (content)		−4,681
Copper ore and concentrate	−8,640	
Regulus, black, coarse	+377	
Unrefined	+3,657	
Refined, ingots, plates, bars	−75	
Lead (content)		−33,907
Ores, flue dust, mattes	−35,906	
Pigs and bars	+1,999	
Zinc (content)		−46,213
Zinc bearing ores	−42,064	
Blocks, pigs, or slabs	−4,149	
Aluminum (equivalent) [2]		−7,469
Bauxite, crude ... long tons	−33,322	
Metal and alloys in crude form	+125	
Cadmium (content) ... pounds		+6,460
Cadmium flue dust ... do	+6,460	
Magnesium, including scrap		+33
Antimony		+7
Regulus, needle or liquated	+7	
Mercury ... 76-pound flasks		+1,797
Barite, crude		+155
Bromine and bromine in compounds ... pounds		−378
Potassium bromide ... do	−378	
Fluorspar, finished		+23,566
Acid grade	−32,566	
Metallurgical grade	+56,185	
Reexport of foreign merchandise, both grades	−53	
Mica, except scrap ... pounds		−1,194,599
Unmanufactured ... do	−582,081	
Manufactured ... do	−612,518	

[1] Estimated by the subtraction of "imports for consumption" and "reexports of foreign merchandise" from "general imports." All data from U. S. Department of Commerce.
[2] See footnotes 11 and 13, table 4.

TRANSPORTATION

Rail and Water.—Further reflecting the generally lower level of activity in the basic minerals industry in 1954, rail transport and water transport of mineral products (including fuels) were down 13 and 9 percent, respectively, over 1953, as indicated in table 12. For metals and minerals except fuels, the declines were even greater—15 percent for rail and 18 percent for water. Largest declines were in iron ore and scrap, metals and alloys, other ores and concentrates, and crushed limestone. The decrease in shipments of metals and minerals (except fuels) was greater, in both rail and water transport, than for all products, resulting in a decline between 1953 and 1954 in metals and minerals (except fuels) as a percentage of all products.

TABLE 12.—Rail and water transportation of mineral products in the United States, 1953–54, by product

(Thousand short tons)

Product	Rail [1]			Water [2]		
	1953	1954	Change from 1953 (percent)	1953	1954	Change from 1953 (percent)
Metals and minerals, except fuels:						
Iron ore	130,148	88,272	−32	100,203	62,665	−37
Iron and steel scrap	24,417	17,722	−27	1,728	1,364	−21
Metals and alloys	13,782	10,827	−21	} 3,033	2,455	−19
Other ores and concentrates	14,550	13,233	−9			
Other scrap	2,119	2,142	+1			
Slag	7,958	6,587	−17	(3)	(3)	(3)
Sand and gravel	70,512	68,525	−3	} 53,224	56,735	+7
Stone, crushed, except limestone	54,704	52,107	−5			
Limestone, crushed	21,514	15,174	−29	28,468	25,983	−9
Cement	29,943	31,603	+5	3,803	3,817	(4)
Phosphate rock	22,092	23,674	+7	2,328	2,465	+6
Clays	10,069	9,339	−7	1,286	1,511	+17
Sulfur	4,558	4,440	−3	3,787	4,121	+9
Other	26,092	25,323	−3	3,913	4,067	+4
Total	432,458	368,968	−15	201,773	165,183	−18
Mineral fuels and related products:						
Coal:						
Anthracite [5]	38,663	34,220	−11	2,448	1,606	−34
Bituminous [5]	335,168	297,723	−11	122,458	113,782	−7
Coke [5]	21,870	14,266	−35	777	503	−35
Petroleum, crude	3,883	3,606	−7	70,586	64,572	−9
Gasoline	11,502	11,189	−3	79,865	80,962	+1
Distillate fuel oil	} 12,169	10,810	−11	60,656	62,515	+3
Residual fuel oil				38,568	40,100	+4
Kerosine	} 20,294	19,439	−4	10,063	10,044	(4)
Other				13,766	10,319	−25
Total	443,549	391,253	−12	399,187	384,403	−4
Total mineral products	876,007	760,221	−13	600,960	549,586	−9
Grand total all products	1,370,937	1,212,301	−12	706,151	653,796	−7
Mineral products as percent of grand total:						
Metals and minerals, except fuels	32	30		29	25	
Mineral fuels and related products	32	32		56	59	
Total mineral products	64	62		85	84	

[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, 1953 and 1954: Statements 54100 and 55100.

[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 1953 and Calendar Year 1954, part 5, National Summaries.

[3] Not separately classified.

[4] Less than 0.5 percent.

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

Rail Rates.—For the first time since these data have been collected, the index of average freight rates for products of mines (including mineral fuels) turned downward, from 109 in 1953 to 108 in 1954, a slightly smaller decrease than that for all commodities, as shown in table 13. Rates in the official and southern territories fell about 2 percent; those in the southwestern and mountain-Pacific territories rose about 2 percent, and there was no change in the index for the western trunkline territory. Both interstate and intrastate rates were lower in 1954 for products of mines.

TABLE 13.—Indexes of average freight rates on railroad carload traffic in the United States, 1951–54 [1]

(1950=100)

Item	1951	1952	1953	1954
ALL CARLOAD TRAFFIC				
Products of mines [2]	102	108	109	108
Iron ore	103	110	110	111
Clay and bentonite	103	112	115	114
Sand, industrial	105	114	113	109
Gravel and sand, n. o. s	103	108	110	108
Stone and rock, broken, ground, and crushed	103	108	110	110
Fluxing stone and raw dolomite	104	110	111	112
Salt	102	108	109	107
Phosphate rock	102	109	112	113
Manufactures and miscellaneous	102	110	112	110
Fertilizers, n. o. s	102	110	114	113
Iron, pig	104	113	114	113
Cement: Natural and portland	103	110	112	110
Lime, n. o. s	102	110	113	113
Scrap iron and scrap steel	105	112	115	111
Furnace slag	102	107	107	107
Products of agriculture	102	108	110	110
Animals and products	102	110	113	112
Products of forests	102	110	113	113
Forwarder traffic	103	113	114	112
All commodities	102	109	111	109
PRODUCTS OF MINES ONLY [2]				
Intraterritorial movements:				
Official	102	108	109	107
Southern	101	107	109	107
Western trunkline	102	109	109	109
Southwestern	102	107	110	112
Mountain Pacific	101	106	106	108
All movements, by type of rate:				
Interstate rates	102	108	109	108
Intrastate rates	102	107	108	107

[1] U. S. Interstate Commerce Commission, Bureau of Transport Economics and Statistics, Indexes of Average Freight Rates on Railroad Carload Traffic 1947–54: Statement RI-I, 1947–54, Washington, January 1956, 14 pp. 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.[15]—Employment in the mining of metals and minerals except fuels declined 4 percent in 1954 from 1953 levels. As might be expected from the relatively better year experienced by the nonmetallics, employment in that group declined only 1 percent compared with 7 percent for metal mining. Employment in fuels declined 12 percent. Employment in all industries was 3 percent lower in 1954 than in 1953.

	Change in employment 1954 over 1953 (percent)
All industries	−3
Mining	−10
Metals and minerals (except fuels)	−4
Metal mining	−7
Nonmetallic mining and quarrying	−1
Fuels	−12
Mineral manufacturing [1]	−10
Manufacturing	−7
Construction	−4

[1] Based on categories listed under "Mineral manufacturing" in table 14.

[15] Based on U. S. Department of Labor, Bureau of Labor Statistics, national averages of all employees in nonagricultural establishments. Data are published currently in Monthly Labor Review and accumulated in mimeographed releases.

Employment in the mineral industries (nonfuel) can be seen in greater detail in table 14. Within the year nonmetallic mining and quarrying and metal mining behaved quite differently. The former started the year at a low level, rose rapidly through August, and drifted downward the last 4 months. Metal mining started the year at a high level and moved downward most of the year, with a modest upturn the last 2 months. In the mineral-manufacturing categories,

TABLE 14.—Employment in the mineral industries (nonfuel) in the continental United States, 1951–54 by industry [1]

(In thousands)

Year and month	Mining (nonfuel)					
	Total	Nonmetallic mining and quarrying	Metal			
			Total [2]	Iron	Copper	Lead and zinc
1951	203.4	102.4	101.0	37.7	25.9	20.5
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:						
January	205.8	100.8	105.0	39.1	29.3	17.0
February	204.2	100.3	103.9	38.2	29.1	17.2
March	203.9	101.5	102.4	37.3	29.0	16.7
April	202.7	103.5	99.2	36.0	27.4	16.5
May	205.3	105.7	99.6	36.4	27.5	16.4
June	207.0	106.6	100.4	35.8	28.4	16.5
July	208.4	107.6	100.8	36.0	28.3	16.6
August	206.7	107.6	99.1	35.1	28.3	16.3
September	197.2	107.2	90.0	34.4	22.6	14.8
October	196.7	106.2	90.5	32.9	24.8	14.6
November	199.3	105.6	93.7	31.4	26.9	16.0
December	196.5	104.0	92.5	29.8	27.6	15.9
Year (average)	202.8	104.7	98.1	35.2	27.4	16.2

Year and month	Mineral manufacturing				
	Fertilizers	Cement, hydraulic	Blast furnaces, steel works, and rolling mills	Smelting and refining of nonferrous metals	
				Primary	Secondary
1951	36.0	40.6	643.5	51.6	13.2
1952	36.9	40.0	570.7	55.7	12.7
1953	37.2	41.8	653.3	[3] 61.0	13.5
1954:					
January	34.9	41.2	614.2	62.3	12.8
February	40.0	40.8	601.4	62.9	12.4
March	46.5	41.1	593.3	62.5	12.4
April	46.9	40.9	580.1	62.3	12.7
May	40.4	40.5	573.9	62.5	12.6
June	33.1	39.4	579.0	63.3	12.4
July	30.5	42.7	573.2	63.8	12.3
August	31.7	42.8	570.9	63.7	12.3
September	33.9	42.9	570.0	61.3	12.0
October	35.1	42.9	567.4	61.5	12.2
November	34.0	42.5	571.3	64.4	12.4
December	34.8	42.5	577.2	64.6	12.3
Year (average)	36.8	41.7	581.0	62.9	12.4

[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.

the decline in employment was lower than in mining. Employment in both cement and in primary metal smelting and refining rose gradually during the year. Employment in the latter was 3 percent higher for the year than in 1953.

Total Labor Payments.[16]—The decline in business activity in nonfuel mining in 1954 was also reflected in total payments for wages, salaries, and supplements, which fell 8 percent below the 1953 total. Total payments in metal mining fell 10 percent; the relatively better year for the nonmetallics resulted in a 2-percent gain in total payments in that category. Payments in fuel mining were down 9 percent. The decline in primary metal industries was 12 percent; comparable decreases for all manufacturing and all industries were 5 and 1 percent, respectively.

	Wages and salaries	Supplements	Total compensation
All industries	−1	8	−1
Mining	−9	−2	−8
Nonfuel mining	−5	+13	−5
Metal mining	−11	+6	−10
Nonmetallic mining and quarrying	+1	+27	+2
Fuels mining	−10	−4	−9
Manufacturing	−5	+7	−5
Primary metal industries	−13	−1	−12

Hours and Earnings.[17]—The average number of hours worked in 1954 by production and related workers in the nonfuel mining was lower than in 1953 by 1.6 hours. This was 2.1 hours lower than the average for 1952. As a result, although hourly earnings went up from $1.87 to $1.91, average weekly earnings fell from $82.27 to $80.84. In metal mining, average weekly hours worked dropped 2.6 hours from the 1953 average. With only a 3-cent increase in hourly earnings, weekly earnings in nonfuel mining dropped $4.08 to $84.46. The largest decrease in weekly earnings was in iron-ore mining, which was $8.71 lower than in 1953. In the mining group, only nonmetallic mining and quarrying showed an increase in weekly earnings. In the mineral-manufacturing group, weekly earnings increased in 4 categories and decreased in 5 categories. Average weeklv hours fell slightly for the total group, though much less than in the mining group.

Average Annual Earnings.[18]—Average annual wages and salaries for full-time equivalent employees in nonfuel mining fell 2 percent in 1954 from 1953, the net effect of a 5-percent decrease in metal mining and a 2-percent increase in nonmetallic mining and quarrying. The decrease in primary metal-manufacturing industries was also 2 percent. By comparison, average annual earnings increased 1 percent in fuel mining, 2 percent in all manufacturing, and 2 percent in

[16] Survey of Current Business, vol. 35, No. 7, July 1955, pp. 14–15.
[17] U. S. Department of Labor, Bureau of Labor Statistics, mimeographed releases on Employment, Hours, and Earnings.
[18] U. S. Department of Commerce, Office of Business Economics, National Income Number: Vol. 35, July 1955.

TABLE 15.—Average hours and gross earnings of production and related workers in the mineral industries (nonfuel) in continental United States, 1951–54, by industry [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	
1951	$70.79	44.3	$1.60	$74.56	43.6	$1.71	$72.68	42.5	$1.71
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
	Metal (continued)						Nonmetallic mining and quarrying		
	Copper			Lead and zinc					
1951	$78.37	46.1	$1.70	$76.11	43.0	$1.77	$67.05	45.0	$1.49
1951	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
	Mineral manufacturing								
	Fertilizers			Cement hydraulic			Blast furnaces, steelworks, and rolling mills [4]		
1951	$52.33	42.2	$1.24	$65.21	41.8	$1.56	$77.30	40.9	$1.89
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	37.7	2.20
	Electrometallurgical products			*Other*			Primary smelting and refining of nonferrous metals [4]		
1951	$74.46	41.6	$1.79	$77.30	40.9	$1.89	$69.97	41.4	$1.69
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
	Primary smelting and refining of copper, lead, and zinc			*Primary refining of aluminum*			Secondary smelting and refining of nonferrous metals		
1951	$69.38	41.3	$1.68	$70.97	41.5	$1.71	$64.94	41.1	$1.58
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

[1] See footnote 17, and footnote 1, table 14, regarding basis of data.
[2] Weighted average of data for metal mining and nonmetallic mining and quarrying, computed by author of chapter.
[3] Includes other metal mining, not shown separately.
[4] Italicized titles which follow are components of this industry.

all industries. Whereas in 1953 only 8 of the 70-odd individual industries shown exceeded the average for metal mining, in 1954 it was exceeded by 12 industry averages.

	1953[1] (average)	1954 (average)	Change from 1953 (percent)
All industries	$3,604	$3,681	+2
Mining	4,373	4,385	0
Nonfuel mining	4,452	4,356	−2
Metal mining	4,879	4,614	−5
Nonmetallic mining and quarrying	4,028	4,112	+2
Fuels mining	4,347	4,396	+1
Manufacturing	4,055	4,123	+2
Primary metal industries	4,712	4,626	−2

[1] Revised figures.

PRICES, COSTS, AND PRODUCTIVITY

Prices.—Except for iron and steel scrap whose price relative fell 23 percent, and nonferrous metals, with a 1-percent decline, metal and mineral prices, as measured by the Bureau of Labor Statistics, rose slightly over 1953 (table 16). The largest increase was 4 percent in clay products. Seven of the 10 metals in the primary metal class were higher in 1954 than in 1953, the exceptions being tin, zinc, and antimony.

Costs.—A list of input items whose costs are of major importance to the mining and metal-producing industry are presented in table 17. Price relatives for coal, petroleum products, and lumber were lower in 1954 than in 1953, but there were increases in coke, gas, explosives, and construction machinery and equipment. The decrease in coal brought it to below its 1952 price relative, and the lumber price relative fell for the second consecutive year. Coke, gas, explosives, and construction machinery, on the other hand, rose for the second consecutive year.

TABLE 16.—Price relatives for selected metals and mineral commodities, January and December 1954, and annual averages, 1953 and 1954 [1]

(1947–49=100)

Commodity	1954		Change from January (percent)	Annual average		Change from 1953 (percent)
	January	December		1953	1954	
Iron ore	157.7	157.7	0	153.8	157.7	+3
Iron and steel scrap	78.7	86.9	+10	103.1	79.8	−23
Iron and steel products	132.0	135.0	+2	131.3	132.9	+1
Nonferrous metals	121.5	127.6	+5	125.1	124.2	−1
Clay products	131.9	135.4	+3	128.1	133.1	+4
Gypsum products	122.1	122.1	0	121.0	122.1	+1
Concrete ingredients	119.9	122.3	+2	117.4	121.0	+3
Building lime, insulation materials, and asbestos-cement shingles	119.8	119.5	−(2)	116.8	120.1	+3
Fertilizer materials	114.0	113.3	−1	112.9	113.0	+(2)
All commodities (mineral and all other)	110.9	109.5	−1	110.1	110.3	+(2)

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

TABLE 17.—Price relatives for selected cost items in nonfuel mineral production, January and December, 1954, and annual averages, 1953 and 1954 [1]

(1947-49=100)

Commodity	1954 January	1954 December	Change from January (percent)	Annual average 1953	Annual average 1954	Change from 1953 (percent)
Coal	111.9	105.2	−6	112.8	106.3	−6
Coke	132.5	132.4	−(2)	132.0	132.5	+(2)
Gas	111.8	110.2	−1	107.8	108.8	+1
Petroleum products	114.2	110.4	−3	112.7	110.8	−2
Industrial chemicals	118.4	117.4	−1	117.6	117.6	0
Lumber	115.9	119.8	+3	119.3	117.3	−2
Explosives	121.8	121.8	0	119.7	121.8	+2
Construction machinery and equipment	131.2	132.6	+1	129.3	131.6	+2

[1] U. S. Department of Labor, Bureau of Labor Statistics; 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. Crude ore mined per man-hour has increased over the period 1935–53 (earlier years are not shown in table 18) for

TABLE 18.—Labor productivity indexes for copper, iron ore, and lead and zinc mining, 1945–49 (average) and 1950–54 [1]

(1947-49=100)

[U. S. Bureau of Labor Statistics]

Year	Copper ore		Iron ore		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
1945–49 (average)	98.2	98.6	100.1	99.8	114.9	112.7
1950	120.6	118.4	109.2	107.9	109.9	109.2
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	(2)	(2)	(2)	(2)	(2)	(2)
	Recoverable metal per—		Recoverable metal [3] per—		Recoverable metal per—	
	Production worker	Man-hour	Production worker	Man-hour	Production worker	Man-hour
1945–49 (average)	98.6	99.0	101.5	101.1	98.1	96.6
1950	118.0	115.8	105.3	104.0	119.2	118.4
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] 106.5	[4] 110.4	[4] 87.1	[4] 93.2	(2)	(2)

[1] U. S. Department of Labor, Bureau of Labor Statistics, Monthly Labor Review, February 1956, vol. 79, No. 2.
[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] Preliminary figure.

both copper ore and iron ore. The average annual increase has been 5.9 percent in copper and 3.3 percent in iron ore. On the other hand, crude ore mined per man-hour for lead and zinc ores rose in the 1935–45 period, fell in the 1945–48 period, and rose again in the 1948–52 period, with an average annual increase of 0.5 percent over the 1935–52 period. In recoverable metal per man-hour, copper and iron ore also increased over the period, but at the lower average annual rates of 3.3 and 1.6 percent, respectively. In lead and zinc, recoverable metal per man-hour declined at an average annual rate of 0.2 percent.

Relative Labor Costs.—By using average hourly earnings and converting productivity into value terms, estimates can be made of relative labor costs per dollar of recoverable metal.

(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	170	130	N. a.	80	113	N. a.

Only in copper mining has the value of recoverable metal risen faster than average hourly earnings; this is attributable to good increases both in physical productivity and in the price of copper over the period. Relative labor costs fell in iron-ore mining in the 1949–51 period but rose to 113 in 1954, largely as a result of the large increases in average hourly earnings. Lead and zinc, with both the poorest physical productivity record and the poorest price record of the three, had reached 133 by 1953, with 1954 data not available.

INCOME

National Income Originated.—National income originated in total mining except fuels (table 19), decreased 3 percent from 1953, with metal mining down 11 percent and nonmetallic mining and quarrying up 8 percent. Income in the primary metal industries decreased 17 percent in 1954 while stone, clay, and glass products decreased 1 percent. Income originated in total mining except fuels remained at 0.47 percent of the total national income in 1954.

Nonemployee Income.[19]—Nonemployee income, comprised largely of business profits before taxes (though it also contains net interest and inventory valuation adjustments), rose 2 percent in 1954 in nonfuel mining as the result of a 15-percent decrease in metal mining and a 20-percent increase in nonmetallic mining and quarrying. Nonemployee income in all mining was down 3 percent over 1953. The net interest cost for all mining declined from $34 million to $32 mil-

[19] Survey of Current Business, National Income Number: July 1955, p. 14. "Nonemployee income" is defined here as national income by industrial origin minus compensation of employees; in years in which a National Income edition is published this category is called "Other."

lion, and the inventory valuation adjustment was $1 million. Nonemployee income in 1953 and 1954 was as follows:

	1953 (million dollars)	1954 (million dollars)	Change from 1953 (percent)
All industries	94,408	91,772	−3
Mining	1,540	1,491	−3
Nonfuel mining	430	436	+2
Metal mining	232	198	−15
Nonmetallic mining and quarrying	198	238	+20
Fuels mining	1,110	1,055	−5
Manufacturing	21,945	18,616	−15
Primary metal industries	2,435	1,642	−23

TABLE 19.—National income originated in the mineral industries in the United States, 1952–54 [1]

(Million dollars)

Industry	1952 [2]	1953 [2]	1954	Change from 1953 (percent)
All industries	289,537	303,648	299,673	−1
Metal mining	721	786	698	−11
Nonmetallic mining and quarrying	604	648	697	+8
Total mining except fuels	1,325	1,434	1,395	−3
Total mining including fuels	5,420	5,616	5,234	−7
Primary metal industries	7,852	9,360	7,741	−17
Stone, clay and glass products	2,816	3,033	3,009	−1
(Percent)				
All industries	100.00	100.00	100.00	
Metal mining	.25	.26	.23	
Nonmetallic mining and quarrying	.21	.21	.23	
Total mining except fuels	.46	.47	.47	
Total mining including fuels	1.87	1.85	1.75	
Primary metal industries	2.71	3.08	2.58	
Stone, clay and glass products	.97	1.00	1.00	

[1] U. S. Department of Commerce, Office of Business Economics; Survey of Current Business, National Income Number: July 1955, p. 14. In arriving at national income, depletion charges are not deducted. This affects the data for the mining industries.
[2] Revised figures.

Profits and Dividends.—Profit rates (after corporate income taxes) in the primary nonferrous metal industries in 1954 were 4 percent lower than in 1953. Profit rates in primary iron and steel were down 10 percent from 1953; those in stone, clay, and glass products were down 3 percent. In each of the three categories, however, fourth-quarter profit rates were higher than first-quarter rates. Rates for all manufacturing were 4 percent lower than in 1953, and fourth-quarter rates were somewhat lower than those in the first quarter.[20]

Business Failures.—Dun & Bradstreet data in table 20 showed only a slight increase in the number of failures in mining (including fuels) in 1954 over 1953, but a very large increase in the liabilities involved in failures. Liabilities involved were $8 million in 1954 compared with only $3 million in 1953. The number of failures in manufacturing and in all industries showed greater relative increases than in the liabilities involved in these failures.

[20] Federal Trade Commission and Securities and Exchange Commission, United States Manufacturing Corporations, Quarterly Financial Report, 1st Quarter, 1955, p. 18.

TABLE 20.—Industrial and commercial failures and liabilities, 1952–54 [1]

	1952	1953	1954
Mining: [2]			
Number of failures	42	41	42
Current liabilities (thousand dollars)	3,794	3,034	8,007
Manufacturing:			
Number of failures	1,539	1,816	2,240
Current liabilities (thousand dollars)	101,160	155,820	163,277
All industrial and commercial industries:			
Number of failures	7,611	8,862	11,086
Current liabilities (thousand dollars)	283,314	394,153	462,628

[1] U. S. Department of Commerce, Bureau of the Census, Statistical Abstract of the United States, 1955, Washington, 1955, p. 503, from monthly data published in Dun's Statistical Review, Dun & Bradstreet, Inc., New York, N. Y.
[2] Including fuels.

INVESTMENT

New Plant and Equipment.—Expenditures in 1954 on new plant and equipment by mining concerns (fuel and nonfuel) were estimated at $975 million, $11 million lower than in 1953. Expenditures in primary iron and steel firms were lower than 1953 by $456 million, a 38-percent drop from 1953 and the second consecutive year of large decreases for this category. Expenditures in primary nonferrous metals were also down for the second consecutive year—$166 million (40 percent) lower than in 1953. All manufacturing was 7 percent lower in 1954; all businesses were 5 percent lower.

Quarterly expenditures (adjusted for seasonal variation) by mining firms (fuel and nonfuel) were low in the first quarter, high in the last three quarters. Expenditures in pig iron and steel were low in the third quarter. In the primary nonferrous metals, expenditures were low in the latter half of the year.[21]

Mining-Security Issues.—The mining industry (including fuels) accounted for 5.7 percent of all new corporate securities offered in 1954, compared with 2.6 percent in 1953. Table 21 shows that corporate financing in mining, as in previous years, is more heavily in terms of common stocks than is the case for all corporations or all manufacturing corporations. The percentage in common stocks for mining did fall, however, from 43 percent in 1953 to 33 percent in 1954, and the percentage of financing in bonds rose from 55 to 64 percent. Mining corporations indicated a smaller percentage—about

TABLE 21.—Estimated gross proceeds of new corporate securities offered for cash in the United States in 1954 [1]

Type of security	Total corporate		Manufacturing		Mining [2]	
	Million dollars	Percent	Million dollars	Percent	Million dollars	Percent
Bonds	7,487	79	1,877	83	347	64
Preferred stock	816	8	228	10	14	3
Common stock	1,213	13	163	7	178	33
Total	9,516	100	2,268	100	539	100

[1] U. S. Securities and Exchange Commission, Statistical Bulletin: Vol. 14, No. 10, October 1955, p. 4.
[2] Including fuels.

[21] Survey of Current Business, vol. 35, No. 3, March 1955, p. 8. 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

40 percent—of net proceeds planned for plant and equipment than was indicated by manufacturing corporations or by all corporations.

Prices of Mining Securities.—The index of prices of common stock for mining (including fuels) was 11 percent above 1953, as indicated in table 22. In the same period, however, the composite index rose 19 percent, and similar stocks in manufacturing rose 23 percent.

TABLE 22.—Indexes of common-stock prices, 1951–54 [1]

(1939=100)

Year	Composite [2]	Manufacturing	Mining [3]
1951	184.9	206.8	204.9
1952	195.0	220.2	275.7
1953	193.3	220.1	240.5
1954	229.8	271.3	267.0

[1] Economic Indicators, Prepared for the Joint Committee on the Economic Report by the Council of Economic Advisers: February 1956, 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 Investment.[22]—The book value of direct private investment of the United States in mining and smelting industries in foreign countries by the end of 1954 increased 7 percent above the end of 1953. The addition during the period was $138 million, somewhat less than the $291 million added in 1953. The largest increase in investment was the $106 million added in Canada in 1954.

Earnings on direct investments abroad in mining and smelting rose from $149 million in 1953 to $204 million in 1954, an increase of

TABLE 23.—Direct private investments of the United States in foreign mining and smelting industries, 1954 [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	Net capital movements	Undistributed earnings of subsidiaries	Book value, end of year
Canada	677	85	21	783	5,242	469	215	5,939
Latin American Republics:								
Chile	445	−38	(3)	407	657	−28	4	633
Mexico	144	18	−20	142	514	15	−6	523
Peru	170	(3)	2	172	268	−13	(3)	255
Total [4]	999	18	−15	1,003	6,034	102	121	6,256
Western European countries	30	(3)	5	35	2,369	36	197	2,605
Western European dependencies	136	−5	8	105	603	−6	41	600
Union of South Africa	59	9	1	69	212	−12	16	216
All other countries	32	3	8	76	1,869	172	51	2,132
Total, all areas	1,933	110	28	2,071	16,329	761	641	17,748

[1] Survey of Current Business, International Investments and Earnings: Vol. 35, No. 8, August 1955, pp. 10–20. Figures may not add exactly to totals due to rounding.
[2] Revised figures.
[3] Less than $500,000.
[4] Includes other countries not shown above.

[22] Survey of Current Business, International Investments and Earnings: Vol. 35, No. 8, August 1955. pp. 10–20.

37 percent. Of the $204 million earnings in 1954, $133 million (65 percent) was on investments in Canada and the Latin American Republics.

DEFENSE MOBILIZATION

Defense Production Act.[23]—The various types of Government and related activities aimed at the expansion capacity of metals and minerals by June 30, 1954, had resulted in the completion of programs for nearly half of the materials. Gross expansion transactions certified through June 30, 1954, amounted to $7.6 billion, which are estimated will ultimately cost the Government about $1.11 billion. For materials alone—largely metals and minerals—the gross transactions totaled $6.1 billion and probable ultimate net cost (estimated nonrecoverable cost to the Government of all transactions under a certified program) $1.03 billion as of June 30, 1954.

Gains in production of many of the strategic materials coupled with reductions in requirements resulted in the amelioration of shortages—that is, imbalances between visible supply and stated requirements—in aluminum, beryl, chromite, copper, lead, manganese, molybdenum, platinum, tungsten, zinc, and columbite-tantalite.

By December 31, 1954, gross transactions certified for purchases and other programs under the act had reached $8.2 billion. Probable ultimate net costs were estimated at $1.2 billion. This represented the total gross transactions and probable ultimate net costs incurred under the $2.1 billion borrowing authority, dating back to 1950. It includes the total certified by ODM and DPA for operation by 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 Administration (Interior). As of December 31, 1954, materials-expansion programs accounted for about 82 percent of the gross transactions and about 89 percent of the probable ultimate net cost.

Domestic Purchase Programs and Loans.—GSA continued in 1954 to administer the domestic purchase programs for the commodities shown in table 24. It was a year of heavy purchases; only chrome and mica fell short of doubling the 1953 year-end accumulation. Tungsten and columbium-tantalum doubled, manganese tripled, beryl increased almost fourfold, and asbestos accumulations were nine times those of year end 1953. Of the total gross transactions consummated (contracts or agreements that have required, will require, or may require the disbursement of Government funds), which amounted to $7.71 billion as of December 31, 1954, $7.01 billion or 91 percent was attributed to the above purchase programs. On a probable ultimate net cost basis, $683 million of a total $826 million (83 percent) was attributed to these purchase programs.

By the end of 1954 loans under this borrowing authority carried a gross transaction consummated value of $339 million. The probable ultimate net cost of these loans is carried on the Government books as zero. No new loans for materials expansion projects were made during the fiscal year by the Export-Import Bank or by the Reconstruction Finance Corporation (Treasury); as of the end of 1954 loans approved

[23] Joint Committee on Defense Production Activities, Fourth Annual Report: House Rept. 1, 84th Cong., 1st sess., Jan. 5, 1955; and Executive Office of the President, Office of Defense Mobilization, Report on Borrowing Authority for the quarter ending December 31, 1954.

TABLE 24.—Commodities delivered under United States Government domestic purchase programs, 1953–54 [1]

Commodity	Quantity delivered as of December 31, 1953	Quantity delivered as of December 31, 1954	Authorized total purchases
Tungsten concentrate (thousand short-ton units)	600	1,460	3,000
Manganese ore (thousand long-ton units):			
Butte and Philipsburg depots	429	1,418	6,000
Deming depot	790	2,213	6,000
Wenden depot	2,089	5,821	6,000
Domestic small producers (carload program)	557	2,276	19,000
Chrome ores and concentrates (long tons) [2]	46,640	77,399	200,000
Mica: Block, film, and hand-cobbed (short tons hand-cobbed equivalent)	2,593	4,816	25,000
Beryl (short tons)	145	557	1,500
Asbestos, chrysotile, nonferrous (short tons):			
Crude No. 1 and No. 2	176	717	1,500
Crude No. 3 [3]	150	333	-----------
Columbium-tantalum ores and concentrates (thousand pounds combined contained pentoxides) [4]	3,486	7,354	15,000

[1] GSA, Office of Public Information and Reports, releases of Jan. 27, 1954 (GSA-250), and Feb. 7, 1955 (GSA-316).
[2] Purchased with stockpile funds for the National Strategic Stockpile.
[3] Crude No. 3 accepted on tiein basis with other 2 grades, not figured into the quantity authorized.
[4] Mostly foreign. Figures not available for domestic only.

totaled 44 and 95 million for the two agencies, respectively. During the fiscal year 3 private bank loans, totaling $3.4 million, were guaranteed by GSA. As of July 31, 1954, the total of such loans for mineral expansion projects was $86 million.

Mineral Research and Exploration Under the Defense Production Act.—During 1954 numerous research projects were undertaken by other Government agencies and by private concerns for GSA. The Bureau of Mines undertook an investigation of techniques of extracting selenium from volcanic rock in west central Wyoming and from seleniferous wild plants found in the Western States. The Bureau of Mines also undertook research on the recovery of commercial-grade beryl and spodumene from the lithium mines in North Carolina. The Bureau of Mines also investigated domestic sources of columbium and tantalum and methods of separating and beneficiating the metals. The Geological Survey, under an agreement with GSA, carried out explorations for refractory chrome ore in Cuba. Land owners entered agreements to pay royalties to the Government for any production resulting from this project, but not to exceed the costs of exploration. Geological Survey also began a 5-year program of exploration for domestic deposits of columbium and tantalum. The National Academy of Sciences undertook studies of substitutes for selenium, of processes for beneficiating low-grade domestic manganese, and of new processes for recovery of nickel and cobalt.

Numerous contracts involving research and exploration were placed during the year. The E. S. Nossen Laboratories, Mangaslag, Inc., and Southwest Engineering Co. undertook research on the recovery of manganese. The Nickel Processing Corp. engaged in research activities involving laboratory work and pilot-plant operations at the Nicaro plant in Cuba. National Lead Co. contracted to perform research on commerical utilization of Arkansas deposits of brookite and the problems of separating out columbium, tantalum, titanium, and vanadium.

Accelerated Tax Amortizations.—Changes in the reported status of certificates of necessity covered by progress reports between March 31, 1954, and September 30, 1954, are shown in table 25. The total number of certificates in mineral and related industries increased by a net of only 15 during the period. Certificates of necessity in mineral and related industries continued to represent the same ratios to certificates in all industries at each date: 4 percent of the total number, 14 percent of total estimated cost, and 11 percent of total value in place. Although the percentage in place in mineral and related industries increased from 56 to 63 percent of total estimated cost, it continued to be considerably lower than the percentage in place for all industry which increased from 74 to 80 percent. Percentage in place remained low for iron ore, uranium-vanadium-radium

TABLE 25.—Certificates of necessity covered by progress reports in selected mineral and related industries in the United States as of March 31, 1954 and September 30, 1954 [1]

Industry	March 31, 1954				September 30, 1954			
	Number	Reported total cost (million dollars)	Value reported in place (million dollars)	In place (percent) [2]	Number	Reported total cost (million dollars)	Value reported in place (million dollars)	In place (percent) [2]
Mining, extracting and quarrying:								
Metallic:								
Iron ores	133	1,098	485	44	136	1,203	560	47
Copper ores	12	123	87	71	11	122	106	87
Lead and zinc ores	19	36	27	73	20	36	29	77
Bauxite and other aluminum ores	11	138	56	40	10	122	77	64
Tungsten ores	11	6	6	100	11	6	6	100
Uranium-vanadium-radium ores	9	7	6	82	11	16	8	51
Other metallic ores	12	46	37	80	15	132	42	32
Nonmetallic:								
Limestone	13	28	11	39	13	28	14	49
Barite	5	2	2	100	5	2	2	96
Fluorspar	5	3	3	92	5	3	3	100
Phosphate rock	5	14	6	43	5	14	7	53
Sulfur	8	25	21	82	8	25	21	85
Other chemical and fertilizer mineral mining	11	11	9	79	12	13	8	64
Industrial chemicals:								
Fertilizers	17	85	30	36	18	72	35	48
Explosives	12	3	3	82	13	4	3	83
Stone, clays, and glass products:								
Cement	28	125	97	77	33	131	109	83
Lime	28	18	18	100	28	18	18	100
Mineral wool	15	21	20	95	14	20	20	100
Abrasive products	64	35	31	90	65	34	32	94
Minerals and earths, ground or treated	15	14	8	57	15	14	8	59
Nonclay refractories	35	54	49	92	35	54	50	93
Other nonmetallic mineral products	8	3	3	91	7	3	3	100
Primary metal industries:								
Blast furnaces	106	1,040	459	44	104	914	494	54
Electrometallurgical products	39	238	218	92	40	233	222	95
Primary smelting and refining of:								
Copper	5	81	24	29	7	82	39	48
Lead and zinc	21	27	27	99	21	27	27	100
Aluminum	39	783	537	69	38	622	550	88
Other nonferrous metals	19	58	26	44	20	51	32	63
Secondary smelting and refining of nonferrous metals and alloys	13	4	4	97	13	4	4	98
All industries, total	17,757	29,011	21,500	74	18,545	29,479	23,618	80
Industries listed above, total	718	4,126	2,310	56	733	4,005	2,529	63
Percent of all industries	4	14	11	--------	4	14	11	--------

[1] Office of Defense Mobilization, Report of Progress under Certificates of Necessity, as of September 30, 1954, by Standard Industrial Classification, Unpub. repts.
[2] Percentages based on figures before rounding.

ores, "other metallic ores," phosphate rock, fertilizers, and blast furnaces. Value in place was complete for tungsten ores, fluorspar, lime, mineral wool, and lead and zinc primary smelting and refining. Of the 29 categories listed, 11 were reported to be above 90 percent in place as of September 30.

Defense Minerals Exploration Administration.—Government assistance to encourage exploration for new domestic sources of strategic minerals was continued. Through 1954, 169 certifications of discovery or development had been issued by the agency, 80 of which were issued during 1954. Certifications on projects in 20 States were made on asbestos, beryl, columbium, tantalum, corundum, fluorspar, lead, manganese, mercury, mica, monazite, thorium, tungsten, uranium, and zinc. A total of 217 contract projects were in force December 31, 1954.[24]

National Strategic Stockpile Program.—Reorganization Plan 3, the principal purpose of which was to centralize final responsibility for all phases of the defense-materials program, transferred the management of the National Strategic Stockpile program to the ODM on June 12, 1953. Several significant changes were made in the basic concepts of strategic stockpiling in 1954, the first full year of operation under ODM management. Three levels of stockpile objectives were established: The minimum objective, the long-term objective, and the supplemental stockpile. Under the minimum program an objective for a material is set on the basis of the quantity that must be acquired and stored to provide for the deficit (as estimated) between essential wartime requirements and wartime supplies from domestic and foreign production. Guidance and assumptions are furnished by the National Security Council, and each commodity is subjected to a detailed "balance-sheet" analysis of estimated requirements and supplies. Military requirements are computed by the military agencies, civilian requirements by the civilian agencies, chiefly the United States Departments of Commerce and Agriculture. These estimates consider wartime substitutes, conservation, and technological change in usage.

Supply estimates are adjusted for expected expansion projects, estimated depletion of deposits, and possible losses or interruptions of foreign supply estimated on the basis of strategic discount factors. Basic data used in calculating minimum objectives are compiled by seven interdepartmental commodity committees. After proposed objectives are reviewed by the Interdepartmental Materials Advisory Committee, final objectives are set by the ODM. Minimum objectives are to be completed as quickly as possible, at the lowest possible cost, without interfering with defense production and without creating undue hardship within the civilian economy. At the same time stockpiling is to make maximum contribution to domestic sources of supply commensurate with keeping the United States in a position to turn to foreign sources where complete reliance on domestic supply is not possible.

The second stockpiling level—the long-term objective—emanates from a policy established by President Eisenhower on March 26, 1954, which, in turn, was based on a recommendation of the President's Cabinet Committee on Minerals Policy. Under this philosophy additional security in materials is sought through higher objectives, computed by assuming that during wartime no foreign supplies will be

[24] Defense Minerals Exploration Administration Unpublished repts.

available except from sources of about equal reliability as afforded by sources within the United States. This second stockpiling level is less urgent than the first and can be expected to be met over a longer period of time. Open-market procurement on behalf of the higher objective must be made at prices advantageous to the Government (more so than under the minimum objective) and should assist in helping to maintain some essential component of a commodity's supply preparedness, and preference should be given to newly mined domestic metals and minerals.

A third level of stockpiling, which can contribute to the long-term objective but which can also be in addition to the minimum and long-term programs, was created under Title I of the Agricultural Trade Development and Assistance Act of July 1954. Materials for this supplemental stockpile may be purchased with foreign currencies acquired through the sale of surplus agricultural commodities. The kind and quantities of strategic materials that can be acquired in this manner are to be determined by the ODM.

During 1954 about $800 million worth of strategic materials was added to the strategic stockpile and became material on hand. The total value of the National Stockpile on December 31, 1954, was about $5 billion; in addition, about $2.6 billion was on order or expected to be acquired under Defense Production Act contracts or through the exchange of agricultural commodities. From the standpoint of minimum objectives, 39 commodity objectives were complete, 9 were 75 to 99 percent complete, 10 were 50 to 74 percent complete, and 17 were less than 50 percent complete. Of the $5 billion worth of materials in inventory, about 85 percent is "minimum objective" material, the remainder being in the long-term category. On December 31, 1954, the minimum objective inventory for all 75 materials was about two-thirds of the total minimum objective goal. As of the same date, no strategic material had actually been acquired for the supplemental stockpile.[25]

Atomic Energy Commission.[26]—The Atomic Energy Act of 1954 became law on August 30, representing the first complete revision of the statutory charter of the Commission since the original legislation of 1946. The new act places greater emphasis on research covering peacetime uses of atomic energy to include agricultural, medical, and industrial uses, generation of usable nuclear power, and demonstration of the practical value of using atomic production facilities for industrial and commercial purposes. The new act provides for greater international cooperation; and in signing the act, President Eisenhower called for an international agency to advance peacetime applications. On December 4, 1954, the United Nations General Assembly endorsed a United States proposal to create such an agency.

Production of uranium ores and concentrate in the United States reached new levels in 1954 to form a new and significant segment of nonferrous metal mining, both from the standpoint of value of product and employment. Large increases occurred in the number of producing mines, in the number of long-established mining companies entering the field, and in the number of areas of production. The AEC purchasing program was extended to 1962. South Africa became a

[25] Executive Office of the President, Office of Defense Mobilization, Stockpile Reports to the Congress: January–June 1954, and July–December, 1954.
[26] U. S. Atomic Energy Commission, 17th Semiannual Report: January 1955.

major producing area during 1954, joining Canada, Australia, the Belgian Congo, and the United States as the largest Free World producers.

WORLD REVIEW

World Production.—The progress of world production of minerals and metals was slowed somewhat in 1954, with about 1 in 3 of the principal metals falling below 1953. Minerals with lower production in 1954 included iron ore, bismuth, cadmium, chromite, industrial diamonds, fluorspar, graphite, magnesium, manganese, and tungsten. Increases in world production were registered, on the other hand, by the other two-thirds of the principal minerals. The more important gains were in aluminum and bauxite, columbium-tantalum, nickel, the platinum-group metals, and potash. Copper, lead, and zinc were only slightly above their 1953 levels.[27] The index of world mine production computed by the United Nations, which includes fuels,[28] was 1 percent higher in 1954 than in 1953.

Indexes of production in metal-mining and metal-making industries in European countries, as prepared by the United Nations, are presented in table 26. Progress in these countries was improved over 1953, with all but three of them showing gains over 1953. The largest gains were made in Austria, West Berlin, and Greece. Indexes of production in metal-using industries, also prepared by the United Nations, increased in 1954 (based on three quarters) for most European countries, the largest increases being in West Germany, Greece, and Ireland.[29]

TABLE 26.—Index numbers of production in metal-mining and metal-making industries in selected European countries, 1952–54 [1]

(1950=100)

Country	1952	1953	1954 [2]	Country	1952	1953	1954 [2]
Austria	135	148	173	Italy	142	141	155
Belgium	124	113	121	Netherlands	111	140	152
Luxembourg	130	115	114	Norway	118	127	126
Finland	137	130	145	Spain	122	129	[3] 127
France	122	111	116	Sweden	122	123	119
Germany, West	134	129	144	Turkey [4]	136	167	--------
Berlin, West	192	210	266	United Kingdom	109	106	112
Greece	189	227	269				

[1] United Nations Economic Survey of Europe in 1954, February 1955, p. 200. Indexes cover the production of metalliferous ores, primary metal, rolled products, castings, forgings, and other basic forms of ferrous and nonferrous metals.
[2] Based on three quarters only. Fourth quarter not available.
[3] Based on one quarter only.
[4] The index numbers cover metal mining only and exclude metal making, for which no data are available.

World Prices.—In 1954 there was no change in the index of annual average prices of commodities of mineral origin exchanged in international trade.[30] This index was 1 percent less than 1948 and 11 percent below 1952. The 1954 price experience for mineral-origin commodities compares with a 1-percent decrease for manufacturing raw materials from agriculture, a 2-percent decrease for manufactured goods, and a 1-percent decrease for all commodities in world trade.

[27] See table 10, Statistical Summary of Metals and Nonmetals chapter, of this volume.
[28] Statistical Office of the United Nations, Monthly Bulletin of Statistics: Vol. 10, No. 2, February 1956, p. 6.
[29] See footnote 1, table 26.
[30] Statistical Office of the United Nations, Monthly Bulletin of Statistics: Vol. 10, No. 5, May 1956, p. vii.

Review of Metallurgical Technology

By Oliver C. Ralston[1] and Hillary W. St. Clair[2]

THIS REVIEW of the general trends in metallurgy and mineral technology for 1954 has drawn largely on annual reviews that appeared in the technical press soon after the close of the year. In this sense it is a review of the reviews. This is entirely in keeping with the purpose of this chapter which is to try to distinguish the more significant and permanent trends from the transitory changes in the technology of the mineral industry. The amazing rate of growth of industry and the complexity of the technological developments that affect the mineral industry make the aims of this chapter almost impossible of full attainment.

The rapid advances in science and technology have been accompanied by an incongruous lag in the growth of enrollment in engineering and technical colleges, so the shortage of engineers and scientists is likely to become increasingly acute. This problem so alarmed leaders in industry, education, and government that concerted action was taken to stimulate interest among high-school students to enter the professions of science and engineering.

There is a particular need for arousing more interest in the study of metallurgy, which has been neglected in favor of other fields, such as electronics, nucleonics, aviation, communication, and other areas that have had more spectacular appeal to young men entering college. As metals provide the basic materials for nearly all the technologic advances characteristic of our culture, there is increasing need for scientists and engineers trained in extracting, refining, and utilizing of metals. Young men of high-school age need to become more aware of the advantages offered by training in metallurgy for the men of tomorrow.

MINERAL CONCENTRATION

As the grade of ores being mined steadily decreases, the techniques of ore dressing in physical separation of minerals are being extended more and more. Direct-smelting ores of copper, lead, and zinc have virtually disappeared from the scene; smelters operate almost entirely on concentrates. This trend is being extended to iron ores. Developments in concentration of iron ores probably will continue to dominate ore dressing for the next several years.

The most expensive steps in ore dressing are crushing and grinding. The costs lie largely in electric power and replacement of grinding mediums, and so economies in energy and grinding mediums are peren-

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[1] Chief metallurgist.
[2] Assistant chief metallurgist

nial problems. Studies [3] have indicated that the mechanical efficiencies of mechanical crushing and blasting are about equal. Since electrical energy is cheaper than chemical energy in explosives, economy lies in the direction of using the minimum amount of size reduction by blasting. The world's largest gyratory was installed in the Mesabi range for crushing taconite ores. This crusher, requiring 1,000 horsepower, will have a capacity of 3,500 tons per hour and will take pieces of rock as large as 60 inches in diameter.

The usual crushing practice is to reduce from run-of-mine ore to rod- or ball-mill feed in three stages of crushing. The trend during the year was to eliminate closed-circuit crushing because of the complication it introduces in dust-control systems. A fourth crushing stage was often introduced to avoid recycling from the third stage. The usual feed to the rod mill had a maximum size of ¾ to ⅞ inch.

Studies [4] on the relation of ball diameter to rate of wear showed that at speeds up to 50 percent of the critical speed of rotation ball wear is proportional to the square of the diameter. At higher speeds and with coarser ore and heavier balls, the exponent increases from 2 to the range 2.2 to 2.5.

Measurements of the energy consumed in grinding minerals revived the old controversy as to whether the energy is proportional to new surface created (Rittinger's law) or the average ratio of reduction of volume (Kick's law).[5] Comminution of brittle minerals was shown to be basically similar to metal grinding. Grinding data showed better agreement with Kick's law than Rittinger's law particularly when the particle size range was very wide and the size range extended below 1 micron. The study indicated that plastic deformation may be an important factor in grinding substances ordinarily considered brittle.

Other investigators suggested that crushing and grinding have some features of a chemical reaction because they involve breaking chemical bonds. Renewed study of the basic mechanism of grinding is needed for better understanding of the theory of this important process to give a more adequate basis for correlation of empirical data on crushing and grinding.

A great many shaking screens were used in the taconite concentrators, not only for return of oversize but also for early separation of undersize products to send them immediately to the size-reduction step best suited to that size.

The hydraulic cyclone continued to find new applications as a classifier, particularly in regrind circuits and for classifying reground middlings and concentrates. Consideration was also being given to the use of cyclones in primary grinding circuits. A careful study of size classification made in a 1-inch prototype cyclone by the Bureau of Mines confirmed observations of others that it is much more effective than drag or spiral classifiers for accurate size classification. It is particularly effective in the minus-200-mesh sizes.

Other important advantages are the low cost of installation and small space requirements. They are partly offset by larger power

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[3] Bond, Fred C., Which Is the More Efficient Rock Breaker?: Eng. and Min. Jour., vol. 155, No. 1, January 1954, p. 82.

[4] Hukki, R. T., Correlation Between Principal Parameters Affecting Mechanical Ball Wear: Trans. AIME, vol 199, 1954, pp. 642–644.

[5] Walker, D. R., and Shaw, M. C., A Physical Explanation of the Empirical Laws of Comminution: Trans. AIME, vol. 199, 1954, pp. 313–320.

requirements and more rapid wear. Rubber linings and ceramic shapes were found satisfactory to prevent wear in many applications. Strangely enough, ceramic shapes were preferred to rubber when used on coal.

An innovation worthy of note was the use of a Dorrclone horizontally mounted on the feed opening of the grinding mill at the London mill of Tennessee Copper Co.,[6] to separate an undersize for copper flotation and feed the sands into the ball mill. The circulating load builds up to 87 percent. The advantages of better classification offset the higher cost of operation of the cyclone.

The greatest developments in mineral concentration were taking place in concentration of iron ores. A tremendous building program was in progress in the Lake Superior region to prepare for large-scale utilization of taconites and low-grade iron ores. Although several very large plants were in operation, they served as pilot units to set the pattern for much larger operation. The production of taconite concentrates from the Mesabi range was expected to reach 12 million tons in 1958 and 23 million tons by 1963.

The first iron ores to be concentrated consisted chiefly of magnetite, so magnetic concentration was the principal method employed. In some instances nonmagnetic ores were given a mild reducing roast to produce a reduced hematite with magnetic properties. The first unit of such a plant was put into operation at Negaunee, Mich., by Jones & Laughlin. The reduction roast is done in a fluidized bed. The economy of operation with this extra step had yet to be demonstrated.

Dense-medium separation, using pulverized magnetite or ferrosilicon as the mediums, was also finding application in iron ore concentration. Grinding costs were kept to a minimum by eliminating gangue at as large size as possible. When magnetite is the mineral being separated it serves as its own dense medium.

Cyclones proved useful in applying sink-float techniques to finer sizes. A method[7] was proposed in which two hydraulic cyclones are used in series on a partly ground pulp. The first operates at such a rate that the apex product is made up of coarse dense mineral and dense medium, the coarse mineral being reground. The vortex discharge goes to a second cyclone in a somewhat diluted condition, giving an apex product a dense medium and a vortex product of fine mineral. The coarse gangue mineral may be thickened and returned to the circuit. The process may apply better to dense sulfide ores than magnetite ores.

A magnetic filter was developed in Sweden at the Luossavaara-Kurunavaara. It is similar to a vacuum drum filter, but along the bottom of the inside of the drum are four electromagnets to attract magnetite to the filtering surface leaving nonmagnetic gangue in suspension. It was reported to operate well on thin pulps and to act as a thickener as well as a magnetic separator. It was suggested as means for thickening dense-medium pulps of magnetite or ferrosilicon.

Developments affecting concentration and hydrometallurgy included the new types of flocculating agents consisting of water-soluble high-molecular-weight polymers, such as the products known as Se-

[6] Lewis, F. M., and Johnson, E. C., The Liquid-Solid Cyclone As a Classifier in the Closed-Circuit Grinding of Concentrates: Trans. AIME, vol. 199, 1954, pp. 620–621.

[7] Fern, K. A., and Allen, C. F., Separation of Coarse-Light Minerals in Multi-Separator Stages: U. S. Patent 2,668,667, Feb. 8, 1954.

peran and Aerofoc. Very small amounts of these reagents (hundredths of a pound per ton of solids) speed thickening and filtration and decrease the moisture in the filter cake.

Interest was renewed in the application of the principles of physical and surface chemistry to the flotation process. A study [8] in which an attempt was made to apply thermodynamic reasoning to the adsorption processes occurring at the respective solid-liquid and solid-gas interfaces indicated the need for more study of the solid-gas interface. The study showed that collectors and depressants may decrease surface tensions at both the solid-liquid and solid-gas interfaces so that whether or not a mineral particle is floated depends primarily on whether the added reagent tends to absorb more at the mineral-air or mineral-water interface.

PYROMETALLURGY

Concentration of iron ores requires extremely fine grinding to free the iron oxides from the siliceous gangue. After the separation has been effected the finely divided concentrate must be agglomerated to prepare it for smelting in the blast furnace, thus interest has been stimulated in pelletizing and sintering as extremely large scale operations. Particular interest was shown in waterbound spherical pellets, properly dried and indurated by heating. Such a process had been used successfully for many years in agglomerating fluorspar concentrate for use in open-hearth furnaces. A similar technique was successfully used by the Bureau of Mines at its Minneapolis Experiment Station to prepare iron concentrate for gaseous reduction in a vertical shaft furnace.

More and more uses were found for the techniques involving fluidized beds for reactions involving gases and solids. These techniques were first developed in the petroleum industry for circulating solid catalysts. By proper introduction of rising streams of gases into finely divided solids, the bed can be expanded and made to behave as a free-flowing mass allowing excellent gas-solid contact and permitting remarkable uniformity of temperature and temperature control in exothermic reactions. As a metallurgical technique, it was first applied to roasting arsenical gold ores and calcining limestone. Application need not be restricted to a dry feed; it works equally well when the feed is introduced as a slurry, and so it serves very well as a drier. It was applied to many diverse uses such as calcination of alumina hydrate and drying of coal. It also showed great promise for difficult operations, such as sulfide concentrate and chlorination of titania. A proposed application of particular interest was the reduction of zinc oxide to metallic zinc, patented by American Metal Co., Ltd.[9]

The experimental low-shaft furnace operated in Belgium was followed with great interest. This project was particularly notable as an international research project jointly operated by seven nations of Western Europe: Austria, Belgium, France, Greece, Holland, Italy,

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[8] De Bruyn, P. L., Overbeek, J. Th. G., and Schuhman, R., Jr., Flotation and the Gibbs Adsorption Equation: Trans. AIME, vol. 199, 1954, pp. 519–523.

[9] Garbo, Paul W., Fluidization in Zinc Production: U. S. Patent 2,475,607, July 12, 1949. Fluidizing Process for Zinc Recovery: U. S. Patent 2,478,912, Aug. 16, 1949.

Kalbach, John C., Stage-Wise Fluidizing of Zinc Compounds: U. S. Patent 2,559,631, July 10, 1951. Reduction of Zinc Compounds: U. S. Patent 2,560,175, July 10, 1951.

and Luxembourg. The Battelle Memorial Institute also participated in the project.

The main purpose of this investigation was to study the possibilities of producing pig iron from fine iron ore and noncoking coal, which are not suitable raw materials for a standard blast furnace. The experimental tests were designed to permit observation of the effects of each operating variable to make comparisons of the operations of this furnace with a conventional blast furnace.

According to a report by the International Committee for Research on the Low-Shaft Furnace,[10] the furnace has a remarkably high thermal efficiency, comparing favorably with a conventional blast furnace in heavy production. Excess oxygen used in the blast causes a high smelting temperature and allows production of very basic slags. Despite high sulfur in the ores, both the sulfur and silicon content of the pig iron can be kept low. The major operating difficulty, as expected, was hanging of the charge on the walls of the furnace.

Similar studies on low-shaft blast-furnace smelting of iron ores were in progress at the Bureau of Mines experiment station at Pittsburgh, Pa. It was shown that a prototype furnace can be operated indefinitely and that the results of an experimental test in the furnace can be reproduced. It is believed that this furnace can be used as a pilot furnace and that operating data on this furnace can be correlated with those of a conventional blast furnace. Further tests were planned to study the smelting of pelletized iron-ore concentrate and substitution of anthracite for coke.

Another noteworthy development has been observed in the patent literature involving renewed interest in blast-furnace smelting of zinc ores. Various attempts have been made over the past 60 years to reduce zinc ores directly to liquid zinc in a blast furnace. The history of these attempts was reviewed by Maier,[11] and an analysis was made on the basis of chemical thermodynamics to show why these attempts failed and point out the conditions under which liquid zinc could be produced by direct smelting.

A series of patents [12] recently issued to British smelters, particularly National Smelting Co., Ltd., describe a different approach. Zinc ores are smelted in a blast furnace to give a hot-top gas containing 5 percent Zn, 5 percent CO_2, 27 percent CO, and 63 percent N_2. The zinc vapor is shock-cooled and scrubbed out of the gases by passing them through a shower of molten zinc or lead. The problem is chiefly one of rapid condensation to recover the zinc from the vapor before it is reoxidized by the CO_2 in the reaction gases. The molten metal for chilling and scrubbing the gases is sprayed through the gases by means of a rapidly rotating disk dipping into a pool of metal held at a temperature just above the melting point. When lead is used as the collecting metal, the zinc is selectively separated by freezing. The mixture flows into a chamber where the temperature of the lower part is kept above the freezing point of lead but below that of zinc. The

[10] Metal Progress, Pig Iron Made From Low-Grade Fine Ore and Noncoking Coal: Vol. 67, No. 1, January 1955, pp. 81–86.

[11] Maier, C. G., Zinc Smelting From a Chemical Viewpoint: Bureau of Mines Bull. 324, 1930, p. 54.

[12] Robson, Stanley, and Derham, L. J., Production of Zinc: U. S. Patent 2,668,047, Feb. 2, 1954. Production of Zinc: U. S. Patent 2,671,725, Mar. 9, 1954.
Woods, S. E., Zinc Smelting: U. S. Patent 2,882,462, June 29, 1954.
Morgan, S. W. K., Process of Smelting Oxidized Zinc Ores: U. S. Patent 2,684,899, July 27, 1954.

zinc solidifies and rises to the top of the chamber where the temperature is above the melting point of zinc so that molten zinc may be drawn off. Molten lead from the lower part is returned to the condenser.

The blast furnace was also used in Germany for production of zinc oxide from zinc ores.[13]

HYDROMETALLURGY

Two interesting developments in hydrometallurgy were development of liquid-extraction techniques and the use of ion-exchange resins for selective extraction of metals from solutions. These developments came largely as a result of projects sponsored by the Atomic Energy Commission. Much of the information on these techniques was released and published.

Liquid-liquid extraction is an abbreviated term for selective extraction of a dissolved substance from an aqueous solution by an immiscible liquid solvent or vice versa. The process is usually carried out continuously in a series of stages in which the two liquids move counter currently. It has been used chiefly for separating and refining uranium, rare earths, and zirconium and hafnium. Research was in progress on many other separations, such as columbium from tantalum, cobalt from nickel, etc.

Further developments took place in pressure leaching in autoclaves and direct precipitation of metals from solutions by hydrogen or carbon under pressure. Both techniques were developed primarily for treating nickel-cobalt-copper concentrates. Several new patents appeared during the year concerning the processes employed by Sherritt Gordon, Ltd.,[14] and Chemical Construction Co.[15]

Pressure leaching has also been applied to carbonate leaching of uranium ores.[16] Leaching was done under oxygen pressure higher than atmospheric to ensure that all of the uranium was converted to the soluble hexavalent state.

One unsolved problem of hydrometallurgy is economical recovery of cobalt and nickel from lateritic iron ores. The largest known potential supply of nickel in the world is the laterite-serpentine ores of Cuba. They also contain important reserves of cobalt, chromium, and iron. Only nickel was being recovered at the United States Government-owned plant operated by the Nickel Processing Co. at Nicaro. The process was the ammonia-leaching process developed by Caron.[17]

Perhaps the largest new development in hydrometallurgy during 1954 was Anaconda's new copper-leaching plant at Yerrington, Nev.

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[13] Heilwig, Hans J., Zinc Oxide Blast Furnace of the Tower Hary Mines and Smelting Works: Ztschr. Erzbergbau u. Metallhuttenwerk, vol. 2, 1949, pp. 263–268.

[14] MacKiev, V. N., Method of Separating Metal Values From Ammoniacal Solutions: U. S. Patent 2,693,404, Nov. 2, 1954.

[15] Schaufelberger, F. A., Separation of Ni and Co From Acid Solutions: U. S. Patent 2,694,005, Nov. 9, 1954.

Schaufelberger, F. A., and McGauley, P. J., Separation of Ni and Co From Amine Solutions: U. S. Patent 2,693,006, Nov. 9, 1954.

[16] Forward, F. A., and Halpern, J., Developments in the Carbonate Processing of Uranium Ores: Jour. Metals, vol. 6, No. 12, December 1954, pp. 1408–1414.

[17] Caron, M. H., Ammonia Leaching of Nickel Sulfide Ores; Half Century Review: Trans. Inst. Min. and Met. (London), vol. 64, 1954–55, pp. 611-616.

The copper is leached with sulfuric acid and precipitated on scrap iron to produce a cement copper for smelting.[18]

PHYSICAL METALLURGY

Developments in jet engines, gas turbines, and the need for high-temperature construction materials continued to stimulate interest in high-temperature alloys. Cobalt and nickel-base alloys can be used at temperatures up to 1,600° F. New alloys were developed that were expected to be usable at 1,650° to 1,700° F. Molybdenum has excellent properties for high-temperature uses except for poor oxidation resistance. Some investigators believe that this may be overcome by nickel or other cladding so that molybdenum can be used at temperatures up to 2,000° F.

The aircraft industry's search for materials with higher strength-weight ratio led to intensified research in high-strength alloy steels. Steels are available with yield strengths up to 250,000 p.s.i., and others are under investigation with strengths in the range of 250,000 to 300,000 p.s.i. A specially heat-treated nickel-chromium steel was reported to have a yield strength of 400,000 p.s.i. by a European laboratory.

The demand for aluminum continued to keep ahead of the supply, despite the phenomenal growth of new production facilities. The ease of fabrication of aluminum, because of its low melting point, and its resistance to atmospheric corrosion are probably more important than low density in promoting wider use as a metal of construction.

Several new aluminum alloys came into production. A modified 78S alloy has a yield strength of 80,000 p.s.i. with a 5- to 10-percent elongation. The combination of aluminum and alumina sintered together was found to have exceptional mechanical properties, as well as excellent stability and good physical properties up to 900° C.

Several new titanium alloys appeared during the year. By heat treatment 1 alloy was given a yield strength of 220,000 p.s.i. Titanium alloys were shown to suffer hydrogen embrittlement because of a much lower hydrogen solubility at room temperature. The hydrogen may be removed by melting under vacuum; embrittlement does not occur when the hydrogen content is less than 100 parts per million.

Vacuum melting was gaining in usage because of the greater purity that may be maintained in the alloy, and freedom from voids and inclusions. It was applied particularly to stainless and high-temperature steels and to certain other specialties, such as tool steel, spring steel, and ball bearings.

Continuous casting, which has been widely used in the nonferrous industry, was applied to steel, particularly in combination with vacuum melting. The continuous casting machines have water-cooled copper molds with removable bottoms. The ingot is extracted continuously through the bottom, sheared, and fed directly into a rolling mill. The principal advantages are simplicity of operation, better surface finish, and greater yields from the ingot.

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[18] Ramsey, R. H., Anaconda's Nevada Project—New Approach to Copper Mining: Eng. and Min. Jour., vol. 155, August 1954, pp. 71-93.

Review of Mining Technology

By E. D. Gardner[1]

ALL BRANCHES of the mining industry continued efforts to improve the technology of mining during 1954. The trend toward greater mechanization continued. Labor rates and cost of supplies again increased during the year.

On the whole, the mineral industries were prosperous during the year, but the total production was less than in 1953—the year of highest production in history. The total value of the 1954 mineral production, including fuels, was $14.1 billion, as compared with $14.4 billion in 1953. Coal production was again less than in the previous year, and the lead and zinc industry suffered because of relatively low prices for these metals. The total value of metals in 1954 was $1.5 billion, compared with $1.8 billion in 1953. The total value of the industrial minerals was $2.6 billion, which again established a new high record.

EXPLORATION

The metal-mining industry continued to adapt oil-well drilling equipment and techniques for putting down both exploration and blast holes. The wireline procedure for pulling core barrels in the oil industry has been successfully modified for use in diamond-drill holes down to BX (1⅝-inch core) size.[2] The principal advantage of the new procedure is that the entire drill string remains in the hole until the bit needs replacing, thereby increasing the effective drilling time. Improved core recovery is also reported, with less caving in the hole and less premature blocking of the bit.

A camera with which the interior of boreholes can be photographed began to be used by the mineral industries in 1954. NX holes (3-inch diameter) up to 2,000 feet deep can be photographed and useful data pertaining to rock structure thus obtained.[3]

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[1] Chief mining engineer.

[2] Burnhart, V. N., Lower Diamond Drilling Costs With Wireline Core Barrel: Min. Eng., vol. 7, No. 6, June 1955, pp. 548–550.

[3] Burwell, E. B., Jr., and Nesbitt, R. H., The NX Borehole Camera: Min. Eng., vol. 6, No. 8, August 1954, pp. 805–808.

The deepest exploratory diamond-drill hole in the United States was a 6,000-foot hole inclined 80° to the horizontal; it was drilled with BX-size bits.[4]

Rotary drills such as are used in the petroleum industry for making "shot" holes in geophysical prospecting were first used extensively on the Colorado Plateau about 1952 in searching for and sampling relatively shallow uranium deposits. The drills were found particularly useful for reconnaissance, as the cost per foot of hole was considerably less than with diamond drills. After an ore body is found and outlined, the results may be checked by diamond drilling. The rotary drills also were being used in other mineral fields.

A new rotary drill for sampling plastic formations has been developed at Bauxite, Ark. A hole is drilled with carbide bits on the end of an auger that revolves around a 4-inch core barrel. The cuttings from around the core barrel are moved to the surface by the auger flights, and the core barrel is pushed down as drilling proceeds. The flight sections are 5 feet long; the core barrel is pulled at this interval. The core is forced out of the core barrel at the surface by a 7-ton hydraulic ram mounted on the drill frame. Up to 125 feet of hole is drilled per 8-hour shift. Drilling is done dry. An excellent recovery of core is made.

Diamond drills were used in exploratory drilling at the Fad shaft of the Eureka Corp. at Eureka, Nev., but cores could not be obtained in the main ore body because of the softness and friability of the ore. In 1951 the corporation explored an adjacent area by means of a rotary drill from the oilfields; the drill column was 4½-inch O. D. drill pipe. The ore zone to be explored was 2,000 feet from the surface and was successfully cored with the rotary rig. Additional ore samples were obtained by whipstocking.

SHAFT SINKING

Shaft-sinking practices were improved during the year. A new positive-action mucking machine for use in vertical and inclined shafts has been developed in Canada.[5] The digging unit is an air-activated clamshell dipper attached to the end of a telescoping boom. The direction of the boom is controlled by swing cylinders. The machine is attached to the bottom of a mine cage, with operating controls in the cage.

The sinking operations were almost completely mechanized in sinking a 940-foot shaft in Missouri.[6] A 4-drill jumbo was designed, in which each drill had independent action and all holes of a round could be drilled to a predetermined pattern and at the proper depth and pitch. The motors of the mucking machine were on the surface, and

[4] Richardson, S. B., Metal-Mine Practice: Min. Jour. (London), May 1955, p. 87.
[5] Pierce, Roger V., New Positive-Action Mucking Machine Works in Incline and Vertical Shafts: Eng. and Min. Journ., vol. 156, No. 5, May 1955, pp. 82–84.
[6] Bain, C. Kremer, A Highly Mechanized Shaft Sinking Operation: Min. Cong. Jour., vol. 40, No. 6, June 1954, pp. 38–39.

were operated by remote control by the operator at the bottom. The shaft was sunk without a lost-time accident, and all blast rounds broke well.

HOISTS

Friction-driven mine hoists (Koepe) have been used widely in Europe. This type of hoist was receiving attention in the United States and in Canada. The first United States installation was at the Cleveland-Cliffs iron mine at Ishpeming, Mich.; it was scheduled for operation in 1955. Three such hoists were on order in Canada in 1954.[7] The advantages claimed are (1) increased safety in operation, (2) less rope wear, (3) lower power consumption and lower peak demand, and (4) lower cost of equipment and powerhouse.

MINING METHODS

Mining methods and mining practices continued to be improved during the year.

Square-set-and-fill has been the standard method of mining vein deposits in the Butte district. A successful change from square-setting to horizontal cut-and-fill has been made at the Mountain Con mine.[8]

Stopes are 50 to 100 feet long and range up to 25 feet in width. The cuts are 10 feet high. Horizontal rounds about 11 feet long are drilled and blasted with millisecond delays. The strength of the powder was reduced by one-third and the length of the cartridges doubled. The charge is not tamped. Less than half of the number of holes is required to break the equivalent amount of ground than in previous operations, and better fragmentation is obtained. Moreover, less shattering of the hanging wall has resulted from the new practice. The ore and the hanging wall are rock-bolted immediately after blasting. The broken ore is pulled into chutes by scrapers. The scrapers were redesigned, and the scraper practice was otherwise improved to permit rapid removal of the ore.

As soon as the last round is scraped from the stope, the cut is filled with unselected tailings. An average of 4 stopes can be filled in 8 hours. Stoping costs have been reduced 12 percent. Ventilation has been improved, and cooling has become more effective. The rock temperature is 135° F. Rock bolting can be credited with making horizontal cut-and-fill stoping practicable at this mine.

Mining practices continued to improve in the Carlsbad, N. Mex., potash field. Sustained efforts were being made to achieve low-cost, highly mechanized operations.[9] Three continuous miners, developed

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7 Bjorge, Guy N., Friction Type (Koepe) Hoists: Min. Cong. Jour., vol. 40, No. 11, November 1954, pp. 42–44.

8 O'Leary, V. D., Paper presented at the 1955 Mining Convention, American Mining Congress: Las Vegas, Nev., Oct. 10–13, 1955.

9 Chafetz, A. B. and Skinner, E. C., Late Developments in Mining at Carlsbad: Min. Cong. Jour., vol. 40, No. 4, April 1954, pp. 71–74, 105.

for coal mining, were used on tests at three mines. One company designed and built its own continuous miner; plans call for the purchase of four more of these machines, as well as several additional continuous miners. All material in the potash beds must be cut; no tearing action takes place with a continuous miner, as in coal. The width of a cut was 18 feet and the depth 18 inches. The indicated hourly production was 40 to 60 tons per machine in an 8-foot-high heading. Shuttle cars were used with the continuous miners. Bulldozers have been introduced for cleaning up, roadmaking, and stockpiling.

Belt haulage was being increased and a semiportable crusher used at one mine. Shuttle cars dump directly into the crusher, which, in turn, discharges onto a belt conveyor.

A 40-ton diesel-electric locomotive has been installed for mainline haulage at 1 mine. Sixteen-ton cars have been installed at another mine.

The Bureau of Mines designed and built the first model of a new machine by which ore could be sliced from place in steeply dipping veins. The ore is displaced by means of a vertical row of pneumatic pavement breakers as the machine is pulled up the face. Field tests were begun in cooperation with a company mining phosphate in Montana.

DRILLING

SURFACE

Rotary drills continued to replace churn drills at opencut mines for putting down blastholes. These drills were first sold for use in sedimentary formations, but experience has shown that they are effective in other rocks, such as the copper-bearing porphyries.

The trend in recent years has been toward larger diameter holes in churn drilling; 9- and 12-inch holes had become common practice. The new rapid rotary drills, however, usually put down holes about 7½ inches in diameter and thus reversed the trend.

At the San Andreas, Calif., mine of the Calaveras Cement Co., the advantage of large-diameter holes was retained in the changeover from churn to rotary drilling by purchasing a rotary drill that put down a 9⅞-inch hole. This machine drills 160 feet a shift, an eightfold increase over the footage obtained with 9-inch churn drills. Hughes rotary bits are used.[10] Hard streaks, comprising quartzite and chert, occur in the limestone. A tungsten carbide bit was used when these hard streaks were encountered. Such a bit will deliver 1,400 feet of drilling as against 24 inches with a regular rock bit. A comparative test made with a 7⅝-inch rotary and the 9⅞-inch rig showed decided economic advantage in the use of the machine making the larger diameter hole.

The introduction of mobile drill units at the Utah Copper mine in 1954 (1) reduced the personnel in the drilling and blasting department

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[10] Day, Ray, Calaveras Quarry's Jumping Drill Footage: Excavating Eng., vol. 48, No. 10, October 1954, pp. 18–25.

34 percent, (2) retired 60 miles of compressed-air line, (3) eliminated an annual cost of $105,000 for operating a central air plant, (4) retired 94 conventional drills and accessories, (5) increased shovel efficiency, and (6) improved safety.[11]

Formerly, blast holes were drilled with hammer machines mounted on tripods; about two-thirds were toe holes and one-third vertical holes. A mobile drill unit comprises and air compressor and a mount for one drill, built on a diesel tractor. The holes are drilled 24 to 28 feet deep, with 3 changes of steel. Nine rigs do the drilling necessary to break 250,000 tons of ore and waste per day.

Progress was made during the year in jet-piercing blastholes. The special field of this manner of making hole is in difficult drilling rock. The Big Rock Stone & Material Co. has replaced churn drills with jet machines at its Nepheline Syenite Quarry near Little Rock, Ark. Two jet rigs were used instead of 12 churn drills for mining 3 million tons a year, with a saving of one-fourth in the cost per foot of hole.

UNDERGROUND

The drilling of blastholes remained an important item of expense in most underground mines. It is estimated that the total footage of blastholes drilled in the United States is 365 million feet yearly, in Canada 70 million feet, and in the world, 1 billion feet.[12]

Improvements were made during the year in air drills, jumbos, drill steel, and carbide bits. Drilling and blasting practices were also improved at many mines.

DRILLS

A new air drill designed especially for putting down long blastholes with jointed pipe came on the market during the year.

The noise of rock drills was a subject of research. Such noise would not be tolerated in a surface factory. It can be considered a hazard and is a factor contributing toward the trend to rotary drilling at mines.

Progress was made during the year in developing rotary drills for putting in blastholes in underground mining. A number of mines had adopted the practice of drilling an 8-inch or larger center hole in development headings to take the place of a number of smaller holes in burnt-cut rounds.

A production rotary drill for drilling 2-inch holes in oil-shale was developed by the Bureau of Mines at Rifle, Colo. At least one manufacturer of mining equipment had shown interest in developing such a drill for drilling small-diameter holes in rock for general use underground. Bit life was very good in drilling vertical down holes at Rifle, but the life of the bits in horizontal drilling remained unsatis-

[11] Snow, L. E., Mobile Drill Improvements at Utah Copper Pit: Min. Cong. Jour., vol. 41, No. 1, January 1955, pp. 18–21.
[12] Work cited in footnote 4.

factory. At the end of the year, it appeared that an improved bit would have to be developed before rotary drilling of conventional blast holes could become general in underground mines.

The use of an 8-inch rotary drill for drilling a center hole to replace a cluster of holes for making a burnt cut in development headings materially increased the rate of advance at the White Pine mine in Mich.[13] Experimental work was also being done with a pneumatic-rotary type drill for regular blast holes at this mine.

DRILL SUPPORTS

The old conventional drill column has been largely replaced either by jacklegs or by jumbos at most metal mines. The jumbo is favored in flat, thick ore bodies and, generally, in development headings. The airleg is favored in ore bodies with steep dips and also where selective mining is necessary. It was also used at some mines for advancing development headings where conditions are favorable. Except in very hard ground, the usual practice in headings was to load out a round already broken and then drill and blast a round each shift.

A typical example was reported by J. R. Ramsell, manager of the Kerr-Addison Gold Mining, Ltd., Virginiatown, Ontario.[14] Before 1953 drifting practice comprised the use of 2-column-mounted, drifter-type machines, with 2 men drilling and blasting a round in an 8½- by 8½-foot heading on 1 shift and a 2-man mucking crew cleaning out the round on the next shift. The average length of round obtained was approximately 8½ feet.

With the introduction of airleg drilling, the whole cycle is completed in 1 shift by 3 men. They clean out the round blasted on the previous shift and, using three drills, drill and blast the next round. Thus an advance of 7.4 feet per shift is obtained, and as the mine operates on a 2-shift-per-day basis, a daily advance of 14.8 feet is made, compared with 8½ feet by the previous method. Besides a sharp increase in the rate of advance in development headings, consumption of powder per foot of advance was reduced, and it was no longer necessary to find work for the mucking crew for part of a shift. New men can learn more quickly how to drill with this type of equipment than with the old type.

DRILL STEEL

The breakage of drill rods used in percussion drilling still presents a problem to the mining industry. Rod breakage is an important item of expense; the rod now is the weakest link in the drilling chain. The cost of drill-rod failures per ton of ore has become more evident as drilling techniques have been improved. Both the manufacturers

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[13] Ewoldt, Harold B., Mining and Milling at White Pine: Min. Cong. Jour., vol. 41, No. 3, March 1955, pp. 24–26.

[14] Paper presented at the 1955 Mining Convention, American Mining Congress, Las Vegas, Nev., October 10–13, 1955.

and the users of the steel appreciate the problem, and considerable research on physical and metallurgical phases of the work was in progress.

The problem is no easy one to solve. Energy for shattering the rock is supplied by rapidly repeated blows through long, slender rods. The transmission of energy is complicated by joints and couplings in the rods. The stress concentration in hollow steel is complex. When the anvil block strikes the rod it is under compression; when it rebounds it is in tension and rotation, introducing torsional stress.[15]

Most failures have been at or near the ends of the rods; an abrupt change from heat-treated to natural steel is a common cause of failure. Failure of threaded ends of rods is also frequent. There appears to be room for better thread designs. The reported life of drill rods in Sweden was considerably longer than in the United States. Apparently, the Swedish practice of using integral bits affects the results attained.

Efforts were being made by the manufacturers to provide better steel for the rods and to use maximum care in making them. Rods may be fabricated in the mine shops or by suppliers. There remains room for improvement in practices at many places. One supplier shot-peened the rods, with a reported increase of life. Carelessness in shipping and handling rods causes failure. Fatigue cracks start at nicks in the surface of a rod.

The Canadian Department of Mines and Technical Surveys has been a pioneer in research on the mechanical and metallurgical failure of drill steel. It has devised tests for rod fatigue and for the relative strengths of steel and also for block and endurance tests. The mathematical relationship between the energy introduced by the machine and the resistance encountered by the bit has been studied. Research on the general problem also was being conducted in the United States.

Development of a satisfactory jointed steel drill rod with a detachable tungsten carbide bit, used in conjunction with a 3½- or 4-inch heavy drifter, has drastically reduced the cost of long-hole drilling at the Copper Mountain mine of the Granby Consolidated Mining, Smelting & Power Co., Ltd, in southern British Columbia.[16]

After a block of ore is undercut, blastholes are drilled 60 to 100 feet deep to induce caving; occasionally the depth of hole is up to 140 feet. Blasthole drilling costs were \$0.55 per foot of hole, compared with \$1.07 for diamond drilling. Furthermore, the larger-diameter holes (2⅛ inches compared to 1$\frac{9}{16}$ inches with diamond drills) allowed greater burden on each hole, and 4.33 tons was broken per foot of hole, compared with 2.77 with the smaller diameter holes.

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[15] Work cited in footnote 4.

[16] Postle, L. T., Recent Developments at Copper Mountain Mine: Min. Cong. Jour., vol. 40, No. 4, April 1954, pp. 62–64.

EXPLOSIVES

A new "make-it-yourself" explosive, named "Akremite," came into use during 1954. It was developed by the Maume Colliers Co. at Terre Haute, Ind.[17] Commercial, granulated ammonium nitrate containing less than 1½ percent moisture is mixed with carbonaceous material, such as lampblack or coal dust, and then packed into plastic, moistureproof bags; these bags are used as cartridges for charging blastholes. A primer charge is used for detonating. The total costs of mixing, packaging, and delivering the explosive to the pits is stated to be less than 6 cents a pound. Good results were reported at several mines in breaking sandstones and shales.

MINE SUPPORT

ROCK BOLTING

Rock bolting increased in metal mines, and new applications were found during the year. As in coal mines, substitution of rock bolting for timbering has permitted improvements in other mining practices.

Advance headings in ore were rock-bolted at the Mountain Con mine at Butte, Mont.[18] The bolts were installed in a predetermined pattern and headings kept bolted within 2 or 3 feet of the faces. Elimination of timber sets permitted a reduction of one-third in the rock section of the headings; the saving was $7.00 per foot of advance for about 3 miles of headings per year.

CONCRETING

The support of grizzly and slusher drifts is an important item of expense at mines using caving methods of mining. The use of concrete for supporting such entries gained during the year. Improvements were also made in the concreting practices.

At the Jeffrey asbestos mine of the Canadian Johns-Manville Co., portable aluminum forms were used in concreting slusher drifts. They are easier to handle than steel forms; since it is necessary that all wood and other scrap be kept out of the ore in asbestos mining, plywood forms proved unsatisfactory.

Concrete support generally has not proved satisfactory in extremely heavy or in moving ground. Replaceable timber or steel sets have been preferred. Yieldable steel arch supports have proved successful in slusher drifts at a few mines.

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[17] Davis, Harold, and Flowers, A. E., "Make-It-Yourself" Explosive Shatters Blasting Costs: Eng. and Min. Jour., vol. 156, No. 5, May 1955, pp. 96–99.

[18] Work cited in footnote 9.

EXCAVATION

SURFACE

Improvements were made in earth-moving equipment during the year and adopted at surface mines. A trend appeared toward use of larger capacity shovels and draglines in open pits.

Bucket-wheel excavators have been used in Germany for years, particularly in the brown-coal fields, both for stripping overburden and for mining. They have an advantage in stripping coal in that the spoil can be discharged farther back from the face into a pit than is possible with either draglines or shovels.

This type of excavator has not been commonly used in the United States. Three such machines have been used for stripping coal in the Midwest for several years, and late in 1954 a new installation was made at another coal mine [19] in Illinois. This machine was made by an American manufacturer.

The wheel excavator was teamed with a stripping shovel equipped with a 30-cubic yard dipper. The 2 machines, working in tandem, systematically moved 55 to 80 feet of overburden to uncover a coal seam 4½ to 5 feet thick. An average of 60 feet of loam, clay, sand, and some shale was removed by the excavator. The wheel cuts a 50-foot-wide shelf on a high wall with a 2-to-1 slope. The machine is mounted on four sets of crawlers. Digging is done with ⅞-cubic yard buckets on a revolving wheel. The theoretical capacity is 52 buckets per minute. The buckets discharge onto a conveyor, which in turn discharges onto the stacker conveyor, which dumps the spoil on mined areas up to 250 feet from the centerline of the machine.

UNDERGROUND

Progress was made during the year in developing tunneling machines. A successful machine was developed for boring a 25-foot, 9-inch tunnel in shales.[20] It embraced a new idea; most of the breaking in excavating is done with a rotary cutterhead, which partly shatters the rock.

An all-purpose machine, named the "Gismo," developed for mining gently dipping deposits in the Pend Oreille district of Washington, came on the market during the year. The machine mounts jibs on the front end for drilling. After a round is blasted, the broken material is loaded by the machine into an internal hopper and transported back to chutes in 6-cubic yard batches. It is powered by an attached diesel tractor.

[19] Bucyrus-Erie Co., Wheel Excavator Speeds Stripping at Truax-Traer: Min. Cong. Jour., vol. 41, No. 6, June 1955, pp. 74–77.

[20] Canadian Mining Journal, Robbins Tunnel Boring Machine: Vol. 76, No. 11, November 1955, pp. 72–74.

Loading of ore and rock underground has become largely mechanical. In flat-bedded deposits the same type of equipment as is used on the surface is employed, where room permits.

Overshot front-end loaders generally were used in mine-development headings.

An improved, heavy-duty, crawler-mounted diesel loader, with front-end loading, came on the market during the year. It met a demand for a relatively large capacity machine that could work in relatively narrow workings.

TRANSPORTATION

SURFACE

The trend to larger trucks at surface mines continued during the year. The trend of replacing trolley locomotives with diesel electrics also continued.

COMMUNICATIONS

More radio systems were installed at opencut mines. Supervising personnel and maintenance men thus can be contacted immediately when the need arises. Better supervisory coordination results. The system was used for dispatching trucks and trains and directing blasting operations. In some areas the allotted FM bands were crowded, and additional bands were needed.

UNDERGROUND

Track haulage has almost been replaced by diesel trucks or shuttle-cars in mining flat-bedded, relatively thick mineral deposits underground. A factory-engineered "scooter" came on the market for hauling ore in small-scale mines during the year.

The trend continued toward better track, more powerful locomotives, and larger mine cars for mainline haulage in mines using this form of transport. More diesel locomotives went into noncoal mines during the year.

HANDLING SUPPLIES

Introduction of new and improved industrial equipment has increased the trend toward mechanization of handling supplies at many mines.

At the Lark mine of the United States Smelting, Refining & Mining Co. about 22,000 b. f. m. of timber was used daily. This timber formerly was handled several times by hand before it reached the place it was used. Begining in 1948 a straddle truck and a lift truck were purchased for moving timber at the surface. The timber was packaged and handled by power on a monorail at shaft collars. Other materials were handled similarly. Surface handling of timber has been reduced 32 percent, and the costs of handling timber and other supplies underground have been reduced 12 percent, although wages have been increased 22 percent during the same period. The time required to handle supplies through the shafts has been appreciably decreased, thereby increasing the time the shafts are available for production work. Accidents resulting from handling materials have been substantially reduced.[21]

[21] Wells, H. H., Handling Materials at Lark: Min. Cong. Jour., vol. 41, No. 3, March 1955, pp. 33–35.

Statistical Summary of Mineral Production

By Kathleen J. D'Amico [1]

A COMPLETE summary is given in this volume and 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. A summary table comparing world and United States mineral production also is included.

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

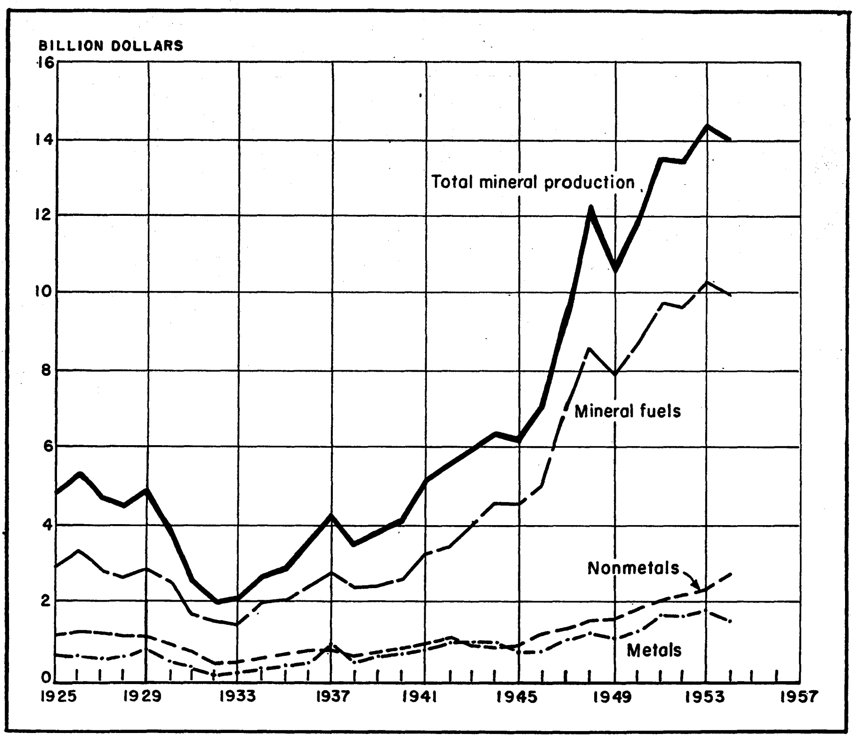

FIGURE 1.—Value of mineral production in continental United States, 1925–54.

[1] Publications editor.

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 limestone in 1954 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, 1925–54, 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	1940	2,662	784	752	4,198
1926	3,371	1,219	721	5,311	1941	3,228	989	890	5,107
1927	2,875	1,201	622	4,698	1942	3,568	1,056	999	5,623
1928	2,666	1,163	655	4,484	1943	4,028	916	987	5,931
1929	2,940	1,166	802	4,908	1944	4,574	836	900	6,310
1930	2,500	973	507	3,980	1945	4,569	888	774	6,231
1931	1,620	671	287	2,578	1946	5,090	1,243	729	7,062
1932	1,460	412	128	2,000	1947	7,188	1,338	1,084	9,610
1933	1,413	432	205	2,050	1948	9,502	1,552	1,219	12,273
1934	1,947	520	277	2,744	1949	7,920	1,559	1,101	10,580
1935	2,013	564	365	2,942	1950	8,689	1,822	1,351	11,862
1936	2,405	685	516	3,606	1951	9,779	2,079	1,671	13,529
1937	2,798	711	756	4,265	1952	9,615	2,163	1,614	13,392
1938	2,436	622	460	3,518	1953	10,249	[2] 2,342	[2] 1,797	[2] 14,388
1939	2,423	754	631	3,808	1954	9,909	[3] 2,617	1,506	14,032

[1] Data for 1925–46 are not strictly comparable with those for subsequent years, since for the earlier years the value of heavy clay products has not been replaced by the value of raw clays used in such products.
[2] Revised figure.
[3] The total has been adjusted to eliminate duplication in the value of clays and stone.

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TABLE 2.—Mineral production in continental United States, 1951–54[1]

Mineral	1951		1952		1953		1954	
	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	1,378,434	$4,159,259	1,570,698	$4,687,512	1,440,544	$4,349,327	1,337,822	$3,686,227
Gilsonite	65,521	1,895,374	60,740	1,779,815	60,505	2,184,328	75,943	2,724,023
Carbon dioxide, natural (estimated)...thousand cubic feet	547,436	161,000	737,000	226,250	670,600	203,450	638,900	210,700
Coal:								
Bituminous [2]	529,879,295	2,614,219,188	463,137,264	2,276,189,066	453,577,946	2,232,698,609	386,796,876	1,749,538,569
Lignite	3,291,104	8,043,962	3,017,300	7,211,912	2,851,032	6,793,648	4,242,806	10,330,000
Pennsylvania anthracite	42,669,997	405,817,963	40,582,558	379,714,076	30,949,152	299,139,687	29,083,477	247,870,023
Helium...cubic feet	108,970,000	1,387,000	145,810,332	1,896,096	157,652,134	2,102,721	189,873,071	3,202,206
Natural gas (marketed production)...million cubic feet	7,457,359	542,964,400	8,013,457	623,649,460	8,396,916	774,966,250	8,742,546	882,501,350
Natural-gas liquids:								
Natural gasoline and cycle products...thousand gallons	4,971,834	369,718,000	5,102,244	371,468,000	5,327,448	406,242,000	5,385,282	402,418,000
LP-gases...do	3,627,834	138,443,000	4,285,386	161,692,000	4,692,870	191,598,000	5,204,304	178,994,000
Peat	194,416	1,489,225	210,582	1,729,511	204,209	1,617,947	243,257	2,248,532
Petroleum (crude)...thousand 42-gallon barrels	2,247,711	5,690,410,000	2,289,836	5,785,230,000	2,357,082	6,327,100,000	[3] 2,314,988	[3] 6,424,930,000
Total mineral fuels	------------	9,779,000,000	------------	9,615,000,000	------------	10,249,000,000	------------	9,909,000,000
NONMETALLIC MINERALS (EXCEPT FUELS)								
Abrasive stone: [4]								
Grindstones and pulpstones	5,571	315,871	3,974	247,434	2,499	169,951	2,218	163,995
Millstones	(5)	6,000	(5)	9,285	(5)	18,375	(5)	(5)
Pebbles (grinding)	3,062	84,306	2,804	93,949	2,472	81,159	3,070	99,491
Tube-mill liners (natural)	1,408	77,027	1,739	67,724	1,219	68,688	933	59,471
Asbestos	51,645	3,912,500	53,864	4,713,032	54,456	4,857,359	47,621	4,697,962
Barite	860,669	7,968,023	941,825	8,797,944	944,212	9,435,749	883,283	8,508,185
Boron minerals	862,797	20,030,000	583,828	14,105,000	715,228	17,668,000	790,449	26,714,440
Bromine...pounds	129,563,073	26,179,556	156,201,577	30,639,292	164,143,348	35,372,386	187,399,110	41,312,669
Calcium-magnesium chloride 75-percent (Ca, Mg) Cl_2 basis	328,042	4,756,242	(6)	(6)	(6)	(6)	(6)	(6)
Cement...376-pound barrels	240,331,112	611,751,089	250,821,410	637,746,171	260,696,761	698,268,154	274,703,163	763,413,017
Clays	43,415,779	128,622,316	42,287,073	131,032,163	[7] 42,297,853	[7] 125,023,924	42,365,206	123,165,420
Emery	11,634	160,212	10,352	141,911	10,562	143,974	9,758	132,313
Epsom salts from epsomite	------------	------------	(6)	(6)	200	8,000	(6)	(6)
Feldspar...long tons	400,439	2,815,587	420,831	3,696,018	452,600	4,594,450	411,018	3,490,466
Fluorspar	347,024	14,369,521	331,273	15,353,634	318,036	15,736,908	245,628	12,332,779
Garnet (abrasive)	14,050	1,246,947	11,390	981,841	10,520	988,797	14,183	971,353

For footnotes, see end of table.

TABLE 2.—Mineral production in continental United States, 1951–54 [1]—Continued

Mineral	1951		1952		1953		1954	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
NONMETALIC MINERALS—Continued								
Gem stones (estimated)	(5)	$450,000	(5)	$490,000	(5)	$492,000	(5)	$597,000
Graphite	6,808	771,434	5,081	594,618	6,281	(6)	(6)	(6)
Gypsum	8,665,534	24,024,101	8,415,300	22,896,051	8,292,876	23,175,073	8,995,960	27,383,515
Iron oxide pigment materials (crude)	-----	-----	-----	-----	-----	-----	33,998	341,694
Lime (open-market)	8,236,422	96,507,144	8,055,609	94,795,435	9,659,414	111,777,018	8,612,360	101,273,040
Lithium minerals	12,897	896,000	15,611	1,052,000	(6)	(6)	(6)	(6)
Magnesite	670,167	4,506,712	510,750	2,871,548	553,147	3,223,759	284,015	1,391,392
Magnesium compounds from sea water and brines (except for metals) ... MgO equivalent	118,638	9,638,085	121,525	9,392,913	136,824	10,459,502	111,716	8,943,684
Marl:								
Calcareous (except for cement)	269,955	233,787	260,213	187,148	277,354	173,347	206,257	152,491
Greensand	5,067	263,944	4,600	177,847	6,821	193,404	2,838	198,909
Mica:								
Scrap	71,871	1,884,087	75,236	1,954,286	73,259	1,823,840	81,073	1,733,772
Sheet ... pounds	594,884	160,322	697,989	908,135	1,068,706	2,153,584	662,150	2,393,041
Olivine	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)
Perlite	153,502	858,099	164,845	1,002,920	198,751	1,439,658	219,703	1,762,100
Phosphate rock [8] ... long tons	10,775,032	64,761,149	12,064,892	72,458,982	12,503,830	76,631,755	13,821,100	86,669,081
Potassium salts ... K_2O equivalent	1,408,408	44,788,880	1,598,354	53,754,316	1,731,607	[7] 65,403,202	1,918,157	71,818,934
Pumice and pumicite	749,192	2,739,907	597,044	2,266,981	1,338,206	2,509,501	1,552,074	2,934,837
Pyrites ... long tons	1,017,769	4,656,000	994,342	4,947,000	922,647	5,006,499	908,715	7,159,496
Quartz from pegmatites and quartzite	281,047	1,165,370	246,604	1,013,637	241,722	1,384,398	(9)	(9)
Salt (common)	20,196,565	69,615,662	19,532,276	70,870,767	20,775,073	78,129,657	20,660,379	105,470,444
Sand and gravel	393,644,618	329,870,466	424,605,508	344,568,531	[7] 432,285,569	[7] 369,214,099	553,692,386	496,671,727
Sand and sandstone (ground)	818,479	7,163,343	792,802	6,922,586	784,792	6,873,591	(10)	(10)
Slate	819,360	14,534,327	739,640	12,706,651	698,589	12,638,465	760,921	12,960,614
Sodium carbonate (natural)	350,688	8,368,037	323,479	7,828,033	419,206	10,627,460	527,282	13,536,345
Sodium sulfate (natural)	(6)	(6)	236,825	8,217,000	248,230	3,340,760	249,701	3,890,303
Stone [11]	284,146,601	433,044,352	301,736,339	460,115,552	[7] 302,248,274	[7] 473,079,603	404,550,849	602,037,290
Strontium minerals (crude)	-----	-----	-----	-----	50	1,000	12	300
Sulfur:								
Frasch-process mines ... long tons	4,988,101	107,300,000	5,141,392	110,925,000	5,224,202	141,054,000	5,328,040	142,014,215
Other mines ... do	3,945	75,609	4,686	91,310	152,473	769,140	185,085	(6)
Sulfur, recovered elemental ... do	[7] 193,780	5,050,149	[7] 226,258	5,660,794	[7] 315,019	8,059,243	399,950	11,208,576
Talc, pyrophyllite, and soapstone	[12] 636,068	[12] 11,322,830	[12] 593,147	[12] 11,347,317	[13] 631,538	[13] 3,524,035	[13] 618,994	[13] 3,492,548
Titanium-iron concentrate (nontitanium use)	(6)	(6)	(6)	(6)	1,585	7,500	(6)	(6)
Tripoli	37,476	1,105,135	35,459	1,043,124	36,183	1,138,635	41,625	1,458,762
Vermiculite	209,008	2,679,148	208,906	2,657,826	189,535	2,445,381	195,538	2,537,577
Undistributed: Aplite, brucite, diatomite, iodine, kyanite, sharpening stones, wollastonite, and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 6). Ex-								

cludes value of clays used for cement		7,992,344		6,484,763		[7] 12,474,546		22,438,142
Total nonmetallic minerals		2,079,000,000		2,163,000,000		[7] 2,342,000,000		[15] 2,617,000,000
METALS								
Antimony ore and concentrate ... gross weight	9,100	(14)	4,434	(14)	2,161	(14)	4,686	(14)
Bauxite ... long tons, dried equivalent	1,848,676	12,477,516	1,667,047	10,776,254	1,579,739	13,439,141	1,994,896	16,403,388
Beryllium concentrate ... gross weight	484	161,361	515	233,757	751	354,681	669	303,649
Chromite ... do	7,056	510,741	21,304	1,776,981	58,817	3,432,872	160,412	6,955,653
Cobalt (content of ore) ... pounds	755,631	(14)	836,372	(14)	1,775,489	(14)	2,219,396	(14)
Columbium-tantalum concentrate pounds, gross weight	925	1,528	5,385	16,723	14,867	29,780	32,829	57,262
Copper (recoverable content of ores, etc.)	928,329	449,311,235	925,359	447,873,756	926,448	531,781,152	835,468	492,926,757
Gold (recoverable content of ores, etc.) ... troy ounces	1,741,026	60,935,910	1,652,704	57,844,640	1,704,510	59,657,850	1,588,799	55,607,965
Iron ore, usable (excluding byproduct iron sinter) long tons, gross weight	115,621,556	629,837,139	97,236,397	590,346,970	117,197,537	790,491,229	76,089,865	525,416,136
Lead (recoverable content of ores, etc.)	388,143	134,297,478	390,161	125,631,842	342,635	89,770,370	325,419	89,164,759
Manganese ore (35 percent or more Mn) ... gross weight	105,007	6,045,452	115,379	8,251,774	157,536	[7] 12,480,009	206,128	15,175,533
Manganiferous ore (5 to 35 percent Mn) ... do	1,171,991	5,239,986	1,009,018	5,116,985	1,239,390	[7] 6,946,612	558,332	3,079,380
Manganiferous residuum ... do	267,751	(14)	215,255	(14)	293,758	(14)	214,931	(14)
Mercury ... 76-pound flasks	7,293	1,532,478	12,519	2,492,533	14,297	2,759,750	17,497	4,626,032
Molybdenum (content of ore and concentrate) ... pounds	37,954,544	36,176,900	42,717,443	40,844,575	53,823,235	52,361,505	61,104,742	64,070,350
Nickel ore ... do					21,254	(14)	27,719	(14)
Silver (recoverable content of ores, etc.) ... troy ounces	39,733,909	35,961,195	39,419,344	35,676,497	37,535,451	33,971,479	36,907,686	33,403,320
Tin (content of ore and concentrate) ... long tons	19	55,757	17	45,324	(14)	(14)	(14)	(14)
Titanium concentrate:								
Ilmenite ... gross weight	510,840	7,689,272	522,515	8,022,752	512,176	7,222,641	531,895	7,375,274
Rutile ... do	(14)	(14)	(14)	(14)	6,476	702,791	7,305	869,677
Tungsten concentrate ... 60-percent WO_3 basis	6,265	22,936,638	7,603	28,943,162	9,587	35,932,751	13,691	51,433,357
Vanadium ... pounds	6,175,371	(14)	7,200,013	(14)	9,285,898	(14)	9,860,028	(14)
Zinc (recoverable content of ores, etc.)	681,188	249,330,389	666,001	222,981,864	547,430	125,320,890	473,471	102,179,867
Zirconium concentrate	(14)	(14)	(14)	(14)	21,234	793,685	17,959	820,041
Undistributed: Magnesium chloride for magnesium metal, platinum-group metals (crude), rare-earth metal concentrate, and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 14)		18,571,347		26,782,134		[7] 29,825,786		36,083,831
Total metals		1,671,000,000		1,614,000,000		[7] 1,797,000,000		1,506,000,000
Grand total mineral production		13,529,000,000		13,392,000,000		[7] 14,388,000,000		14,032,000,000

[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] Final figure. Supersedes preliminary figure given in commodity chapter.
[4] Excludes sharpening stones, value for which is included with "Nonmetallic minerals, undistributed."
[5] Weight not recorded.
[6] Value included with "Nonmetallic minerals, undistributed."
[7] Revised figure.
[8] Basis for reporting phosphate rock has been changed from shipments to marketable production, because the latter more nearly reflects output at the mine on a calendar year basis.
[9] Beginning with 1954, quartz from pegmatites and quartzite included with stone.
[10] Beginning with 1954, sand and sandstone (ground) included with sand and gravel or stone.
[11] Excludes abrasive stone, bituminous limestone, bituminous sandstone, and ground soapstone, all included elsewhere in table. Also excludes limestone for cement and lime.
[12] Sold or used by producers. Quantity and value ground material.
[13] Mine production of crude material.
[14] Value included with "Metals, undistributed."
[15] The total has been adjusted to eliminate duplication in the value of clays and stone.

TABLE 3.—Minerals produced in continental United States and principal producing States in 1954

Rank in value	Mineral	Principal producing States	
		In order of quantity	In order of value
	Abrasive stone:		
74	Grindstones and pulpstones	Ohio	Rank same as for quantity.
86	Millstones	Not available	North Carolina, New York.
78	Pebbles (grinding)	Minnesota, Wisconsin, North Carolina, Texas	Rank same as for quantity.
83	Sharpening stones	Arkansas, New Hampshire, Indiana	Do.
79	Tube-mill liners (natural)	Minnesota, Wisconsin, North Carolina	Do.
70	Antimony ore and concentrate	Idaho, Nevada	Do.
67	Aplite	Virginia	Do.
41	Asbestos	Vermont, Arizona, North Carolina, California	Do.
39	Asphalt (native)	Texas, Kentucky, Alabama, Oklahoma	Utah, Texas, Kentucky, Oklahoma.
35	Barite	Arkansas, Missouri, Nevada, Georgia	Arkansas, Missouri, Georgia, Nevada.
26	Bauxite	Arkansas, Alabama, Georgia	Arkansas, Georgia, Alabama.
69	Beryllium concentrate	South Dakota, New Mexico, Georgia, Colorado	South Dakota, Georgia, New Mexico, Maine.
24	Boron minerals	California	Rank same as for quantity.
21	Bromine	Texas, Michigan, California, West Virginia	Michigan, Texas, California, West Virginia.
85	Brucite	Nevada	Rank same as for quantity.
40	Calcium-magnesium chloride	Michigan, California, West Virginia, Ohio	Do.
71	Carbon dioxide (natural)	New Mexico, Utah, California, Washington	New Mexico, Washington, California, Oregon.
4	Cement	Pennsylvania, California, Texas, Michigan	Rank same as for quantity.
38	Chromite	Montana, California, Oregon	Do.
11	Clays	Ohio, Pennsylvania, California, Georgia	Georgia, Ohio, Pennsylvania, Wyoming.
2	Coal:		
	Bituminous	West Virginia, Pennsylvania, Kentucky, Illinois	Rank same as for quantity.
	Lignite	Montana, California, North Dakota, South Dakota	Do.
	Pennsylvania anthracite	Pennsylvania	Do.
53	Cobalt (content of ore)	Idaho, Pennsylvania	Do.
80	Columbium-tantalum concentrate	South Dakota, Colorado, New Mexico, New Hampshire.	Do.
9	Copper (in ores, etc.)	Arizona, Utah, Nevada, New Mexico	Do.
31	Diatomite	California, Nevada, Oregon, Washington	Do.
77	Emery	New York	Do.
87	Epsomite	Washington	Do.
46	Feldspar	North Carolina, Colorado, South Dakota, New Hampshire.	Do.
30	Fluorspar	Illinois, Colorado, Kentucky, Montana	Illinois, Colorado, Kentucky, Nevada.
60	Garnet (abrasive)	New York, Idaho, California, Florida	Rank same as for quantity.
66	Gem stones	Not available	California, Oregon, Texas, Nevada.
19	Gold (in ores, etc.)	South Dakota, Utah, California, Arizona	Rank same as for quantity.
82	Graphite: Amorphous	Rhode Island	Do.
23	Gypsum	Michigan, Texas, California, New York	Michigan, New York, Texas, Iowa.
47	Helium	Texas, New Mexico, Kansas	Rank same as for quantity.
61	Iodine	California	Do.
7	Iron ore (usable)	Minnesota, Michigan, Alabama, Utah	Minnesota, Michigan, Alabama, New York.
68	Iron oxide pigments	Michigan, Virginia, Illinois, New York	Rank same as for quantity.
59	Kyanite	Virginia, South Carolina	Do.
15	Lead (in ores, etc.)	Missouri, Idaho, Utah, Colorado	Do.
14	Lime (open-market)	Ohio, Missouri, Pennsylvania, Texas	Ohio, Pennsylvania, Missouri, Illinois.

48	Lithium minerals	North Carolina, South Dakota, California, Colorado	Rank same as for quantity.
58	Magnesite	Nevada, Washington, California	Washington, Nevada, California.
25	Magnesium chloride (for magnesium metal)	Texas, Michigan	Rank same as for quantity.
34	Magnesium compounds from sea water and brines (except for metal).	California, Michigan, New Jersey, Texas	Michigan, California, New Jersey, Texas.
27	Manganese ore	Nevada, Montana, Virginia, Arkansas	Rank same as for quantity.
49	Manganiferous ore	Minnesota, New Mexico, Michigan, Nevada	Minnesota, Nevada, Michigan, New Mexico.
54	Manganiferous residuum	New Jersey	Rank same as for quantity.
75	Marl (calcareous)	Michigan, Virginia, Indiana, Wisconsin	Michigan, Nevada, California, Virginia.
73	Marl (greensand)	New Jersey, Maryland	Rank same as for quantity.
42	Mercury	California, Nevada, Idaho, Oregon	Do.
43	Mica:	North Carolina, Georgia, California, Arizona	North Carolina, Georgia, New Hampshire, South Dakota.
	Scrap	do	North Carolina, Georgia, California, South Dakota.
	Sheet	North Carolina, Connecticut, New Hampshire, Georgia.	North Carolina, New Hampshire, Georgia, South Dakota.
18	Molybdenum (content of ore and concentrate)	Colorado, Utah, Arizona, New Mexico	Rank same as for quantity.
3	Natural gas	Texas, Louisiana, Oklahoma, California	Texas, Louisiana, California, West Virginia.
6	Natural-gas liquids:		
	Natural gasoline and cycle products	Texas, California, Louisiana, Oklahoma	Rank same as for quantity.
	LP-gases	Texas, Oklahoma, California, Louisiana	Texas, California, Oklahoma, Louisiana.
65	Nickel (content of ore)	Idaho, Oregon	Oregon, Idaho.
76	Olivine	North Carolina, Washington	Rank same as for quantity.
52	Peat	Washington, Florida, Ohio, Michigan	Michigan, Ohio, New Jersey, Iowa.
55	Perlite	New Mexico, Nevada, Colorado, California	New Mexico, Colorado, Nevada, California.
1	Petroleum (crude)	Texas, California, Louisiana, Oklahoma	Rank same as for quantity.
16	Phosphate rock	Florida, Tennessee, Idaho, Montana	Do.
72	Platinum-group metals (crude)	California	Do.
17	Potassium salts	New Mexico, California, Utah, Michigan	Do.
50	Pumice and pumicite	California, New Mexico, Wyoming, Colorado	New Mexico, California, Colorado, Idaho.
37	Pyrites	Tennessee, California, Virginia, Montana	Rank same as for quantity.
62	Rare earth metals concentrate	California	Do.
12	Salt (common)	Michigan, New York, Louisiana, Texas	Michigan, New York, Ohio, Louisiana.
8	Sand and gravel	California, Michigan, New York, Texas	California, New York, Ohio, Illinois.
22	Silver (in ores, etc.)	Idaho, Utah, Montana, Arizona	Rank same as for quantity.
29	Slate	Vermont, Pennsylvania, Georgia, New York	Vermont, Pennsylvania, New York, Georgia.
28	Sodium carbonate (natural)	California, Wyoming	Rank same as for quantity.
44	Sodium sulfate (natural)	California, Texas, Wyoming	Do.
5	Stone	Pennsylvania, Ohio, Michigan, Illinois	Pennsylvania, Ohio, California, New York.
88	Strontium minerals	California	Rank same as for quantity.
10	Sulfur, from Frasch-process mines	Texas, Louisiana	Do.
56	Sulfur (from other mines)	California	Do.
32	Sulfur, recovered elemental	Wyoming, Texas, Arkansas, California	Wyoming, Texas, California, Arkansas.
45	Talc, pyrophyllite and soapstone	New York, California, North Carolina, Vermont	Rank same as for quantity.
84	Tin (content of ore and concentrate)	Colorado	Do.
	Titanium concentrate:		
36	Ilmenite	New York, Florida, Virginia	Do.
63	Rutile	Florida	Do.
89	Titanium-iron concentrate	California	Do.
57	Tripoli	Illinois, Missouri, Pennsylvania	Missouri, Illinois, Pennsylvania.
20	Tungsten concentrate	Nevada, California, North Carolina, Colorado	Rank same as for quantity.
33	Vanadium	Colorado, Utah, New Mexico, Arizona	Colorado, Utah, Arizona, New Mexico.
51	Vermiculite	Montana, South Carolina, Arizona, North Carolina	Montana, South Carolina, North Carolina, Arizona.
81	Wollastonite	New York	Rank same as for quantity.
13	Zinc (in ores, etc.)	Idaho, Montana, New York, Oklahoma	Do.
64	Zirconium concentrate	Florida	Do.

TABLE 4.—Value of mineral production in continental United States, 1951–54, by States, in thousand dollars, and principal minerals produced in 1954

State	1951	1952	1953	1954			
				Value	Rank	Percent of U. S. total	Principal minerals in order of value
Alabama	164,280	158,382	[1] 187,087	151,330	20	1.08	Coal, iron ore, cement, stone.
Arizona	243,886	231,702	256,616	252,959	17	1.80	Copper, cement, zinc, gold.
Arkansas	119,844	117,687	127,090	131,745	21	.94	Petroleum, bauxite, sand and gravel, stone.
California	1,210,076	1,215,130	[1] 1,393,987	1,429,627	2	10.19	Petroleum, natural-gas liquids, natural gas, cement.
Colorado	179,435	187,589	211,586	256,197	15	1.83	Petroleum, molybdenum, coal, cement.
Connecticut	6,247	7,125	7,917	9,581	45	.07	Sand and gravel, stone, lime, clays.
Delaware	584	677	659	947	48	.01	Sand and gravel, stone, clays.
District of Columbia	82	7	15	----	----	----	Clays.
Florida	76,897	82,878	92,336	106,510	26	.76	Phosphate rock, stone, cement, clays.
Georgia	46,675	51,450	51,395	55,803	31	.40	Clays, stone, cement, sand and gravel.
Idaho	83,171	77,848	[1] 67,000	69,693	29	.50	Lead, silver, zinc, phosphate rock.
Illinois	489,934	460,005	462,443	473,077	7	3.37	Petroleum, coal, stone, sand and gravel.
Indiana	174,388	162,031	169,781	165,369	19	1.18	Coal, cement, petroleum, stone.
Iowa	47,706	52,481	51,994	58,798	30	.42	Cement, stone, sand and gravel, coal.
Kansas	400,087	403,370	413,231	449,587	8	3.20	Petroleum, natural gas, cement, stone.
Kentucky	442,264	398,446	381,742	327,503	11	2.33	Coal, petroleum, natural gas, stone.
Louisiana	787,678	848,401	965,237	996,978	3	7.11	Petroleum, natural gas, natural-gas liquids, sulfur.
Maine	8,516	8,981	10,503	10,716	44	.08	Cement, sand and gravel, stone, slate.
Maryland	26,153	26,847	27,085	30,743	39	.22	Sand and gravel, stone, cement, coal.
Massachusetts	17,077	17,812	17,191	18,851	42	.13	Stone, sand and gravel, lime, clays.
Michigan	258,471	254,518	286,487	280,150	14	2.00	Iron ore, cement, petroleum, salt.
Minnesota	432,577	397,440	542,545	351,475	10	2.50	Iron ore, sand and gravel, stone, cement.
Mississippi	103,030	101,875	107,868	110,563	25	.79	Petroleum, natural gas, sand and gravel, cement.
Missouri	135,249	140,977	128,207	131,280	22	.94	Lead, cement, stone, lime.
Montana	126,376	122,069	132,184	126,412	24	.90	Copper, petroleum, zinc, sand and gravel.
Nebraska	18,469	20,597	33,281	42,393	35	.30	Petroleum, cement, sand and gravel, stone.
Nevada	57,674	64,231	73,523	89,138	28	.63	Copper, tungsten, manganese ore, sand and gravel.
New Hampshire	1,295	1,945	1,805	2,112	46	.02	Sand and gravel, stone, feldspar, mica.
New Jersey	60,099	57,468	51,945	47,044	34	.33	Sand and gravel, stone, zinc, iron ore.
New Mexico	256,302	288,500	[1] 336,580	373,599	9	2.66	Petroleum, potassium salts, copper, natural gas.
New York	188,816	180,751	186,868	192,764	18	1.37	Cement, iron ore, stone, sand and gravel.
North Carolina	29,647	34,726	[1] 38,451	41,651	36	.30	Stone, tungsten concentrate, sand and gravel, mica.
North Dakota	10,247	12,057	19,237	22,223	40	.16	Petroleum, sand and gravel, natural-gas liquids, natural gas.
Ohio	302,612	292,689	[1] 302,242	293,659	12	2.09	Coal, stone, cement, lime.
Oklahoma	607,486	621,351	[1] 679,003	650,205	5	4.63	Petroleum, natural gas, natural-gas liquids, coal.

Oregon	28,402	26,674	24,449	32,268	38	.23	Sand and gravel, stone, cement, diatomite.
Pennsylvania	1,289,226	1,145,633	1,121,622	925,545	4	6.60	Coal, cement, stone, natural gas.
Rhode Island	1,278	1,250	1,462	1,461	47	.01	Sand and gravel, stone, graphite.
South Carolina	11,444	14,686	17,771	17,744	43	.13	Cement, clays, stone, sand and gravel.
South Dakota	29,652	30,455	[1] 33,823	37,859	37	.27	Gold, sand and gravel, stone, cement.
Tennessee	100,047	100,932	98,050	105,686	27	.75	Coal, stone, cement, phosphate rock.
Texas	3,269,199	3,379,813	3,647,913	3,730,162	1	26.58	Petroleum, natural gas, natural-gas liquids, sulfur.
Utah	257,145	265,501	298,629	255,234	16	1.82	Copper, coal, iron ore, molybdenum.
Vermont	18,516	17,891	20,302	20,483	41	.15	Stone, slate, asbestos, copper.
Virginia	161,252	164,679	152,979	129,603	23	.92	Coal, stone, cement, sand and gravel.
Washington	54,554	56,139	54,577	53,300	33	.38	Cement, sand and gravel, stone, zinc.
West Virginia	941,748	825,733	790,110	636,311	6	4.53	Coal, natural gas, stone, petroleum.
Wisconsin	48,350	55,710	[1] 55,212	54,286	32	.39	Sand and gravel, stone, iron ore, cement.
Wyoming	204,357	206,828	255,906	281,306	13	2.00	Petroleum, coal, clays, sodium salts.
Total	13,529,000	13,392,000	[1] 14,388,000	14,032,000		100.00	Petroleum, coal, natural gas, cement.

[1] Revised figure.

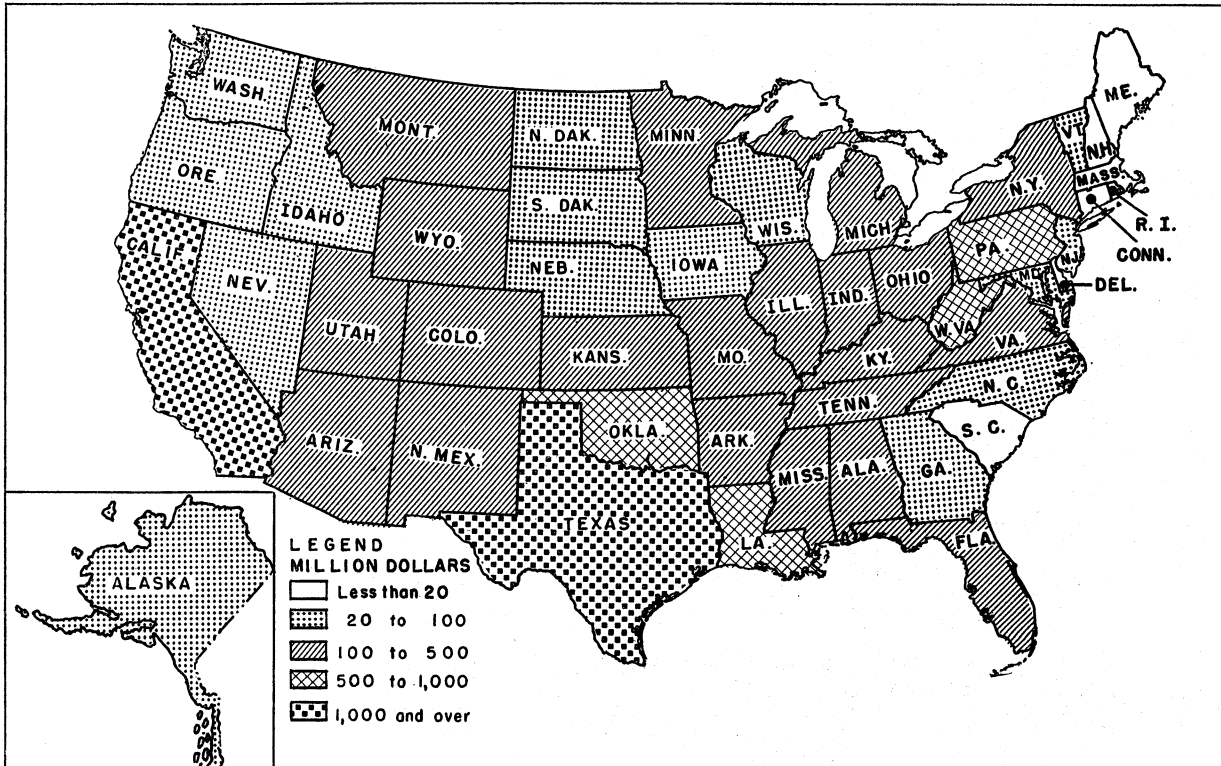

FIGURE 2.—Value of mineral production in continental United States and Alaska, 1954, by States.

TABLE 5.—Mineral production in the United States, 1951–54, by States [1]

ALABAMA

Mineral	1951		1952		1953		1954	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
Cement [2] ......376-pound barrels..	10,586,825	$24,523,073	10,642,409	$25,084,379	10,427,542	$25,701,421	11,121,599	$28,582,683
Clays	1,269,697	1,718,644	1,264,412	1,903,956	1,198,093	1,815,606	1,330,900	2,258,211
Coal	13,596,982	82,465,625	411,383,427	70,759,815	12,532,061	79,370,036	10,282,506	64,029,502
Iron ore (usable) ......long tons, gross weight..	8,181,737	34,799,951	7,243,214	37,940,412	7,446,130	55,640,338	5,913,462	33,327,083
Lime (open-market)	455,953	4,395,922	424,028	4,458,604	470,541	5,018,156	421,807	4,488,167
Natural gas (marketed production) ......million cubic feet..	1	50	4	160	41	2,000	87	5,000
Petroleum (crude) ......thousand 42-gallon barrels..	1,020	(3)	1,279	(3)	1,694	3,290,000	[4] 1,584	[4] 3,690,000
Sand and gravel	3,535,871	2,806,540	3,722,555	2,955,630	3,710,707	3,002,683	3,966,345	3,450,858
Stone (except for cement and lime, 1951–53)	2,818,421	7,254,671	3,052,150	7,948,410	[5] 3,957,452	[5] 8,154,467	7,393,530	11,608,937
Undistributed: Native asphalt, bauxite, pozzolan cement, graphite (1951–53), mica (1952–54), salt (1952–54), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3.) Excludes value of clays for cement (1951–53)	....	6,315,082	....	7,330,582	....	[4] 5,092,087	....	4,855,545
Total Alabama	....	164,280,000	....	158,382,000	....	[5] 187,087,000	....	[6] 151,330,000

ARIZONA

Mineral	1951		1952		1953		1954	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
Brucite	....	....	....	....	100	$1,250	....	....
Clays	226,672	$471,973	247,329	$579,175	197,401	715,248	253,672	$814,202
Coal	4,969	29,814	5,003	33,000	5,140	32,135	10,925	68,110
Copper (recoverable content of ores, etc.)	415,870	201,281,080	395,719	191,527,996	393,525	225,883,350	377,927	222,976,930
Fluorspar	1,623	(3)	434	(3)	1,951	113,270	(3)	(3)
Gold (recoverable content of ores, etc.) ......troy ounces..	116,093	4,063,255	112,355	3,932,425	112,824	3,948,840	114,809	4,018,315
Gypsum	(3)	(3)	11,314	28,285	13,484	43,824	(3)	(3)
Lead (recoverable content of ores, etc.)	17,394	6,018,324	16,520	5,319,440	9,428	2,470,136	8,385	2,297,490
Lime (open-market)	54,023	772,899	53,019	757,390	96,408	1,238,204	88,932	1,131,334
Manganese ore (35 percent or more Mn) ......gross weight..	173	(3)	203	(3)	(3)	(3)	....	....
Manganiferous ore (5 to 35 percent Mn) ......do....	224	(3)	....	....	....	....	....	....
Mercury ......76-pound flasks..	(3)	(3)	....	....	....	....	163	43,096
Mica (scrap)	1,763	50,030	(3)	(3)	3,721	114,870	1,682	17,773
Molybdenum (content of ore and concentrate) ......pounds..	1,172,740	1,101,641	2,022,832	1,987,418	1,446,557	1,425,552	1,538,088	1,524,936
Perlite	1,520	10,795	2,747	14,568	1,511	9,824	1,296	6,990
Pumice	(3)	(3)	(3)	(3)	123,797	425,985	80,883	125,927

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1951–54, by States [1]—Continued

ARIZONA—Continued

Mineral	1951		1952		1953		1954	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
Sand gravel	2,691,100	$2,203,345	1,824,330	$1,635,903	3,446,821	$2,680,470	3,764,080	$3,067,076
Silver (recoverable content of ores, etc.) troy ounces	5,120,985	4,634,750	4,701,330	4,254,941	4,351,429	3,938,263	4,298,811	3,890,641
Stone (except limestone for cement and lime, 1951–53)	308,881	353,872	235,020	355,709	442,358	618,748	1,205,452	1,914,315
Tungsten concentrate 60-percent WO_3 basis	11	36,663	71	251,136	134	468,858	132	456,965
Zinc (recoverable content of ores, etc.)	52,999	19,291,636	47,143	15,651,476	27,530	6,331,900	21,461	4,635,576
Undistributed: Asbestos, barite, beryllium concentrate (1951, 1953–54), cement, diatomite (1954), feldspar, gem stones, quartz (1951–53), vanadium, vermiculite (1954), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)		3,566,376		5,373,512		[4] 6,155,729		6,651,954
Total Arizona		243,886,000		231,702,000		256,616,000		[6] 252,959,000

ARKANSAS

Mineral	1951		1952		1953		1954	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
Barite	407,085	[7] $3,765,536	428,522	[7] $3,963,828	380,763	[7] $3,945,583	370,621	$3,488,483
Bauxite long tons, dried equivalent	1,815,274	12,259,742	1,603,833	10,235,254	1,529,976	12,975,992	1,949,368	15,993,887
Clays	491,459	1,206,858	552,576	1,513,934	529,126	1,734,414	617,450	2,556,367
Coal	1,106,705	8,686,410	873,088	6,839,113	775,207	6,143,757	477,268	3,589,217
Iron ore (usable) long tons, gross weight	1,343	(³)	115	(³)	254	(³)	716	(³)
Lead (recoverable content of ores, etc.)	33	11,418	4	1,288				
Manganese ore (35 percent or more Mn) gross weight	3,718	(³)	2,246	(³)	6,123	526,647	13,728	1,020,752
Manganiferous ore (5 to 35 percent Mn) do	1,429	(³)	896	(³)				
Natural gas (marketed production) million cubic feet	44,656	1,786,000	42,325	1,735,000	41,510	2,200,000	33,471	1,841,000
Natural-gas liquids:								
Natural gasoline and cycle products thousand gallons	58,212	4,247,000	61,782	4,580,000	58,422	4,123,000	50,778	3,234,000
LP-gases do	40,404	1,606,000	49,098	2,079,000	55,188	2,562,000	58,506	2,521,000
Petroleum (crude) thousand 42-gallon barrels	29,798	73,900,000	29,440	72,420,000	29,681	77,170,000	[4] 29,130	[4] 79,520,000
Sand and gravel	3,868,940	3,569,114	5,011,095	4,977,219	4,903,835	4,955,383	6,611,860	6,566,806
Slate	27,080	174,329	(³)	(³)	34,516	315,858	41,845	379,076
Stone (except limestone for cement and lime, 1951–53)	2,535,746	3,216,426	[8] 2,967,479	[8] 3,346,201	[8] 3,545,350	[8] 5,069,750	4,604,067	5,929,638
Zinc (recoverable content of ores, etc.)	50	18,200	26	8,632				
Undistributed: Abrasive stones, cement, gypsum, lime, soapstone (1953–54), stone (dimension miscellaneous, 1952), recovered elemental sulfur, and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)		5,396,967		5,987,245		5,367,669		5,742,325
Total Arkansas		119,844,000		117,687,000		127,090,000		[6] 131,745,000

Antimony ore and concentrate ---- gross weight	----	----	9	(3)	----	----	----	----
Boron minerals	862, 797	$20, 030, 000	583, 828	$14, 105, 000	715, 228	$17, 668, 000	790, 449	$26, 714, 440
Cement ---- 376-pound barrels	28, 956, 470	77, 753, 697	29, 786, 245	79, 457, 745	32, 002, 317	90, 872, 741	32, 761, 990	98, 251, 245
Chromite ---- gross weight	6, 302	447, 769	14, 713	[7] 1, 269, 000	26, 512	2, 078, 461	30, 661	2, 285, 250
Clays	2, 590, 040	4, 732, 124	2, 743, 130	4, 852, 266	2, 429, 888	4, 952, 723	2, 722, 850	4, 477, 174
Coal (lignite)	3, 657	37, 500	2, 998	30, 700	----	----	(3)	(3)
Copper (recoverable content of ores, etc.)	921	445, 764	800	387, 200	382	219, 268	362	213, 580
Gem stones	(9)	(3)	(9)	100, 000	(9)	(3)	(9)	(3)
Gold (recoverable content of ores, etc.) ---- troy ounces	339, 732	11, 890, 620	258, 176	9, 036, 160	234, 591	8, 210, 685	237, 886	8, 326, 010
Gypsum	1, 092, 883	2, 602, 758	1, 236, 430	2, 721, 134	1, 199, 489	2, 855, 983	1, 161, 502	2, 803, 862
Iron ore (usable) ---- long tons, gross weight	1, 182, 799	(3)	1, 463, 239	(3)	1, 697, 652	(3)	1, 270, 292	(3)
Lead (recoverable content of ores, etc.)	13, 967	4, 832, 582	11, 199	3, 606, 078	8, 664	2, 269, 968	2, 671	731, 854
Lime (open-market)	203, 344	3, 366, 959	238, 957	3, 752, 738	301, 422	4, 653, 303	212, 381	3, 387, 981
Magnesium compounds from sea water and bitterns (partly estimated) MgO equivalent	(3)	(3)	50, 277	3, 529, 362	55, 886	3, 483, 483	40, 969	2, 715, 689
Manganese ore (35 percent or more Mn) ---- gross weight	----	----	8, 081	(3)	5, 413	(3)	831	45, 091
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
Mercury ---- 76-pound flasks	4, 282	899, 777	7, 241	1, 441, 683	9, 290	1, 793, 249	11, 262	2, 977, 560
Natural gas (marketed production) ---- million cubic feet	566, 751	82, 745, 000	517, 450	86, 414, 000	531, 346	104, 675, 000	507, 289	104, 502, 000
Natural-gas liquids:								
Natural gasoline and cycle products ---- thousand gallons	887, 544	65, 923, 000	870, 996	64, 945, 000	910, 350	85, 691, 000	923, 160	89, 293, 000
LP-gases ---- do	352, 842	15, 528, 000	393, 792	16, 700, 000	397, 572	21, 961, 000	396, 186	22, 262, 000
Peat	6, 432	42, 016	10, 527	76, 706	9, 196	73, 897	8, 090	85, 458
Perlite	(3)	(3)	(3)	(3)	15, 282	112, 790	14, 811	103, 148
Petroleum (crude) ---- thousand 42-gallon barrels	354, 561	797, 760, 000	359, 450	801, 570, 000	365, 085	909, 060, 000	[4] 355, 865	[4] 907, 460, 000
Pumice and pumicite	264, 411	1, 228, 569	129, 780	793, 716	433, 105	647, 910	566, 664	651, 638
Salt (common)	1, 275, 574	5, 261, 780	1, 148, 693	4, 880, 392	1, 123, 365	6, 263, 059	1, 185, 844	6, 126, 194
Sand and gravel	46, 927, 452	41, 279, 835	53, 051, 260	43, 633, 125	58, 429, 528	53, 224, 203	70, 524, 612	68, 138, 578
Silver (recoverable content of ores, etc.) ---- troy ounces	1, 145, 219	1, 036, 481	1, 099, 658	995, 246	1, 036, 372	937, 969	309, 575	280, 181
Stone (except limestone for cement and lime, 1951–53)	12, 537, 344	14, 714, 524	14, 374, 930	17, 697, 085	[5] 14, 497, 348	[5] 18, 472, 652	23, 303, 756	37, 541, 114
Strontium minerals	----	----	----	----	50	1, 000	12	300
Sulfur ore ---- long tons	(3)	(3)	(3)	(3)	152, 203	(3)	185, 085	(3)
Talc, pyrophyllite, and soapstone	[10] 126, 784	[10] 2, 269, 771	[10] 120, 574	[10] 2, 868, 255	[11] 126, 442	[11] 1, 132, 700	[11] 133, 474	[11] 1, 211, 201
Tungsten concentrate ---- 60-percent WO_3 basis	3, 007	11, 557, 325	2, 980	11, 360, 569	2, 382	8, 939, 146	3, 512	13, 209, 371
Zinc (recoverable content of ores, etc.)	9, 602	3, 495, 128	9, 419	3, 127, 108	5, 358	1, 232, 340	1, 415	305, 640
Undistributed: Asbestos (1951, 1953–54), barite, bromine, calcium-magnesium chloride, carbon dioxide, diatomite, feldspar, abrasive garnet (1954), iodine, lithium minerals, magnesite, mica (1952 and 1954), molybdenum, platinum-group metals (crude), potassium salts, pyrites, quartz (1951–53), ground sand and sandstone (1951–53), slate, sodium carbonate and sulfate, rare earth metal concentrate (1953–54), stone (dimension limestone and crushed marble, 1953), recovered elemental sulfur, titanium-iron concentrate (non-titanium use), wollastonite (1952), and minerals whose value must be concealed for particular years indicated in appropriate column by footnote reference 3). Excludes value of clays used for cement (1951–53)	----	40, 194, 867	----	35, 779, 821	----	[5] 42, 473, 296	----	43, 652, 525
Total California	----	1, 210, 076, 000	----	1,215,130,000	----	[5] 1,393,987,000	----	[6] 1,429, 627, 000

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1951–54, by States [1]—Continued

COLORADO

Mineral	1951 Short tons (unless otherwise stated)	1951 Value	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value	1954 Short tons (unless otherwise stated)	1954 Value
Beryllium concentrate......gross weight..	97	$32,339	54	$24,588	75	$39,515	60	$27,130
Clays..........	657,397	1,172,109	568,730	1,087,154	777,969	1,429,780	854,791	1,002,873
Coal..........	4,102,639	21,165,518	3,623,015	19,215,657	3,547,850	19,197,732	2,899,791	16,078,581
Columbium-tantalum concentrate......pounds..	(3)	(3)	(3)	(3)	(3)	(3)	4,967	9,897
Copper (recoverable content of ores, etc.)......	3,212	1,554,608	3,606	1,745,304	2,941	1,688,134	4,523	2,668,570
Feldspar......long tons..	50,451	283,153	38,268	224,385	43,508	267,642	(3)	(3)
Fluorspar..........	20,661	820,322	29,185	1,505,968	53,276	2,872,360	59,197	3,197,252
Gold (recoverable content of ores, etc.)......troy ounces..	116,503	4,077,605	124,594	4,360,790	119,218	4,172,630	96,146	3,365,110
Gypsum..........	(3)	(3)	(3)	(3)	62,936	233,043	(3)	(3)
Iron ore (useable)......long tons, gross weight..	------	------	------	------	900	3,825	6,049	(3)
Lead (recoverable content of ores, etc.)......	30,336	10,496,256	30,066	9,681,252	21,754	5,699,548	17,823	4,883,502
Manganiferous ore (5 to 35 percent Mn)......gross weight..	------	------	76	(3)	------	------	------	------
Mica (scrap)..........	1,882	32,901	(3)	(3)	1,599	19,455	(3)	(3)
Molybdenum (content of ore and concentrate)......pounds......	22,911,949	(3)	24,557,149	(3)	33,851,083	(3)	(3)	(3)
Natural gas......million cubic feet..	14,128	608,000	34,260	1,884,000	28,509	1,654,000	45,705	3,976,000
Peat..........	2,241	19,611	2,312	20,230	6,067	(3)	9,028	(3)
Petroleum (crude)......thousand 42-gallon barrels..	27,823	70,670,000	30,381	77,470,000	36,402	98,650,000	[4] 46,206	[4] 127,990,000
Pumice and pumicite..........	(3)	(3)	(3)	(3)	47,919	99,700	(3)	(3)
Sand and gravel..........	6,916,631	4,452,489	8,461,039	6,268,367	12,438,600	8,609,151	13,552,406	9,026,993
Silver (recoverable content of ores, etc.)......troy ounces..	2,787,882	2,523,174	2,813,643	2,546,489	2,200,317	1,991,398	3,417,072	3,092,623
Stone (except limestone for cement and lime, 1951–53)......	1,470,123	2,334,376	1,708,872	2,566,401	[5 6] 884,104	[5 6] 1,750,726	1,804,004	2,112,093
Tin (content of ore and concentrate)......long tons..	18	54,033	13	33,723	(3)	(3)	(3)	(3)
Tungsten concentrate......60-percent WO_3 basis....	336	1,092,780	625	2,354,664	817	2,902,490	927	3,420,563
Vanadium..........	5,407,161	(3)	6,751,926	(3)	7,993,922	(3)	8,516,174	(3)
Zinc (recoverable content of ores, etc.)......	55,714	20,279,896	53,203	17,663,396	37,809	8,696,070	35,150	7,592,400
Undistributed: Carbon dioxide (1952–54), cement, gem stones, lithium minerals (1953–54), natural-gas liquids, perlite, stone (crushed basalt, 1953), vermiculite (1954), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3). Excludes value of clays used for cement (1951–53)......	------	37,766,254	------	38,936,141	------	[5] 51,609,066	------	68,472,718
Total Colorado......	------	179,435,000	------	187,589,000	------	[5] 211,586,000	------	[6] 256,197,000

CONNECTICUT

Beryllium concentrate ... gross weight	----------	----------	----------	----------	33	$14,321	13	$7,976
Clays	275,900	$252,725	157,500	$157,500	438,200	448,260	288,807	284,652
Feldspar ... long tons	13,811	107,083	10,929	87,432	9,829	63,049	9,280	60,463
Peat	5,586	33,702	10,300	(3)	7,475	30,450	5,856	23,724
Quartz from pegmatites and quartzite	29,273	175,638	(3)	(3)	(3)	(3)	(12)	(12)
Sand and gravel	2,321,715	1,708,910	2,581,247	1,933,214	3,025,840	2,347,750	4,846,282	4,314,557
Stone (except limestone for lime, 1951-53)	2,278,466	3,360,378	2,837,045	4,101,060	[8] 2,826,568	[8] 4,235,327	2,829,198	4,269,430
Undistributed: Columbium-tantalum concentrate (1953-54), lime, mica, stone (dimension basalt, 1953), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)	----------	608,407	----------	845,491	----------	778,303	----------	[13] 620,099
Total Connecticut	----------	6,247,000	----------	7,125,000	----------	7,917,000	----------	9,581,000

DELAWARE

Clays	35,950	$35,450	(3)	(3)	(3)	(3)	(3)	(3)
Sand and gravel	454,563	303,643	515,399	$382,484	520,817	$399,685	971,647	$752,528
Stone	99,201	245,002	94,911	251,759	80,364	215,382	(3)	(3)
Undistributed: Nonmetallic minerals and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)	----------	----------	----------	42,805	----------	43,930	----------	194,706
Total Delaware	----------	584,000	----------	677,000	----------	659,000	----------	947,000

FLORIDA

Clays	202,821	$2,359,113	197,711	$2,071,185	257,911	$2,952,359	371,948	$3,337,130
Natural gas ... million cubic feet	10	1,000	15	1,000	34	2,000	35	3,000
Peat	25,748	161,417	23,729	154,164	27,678	185,524	37,449	168,004
Petroleum (crude) ... thousand 42-gallon barrels	596	(3)	591	(3)	543	(3)	[4] 548	(3)
Phosphate rock [14] ... long tons	8,211,820	48,611,992	9,205,138	54,085,524	9,331,002	56,524,701	10,437,197	64,499,877
Sand and gravel	4,418,573	4,300,682	4,154,613	3,848,077	3,731,432	3,199,368	3,468,842	2,661,152
Stone (except limestone for cement and lime, 1951-53)	8,032,966	9,419,682	7,836,634	9,577,541	9,428,959	11,309,421	14,225,356	16,832,066
Titanium concentrate:								
Ilmenite ... gross weight	(3)	(3)	(3)	(3)	151,109	2,322,451	157,157	2,411,823
Rutile ... do	(3)	(3)	(3)	(3)	6,476	702,791	7,305	869,677
Zirconium concentrate	(3)	(3)	(3)	(3)	21,234	793,685	17,959	820,041
Undistributed: Cement, abrasive garnet, lime, stone (dimension limestone 1953-54), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3). Excludes value of clays used for cement (1951-53)	----------	12,043,100	----------	13,140,989	----------	14,343,637	----------	15,955,786
Total Florida	----------	76,897,000	----------	82,878,000	----------	92,336,000	----------	[6] 106,510,000

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1951–54, by States [1]—Continued

GEORGIA

Mineral	1951		1952		1953		1954	
	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	2,603,338	$23,199,758	2,562,182	$23,137,507	2,651,153	$23,455,315	2,711,422	$24,106,926
Coal	(3)	(3)	32,100	160,500	14,100	70,500	8,090	40,450
Gold (recoverable content of ores, etc.) troy ounces	3	105			2	70		
Iron ore (usable) long tons, gross weight	357,754	1,339,248	319,959	1,439,251	259,964	1,100,725	221,576	871,901
Lime (open-market)	10,616	104,626	7,854	87,587	9,345	95,484	(3)	(3)
Mica (sheet) pounds	(3)	(3)	13,010	18,852	14,063	73,806	(3)	(3)
Peat	2,250	41,000	2,150	38,000	2,305	(3)	5,150	60,920
Sand and gravel	1,226,231	1,041,561	2,133,970	2,029,367	2,051,058	1,900,987	2,703,281	2,466,352
Sand and sandstone (ground)	1,874	18,740	1,765	17,650	(3)	(3)	(15)	(15)
Stone (except limestone for cement and lime, 1951–53)	[8] 5,225,233	[8] 13,933,240	[8] 7,132,082	[8] 17,166,108	[8] 7,112,024	[8] 17,756,302	8,057,600	21,384,227
Talc and soapstone	[10] 77,895	[10] 823,133	[10] 56,491	[10] 653,144	[11] 57,891	[11] 202,619	[11] 50,536	[11] 176,876
Undistributed: Asbestos, barite, bauxite, beryllium concentrate (1952–54), cement, feldspar (1951, 1954), iron oxide pigments (1954), manganese ore (1954), scrap mica, slate, and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3). Excludes value of clays used for cement (1951–53)		6,173,277		6,701,729		6,739,022		7,456,459
Total Georgia		46,675,000		51,450,000		51,395,000		[6] 55,803,000

IDAHO

Mineral	1951		1952		1953		1954	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
Antimony ore and concentrate gross weight	8,805	(3)	4,173	(3)	(3)	(3)	4,682	(3)
Beryllium concentrate					1	$491	(3)	(3)
Clays	28,281	$42,545	23,533	$24,683	26,229	21,339	(3)	(3)
Cobalt (content of ore) pounds			196,516	(3)	1,211,039	(3)	1,702,272	(3)
Copper (recoverable content of ores, etc.)	2,160	1,045,440	3,213	1,555,092	3,136	1,800,064	4,828	$2,848,520
Gold (recoverable content of ores, etc.) troy ounces	45,064	1,577,240	32,997	1,154,895	17,630	617,050	13,245	463,575
Gypsum	65	293	400	1,200	150	450	(3)	(3)
Lead (recoverable content of ores, etc.)	76,713	26,542,698	73,719	23,737,518	74,610	19,547,820	69,302	18,988,748
Mercury 76-pound flasks	357	75,016	887	176,602	(3)	(3)	609	161,013
Mica:								
Scrap			170	5,100			(3)	(3)
Sheet pounds			20,020	115,572	24,216	223,266	(3)	(3)

Nickel ore ... do	-----	-----	-----	-----	21, 254	(3)	25, 726	(3)
Peat	-----	-----	-----	-----	-----	-----	500	(3)
Phosphate rock [14] ... long tons	693, 127	2, 122, 824	866, 330	2, 950, 160	1, 001, 969	4, 149, 943	1, 092, 817	5, 686, 609
Pumice and pumicite	83, 528	133, 192	88, 085	141, 253	85, 224	159, 833	(3)	(3)
Sand and gravel	4, 057, 391	2, 971, 264	3, 925, 863	2, 745, 201	3, 776, 180	2, 841, 440	6, 717, 700	4, 568, 919
Sand and sandstone (ground)	11, 968	107, 738	9, 500	80, 000	5, 304	43, 865	(15)	(15)
Silver (recoverable content of ores, etc.) ... troy ounces	14, 753, 023	13, 352, 231	14, 923, 165	13, 506, 218	14, 639, 740	13, 249, 704	15, 867, 414	14, 360, 811
Stone (except limestone for cement, 1951–53)	1, 457, 182	1, 811, 422	[8] 1, 630, 034	[8] 2, 441, 236	1, 141, 626	2, 260, 875	2, 329, 005	3, 012, 613
Titanium-iron concentrate (nontitanium use)	(3)	(3)	-----	-----	1, 585	7, 500	-----	-----
Tungsten concentrate ... 60-percent WO_3 basis	377	1, 402, 866	333	1, 245, 499	441	1, 665, 983	471	(3)
Zinc (recoverable content of ores, etc.)	78, 121	28, 436, 044	74, 317	24, 673, 244	72, 153	16, 595, 190	61, 528	13, 290, 048
Undistributed: Barite, cement, columbium-tantalum concentrate (1953), abrasive garnet, fluorspar (1951–53), quartz (1953), stone (crushed limestone, 1952), titanium concentrate (1951), vanadium, and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)	-----	3, 550, 445	-----	3, 294, 115	-----	[5] 3, 814, 751	-----	[13] 6, 312, 007
Total Idaho	-----	83, 171, 000	-----	77, 848, 000	-----	[5] 67, 000, 000	-----	69, 693, 000

ILLINOIS

Cement ... 376-pound barrels	8, 377, 387	$19, 853, 132	8, 710, 621	$20, 600, 347	8, 651, 385	$21, 961, 761	9, 109, 076	$23, 147, 871
Clays	2, 589, 464	4, 026, 294	2, 337, 023	3, 871, 051	2, 305, 202	4, 573, 001	2, 027, 092	3, 482, 450
Coal	54, 199, 875	220, 547, 562	45, 789, 982	187, 827, 712	46, 009, 891	181, 597, 998	41, 971, 136	160, 213, 063
Fluorspar	204, 328	9, 294, 703	188, 293	9, 481, 223	163, 303	8, 567, 026	107, 830	5, 989, 219
Lead (recoverable content of ores, etc.)	3, 160	1, 093, 360	4, 262	1, 372, 364	3, 391	888, 442	3, 232	885, 568
Lime (open-market)	462, 690	5, 878, 289	460, 775	5, 917, 038	519, 992	6, 986, 560	532, 051	7, 420, 849
Natural-gas (marketed production) ... million cubic feet	11, 425	1, 748, 000	10, 183	1, 650, 000	9, 282	1, 559, 000	9, 475	1, 345, 000
Natural-gas liquids: LP-gases ... thousand gallons	86, 982	4, 727, 000	(3)	(3)	(3)	(3)	(3)	(3)
Peat	(3)	(3)	(3)	(3)	2, 151	(3)	(3)	(3)
Petroleum (crude) ... thousand 42-gallon barrels	60, 243	166, 870, 000	60, 089	165, 850, 000	59, 026	170, 590, 000	[4] 66, 798	[4] 199, 060, 000
Sand and gravel	20, 130, 567	19, 146, 502	19, 584, 308	19, 214, 195	21, 521, 806	20, 540, 549	24, 443, 055	26, 164, 387
Sand and sandstone (ground)	262, 488	2, 300, 102	267, 180	2, 342, 549	276, 215	2, 461, 767	(15)	(15)
Silver (recoverable content of ores, etc.) ... troy ounces	3, 465	3, 136	3, 781	3, 422	2, 338	2, 116	1, 160	1, 050
Stone (except limestone for cement and lime, 1951–53)	19, 298, 968	23, 474, 516	22, 334, 887	28, 326, 060	22, 938, 732	29, 736, 966	26, 407, 088	31, 134, 135
Zinc (recoverable content of ores, etc.)	21, 776	7, 926, 464	18, 816	6, 246, 912	14, 556	3, 347, 880	14, 427	3, 116, 232
Undistributed: Iron oxide pigments (1954), natural gasoline, recovered elemental sulfur (1953–54), tripoli, and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3). Excludes value of clays used for cement (1951–53)	-----	3, 045, 410	-----	7, 302, 545	-----	9, 629, 924	-----	13, 060, 485
Total Illinois	-----	489, 934, 000	-----	460, 005, 000	-----	462, 443, 000	-----	[6] 473, 077, 000

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1951–54, by States [1]—Continued

INDIANA

Mineral	1951 Short tons (unless otherwise stated)	1951 Value	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value	1954 Short tons (unless otherwise stated)	1954 Value
Clays	1, 524, 731	$1, 914, 457	1, 331, 298	$1, 700, 209	1, 654, 112	$2, 514, 227	1, 946, 069	$2, 990, 716
Coal	19, 450, 445	78, 617, 530	16, 350, 202	64, 977, 328	15, 812, 485	62, 353, 519	13, 400, 188	48, 913, 455
Marl, calcareous (except for cement)	12, 960	18, 129	16, 414	9, 021	13, 540	6, 398	28, 536	18, 515
Natural gas million cubic feet	845	83, 000	836	79, 000	701	49, 000	735	44, 000
Peat	5, 699	22, 824	10, 115	49, 775	6, 919	41, 049	12, 041	59, 149
Petroleum (crude) thousand 42-gallon barrels	11, 100	30, 530, 000	12, 037	33, 100, 000	12, 823	37, 570, 000	[4] 11, 204	[4] 33, 160, 000
Sand and gravel	11, 030, 814	8, 763, 936	11, 546, 014	9, 279, 908	11, 203, 059	9, 500, 914	14, 405, 098	11, 879, 316
Stone (except limestone for cement and lime, 1951–53)	[8] 8, 641, 670	[8] 23, 729, 433	9, 126, 837	21, 965, 454	9, 212, 887	22, 297, 183	11, 181, 838	27, 460, 119
Undistributed: Abrasive stones, cement, lime, pyrites (1951–53), stone (dimension sandstone, 1951), and recovered elemental sulfur (1952–54). Excludes value of clays used for cement (1951–53)		30, 708, 810		30, 870, 155		35, 448, 379		42, 388, 935
Total Indiana		174, 388, 000		162, 031, 000		169, 781, 000		[6] 165, 369, 000

IOWA

Mineral	1951 Short tons (unless otherwise stated)	1951 Value	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value	1954 Short tons (unless otherwise stated)	1954 Value
Cement 376-pound barrels	8, 024, 492	$19, 800, 084	9, 336, 727	$22, 849, 597	9, 111, 358	$23, 330, 177	9, 858, 889	$27, 044, 464
Clays	915, 802	1, 061, 898	864, 667	2, 681, 789	913, 413	974, 539	882, 849	920, 859
Coal	1, 630, 298	6, 109, 776	1, 380, 733	5, 297, 074	1, 388, 006	5, 262, 373	1, 196, 698	4, 502, 561
Gypsum	1, 127, 705	2, 881, 150	1, 122, 409	2, 797, 704	1, 151, 692	2, 939, 654	1, 106, 626	3, 035, 651
Lead (recoverable content of ores, etc.)							4	1, 096
Peat	13, 545	107, 909	14, 500	110, 334	17, 233	(3)	(3)	(3)
Sand and gravel	9, 943, 372	5, 916, 950	10, 796, 979	6, 032, 898	10, 385, 322	6, 400, 827	12, 199, 656	9, 276, 530
Stone (except limestone for cement, 1951–53)	9, 261, 317	12, 170, 082	9, 899, 404	13, 036, 726	10, 715, 078	13, 215, 352	13, 240, 087	16, 388, 141
Undistributed: Nonmetallic minerals and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)						224, 242		251, 173
Total Iowa		[16] 47, 706, 000		[16] 52, 481, 000		[16] 51, 994, 000		[6] 58, 798, 000

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KANSAS

Cement [17] ... 376-pound barrels	8,163,916	$19,413,144	8,811,762	$20,956,886	8,546,250	$21,428,536	9,076,328	$23,874,179
Clays	731,960	728,921	665,582	789,293	670,694	749,579	(3)	(3)
Coal	1,961,101	7,734,478	2,028,601	7,902,590	1,715,004	7,101,386	1,372,294	5,602,808
Helium ... cubic feet	26,280,000	327,000	38,509,000	491,000	42,782,800	563,923	37,530,000	593,163
Lead (recoverable content of ores, etc.)	8,947	3,095,662	5,916	1,904,952	3,347	876,914	4,033	1,105,042
Natural gas (marketed production) ... million cubic feet	417,538	33,821,000	412,544	34,241,000	420,607	36,172,000	412,369	43,711,000
Natural-gas liquids:								
Natural gasoline ... thousand gallons	111,090	6,931,000	115,206	7,286,000	(3)	(3)	(3)	(3)
LP-gases ... do	68,082	2,445,000	77,406	3,116,000	(3)	(3)	(3)	(3)
Petroleum (crude) ... thousand 42-gallon barrels	114,522	294,320,000	114,807	293,910,000	114,566	308,180,000	[4] 119,317	[4] 335,280,000
Pumicite	(3)	(3)	(3)	(3)	(3)	(3)	23,433	92,899
Salt (common)	900,917	6,639,343	911,744	6,850,027	905,227	7,480,556	876,667	7,778,406
Sand and gravel	7,676,888	4,747,544	8,380,065	5,023,593	8,728,291	5,668,308	10,421,554	7,194,171
Stone (except limestone for cement, 1951-53)	7,191,483	9,058,512	8,830,871	12,051,740	8,769,152	11,303,950	10,377,008	12,941,822
Zinc (recoverable content of ores, etc.)	28,904	10,521,056	25,482	8,460,024	15,515	3,568,450	19,110	4,127,760
Undistributed: Natural cement, gypsum, and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3). Excludes value of clays used for cement (1951-53)		303,946		386,847		10,137,870		9,721,342
Total Kansas		400,087,000		403,370,000		413,231,000		[6] 449,587,000

KENTUCKY

Clays	880,240	$5,274,285	880,874	$5,101,266	711,209	$3,118,352	571,481	$2,994,926
Coal	74,972,335	366,686,901	66,114,341	317,386,725	65,060,478	302,871,877	56,964,408	236,736,940
Fluorspar	68,635	2,334,485	48,308	1,863,262	47,244	2,100,493	35,831	1,510,344
Lead (recoverable content of ores, etc.)	107	37,022	60	19,320	52	13,624	80	21,920
Natural gas (marketed production) ... million cubic feet	76,097	16,513,000	73,427	15,934,000	71,405	15,638,000	72,713	16,579,000
Natural-gas liquids:								
Natural gasoline ... thousand gallons	11,130	799,000	30,660	2,191,000	35,406	2,394,000	28,224	1,552,000
LP-gases ... do	79,842	2,129,000	156,198	3,963,000	176,232	4,993,000	189,966	5,066,000
Petroleum (crude) ... thousand 42-gallon barrels	11,622	32,190,000	11,918	32,890,000	11,518	33,520,000	[4] 13,791	[4] 40,270,000
Sand and gravel	2,801,639	2,434,799	3,334,261	2,656,053	3,052,155	2,899,932	4,729,606	4,401,793
Stone (except limestone for cement, 1951-53)	7,048,771	8,609,609	[8] 8,817,859	[8] 10,816,707	[8] 7,429,505	[8] 9,268,237	10,129,725	13,285,786
Zinc (recoverable content of ores, etc.)	3,457	1,258,348	3,280	1,088,960	489	112,470	458	98,928
Undistributed: Native asphalt, cement, stone (dimension sandstone, 1952-53.) Excludes value of clays used for cement (1951-53)		3,997,061		4,535,564		4,811,752		5,625,951
Total Kentucky		442,264,000		398,446,000		381,742,000		[6] 327,503,000

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1951–54, by States [1]—Continued

LOUISIANA

Mineral	1951		1952		1953		1954	
	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	306, 542	$306, 542	390, 136	$433, 808	624, 427	$951, 612	(3)	(3)
Natural gas (marketed production) million cubic feet	1, 054, 199	61, 143, 000	1, 237, 143	82, 889, 000	1, 293, 644	106, 079, 000	1, 399, 222	$124, 531, 000
Natural-gas liquids:								
Natural gasoline and cycle products thousand gallons	657, 006	49, 202, 000	672, 042	48, 579, 000	665, 532	55, 421, 000	665, 070	54, 330, 000
LP-gases do	287, 238	15, 374, 000	297, 444	14, 890, 000	287, 280	12, 654, 000	292, 226	11, 620, 000
Petroleum (crude) thousand 42-gallon barrels	232, 281	614, 680, 000	243, 929	645, 090, 000	256, 632	721, 150, 000	[4] 246, 558	[4] 722, 370, 000
Salt (common)	2, 737, 149	7, 662, 179	2, 553, 448	7, 807, 693	3, 061, 234	9, 189, 526	3, 088, 686	11, 101, 456
Sand and gravel	6, 384, 328	7, 419, 570	6, 005, 119	6, 736, 524	4, 538, 387	5, 162, 248	7, 910, 152	9, 686, 635
Sulfur (Frasch-process) long tons	1, 152, 821	25, 400, 000	1, 449, 668	32, 015, 000	1, 609, 364	43, 453, 000	1, 853, 563	49, 222, 394
Undistributed: Cement, gypsum, lime (1953–54), stone (except limestone for cement, 1952; and crushed limestone, 1954), recovered elemental sulfur (1952–54), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3). Excludes value of clays used for cement (1951–53)		6, 490, 595		9, 959, 888		11, 176, 929		14, 367, 681
Total Louisiana		787, 678, 000		848, 401, 000		965, 237, 000		[13] 996, 978, 000

MAINE

Mineral	1951 Short tons	1951 Value	1952 Short tons	1952 Value	1953 Short tons	1953 Value	1954 Short tons	1954 Value
Cement 376-pound barrels	1, 236, 299	$3, 182, 918	1, 457, 250	$3, 750, 483	2, 001, 464	$5, 422, 272	1, 973, 249	$5, 425, 184
Clays	21, 885	21, 885	26, 050	26, 050	29, 661	27, 476	26, 872	26, 872
Feldspar long tons	19, 273	154, 695	18, 644	147, 371	17, 637	117, 090	(3)	(3)
Peat	1, 805	36, 870	1, 695	57, 541	2, 428	73, 564	2, 350	99, 831
Sand and gravel	5, 366, 694	1, 817, 317	7, 078, 078	2, 187, 531	8, 071, 937	2, 608, 386	7, 460, 620	2, 538, 143
Stone (except limestone for cement and lime, 1951–53)	644, 594	2, 582, 541	[8] 316, 874	[8] 1, 795, 768	[8] 248, 501	[8] 1, 215, 439	1, 023, 709	2, 355, 385
Undistributed: Beryllium concentrate, columbium-tantalum concentrate (1951, 1953–54), gem stones (1951 and 1954), lime, mica, quartz from pegmatites or quartzite (1951–53), slate, stone (crushed limestone, 1952–53), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)		720, 095		1, 015, 827		1, 038, 883		801, 140
Total Maine		8, 516, 000		8, 981, 000		10, 503, 000		[13] 10, 716, 000

MARYLAND								
Clays	756,987	$1,414,342	771,922	$1,426,556	[5] 671,164	[5] $1,135,700	627,311	$1,165,747
Coal	588,639	2,781,343	587,903	2,694,842	530,590	2,441,605	421,616	1,879,018
Gold (recoverable content of ores, etc.) troy ounces	1	35						
Lime (open-market)	67,684	722,011	72,885	746,893	71,705	707,736	67,081	685,427
Natural gas (marketed production) million cubic feet	3,422	684,000	2,372	460,000	1,408	268,000	1,394	282,000
Sand and gravel	7,054,488	8,170,851	6,956,640	8,136,697	7,379,511	8,919,088	10,097,800	12,171,613
Stone (except limestone for cement and lime, 1951-53)	3,181,434	5,983,380	[8] 3,391,679	[8] 6,330,443	[8] 3,578,250	[8] 6,275,124	5,064,526	8,265,521
Undistributed: Beryllium concentrate (1954), cement, greensand marl (1954), mica (1954), potassium salts, quartz (1952), slate, stone, (dimension limestone and crushed marble, 1952-53), recovered elemental sulfur (1951), and talc and soapstone. Excludes value of clays used for cement (1951-53)		6,396,886		7,051,145		7,337,486		7,288,888
Total Maryland		26,153,000		26,847,000		27,085,000		[6] 30,743,000
MASSACHUSETTS								
Clays	150,370	$167,646	140,148	$160,371	152,117	$195,837	128,998	$121,049
Lime (open-market)	143,316	1,930,225	132,135	1,999,545	135,383	2,156,205	127,836	1,709,341
Peat	(3)	(3)	(3)	(3)	2,061	15,962	(3)	(3)
Quartz from pegmatites and quartzite	2,186	17,489	(3)	(3)	(3)	(3)	(12)	(12)
Sand and gravel	7,232,088	5,592,640	7,645,728	6,128,744	7,308,190	5,930,894	9,640,274	8,366,409
Stone (except limestone for lime, 1951-53)	[8] 3,225,839	[8] 9,172,425	[8] 3,355,819	[8] 9,331,871	3,457,708	8,821,108	2,942,435	9,039,590
Undistributed: Nonmetallic minerals		196,694		191,752		71,368		12,077
Total Massachusetts		17,077,000		17,812,000		17,191,000		[13] 18,851,000
MICHIGAN								
Cement 376-pound barrels	14,112,639	$35,121,324	14,760,783	$36,819,042	15,853,096	$41,860,464	16,711,710	$45,691,867
Clays	1,511,087	1,581,815	1,775,917	1,810,916	1,645,804	1,686,113	1,870,814	1,919,204
Coal	7,347	74,861						
Copper (recoverable content of ores, etc.)	24,979	12,089,836	21,699	10,502,316	24,097	13,831,678	23,593	13,919,870
Gypsum	1,566,276	4,402,725	1,487,642	4,200,418	1,446,973	4,091,002	1,693,279	5,035,550
Iron ore (usable) long tons, gross weight	13,611,621	81,765,748	11,779,366	76,088,935	13,312,766	94,691,612	9,709,167	70,004,504
Magnesium compounds from well brines (partly estimated) MgO equivalent	38,306	4,355,820	38,449	3,917,138	43,190	4,591,922	37,038	4,103,766
Manganiferous ore (5 to 35 percent Mn) gross weight	69,626	(3)	22,095	(3)	76,251	(3)	15,361	(3)
Marl, calcareous (except for cement)	178,010	96,639	164,519	86,529	183,685	72,781	106,668	37,724
Natural gas (marketed production) million cubic feet	11,194	1,657,000	9,052	1,322,000	7,774	1,275,000	6,962	1,239,000
Peat	20,180	320,100	29,304	419,856	25,439	257,176	27,847	429,116
Petroleum (crude) thousand 42-gallon barrels	13,927	37,880,000	13,251	35,250,000	12,285	35,870,000	[4] 12,028	[4] 35,600,000
Salt (common)	5,137,639	21,221,330	4,778,347	21,446,382	5,127,387	22,171,988	5,063,633	29,396,812
Sand and gravel	27,540,921	20,976,632	29,193,763	22,400,879	30,459,663	23,170,802	32,040,639	25,516,169

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1951–54, by States [1]—Continued

MICHIGAN—Continued

Mineral	1951 Short tons (unless otherwise stated)	1951 Value	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value	1954 Short tons (unless otherwise stated)	1954 Value
Stone (except limestone for cement and lime, 1951–53)	20, 851, 733	$17, 514, 720	17, 973, 685	$15, 770, 816	21, 615, 686	$17, 639, 525	27, 758, 443	$21, 904, 517
Undistributed: Bromine, calcium-magnesium chloride, iron oxide pigments (1954), lime, magnesium chloride (for metal), natural-gas liquids (natural gasoline, LP-gases, 1952–54), potassium salts, ground sand and sandstone (1951–53), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3). Excludes value of clays used for cement (1951–53)		19, 412, 250		24, 482, 809		25, 276, 772		29, 052, 541
Total Michigan		258, 471, 000		254, 518, 000		286, 487, 000		[6] 280, 150, 000
MINNESOTA								
Clays	129, 942	$187, 605	113, 492	$160, 408	91, 401	$149, 384	(3)	(3)
Iron ore (usable) long tons, gross weight	78, 164, 527	411, 468, 895	63, 906, 069	375, 765, 251	80, 533, 670	517, 850, 509	48, 613, 338	$319, 632, 491
Manganiferous ore (5 to 35 percent Mn) gross weight	1, 010, 651	(3)	912, 118	(3)	1, 091, 491	(3)	504, 057	(3)
Marl, calcareous (except for cement)	2, 925	1, 549	1, 449	722	(3)	(3)	(3)	(3)
Sand and gravel	17, 229, 526	6, 008, 994	19, 825, 157	6, 808, 763	19, 774, 411	7, 304, 351	23, 848, 856	16, 318, 520
Stone (except limestone for cement and lime, 1951–53)	[8] 1, 906, 407	[8] 5, 613, 157	[8] 2, 394, 178	[8] 5, 498, 177	2, 270, 528	6, 587, 096	[8] 2, 629, 456	[8] 7, 485, 291
Undistributed: Abrasive stones, cement, iron oxide pigments (1954), lime, peat (1954), stone (crushed sandstone, 1951 and 1954 and crushed basalt, 1952) and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)		9, 296, 790		9, 206, 865		10, 653, 888		8, 205, 868
Total Minnesota		432, 577, 000		397, 440, 000		542, 545, 000		[13] 351, 475, 000
MISSISSIPPI								
Clays	673, 078	$4. 250, 253	509, 099	$2, 681, 563	560, 047	$3, 158, 385	559, 401	$3, 103, 132
Natural gas (marketed production) million cubic feet	158, 845	10, 007, 000	174, 100	10, 620, 000	154, 254	12, 340, 000	140, 448	11, 657, 000
Natural-gas liquids:								
Natural gasoline and cycle products thousand gallons	30, 618	2, 503, 000	33, 726	2, 606. 000	32, 214	2, 295, 000	27, 804	1, 944, 000
LP-gases do	19, 866	852, 000	19, 614	777, 000	17, 724	713. 000	15, 288	528, 000
Petroleum (crude) thousand 42-gallon barrels	37, 039	82, 970, 000	36, 310	80, 970, 000	35, 620	84, 060, 000	[4] 34, 240	[4] 85, 600, 000

Sand and gravel	3,012,152	2,279,034	2,296,577	1,833,306	2,653,646	2,173,871	5,441,837	4,286,871
Stone	171,131	168,933	90,000	103,500	38,000	43,700	91,218	[4] 181,418
Undistributed: Nonmetallic minerals. Excludes value of clays used for cement (1951–53)	----------	----------	----------	2,283,312	----------	3,083,749	----------	3,352,481
Total Mississippi	----------	103,030,000	----------	101,875,000	----------	107,868,000	----------	[13] 110,563,000
MISSOURI								
Barite	281,895	$2,697,200	304,080	$2,919,795	330,763	$3,338,395	312,791	$3,047,436
Cement ... 376-pound barrels	10,217,421	25,760,473	10,086,850	25,523,038	9,860,179	26,238,460	11,379,257	31,425,190
Clays	2,354,857	10,558,438	2,991,019	12,098,420	2,231,596	11,182,096	1,927,285	5,858,756
Coal	3,269,283	13,405,436	2,954,450	12,048,141	2,393.304	9,848,903	2,513,593	10,028,293
Copper (recoverable content of ores, etc.)	2,422	1,172,248	2,576	1,246,784	2,374	1,362,676	1,925	1,135,750
Iron ore (usable) ... long tons, gross weight	172,466	(3)	268,218	(3)	274,693	(3)	173,394	(3)
Lead (recoverable content of ores, etc.)	123,702	42,800,892	129,245	41,616,890	125,895	32,984,490	125,250	34,318,500
Lime (open-market)	1,122,299	11,285,877	1,130,970	11,326,941	1,212,107	12,084,130	1,125,919	11,165,381
Natural gas (marketed production) ... million cubic feet	14	2,000	16	3,000	15	3,000	16	(3)
Petroleum (crude) ... thousand 42-gallon barrels	24	(3)	21	(3)	39	(3)	(3)	(3)
Sand and gravel	6,809,857	5,969,849	6,790,422	6,122,195	5,792,058	5,233,999	9,891,305	10,203,481
Silver (recoverable content of ores, etc.) ... troy ounces	184,424	166,913	517,432	468,302	359,781	325,620	352,971	319,457
Stone (except limestone for cement and lime, 1951–53)	11,294,227	15,255,427	15,106,544	20,676,958	[5] 13,947,834	[5] 20,552,840	18,615,739	24,695,110
Zinc (recoverable content of ores, etc.)	11,476	4,177,264	13,986	4,643,352	9,981	2,295,630	5,210	1,125,360
Undistributed: Native asphalt, manganese ore (1953–54), ground sand and sandstone (1951–53), stone (dimension marble, 1953), tripoli, and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3). Excludes value of clays used for cement (1951–53)	----------	1,997,134	----------	2,283,550	----------	[5] 2,756,746	----------	2,908,454
Total Missouri	----------	135,249,000	----------	140,977,000	----------	128,207,000	----------	[6] 131,280,000
MONTANA								
Antimony ore and concentrate ... gross weight	29	(3)	----------	----------	(3)	(3)	----------	----------
Chromite ... do	----------	----------	----------	----------	26,089	$869,958	123,096	$4,132,475
Clays	39,231	$41,631	51,304	$73,601	36,994	38,312	(3)	(3)
Coal:								
Bituminous	2,310,348	6,038,638	2,038,808	5,698,778	1,848,334	4,884,209	1,490,846	4,157,325
Lignite	35,070	123,263	30,550	112,953	24,803	93,551	(3)	(3)
Copper (recoverable content of ores, etc.)	57,406	27,784,504	61,948	29,982,832	77,617	44,552,158	59,349	35,015,910
Fluorspar	----------	----------	16,160	(3)	5,932	(3)	15,102	(3)
Gold (recoverable content of ores, etc.) ... troy ounces	30,502	1,067,570	24,161	845,635	24,768	866,880	23,660	828,100
Iron ore (usable) ... long tons, gross weight	----------	----------	----------	----------	6,709	45,083	6,473	(3)
Lead (recoverable content of ores, etc.)	21,302	7,370,492	21,279	6,851,838	19,949	5,226,638	14,820	4,060,680
Manganese ore (35 percent or more Mn) ... gross weight	100,562	(3)	100,070	(3)	113,429	(3)	58,661	(3)
Manganiferous ore (5 to 35 percent Mn) ... do	7,598	(3)	9,357	(3)	5,598	(3)	5,266	(3)
Natural gas (marketed production) ... million cubic feet	36,424	2,003,000	28,714	1,752,000	27,889	1,645,000	30,252	2,057,000

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1951–54, by States [1]—Continued

MONTANA—Continued

Mineral	1951		1952		1953		1954	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
Natural-gas liquids:								
Natural gasoline .... thousand gallons	4,746	$392,000	(3)	(3)	(3)	(3)	(3)	(3)
LP-gases .... do	6,888	481,000	(3)	(3)	(3)	(3)	(3)	(3)
Petroleum (crude) .... thousand 42-gallon barrels	8,958	22,130,000	9,606	$21,610,000	11,920	$26,020,000	[4] 14,195	[4] $31,230,000
Pumice and pumicite	(3)	(3)	----	----	3,000	15,000	175	920
Sand and gravel	9,582,843	6,201,888	6,765,955	3,579,932	6,203,480	2,993,575	13,340,544	7,460,260
Silver (recoverable content of ores, etc.) .... troy ounces	6,393,768	5,786,683	6,138,185	5,555,367	6,689,556	6,054,386	5,177,942	4,686,299
Stone (except limestone for cement and lime, 1951–53)	871,508	986,327	[8] 690,081	[8] 792,897	[8] 802,735	[8] 1,124,731	1,319,829	1,385,239
Tungsten concentrate .... 60-percent WO_3 basis	1	2,832	----	----	14	(3)	678	(3)
Zinc (recoverable content of ores, etc.)	85,551	31,140,564	82,185	27,285,420	80,271	18,462,330	60,952	13,165,632
Undistributed: Barite, cement, gem stones (1951 and 1954), gypsum lime, sheet mica (1954), phosphate rock, pyrites, sodium sulfate (1951) stone (dimension granite, 1952–53), talc, vermiculite, and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)	----	14,825,330	----	17,928,016	----	19,292,629	----	18,518,856
Total Montana	----	126,376,000	----	122,069,000	----	132,184,000	----	[13] 126,412,000

NEBRASKA

Mineral	1951		1952		1953		1954	
	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	115,845	$116,345	167,228	$167,703	175,856	$186,893	163,831	$163,831
Natural gas (marketed production) .... million cubic feet	3,895	499,000	5,568	740,000	6,748	911,000	6,801	796,000
Petroleum (crude) .... thousand 42-gallon barrels	2,558	5,960,000	2,260	6,490,000	6,344	17,190,000	[4] 7,783	[4] 21,400,000
Sand and gravel	4,969,243	3,477,409	5,436,540	3,874,106	5,969,858	4,340,163	8,547,876	6,992,314
Stone (except limestone for cement, 1951–53)	942,967	1,437,899	1,245,106	1,946,448	1,407,158	2,069,984	2,660,170	3,511,494
Undistributed: Cement, natural-gas liquids, and pumice and pumicite. Excludes value of clays used in cement (1951–53)	----	6,978,760	----	7,378,888	----	8,582,904	----	10,637,123
Total Nebraska	----	18,469,000	----	20,597,000	----	33,281,000	----	[6] 42,393,000

NEVADA

Antimony ore and concentrate .... gross weight	156	(3)	152	(3)	20	(3)	4	(3)
Barite	63, 201	$387, 026	68, 062	$391, 242	99, 525	$614, 686	83, 833	$517, 492
Clays	3, 220	33, 420	3, 958	36, 278	(3)	(3)	5, 478	8, 787
Copper (recoverable content of ores, etc.)	56, 474	27, 333, 416	57, 537	27, 847, 908	61, 850	35, 501, 900	70, 217	41, 428, 030
Gold (recoverable content of ores, etc.) .... troy ounces	121, 036	4, 236, 260	117, 203	4, 102, 105	101, 799	3, 562, 965	79, 067	2, 767, 345
Gypsum	643, 637	1, 811, 757	608, 284	1, 666, 938	701, 584	1, 975, 053	654, 422	2, 217, 273
Iron ore (usable) .... long tons, gross weight	299, 010	898, 306	911, 657	3, 991, 970	444, 081	2, 647, 859	351, 250	2, 024, 794
Lead (recoverable content of ores, etc.)	7, 148	2, 473, 208	6, 790	2, 186, 380	4, 371	1, 145, 202	3, 041	833, 234
Manganese ore (35 percent or more Mn) .... gross weight	328	(3)	695	(3)	20, 150	1, 684, 555	(3)	(3)
Manganiferous ore (5 to 35 percent Mn) .... do	1, 250	(3)	7, 947	(3)	25, 064	431, 559	12, 870	165, 075
Mercury .... 76-pound flasks	1, 400	294, 182	3, 523	701, 429	3, 254	628, 120	4, 974	1, 315, 076
Petroleum (crude) .... thousand 42-gallon barrels	----	----	----	----	----	----	33	40, 000
Pumice and pumicite	(3)	(3)	(3)	(3)	21, 269	86, 366	(3)	(3)
Sand and gravel	2, 616, 629	2, 657, 654	2, 098, 211	2, 380, 419	2, 266, 064	2, 088, 948	3, 531, 291	2, 956, 537
Silver (recoverable content of ores, etc.) .... troy ounces	981, 669	888, 460	941, 195	851, 829	697, 086	630, 898	560, 182	506, 993
Stone (except limestone for lime, 1951–53)	834, 807	959, 815	830, 712	1, 158, 608	1, 035, 568	1, 399, 529	1, 832, 781	2, 010, 592
Talc and soapstone	[10] 6, 919	[10] 152, 878	[10] 7, 580	[10] 180, 328	[11] 10, 906	[11] 72, 971	[11] 5, 866	[11] 53, 582
Tungsten concentrate .... 60-percent WO_3 basis	1, 482	4, 780, 237	2, 329	8, 820, 598	3, 683	13, 824, 238	5, 331	20, 048, 448
Zinc (recoverable content of ores, etc.)	17, 443	6, 349, 252	15, 357	5, 098, 524	5, 812	1, 336, 760	1, 035	223, 560
Undistributed: Brucite, diatomite, fluorspar, gem stones (1952–54), lime, magnesite, calcareous marl, molybdenum, perlite, salt, sulfur ore (1951–53), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)	----	4, 418, 333	----	4, 816, 659	----	5, 891, 368	----	12, 435, 000
Total Nevada	----	57, 674, 000	----	64, 231, 000	----	73, 523, 000	----	[13] 89, 138, 000

NEW HAMPSHIRE

Beryllium concentrate .... gross weight	50	$16, 670	(3)	(3)	57	$32, 640	12	$6, 960
Clays	28, 501	28, 501	30, 135	$30, 135	45, 198	41, 427	35, 681	35, 681
Columbium-tantalum concentrate .... pounds, gross weight	----	----	----	----	770	1, 309	255	433
Feldspar .... long tons	(3)	(3)	(3)	(3)	28, 961	286, 069	(3)	(3)
Mica:								
Sheet .... pounds	----	----	(3)	(3)	90, 716	382, 680	42, 466	234, 450
Scrap	(3)	(3)	(3)	(3)	(3)	(3)	325	11, 583
Sand and gravel	2, 260, 410	517, 927	3, 200, 232	1, 001, 591	2, 249, 001	506, 156	2, 240, 548	1, 094, 474
Stone	[8] 62, 355	[8] 349, 606	69, 850	546, 177	76, 701	538, 897	72, 486	473, 298
Undistributed: Abrasive stones, peat, stone (crushed granite, 1951), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)	----	382, 691	----	366, 597	----	15, 617	----	255, 226
Total New Hampshire	----	1, 295, 000	----	1, 945, 000	----	1, 805, 000	----	2, 112, 000

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1951–54, by States [1]—Continued

NEW JERSEY

Mineral	1951		1952		1953		1954	
	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	683, 439	$2, 106, 628	598, 775	$1, 962, 599	532, 185	$1, 326, 297	578, 344	$1, 246, 099
Iron ore (usable)...long tons, gross weight	657, 930	7, 810, 776	685, 466	6, 760, 467	815, 905	10, 114, 970	476, 192	6, 621, 881
Manganiferous residuum...gross weight	267, 751	(3)	215, 255	(3)	293, 758	(3)	214, 931	(3)
Marl (greensand)	5, 067	263, 944	4, 600	177, 847	6, 821	193, 404	2, 101	184, 834
Peat	27, 678	213, 500	21, 800	191, 664	21, 706	(3)	(3)	(3)
Sand and gravel	6, 652, 383	9, 106, 052	7, 060, 074	9, 473, 428	7, 361, 935	10, 835, 948	10, 005, 325	14, 704, 474
Sand and sandstone (ground)	144, 098	1, 053, 991	138, 434	1, 011, 844	127, 921	918, 534	(16)	(17)
Stone (except limestone for lime, 1951–53)	6, 457, 248	10, 987, 705	6, 102, 324	12, 307, 480	6, 036, 259	13, 307, 856	5, 772, 200	12, 109, 950
Zinc (recoverable content of ores, etc.) [18]	62, 917	24, 279, 745	59, 190	21, 520, 612	45, 700	9, 922, 990	37, 416	7, 992, 058
Undistributed: Lime, magnesium compounds, recovered elemental sulfur, and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)	------------	4, 276, 783	------------	4, 061, 840	------------	5, 325, 148	------------	[13] 4, 184, 432
Total New Jersey	------------	60, 099, 000	------------	57, 468, 000	------------	51, 945, 000	------------	47, 044, 000

NEW MEXICO

Mineral	1951 Short tons	1951 Value	1952 Short tons	1952 Value	1953 Short tons	1953 Value	1954 Short tons	1954 Value
Beryllium concentrate...gross weight	141	$47, 008	101	$29, 185	89	$52, 014	117	$43, 771
Clays	75, 653	148, 876	57, 668	107, 633	49, 089	103, 931	47, 832	83, 085
Coal	782, 698	4, 501, 842	759, 437	4, 382, 286	513, 781	3, 081, 366	123, 099	727, 372
Columbium-tantalum concentrate...pounds, gross weight	------------	------------	------------	------------	(3)	(3)	2, 093	3, 558
Copper (recoverable content of ores, etc.)	73, 558	35, 602, 072	76, 112	36, 838, 208	72, 477	41, 601, 798	60, 558	35, 729, 220
Fluorspar	24, 402	1, 163, 098	16, 443	823, 320	11, 890	(3)	8, 876	(3)
Gold (recoverable content of ores, etc.)...troy ounces	3, 959	138, 565	2, 949	103, 215	2, 614	91, 490	3, 539	123, 865
Gypsum	------------	------------	------------	------------	------------	------------	887	2, 661
Helium...cubic feet	------------	------------	------------	------------	11, 158, 000	150, 127	41, 754, 600	735, 183
Iron ore (usable)...long tons, gross weight	32, 210	(3)	7, 793	(3)	7, 525	(3)	3, 316	(3)
Lead (recoverable content of ores, etc.)	5, 846	2, 022, 716	7, 021	2, 260, 762	2, 943	771, 066	887	243, 038
Manganese ore (35 percent or more Mn)...gross weight	226	(3)	2, 360	(3)	------------	------------	------------	------------
Manganiferous ore (5 to 35 percent Mn)...do	79, 844	(3)	52, 934	(3)	(3)	(3)	20, 546	82, 184
Natural gas (marketed production)...million cubic feet	300, 169	11, 406, 000	359, 377	16, 414, 000	399, 086	24, 344, 000	449, 346	35, 049, 000
Natural-gas liquids:								
Natural gasoline and cycle products...thousand gallons	138, 894	10, 507, 000	163, 926	11, 660, 000	171, 654	10, 094, 000	224, 112	11, 744, 000
LP-gases...do	95, 802	3, 170, 000	114, 408	3, 600, 000	121, 212	4, 618, 000	225, 994	5, 704, 000
Perlite	(3)	(3)	(3)	(3)	84, 891	661, 698	111, 040	885, 824
Petroleum (crude)...thousand 42-gallon barrels	52, 719	129, 160, 000	58, 681	144, [illegible]40, 000	70, 441	185, 260, 000	[4] 74, 820	[4] 205, 760, 000

Potassium salts ... K_2O equivalent	1, 217, 617	37, 209, 740	1, 411, 125	46, 385, 452	1, 552, 831	[5] 58, 076, 435	1, 732, 240	64, 366, 641
Pumice and pumicite	245, 564	884, 311	217, 482	755, 139	528, 649	759, 840	363, 926	1, 060, 096
Salt (common)	(3)	(3)	(3)	(3)	62, 087	216, 364	50, 669	333, 255
Sand and gravel	1, 080, 256	1, 087, 857	496, 921	499, 589	1, 416, 380	1, 238, 979	6, 519, 339	8, 340, 251
Silver (recoverable content of ores, etc.) ... troy ounces	443, 267	401, 179	479, 318	433, 807	205, 309	185, 815	109, 132	98, 770
Stone	1, 022, 901	592, 179	[8] 317, 894	[8] 191, 642	624, 528	510, 713	771, 630	714, 037
Tungsten concentrate ... 60-percent WO_3 basis	...	...	...	...	...	...	(19)	1, 414
Zinc (recoverable content of ores, etc.)	45, 419	16, 532, 516	50, 975	16, 923, 700	13, 373	3, 075, 790	6	1, 296
Undistributed: Barite, carbon dioxide, diatomite (1953-54), gem stones, sheet mica (1954), molybdenum, stone (crushed miscellaneous, 1952), recovered elemental sulfur (1953-54), vanadium, and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)	...	1, 726, 948	...	2, 151, 749	...	1, 686, 990	...	1, 766, 267
Total New Mexico	...	256, 302, 000	...	288, 500, 000	...	[5] 336, 580, 000	...	373, 599, 000

NEW YORK

Cement [17] ... 376-pound barrels	13, 862, 522	$34, 687, 090	14, 624, 274	$36, 679, 379	14, 965, 164	$39, 388, 183	14, 496, 876	$38, 861, 205
Clays	1, 559, 472	1, 632, 878	1, 218, 850	1, 291, 736	960, 791	1, 303, 281	1, 199, 158	1, 493, 503
Emery	11, 634	160, 212	10, 352	141, 911	10, 562	143, 974	9, 758	132, 313
Gypsum	1, 259, 484	4, 010, 766	1, 143, 920	3, 816, 148	987, 156	3, 507, 207	1, 133, 579	4, 005, 353
Iron ore (usable) ... long tons, gross weight	3, 649, 531	39, 819, 368	2, 896, 531	34, 514, 879	3, 414, 859	36, 346, 279	2, 802, 873	31, 706, 570
Lead (recoverable content of ores, etc.)	1, 500	519, 000	1, 120	360, 640	1, 435	375, 970	1, 187	325, 238
Natural gas (marketed production) ... million cubic feet	3, 214	807, 000	3, 267	1, 059, 000	2, 347	742, 000	2, 598	847, 000
Peat	...	...	(3)	(3)	3, 775	46, 307	(3)	(3)
Petroleum (crude) ... thousand 42-gallon barrels	4, 254	17, 990, 000	4, 242	17, 940, 000	3, 800	16, 260, 000	[4] 3, 257	[4] 11, 140, 000
Salt (common)	3, 518, 715	16, 552, 890	3, 417, 443	16, 746, 462	3, 322, 659	17, 351, 111	3, 412, 636	22, 754, 118
Sand and gravel	21, 008, 701	19, 285, 299	20, 270, 058	18, 287, 623	22, 530, 891	23, 493, 857	30, 082, 333	29, 756, 301
Silver (recoverable content of ores, etc.) ... troy ounces	47, 568	43, 051	38, 895	35, 202	35, 398	32, 037	34, 576	31, 293
Slate	126, 070	2, 000, 106	125, 930	1, 810, 865	113, 575	1, 733, 332	114, 929	1, 742, 048
Stone (except limestone for cement and lime, 1951-53)	15, 559, 372	24, 326, 118	16, 234, 549	25, 244, 245	[8] 15, 961, 657	[8] 25, 250, 576	19, 410, 121	31, 425, 701
Talc	[10] 152, 652	[10] 4, 170, 987	[10] 149, 837	[10] 4, 069, 771	[11] 156, 299	[11] 940, 541	(3)	(3)
Zinc (recoverable content of ores, etc.)	40, 051	14, 578, 564	32, 636	10, 835, 152	51, 529	11, 851, 670	53, 199	11, 490, 984
Undistributed: Abrasive stone (1953-54), beryllium concentrate (1954), natural cement, abrasive garnet, iron oxide pigments (1954), lime, calcareous marl, pyrites (1951-52), stone (crushed unclassified, 1953), recovered elemental sulfur (1951-52), titanium concentrate, wollastonite, and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3). Excludes value of clays used for cement (1951-53)	...	8, 232, 758	...	7, 917, 911	...	8, 102, 030	...	9, 908, 988
Total New York	...	188, 816, 000	...	180, 751, 000	...	186, 868, 000	...	[9] 192, 764, 000

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1951–54, by States [1]—Continued

NORTH CAROLINA

Mineral	1951		1952		1953		1954	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
Abrasive stones	(9)	$13,263	(9)	$28,992	(9)	$16,150	587	$12,125
Clays	1,462,030	2,177,515	1,357,700	2.080,172	1,466,232	2,534,908	1,872,541	2,519,721
Coal	(3)	(3)	1,600	12,684				
Copper (recoverable content of ores, etc.)							(10)	106
Feldspar ... long tons	166,361	1,230,404	240,364	2,416,031	268,042	3,290,495	230,744	2,220,707
Gold (recoverable content of ores, etc.) ... troy ounces							214	7,490
Lead (recoverable content of ores, etc.)							4	1,049
Mica:								
Scrap	52,550	1,441,886	58,576	1,551,071	56,834	1,428,793	61,049	1,457,122
Sheet ... pounds	464,949	127,204	595,331	664,075	619,895	1,308,494	479,221	1,787,197
Sand and gravel	7,656,370	4,435,702	8,724,748	5,665,169	6,910,982	4,992,991	7,441,200	5,508,284
Silver (recoverable content of ores, etc.) ... troy ounces							438	396
Stone	[8] 8,612,967	[8] 13,292,690	[8] 9,647,513	[8] 14,694,698	[8] 9,317,390	[8] 14,424,323	10,133,728	15,625,331
Talc and pyrophyllite	[10] 113,950	[10] 1,982,927	[10] 115,481	[10] 1,771,518	[11] 119,341	[11] 578,239	[11] 112,704	[11] 388,428
Tin (content of ore and concentrate) ... long tons	1	1,724	4	11,601				
Titanium concentrate (ilmenite) ... gross weight	(3)	(3)	25,328	177,296				
Tungsten concentrate ... 60-percent WO_3 basis	1,041	(3)	1,254	(3)	2,074	(3)	2,538	(3)
Undistributed: Abrasive stone (millstones, 1954), asbestos (1951, 1953–54), beryllium concentrate (1951, 1953–54), columbium-tantalum concentrate (1952–53), lithium minerals, manganiferous ores (1953), olivine, quartz (1951–53), stone (dimension marble, 1951–53, and crushed marble, 1952–53, vermiculite, and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)		4,944,042		5,652,311		[5] 9,876,773		12,122,942
Total North Carolina		29,647,000		34,726,000		[5] 38,451,000		41,651,000

NORTH DAKOTA

Mineral	1951		1952		1953		1954	
	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	18,250	$35,250	(3)	(3)	23,084	$47,862	(3)	(3)
Coal (lignite)	3,224,027	7,784,191	2,983,752	$7,068,259	2,802,558	6,617,980	(3)	(3)
Natural gas (marketed production) ... million cubic feet	456	24,000	369	23,000	498	34,000	1,093	$69,000
Petroleum (crude) ... thousand 42-gallon barrels	25	(3)	1,549	(3)	5,183	10,370,000	[4] 6,025	[4] 12,890,000
Sand and gravel	4,573,341	2,140,466	6,557,069	1,841,216	6,173,737	2,164,685	7,105,466	2,219,747
Stone	281,219	213,061	67,064	4,968	35,031	2,595	1,419	3,784
Undistributed: Nonmetallic minerals and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)		50,000		3,119,900				7,040,820
Total North Dakota		10,247,000		12,057,000		19,237,000		22,223,000

OHIO

Cement ... 376-pound barrels	11, 872, 278	$29, 498, 956	11, 377, 806	$28, 488, 500	12, 532, 437	$32, 957, 308	13, 076, 921	$35, 929, 163
Clays	5, 686, 630	13, 764, 057	5, 493, 830	13, 643, 742	5, 634, 596	9, 327, 706	5, 051, 478	11, 136, 478
Coal	37, 948, 692	146, 677, 710	36, 208, 450	138, 090, 700	34, 736, 773	131, 475, 408	32, 468, 728	117, 519, 936
Lime (open-market)	2, 289, 473	29, 046, 196	2, 205, 432	28, 393, 260	2, 945, 800	35, 310, 353	2, 549, 046	31, 444, 083
Natural gas (marketed production) ... million cubic feet	38, 879	7, 854, 000	30, 993	6, 725, 000	37, 542	8, 334, 000	28, 824	6, 111, 000
Natural-gas liquids:								
Natural gasoline ... thousand gallons	4, 494	399, 000	1, 596	114, 000	([3])	([3])	([3])	([3])
Peat	21, 378	261, 891	24, 828	290, 664	27, 696	260, 474	29, 540	356, 970
Petroleum (crude) ... thousand 42-gallon barrels	3, 140	9, 580, 000	3, 350	10, 020, 000	3, 610	9, 710, 000	[4] 3, 880	[4] 10, 710, 000
Salt (common)	3, 112, 472	5, 848, 478	2, 827, 455	5, 991, 626	3, 040, 237	7, 484, 795	2, 748, 993	12, 358, 521
Sand and gravel	19, 430, 898	21, 394, 891	20, 751, 493	23, 069, 458	24, 032, 388	27, 076, 276	25, 827, 220	27, 873, 469
Stone (except limestone for cement and lime, 1951–53)	[8] 25, 190, 277	[8] 36, 436, 081	[8] 24, 693, 189	[8] 36, 197, 485	[5] [8] 25,285,782	[5] [8] 39, 041, 308	32, 626, 737	47, 802, 169
Undistributed: Abrasive stones, bromine (1951), calcium-magnesium chloride, gypsum, ground sand and sandstone (1951–53), stone (crushed unclassified, 1951–52, dimension unclassified, 1952–53), recovered elemental sulfur, and minerals whose value should be concealed for particular years (indicated in appropriate column by footnote reference 3). Excludes value of clays used for cement (1951–53)	-----------	1, 850, 746	-----------	1, 664, 191	-----------	1, 264, 540	-----------	2, 084, 098
Total Ohio	-----------	302, 612, 000	-----------	292, 689, 000	-----------	302, 242, 000	-----------	[6] 293, 659, 000

OKLAHOMA

Clays	551, 200	$561, 841	520, 050	$577, 420	577, 557	$637, 082	452, 050	$1, 282, 848
Coal	2, 223, 229	13, 873, 424	2, 193, 409	12, 687, 855	2, 167, 594	13, 226, 881	1, 914, 834	11, 264, 692
Lead (recoverable content of ores, etc.)	16, 575	5, 734, 950	15, 137	4, 874, 114	9, 304	2, 437, 648	14, 204	3, 891, 896
Natural gas (marketed production) ... million cubic feet	538, 756	28, 554, 000	554, 033	29, 918, 000	599, 955	41, 397, 000	616, 355	43, 145, 000
Natural-gas liquids:								
Natural gasoline and cycle products ... thousand gallons	397, 236	27, 498, 000	405, 720	29, 459, 000	433, 650	28, 066, 000	478, 590	24, 332, 000
LP-gases ... do	339, 528	12, 436, 000	376, 026	14, 090, 000	414, 036	14, 886, 000	453, 810	13, 506, 000
Petroleum (crude) ... thousand 42-gallon barrels	186, 869	480, 250, 000	190, 435	487, 510, 000	202, 570	546, 940, 000	[4] 185, 851	[4] 518, 520, 000
Sand and gravel	3, 183, 251	2, 321, 653	3, 769, 663	2, 911, 845	[5] 5, 011, 366	[5] 4, 258, 585	5, 424, 131	4, 265, 031
Stone (except limestone for cement and lime, 1951–53)	6, 966, 676	6, 917, 548	[8] 9, 636, 475	[8] 8, 974, 334	[5] 8, 489, 994	[5] 7, 930, 737	[4] 9, 238, 811	[4] 9, 146, 995
Zinc (recoverable content of ores, etc.)	53, 450	19, 455, 800	54, 916	18, 232, 112	33, 413	7, 684, 990	43, 171	9, 324, 936
Undistributed: Native asphalt, cement, gypsum, lime, pumice and pumicite (1952–54), salt, ground sand and sandstone (1951–53), stone (dimension limestone, 1952 and 1954), recovered elemental sulfur (1953–54), and tripoli (1953–54). Excludes value of clays used for cement (1951–53)	-----------	9, 882, 690	-----------	12, 116, 791	-----------	[5] 11, 538, 234	-----------	12, 584, 340
Total Oklahoma	-----------	607, 486, 000	-----------	621, 351, 000	-----------	[5] 679, 003, 000	-----------	[6] 650, 205, 000

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1951–54, by States [1]—Continued

OREGON

Mineral	1951 Short tons (unless otherwise stated)	1951 Value	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value	1954 Short tons (unless otherwise stated)	1954 Value
Chromite ... gross weight	754	$62,972	6,591	$507,981	6,216	$484,453	(3)	(3)
Clays	151,920	162,242	277,072	569,968	292,445	296,050	(3)	(3)
Coal	---	---	1,179	8,650	---	---	---	---
Copper (recoverable content of ores, etc.)	11	5,324	1	484	9	5,166	5	$2,950
Gold (recoverable content of ores, etc.) ... troy ounces	7,927	277,445	5,509	192,815	8,488	297,080	6,520	228,200
Lead (recoverable content of ores, etc.)	2	692	1	322	5	1,310	5	1,370
Manganese ore (35 percent or more Mn) ... gross weight	---	---	---	---	46	(3)		
Manganiferous ore (5 to 35 percent or more Mn) ... do	---	---	---	---	271	(3)	---	---
Mercury ... 76-pound flasks	1,177	247,323	868	172,819	648	125,083	489	129,287
Nickel ore	---	---	---	---	---	---	1,993	(3)
Pumice and pumicite	47,026	137,136	59,578	201,809	73,080	173,822	67,852	177,515
Sand and gravel	10,504,339	9,117,343	12,219,486	8,556,218	8,763,078	8,629,632	13,157,239	14,149,380
Silver (recoverable content of ores, etc.) ... troy ounces	6,218	5,628	4,037	3,654	12,259	11,095	14,335	12,974
Stone (except limestone for cement and lime, 1951–53)	8,721,799	10,831,483	6,250,849	8,893,368	[8] 4,939,080	[8] 6,301,639	5,872,353	8,617,795
Tungsten concentrate ... 60-percent WO_3 basis	1	2,795	4	15,960	(10)	(3)	(10)	(3)
Zinc (recoverable content of ores, etc.)	3	1,092	1	332	---	---	---	---
Undistributed: Asbestos (1951), carbon dioxide, cement, diatomite, gem stones, iron oxide pigments (1954), lime (1951–52), perlite (1951–53), quartz (1951–53), stone (crushed granite, 1953), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3). Excludes value of clays used for cement (1951–53)	---	7,550,554	---	7,549,366	---	8,123,493	---	10,172,067
Total Oregon	---	28,402,000	---	26,674,000	---	24,449,000	---	[6] 32,268,000

PENNSYLVANIA

Mineral	1951 Short tons (unless otherwise stated)	1951 Value	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value	1954 Short tons (unless otherwise stated)	1954 Value
Cement ... 376-pound barrels	41,560,431	$107,035,506	40,037,761	$103,388,586	42,093,765	$114,002,846	43,068,234	$117,912,299
Clays	4,230,567	14,087,550	3,731,130	12,639,864	[5] 3,575,287	[5] 9,987,928	3,524,398	10,243,485
Coal:								
Anthracite	42,669,997	405,817,963	40,582,558	379,714,076	30,949,152	299,139,687	29,083,477	247,870,023
Bituminous	108,163,843	572,194,085	89,181,232	473,475,646	93,330,871	516,490,411	72,010,101	378,658,531
Cobalt (content of ore) ... pounds	755,631	(3)	639,856	(3)	564,450	(3)	517,124	(3)
Copper (recoverable content of ores, etc.)	5,297	2,563,748	3,485	1,686,740	3,027	1,737,498	(3)	(3)
Gold (recoverable content of ores, etc.) ... troy ounces	2,179	76,265	1,500	52,500	1,134	39,690	1,317	46,095
Iron ore (usable) ... long tons, gross weight	1,215,033	(3)	992,110	(3)	1,020,826	(3)	708,109	(3)

Lime (open-market)	1,181,100	14,260,054	1,202,981	13,842,213	1,335,300	16,010,114	1,081,583	13,206,310
Natural gas (marketed production) million cubic feet	128,715	35,654,000	108,684	30,758,000	105,558	30,717,000	145,934	43,634,000
Natural-gas liquids:								
Natural gasoline thousand gallons	8,064	656,000	7,182	548,000	([3])	([3])	4,830	320,000
LP-gases do	756	71,000	798	75,000	1,008	90,000	1,008	89,000
Peat	8,591	46,568	7,898	43,874	8,232	47,516	15,621	141,352
Petroleum (crude) thousand 42-gallon barrels	11,345	48,220,000	11,233	47,740,000	10,649	45,680,000	[4] 9,107	[4] 31,150,000
Sand and gravel	15,737,464	21,488,540	14,696,106	19,920,003	14,715,383	20,692,391	14,218,444	20,595,990
Sericite schist	-----------	-----------	-----------	-----------	2,463	[7] 4,926	1,898	8,541
Silver (recoverable content of ores, etc.) troy ounces	13,575	12,286	9,247	8,369	6,972	6,310	8,415	7,616
Slate	268,830	5,688,870	214,860	4,487,648	202,386	4,419,612	914,205	4,419,439
Stone (except limestone for cement and lime, 1951-53)	[8] 27,399,564	[8] 46,668,590	[8] 25,609,812	[8] 44,676,456	[8] 26,192,607	[8] 48,094,029	40,521,756	61,193,419
Undistributed: Graphite (crystalline, 1953), mica, pyrites, ground sand and sandstone (1951-53), stone (dimension unclassified, 1951; dimension basalt, 1952-53), recovered elemental sulfur (1952-54), tripoli, and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3). Excludes value of clays used for cement (1951-53)	-----------	14,685,221	-----------	12,575,843	-----------	14,461,911	-----------	12,548,574
Total Pennsylvania	-----------	1,289,226,000	-----------	1,145,633,000	-----------	1,121,622,000	-----------	[6] 925,545,000

RHODE ISLAND

Sand and gravel	534,785	$576,781	589,451	$557,396	898,393	$775,700	1,013,014	$979,470
Stone	239,248	651,931	168,993	654,782	161,632	617,096	([3])	([3])
Undistributed: Nonmetallic minerals and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)	-----------	48,945	-----------	37,500	-----------	69,000	-----------	481,186
Total Rhode Island	-----------	1,278,000	-----------	1,250,000	-----------	1,462,000	-----------	1,461,000

SOUTH CAROLINA

Clays	949,270	$4,736,276	947,278	$4,675,261	964,356	$4,801,921	1,136,019	$4,702,027
Sand and gravel	320,195	139,258	1,048,099	892,312	2,975,608	2,564,484	2,813,750	2,550,260
Stone	[8] 2,828,868	[8] 3,690,114	[8] 2,914,839	[8] 3,881,178	[8] 2,913,860	[8] 3,976,370	[8] 2,861,953	[8] 4,233,270
Undistributed: Barite, cement, kyanite, mica (1954), stone (dimension granite), and vermiculite. Excludes value of clays used for cement (1951-53)	-----------	2,878,338	-----------	5,236,961	-----------	6,428,135	-----------	6,373,880
Total South Carolina	-----------	11,444,000	-----------	14,686,000	-----------	17,771,000	-----------	[13] 17,744,000

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1951–54, by States [1]—Continued

SOUTH DAKOTA

Mineral	1951 Short tons (unless otherwise stated)	1951 Value	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value	1954 Short tons (unless otherwise stated)	1954 Value
Beryllium concentrate, gross weight	138	$46,007	334	$166,251	392	$157,656	337	$139,663
Clays	381,611	3,061,988	292,791	2,640,640	330,983	2,826,074	(3)	(3)
Coal (lignite)	28,350	99,008			23,671	82,117	(3)	(3)
Columbium-tantalum concentrate, pounds, gross weight	(3)	(3)	(3)	(3)	4,431	9,022	25,447	43,260
Feldspar, long tons	48,559	290,520	40,163	220,954	50,601	321,026	(3)	(3)
Gold (recoverable content of ores, etc.), troy ounces	458,101	16,033,535	482,534	16,888,690	534,987	18,724,545	541,445	18,950,575
Iron ore (usable), long tons, gross weight					1,060	(3)		
Lead (recoverable content of ores, etc.)	2	692	2	644	10	2,620		
Mica:								
Scrap	2,292	42,714	915	24,148	1,687	27,388	1,510	26,943
Sheet, pounds			4,308	32,034	11,174	77,352	9,661	65,222
Natural gas (marketed production), million cubic feet	7	350	6	300	5	[7] 250	7	[7] 350
Sand and gravel	5,037,384	2,502,340	5,846,140	2,478,314	5,402,378	[5] 2,817,726	19,110,358	7,840,393
Silver (recoverable content of ores, etc.), troy ounces	139,590	126,336	132,102	119,559	138,642	125,478	151,407	137,031
Stone (except limestone for cement and lime, 1951–53)	1,263,322	4,660,074	1,671,187	4,806,882	[5] 1,189,444	[5] 4,997,497	1,614,818	4,928,855
Tungsten concentrate, 60-percent WO_3 basis			(19)	335	2	(3)	(19)	500
Undistributed: Cement, gem stones (1953) gypsum (1954), lime, lithium minerals, petroleum (1954), stone (dimension miscellaneous 1953), vanadium (1954), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3). Excludes value of clays used for cement (1951–53)		2,788,356		3,076,258		[5] 3,654,587		6,121,898
Total South Dakota		29,652,000		30,455,000		[5] 33,823,000		[6] 37,859,000

TENNESSEE

Mineral	1951 Short tons (unless otherwise stated)	1951 Value	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value	1954 Short tons (unless otherwise stated)	1954 Value
Cement, 376-pound barrels	7,162,841	$17,203,080	7,428,604	$17,834,060	7,276,964	$18,283,366	7,569,279	$19,734,262
Clays	1,160,571	3,296,495	1,042,239	3,519,143	1,037,450	3,478,622	1,015,256	3,780,952
Coal	5,400,946	26,956,174	5,264,954	25,559,740	5,466,569	25,151,682	6,428,831	25,477,006
Copper (recoverable content of ores, etc.)	7,069	3,421,396	7,620	3,688,080	7,829	4,493,846	9,087	5,361,861
Fluorspar	140	(3)	348	(3)	426	(3)		
Gold (recoverable content of ores, etc.), troy ounces	108	3,780	241	8,435	293	10,255	218	7,630
Iron ore (usable), long tons, gross weight	35,908	142,447	(3)	(3)	12,751	82,499	(3)	(3)
Lead (recoverable content of ores, etc.)	14	4,844	18	5,796	9	2,358		
Lime (open-market)	108,970	1,097,874	100,189	1,005,235	114,474	1,177,461	80,372	968,078
Manganese ore (35 percent or more Mn), gross weight			126	(3)	2,625	201,898	11,823	919,949
Natural gas (marketed production), million cubic feet	132	12,000	107	11,000	89	11,000	89	10,000
Petroleum (crude), thousand 42-gallon barrels	14	(3)	15	(3)	16	(3)	(3)	(3)
Phosphate rock [14], long tons	1,424,516	10,798,406	1,444,737	11,306,438	1,518,912	11,305,098	1,633,226	11,743,012

Sand and gravel	4,645,041	5,186,617	5,173,401	5,303,321	5,231,329	5,629,687	5,155,185	6,141,139
Silver (recoverable content of ores, etc.) troy ounces	24,960	22,590	57,569	52,103	68,935	62,390	60,795	54,990
Stone (except limestone for cement and lime, 1951-53)	[8] 8,838,796	[8] 14,765,988	10,377,320	17,652,763	[8] 10,485,351	[8] 16,948,053	14,040,187	22,046,016
Zinc (recoverable content of ores, etc.)	38,639	14,064,596	38,020	12,622,640	38,465	8,846,950	30,326	6,550,345
Undistributed: Barite, manganiferous ore (1954), pyrites, stone (dimension sandstone, 1951 and crushed granite, 1953) and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3). Excludes value of clays used for cement (1951-53)		3,070,648		2,363,399		2,364,412		5,479,598
Total Tennessee		100,047,000		100,932,000		98,050,000		[6] 105,686,000

TEXAS

Abrasive stone: Pebbles, grinding	350	$4,710	510	$3,100	400	$5,500	(3)	(3)
Cement 376-pound barrels	17,642,654	42,648,536	19,849,455	48,042,901	19,140,193	48,497,762	21,928,170	$56,674,124
Clays	2,217,053	4,944,965	2,069,020	4,470,182	2,370,975	4,678,974	2,400,924	7,002,024
Coal (lignite)							(3)	(3)
Copper (recoverable content of ores, etc.)	1	483	18	8,712				
Feldspar long tons	(3)	(3)	2,600	31,200			(3)	(3)
Gold (recoverable content of ores, etc.) troy ounces	32	1,120	39	1,365				
Gypsum	1,136,824	2,987,890	1,021,161	2,682,019	1,067,854	2,860,633	1,218,048	3,773,230
Helium cubic feet	82,690,000	1,060,000	107,301,332	1,405,096	103,711,334	1,388,671	110,588,471	1,873,860
Iron ore (usable) long tons, gross weight	1,053,131	(3)	787,193	(3)	1,014,937	(3)	881,190	(3)
Lead (recoverable content of ores, etc.)	43	14,878	56	18,032				
Lime (open-market)	279,957	2,532,387	281,604	2,622,975	475,569	4,380,831	547,436	5,421,732
Manganese ore (35 percent or more Mn) gross weight			56	(3)				
Natural gas (marketed production) million cubic feet	3,781,136	204,181,000	4,147,805	257,164,000	4,383,158	333,120,000	4,551,232	386,855,000
Natural-gas liquids:								
Natural gasoline and cycle products thousand gallons	2,516,094	189,973,000	2,589,594	188,500,000	2,750,370	200,479,000	2,732,100	200,559,000
LP-gases do	2,042,208	71,943,000	2,456,874	88,635,000	2,777,880	109,131,000	2,983,962	95,913,000
Peat	1,238	10,750	1,200	12,000	1,375	(3)	(3)	(3)
Petroleum (crude) thousand 42-gallon barrels	1,010,270	2,610,790,000	1,022,139	2,641,860,000	1,019,164	2,777,900,000	[4] 974,275	[4] 2,768,490,000
Salt (common)	2,401,063	4,000,100	2,640,209	4,402,032	2,845,190	5,010,624	2,864,312	9,310,339
Sand and gravel	18,488,463	15,651,531	18,661,403	17,275,255	15,101,226	12,845,561	26,315,635	24,840,811
Silver (recoverable content of ores, etc.) troy ounces	1,381	1,250	4,672	4,228			100	90
Stone (except limestone for cement and lime, 1951-53)	[8] 7,351,069	[8] 7,626,122	7,604,468	8,664,633	[8] 9,095,109	[8] 8,550,320	24,981,897	28,485,243
Sulfur (Frasch-process) long tons	3,835,280	81,900,000	3,691,724	78,910,000	3,614,838	97,601,000	3,474,477	92,791,821
Sulfur, recovered elemental do	(3)	(3)	38,344	872,134	84,717	2,202,381	107,232	2,889,100
Talc and soapstone	(3)	(3)	[10] 17,800	[10] 216,569	[11] 16,210	[11] 70,658	[11] 19,362	[11] 127,855
Zinc (recoverable content of ores, etc.)	24	8,736	3	996				
Undistributed: Native asphalt, bromine, gem stones, graphite (1951-53), magnesium chloride (for metal), magnesium compounds (except for metal), mercury (1951 and 1953), pumice and pumicite, sodium sulfate, stone (crushed basalt, 1951, and 1953; dimension granite, 1951; dimension sandstone, 1954), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3.) Excludes value of clays used for cement (1951-53)		28,918,581		34,010,619		39,189,833		52,083,713
Total Texas		3,269,199,000		3,379,813,000		[6] 3,647,913,000		[6] 3,730,162,000

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1951–54, by States [1]—Continued

UTAH

Mineral	1951		1952		1953		1954	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
Asphalt and related bitumens, native: Gilsonite	65, 521	$1, 895, 374	60, 740	$1, 779, 815	60, 505	$2, 184, 328	75, 943	$2, 724, 023
Carbon dioxide, natural (estimated) ... thousand cubic feet	97, 436	10, 000	84, 500	10, 000	(3)	(3)	(3)	(3)
Clays	293, 688	1, 277, 763	189, 723	1, 125, 299	188, 348	1, 447, 515	(3)	(3)
Coal	6, 135, 957	32, 652, 543	6, 140, 305	32, 410, 303	6, 544, 145	37, 689, 144	5, 007, 952	29, 761, 341
Copper (recoverable content of ores, etc.)	271, 086	131, 205, 624	282, 894	136, 920, 696	269, 496	154, 690, 704	211, 835	124, 982, 650
Fluorspar	17, 827	398, 480	17, 304	438, 699	15, 527	374, 944	4 403	82, 353
Gold (recoverable content of ores, etc.) ... troy ounces	432, 216	15, 127, 560	435, 507	15, 242, 745	483, 430	16, 920, 050	403 401	14, 119, 035
Iron ore (usable) ... long tons, gross weight	4, 637, 239	10, 141, 653	3, 990, 505	15, 025, 899	4, 617, 288	26, 496, 950	3, 040, 646	19, 277, 434
Lead (recoverable content of ores, etc.)	50, 451	17, 456, 046	50, 210	16, 167, 620	41, 522	10, 878, 764	44. 972	12, 322, 328
Lime (open-market)	(3)	(3)	(3)	(3)	(3)	(3)	30, 428	431, 828
Manganese ore (35 percent or more Mn) ... gross weight	----	----	95	(3)	550	(3)	25	(3)
Manganiferous ore (5 to 35 percent Mn) ... do	1, 369	(3)	3, 397	(3)	5, 155	82, 316	97	(3)
Natural gas (marketed production) ... million cubic feet	3, 733	246, 000	3, 006	225, 000	7, 075	807, 000	16, 024	2, 259, 000
Perlite	3, 422	16, 017	(3)	(3)	(3)	(3)	(3)	(3)
Petroleum (crude) ... thousand 42-gallon barrels	1, 305	(3)	1, 737	(3)	1, 807	(3)	[4] 1, 905	4, 480, 000
Pumice and pumicite	9, 422	11, 478	(3)	(3)	3, 880	4, 385	3, 588	3, 788
Salt (common)	131, 444	570, 379	136, 125	522, 721	154, 088	772, 035	166, 506	1, 020, 061
Sand and gravel	2, 971, 268	2, 268, 750	3, 260, 044	2, 350, 412	4, 627, 808	3, 179, 690	5, 327, 969	3, 592, 286
Silver (recoverable content of ores, etc.) ... troy ounces	7, 310, 665	6, 616, 521	7, 194, 109	6, 511, 032	6, 725, 807	6, 087, 195	6, 179, 243	5, 592, 527
Stone (except limestone for cement and lime, 1951–53)	1, 226, 710	1, 291, 118	[8] 852, 351	[8] 1, 123, 108	997, 330	1, 446, 594	1, 127, 461	1, 545, 841
Tungsten concentrate ... 60-percent WO_3 basis	(10)	565	3	9, 449	35	123, 445	84	308, 634
Vanadium ... pounds	551, 949	(3)	277, 367	(3)	1, 058, 345	(3)	1, 077, 806	(3)
Zinc (recoverable content of ores, etc.)	34, 317	12, 491, 388	32, 947	10, 938, 404	29, 184	6, 712, 320	34, 031	7, 350, 696
Undistributed: Native asphalt (bituminous sandstone, 1951), cement, gypsum, molybdenum, natural gasoline, phosphate rock (1951, 1953–54), potassium salts, stone (crushed marble, 1952), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3). Excludes value of clays used for cement (1951–53)	----	23, 467, 351	----	24, 699, 578	----	[5] 28, 732, 045	----	25, 942, 747
Total Utah	----	257, 145, 000	----	265, 501, 000	----	298, 629, 000	----	[13] 255, 234, 000

VERMONT

Copper (recoverable content of ores, etc.)	3,774	$1,826,616	3,774	$1,826,616	3,947	$2,265,578	4,352	$2,567,680
Gold (recoverable content of ores, etc.)....troy ounces	156	5,460	162	5,670	171	5,985	185	6,475
Lime (open-market)	32,179	432,483	(3)	(3)	(3)	(3)	(3)	(3)
Pyrites....long tons	----	----	17,892	(3)	19,486	(3)	20,713	(3)
Sand and gravel	965,702	646,702	1,264,490	749,835	1,113,607	690,073	1,481,549	1,110,996
Silver (recoverable content of ores, etc.)....troy ounces	41,300	37,379	45,361	41,054	43,128	39,033	48,572	43,960
Stone (except limestone for lime, 1951-53)	450,980	7,253,824	404,391	6,016,530	527,150	8,859,703	436,870	8,178,389
Talc	[10] 78,694	[10] 998,792	[10] 71,027	[10] 926,646	[11] 80,209	[11] 240,627	[11] 66,195	[11] 198,585
Undistributed: Asbestos, clays, slate, and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)	----	7,315,198	----	8,324,329	----	8,201,333	----	[13] 8,377,342
Total Vermont	----	18,516,000	----	17,891,000	----	20,302,000	----	20,483,000

VIRGINIA

Beryllium concentrate....gross weight	----	----	----	----	----	----	(19)	$39
Clays	775,245	$825,097	940,496	$996,351	952,266	$927,571	704,843	723,292
Coal	21,399,869	115,978,072	21,579,368	114,861,137	19,119,050	102,022,118	16,387,292	72,901,277
Feldspar....long tons	30,979	232,099	(3)	(3)	(3)	(3)	(3)	(3)
Iron ore (usable)....long tons, gross weight	7,248	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Lead (recoverable content of ores, etc.)	1,508	521,768	3,792	1,221,024	[5] 2,788	[5] 730,456	4,320	1,183,680
Lime (open-market)	452,680	4,551,656	442,845	4,448,924	477,384	4,947,418	445,158	4,610,645
Manganese ore (35 percent or more Mn)....gross weight	----	----	1,011	(3)	8,454	635,926	22,678	1,780,934
Marl, calcareous (except for cement)	(3)	(3)	(3)	(3)	(3)	(3)	33,174	21,079
Natural gas (marketed production)....million cubic feet	64	10,000	1,133	279,000	3,697	954,000	1,401	380,000
Petroleum (crude)....thousand 42-gallon barrels	12	(3)	10	(3)	8	(3)	[4] 7	(3)
Sand and gravel	5,772,781	5,750,409	7,136,112	5,556,953	5,276,350	5,160,564	7,115,403	8,657,871
Silver (recoverable content of ores, etc.)....troy ounces	----	----	----	----	1,169	1,058	1,773	1,605
Slate	(3)	(3)	(3)	(3)	(3)	(3)	17,410	468,911
Stone (except limestone for cement and lime, 1951-53)	9,277,252	16,621,116	9,670,961	16,969,952	9,091,907	16,258,620	10,893,972	18,137,501
Zinc (recoverable content of ores, etc.)	7,332	2,668,848	13,409	4,451,788	16,676	3,835,480	16,738	3,615,408
Undistributed: Beryllium concentrate (1954), aplite, cement, gypsum, kyanite, iron oxide pigments (1954), mica, pyrites, salt ground sand and sandstone (1951-53), talc and soapstone, titanium concentrate, and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3). Excludes value of clays used for cement (1951-53)	----	14,093,092	----	15,893,790	----	17,505,609	----	19,403,489
Total Virginia	----	161,252,000	----	164,679,000	----	[5] 152,979,000	----	[6] 129,603,000

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1951–54, by States [1]—Continued

WASHINGTON

Mineral	1951		1952		1953		1954	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
Abrasive stone:								
Pebbles (grinding)	28	$336	20	$240	(3)	(3)	(3)	(3)
Pulpstones	22	1,970	12	908				
Antimony ore and concentrate ... gross weight	110	(3)	100	(3)				
Clays	286,364	366,808	291,134	352,576	259,421	$312,141	261,328	$318,500
Coal	857,026	6,031,400	844,197	5,986,129	689,831	5,047,928	619,209	4,478,127
Copper (recoverable content of ores, etc.)	4,089	1,979,076	4,357	2,108,788	3,740	2,146,760	3,626	2,145,240
Epsomite			(3)	(3)	200	8,000	(3)	(3)
Gold (recoverable content of ores, etc.) ... troy ounces	67,405	2,359,175	54,776	1,917,160	62,560	2,189,600	66,740	2,335,900
Gypsum	(3)	(3)	7,900	29,625	3,800	14,250	(3)	(3)
Lead (recoverable content of ores, etc.)	8,002	2,768,692	11,744	3,781,568	11,064	2,898,768	9,938	2,723,012
Manganese ore (35 percent or more Mn) ... gross weight			436	(3)	(3)	(3)		
Manganiferous ore (5 to 35 percent Mn) ... do			142	(3)				
Peat	45,304	98,955	42,580	111,386	32,107	104,274	43,134	153,058
Pumice and pumicite	5,105	10,832	3,604	8,089	(3)	(3)	(3)	(3)
Sand and gravel	10,546,949	7,595,837	13,322,279	9,422,117	11,182,835	9,317,793	16,044,687	13,595,014
Silver (recoverable content of ores, etc.) ... troy ounces	334,948	303,145	315,645	285,675	321,202	290,704	313,735	283,946
Stone (except limestone for cement and lime, 1951–53)	5,029,735	5,664,433	4,523,234	5,491,525	4,438,259	5,890,849	5,366,890	9,526,534
Talc and soapstone	(3)	(3)	(3)	(3)	5,351	28,833	(3)	(3)
Tungsten concentrate ... 60-percent WO_3 basis	9	33,417	4	14,008	5	19,710	18	65,812
Zinc (recoverable content of ores, etc.)	18,189	6,620,796	20,102	6,673,864	32,786	7,540,780	22,304	4,817,664
Undistributed: Barite (1953), carbon dioxide, cement, diatomite (1952–54), gem stones, lime, magnesite, olivine quartz, ground sand and sandstone (1951–53), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3). Excludes value of clays used for cement		20,719,457		19,955,089		18,766,830		16,923,833
Total Washington		54,554,000		56,139,000		54,577,000		[6] 53,300,000

WEST VIRGINIA

Clays	1,103,646	$2,295,026	982,030	$2,421,669	968,838	$2,488,938	587,120	$1,450,539
Coal	163,309,822	853,893,679	141,713,059	741,421,131	134,105,310	693,593,645	115,996,041	541,369,652
Natural gas (marketed production) million cubic feet	191,146	35,553,000	180,995	35,475,000	186,477	44,009,000	191,601	45,601,000
Natural-gas liquids:								
Natural gasoline thousand gallons	46,494	3,337,000	43,302	3,069,000	44,352	3,245,000	41,076	2,593,000
LP-gases do	161,448	5,568,000	199,794	6,187,000	153,090	6,743,000	142,884	5,035,000
Petroleum (crude) thousand 42-gallon barrels	2,757	10,370,000	2,602	9,780,000	3,038	11,570,000	[4] 2,902	[4] 8,500,000
Salt (common)	379,299	1,314,818	392,519	1,438,490	419,907	1,490,592	471,516	2,885,696
Sand and gravel	4,735,271	8,314,195	4,120,105	7,275,370	3,162,776	6,070,847	4,073,991	8,351,153
Stone (except limestone for cement and lime, 1951-53)	[8] 5,754,378	[8] 8,472,639	[8] 4,869,442	[8] 6,826,113	[8] 5,501,148	[8] 8,924,411	7,314,934	11,743,440
Undistributed: Abrasive stones (1951-53), bromine, calcium-magnesium chloride, cement, lime, calcareous marl, ground sand and sandstone (1951-53), stone (dimension limestone 1951-53), and recovered elemental sulfur. Excludes value of clays used for cement (1951-53)		12,629,965		11,838,988		11,974,948		10,504,113
Total West Virginia		941,748,000		825,733,000		790,110,000		[6] 636,311,000

WISCONSIN

Abrasive stone: Pebbles (grinding)	1,327	$26,540	723	$17,352	(3)	(3)	(3)	(3)
Clays	141,746	141,746	134,453	134,493	175,311	$175,276	180,233	$174,488
Iron ore (usable) long tons, gross weight	1,745,120	(3)	1,485,845	(3)	1,655,331	(3)	1,428,910	(3)
Lead (recoverable content of ores, etc.)	1,391	481,286	2,000	644,000	2,094	548,628	1,261	345,514
Lime (open-market)	124,852	1,562,200	107,813	1,368,556	123,997	1,566,085	115,397	1,557,579
Marl, calcareous (except for cement)	20,625	12,925	17,000	8,833	15,871	7,327	19,607	9,817
Peat	(3)	(3)	(3)	(3)	366	(3)	(3)	(3)
Sand and gravel	19,391,772	12,392,464	24,895,947	16,938,228	[5] 23,664,086	[5] 16,253,302	23,978,722	17,396,438
Stone (except limestone for cement and lime, 1951-53)	7,609,323	14,671,858	8,578,882	16,754,675	7,450,396	15,979,756	8,289,373	16,187,738
Zinc (recoverable content of ores, etc.)	15,754	5,734,456	20,588	6,835,216	16,830	3,870,900	15,534	3,355,344
Undistributed: Abrasive stone (tube-mill liners), cement, quartz (1951-53), ground sand and sandstone (1951-53), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3). Excludes value of clays used for cement (1951-53)		13,326,715		13,008,759		[5] 16,810,752		15,839,813
Total Wisconsin		48,350,000		55,710,000		[5] 55,212,000		[6] 54,286,000

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1951–54, by States [1]—Continued

WYOMING

Mineral	1951		1952		1953		1954	
	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	483,050	$5,999,451	706,748	$9,176,507	852,651	$10,036,727	943,505	$9,534,087
Coal	6,429,633	26,937,896	6,088,421	26,451,530	5,244,572	23,743,996	2,831,430	11,541,312
Copper (recoverable content of ores, etc.)	-----	-----	-----	-----	1	574	1	590
Gold (recoverable content of ores, etc.)...troy ounces	9	315	1	35	1	35	407	14,245
Gypsum	(3)	(3)	(3)	(3)	5,493	21,972	7,403	29,612
Iron ore (usable)...long tons, gross weight	616,949	(3)	484,945	(3)	654,285	(3)	458,237	(3)
Natural gas (marketed production)...million cubic feet	71,508	5,363,000	75,313	5,874,000	76,262	6,025,000	71,068	5,970,000
Natural-gas liquids:								
Natural gasoline...thousand gallons	49,392	3,511,000	51,492	4,016,000	(3)	(3)	47,082	3,137,000
LP-gases...do	32,928	1,634,000	38,976	1,881,000	(3)	(3)	46,084	2,128,000
Petroleum (crude)...thousand 42-gallon barrels	68,929	148,200,000	68,074	148,400,000	82,618	195,800,000	[4] 93,533	[4] 229,160,000
Phosphate rock [14]...long tons	166,156	1,088,822	186,715	1,247,256	(3)	(3)	(3)	(3)
Pumice	1,867	9,141	2,851	10,918	648	1,898	(3)	(3)
Sand and gravel	2,347,078	1,730,900	2,426,999	1,738,548	3,149,376	2,001,197	4,163,660	2,681,527
Silver (recoverable content of ores, etc.)...troy ounces	2	2	-----	-----	11	10	74	67
Stone (except limestone for cement, 1951–53)	1,645,475	1,857,267	1,466,567	1,688,890	1,431,372	1,839,922	1,616,015	1,665,302
Sulfur, recovered elemental...long tons	(3)	(3)	(3)	(3)	(3)	(3)	113,101	2,977,954
Vermiculite	(3)	(3)	(3)	(3)	403	2,418	-----	-----
Undistributed: Cement, feldspar (1953), gem stones, manganiferous ores (1953), sodium carbonate and sulfate, sulfur ore (1951–53), vanadium (1954), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3). Excludes value of clays used for cement in 1953	-----	8,025,379	-----	6,343,624	-----	16,432,721	-----	12,826,704
Total Wyoming	-----	204,357,000	-----	206,828,000	-----	255,906,000	-----	[6] 281,306,000

[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 "Undistributed."
[3] Value included with "Undistributed."
[4] Final figure. Supersedes preliminary figure given in commodity chapter.
[5] Revised figure.
[6] Total adjusted to eliminate duplication in the value of clays and stone.
[7] Estimate.
[8] Excludes certain stone, value for which is included with "Undistributed."
[9] Weight not recorded.
[10] Sold or used by producers. Quantity and value of ground material included.
[11] Mine production of crude material.
[12] Beginning with 1954 quartz from pegmatites and quartzite included with stone.
[13] Total has been adjusted to eliminate duplication in the value of raw materials used in the manufacture of cement and/or lime.
[14] Basis for reporting phosphate rock has been changed from shipments to marketable production, because the latter more nearly reflects output at the mine on a calendar year basis.
[15] Beginning with 1954 sand and sandstone (ground) included with sand and gravel or stone.
[16] Includes value of nonmetallic minerals; excludes value of clays used for cement.
[17] Excludes natural cement, value for which is included with "Undistributed."
[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.

TABLE 6.—Mineral production in Territories of the United States, 1951–54, by individual minerals [1]

Territory and mineral	1951		1952		1953		1954	
	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	301	(2)	420	(2)	------	------	------	------
Chromite ... do	------	------	------	------	------	------	2,953	$208,257
Coal	494,333	$3,766,987	686,218	$5,779,423	861,471	$8,451,542	666,618	6,442,414
Copper (recoverable content of ores, etc.)	[3] 1	387	------	------	------	------	4	2,360
Gold (recoverable content of ores, etc.) ... troy ounces	239,637	8,387,295	240,557	8,419,495	253,783	8,882,405	248,511	8,697,885
Lead (recoverable content of ores, etc.)	[3] 21	7,266	1	386	9	2,240	------	------
Mercury ... 76-pound flasks	------	------	28	5,575	40	7,721	1,046	276,552
Sand and gravel	6,887,646	3,738,516	10,781,926	8,650,582	7,689,278	5,079,681	6,639,638	6,301,939
Silver (recoverable content of ores, etc.) ... troy ounces	32,870	29,749	32,968	29,854	35,387	32,027	33,697	30,497
Stone	------	------	(2)	(2)	47,086	169,711	283,734	465,423
Tin (content of ore and concentrate) ... long tons	69	197,163	82	220,956	49	105,917	199	409,953
Tungsten concentrate ... 60-percent WO_3 basis	10	(2)	8	(2)	3	(2)	------	------
Zinc (recoverable content of ores, etc.)	[3] 1	218	------	------	------	------	------	------
Undistributed: Clays (1954), gem stones (1952–53), platinum group metals, and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 2)	------	3,441,090	------	3,195,336	------	1,520,782	------	1,576,380
Total Alaska	------	19,569,000	------	26,302,000	------	24,252,000	------	24,412,000
Hawaii:								
Lime (open-market)	8,740	236,052	8,894	240,786	7,431	223,575	8,375	251,610
Sand and gravel	2,561	5,710	111,716	143,541	110,558	156,853	119,121	318,754
Stone	[4] 650,094	[4] 1,337,474	705,994	1,545,301	[4] 1,299,501	[4] 2,654,358	1,485,427	2,993,032
Undistributed: Other nonmetallic minerals	------	147,063	------	17,164	------	297,474	------	58,778
Total Hawaii	------	1,726,000	------	1,947,000	------	3,332,000	------	[5] 3,596,000
Total Territories	------	21,295,000	------	28,249,000	------	27,584,000	------	28,008,000

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Value included with "Undistributed."
[3] Produced in 1950, but not shipped until 1951 from a mine not active in 1951.
[4] Excludes certain stone value for which is included with "Undistributed."
[5] Total has been adjusted to eliminate duplication in the value of limestone used in lime.

TABLE 7.—Mineral production in possessions of the United States, 1951–54, by individual minerals [1] [2]

Possession and mineral	1951		1952		1953		1954	
	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
Stone					[3] 74,750	[3] 16,500	57,600	15,000
Total American Samoa						[3] 17,000		16,000
Canal Zone:								
Sand and gravel	32,000	$26,000	56,600	$53,000	85,914	95,500		
Stone (crushed)	55,500	112,000	86,000	152,000	171,908	231,752	187,446	245,170
Total Canal Zone		138,000		205,000		327,000		245,000
Canton: Stone (crushed)	360	900	150	375	4,200	8,750	2,600	5,000
Guam: Stone	720,000	675,000	948,000	870,000	2,080,650	5,573,169	842,660	2,275,182
Johnston: Stone							98	300
Midway: Stone (crushed)	(4)	(4)	[3] 7,200	[3] 6,000	204	638	490	1,500
Puerto Rico:								
Cement ... 376-pound barrels	4,297,583	11,252,350	3,994,483	10,517,894	3,641,135	9,335,421	3,682,187	9,663,445
Iron ore (usable) ... long tons	39,219	225,509	138,613	797,025	142,643	245,000		
Lime (open-market)	10,350	191,415	8,575	195,000	7,338	157,467	8,384	198,452
Salt (common)	10,566	119,338	12,676	122,158	13,692	131,490	8,758	98,110
Sand and gravel	99,628	99,657	122,730	164,166	226,586	250,202	374,690	833,654
Stone (except limestone for cement and lime, 1951–53)	283,697	613,751	[5] 689,320	[5] 1,807,388	[5] 648,400	[5] 1,237,236	[5] 1,751,996	[5] 2,492,827
Undistributed: Other nonmetallic minerals				6,328		44,466		154,331
Total Puerto Rico		12,502,000		13,610,000		11,401,000		[6] 12,381,000
Virgin Islands: Stone (crushed)	11,600	47,300	12,900	51,900	10,789	45,853	3,939	17,134
Wake: Stone (crushed)	240	600	4,260	8,000	11,980	20,615	780	1,300
Total		13,364,000		14,751,000		17,394,000		14,943,000

[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] Data not available.

[5] Excludes certain stone value for which is included with "Undistributed."

[6] Total has been adjusted to eliminate duplication in the value of stone.

TABLE 8.—Principal minerals imported for consumption in the United States, 1953–54

(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	1953		1954	
	Short tons (unless otherwise stated)	Value (thousand dollars)	Short tons (unless otherwise stated)	Value (thousand dollars)
METALLIC				
Aluminum:				
Metal	300,928	115,761	215,250	[1] 83,573
Scrap	26,621	8,072	14,845	[1] 4,675
Plates, sheets, bars, etc	31,932	18,637	13,655	[1] 8,402
Antimony:				
Ore (antimony content)	7,778	2,039	4,722	1,290
Needle or liquated	17	9	33	17
Metal	2,612	1,402	2,802	1,349
Oxide	1,296	580	1,476	645
Arsenic: White	4,717	574	4,848	545
Bauxite:				
Crude ... long tons	[2] 4,390,576	[2] 29,585	5,283,888	36,437
Calcined, when imported for manufacture of fire brick ... long tons	91,606	2,116	99,931	2,372
Beryllium ore	[2] 7,998	[2] 3,753	5,816	2,574
Bismuth ... pounds	641,428	1,273	628,833	1,235
Boron carbide ... do	72,526	122	24,209	50
Cadmium:				
Metal ... do	1,555,140	2,674	402,299	654
Flue dust (cadmium content) ... do	1,863,538	1,587	1,482,565	1,078
Calcium:				
Metal	990,017	1,010	685,417	728
Chloride	2,671	85	1,547	51
Chromite:				
Ore and concentrates (Cr_2O_3 content)	[2] 942,492	[2] 56,102	608,735	34,112
Ferrochrome (chromium content)	20,604	10,398	9,563	3,502
Metal	177	300	143	225
Cobalt:				
Alloy (cobalt content) ... pounds	2,412,804	(3)	2,360,360	(3)
Ore ... (do) ... do	51,323	88	3,349	6
Metal ... do	14,431,894	33,203	14,227,868	35,391
Oxide (gross weight) ... do	610,054	980	430,400	723
Salts and other compounds (gross weight) ... do	273,286	173	353,094	211
Columbium ore ... do	[2] 4,186,080	[2] 6,891	6,804,076	14,191
Copper (copper content):				
Ore	5,560	3,058	6,182	3,399
Concentrate	96,448	53,007	114,692	62,793
Regulus, black, coarse	6,547	4,041	5,408	3,089
Unrefined, black, blister	279,242	179,226	252,827	148,286
Refined in ingots, etc	[2] 274,111	182,190	215,178	127,138
Old and scrap	7,827	4,018	4,752	[1] 2,081
Old brass and clippings	7,503	3,737	3,657	[1] 1,568
Ferroalloys: Ferrosilicon	2,206	835	3,760	1,244
Gold:				
Ore and base bullion ... troy ounces	661,696	23,112	822,684	28,721
Bullion ... do	682,261	23,878	260,321	9,112
Iron ore:				
Ore ... long tons	11,074,035	[2] 96,788	15,777,824	[1] 119,330
Pyrites cinder ... do	12,053	54	898	4
Iron and steel:				
Pig iron	589,825	25,967	290,716	13,315
Iron and steel products (major):				
Semimanufactures	[2] 867,581	[2] 99,795	258,089	[1] 21,747
Manufactures	[2] 871,892	[2] 119,862	616,022	[1] 75,923
Scrap	[2] 131,568	[2] 4,755	206,316	[1] 5,116
Tinplate scrap	42,092	1,115	32,671	[1] 832
Lead:				
Ore, flue dust, matte (lead content)	67,030	15,214	196,054	[1] 47,967
Base bullion ... do	742	294	41	10
Pigs and bars ... do	379,119	95,285	274,286	[1] 68,420
Reclaimed, scrap, etc ... do	3,660	825	7,217	[1] 1,450
Sheets, pipe, and shot	178	58	397	[1] 129
Babbitt metal and solder (lead content)	1,343	1,869	1,572	[1] 1,946
Type metal and antimonial lead (lead content)	5,016	1,921	3,367	1,251
Manufactures	(3)	243	(3)	[1] 149
Magnesium:				
Metallic and scrap	2,443	877	733	338
Alloys (magnesium content)	3	16	6	30
Sheets, tubing, ribbons, wire and other forms (magnesium content)	5	20	3	14

For footnotes, see end of table.

TABLE 8.—Principal minerals imported for consumption in the United States, 1953–54—Continued

Mineral	1953		1954	
	Short tons (unless otherwise stated)	Value (thousand dollars)	Short tons (unless otherwise stated)	Value (thousand dollars)
METALLIC—continued				
Manganese:				
Ore (35 percent or more manganese) (manganese content)	1,393,000	103,512	1,029,795	75,796
Ferromanganese (manganese content)	98,207	27,181	44,744	10,903
Spiegeleisen, less than 30 percent manganese, more than 1 percent carbon (manganese content)	785	63		
Mercury:				
Compounds ... pounds	29,891	78	35,008	[1] 93
Metal ... flasks	83,393	13,569	64,957	[1] 10,784
Minor metals: Selenium and salts ... pounds	102,165	457	209,596	1,154
Molybdenum: Ore and concentrate (molybdenum content) ... do			154,288	180
Nickel:				
Ore and matte ... do	29,209,949	5,794	28,270,488	5,358
Pigs, ingots, shot, cathodes ... do	[3] 169,427,598	[2] 102,461	194,526,085	[1] 124,179
Scrap ... do	1,730,580	289	888,591	[1] 276
Oxide ... do	63,700,065	26,286	64,528,952	25,234
Platinum group:				
Unrefined materials:				
Ore and concentrate ... troy ounces	[2] 840	[2] 50	2,714	191
Grain and nuggets, including crude, dust and residues ... do	[2] 45,047	[2] 3,424	43,355	2,725
Sponge and scrap ... do	[2] 824	70	4,230	[1] 367
Osmiridium ... do	1,814	175	2,988	290
Refined metal:				
Platinum ... do	340,632	29,325	339,490	[1] 26,500
Palladium ... do	227,080	4,548	188,839	[1] 3,468
Iridium ... do	1,643	252	432	55
Osmium ... do	583	67	199	[1] 20
Rhodium ... do	[2] 12,299	[2] 1,323	13,197	1,336
Ruthenium ... do	[2] 3,326	[2] 213	6,168	333
Radium:				
Radium salts ... milligrams	[2] 85,055	[2] 1,475	57,879	857
Radioactive substitutes	(3)	[2] 170	(3)	150
Rare earths: Ferrocerium and other cerium alloy ... pounds	4,211	18	5,736	22
Silver:				
Ore and base bullion ... troy ounces	37,685,219	31,950	49,008,443	40,404
Bullion ... do	43,824,916	37,220	41,888,631	35,541
Tantalum: Ore ... pounds	[2] 759,409	[2] 1,230	981,872	1,972
Tin:				
Ore (tin content) ... long tons	35,973	82,713	22,140	41,725
Blocks, pigs, grains, etc ... do	[2] 74,570	[2] 175,950	65,552	133,186
Dross, skimmings, scrap, residues, and tin alloys, n. s. p. f. ... pounds	[2] 15,924,059	[2] 11,895	13,277,707	9,378
Tinfoil, powder, flitters, etc	(3)	606	(3)	[1] 785
Titanium:				
Ilmenite	286,644	5,464	275,005	[1] 4,993
Rutile	16,098	1,791	14,965	1,323
Metal ... pounds	71,309	269	385,045	1,371
Ferrotitanium ... do	344,337	115	10,000	4
Compounds and mixtures ... do	180,035	24	10,500	7
Tungsten:				
Ore and concentrate (tungsten content) ... do	[2] 28,060,449	[2] 91,602	24,092,078	[1] 75,879
Metal (tungsten content) ... do	66,546	225	154,096	[1] 343
Ferrotungsten (tungsten content) ... do	603,299	1,687	500,204	837
Other (tungsten content) ... do	[2] 147,971	343	65,650	101
Vanadium:				
Ore (vanadium content) ... do	716,977	421	395,287	238
Flue dust (vanadium content) ... do	1,010	2		
Ferrovanadium ... do	17,364	13		
Salts and compounds ... do	3,090	2	4,000	3
Zinc:				
Ores (zinc content)	[2] 449,732	47,918	479,816	[1] 52,482
Blocks, pigs, and slabs	227,654	50,282	160,138	[1] 33,722
Sheets	196	77	259	88
Old, dross, and skimmings	5,915	557	1,087	103
Dust	1,045	162		
Manufactures	(3)	6	(3)	[1] 41
Zirconium: Ore, including zirconium sand	24,667	572	18,657	[1] 487

For footnotes, see end of table.

TABLE 8.—Principal minerals imported for consumption in the United States, 1953–54—Continued

Mineral	1953		1954	
	Short tons (unless otherwise stated)	Value (thousand dollars)	Short tons (unless otherwise stated)	Value (thousand dollars)
NONMETALLIC				
Abrasives: Diamonds (industrial)____carats	[2] 13,525,776	[2] 49,282	13,991,151	[1] 48,703
Asbestos	[2] 692,245	[2] 59,754	678,390	[1] 55,857
Barite:				
Crude and ground	335,047	2,523	317,345	[1] 2,284
Witherite	4,928	179	4,415	153
Chemicals	6,074	507	3,548	453
Bromine and compounds____pounds	575	41	77,649	121
Cement____376-pound barrels	386,051	1,266	450,248	[1] 1,763
Clay:				
Raw	146,851	2,142	163,157	[1] 2,445
Manufactured	2,260	53	1,543	40
Cryolite____long tons	26,301	3,528	18,876	2,216
Feldspar: Crude____do	5,901	61	79	3
Fluorspar	[2] 359,569	11,427	293,320	[1] 8,962
Gem stones:				
Diamonds____carats	[2] 1,174,712	[2] 107,573	1,482,045	122,187
Emeralds____do	42,513	349	24,460	385
Other	(3)	22,273	(3)	[1] 21,022
Graphite	51,323	2,809	40,839	[1] 2,281
Gypsum:				
Crude, ground, calcined	3,185,180	4,320	3,368,817	[1] 4,904
Manufactures	(3)	472	(3)	473
Iodine, crude____pounds	957,638	1,606	945,985	1,034
Jewel bearings____number	86,892,637	3,708	49,262,027	[1] 2,219
Kyanite	6,620	288	4,826	[1] 197
Lime:				
Hydrated	2,177	31	1,259	[1] 17
Other	31,149	507	30,613	538
Dead-burned dolomite	3,876	259	4,426	345
Magnesium:				
Magnesite	42,010	2,574	70,650	4,250
Compounds	7,551	318	10,092	[1] 308
Mica:				
Uncut sheet and punch____pounds	2,599,007	4,279	1,829,457	[1] 3,198
Scrap	3,927	72	4,647	[1] 63
Manufactures	5,763	[2] 10,910	3,363	[1] 5,449
Mineral-earth pigments:				
Iron oxide pigments:				
Natural	2,716	123	2,546	121
Synthetic	4,531	523	4,997	603
Ocher, crude and refined	177	9	154	9
Siennas, crude and refined	700	60	338	35
Umber, crude and refined	2,725	78	2,598	74
Vandyke brown	164	9	89	5
Nitrogen compounds (major)	2,189,725	105,724	1,913,200	[1] 89,321
Phosphate, crude____long tons	101,171	2,545	122,016	[1] 3,081
Phosphatic fertilizers____do	[2] 25,599	[2] 1,310	26,316	[1] 1,507
Pigments and salts:				
Lead pigments and salts	83	22	712	[1] 169
Zinc pigments and salts	1,464	316	3,178	[1] 582
Potash	[2] 250,557	[2] 9,953	225,230	8,387
Pumice:				
Crude or unmanufactured	32,712	166	20,951	117
Wholly or partly manufactured	943	20	950	[1] 21
Manufactures, n. s. p. f.	(3)	5	(3)	[1] 7
Quartz crystal (Brazilian pebble including all classes)____pounds	1,320,683	2,255	780,556	1,579
Salt	137,308	473	160,770	[1] 879
Sand and gravel:				
Glass sand	5,690	114	10,329	93
Other sand	313,176	330	271,364	[1] 298
Gravel	87,028	10	2,387	[1] 2
Sodium sulfate	61,198	1,082	118,512	2,141
Stone and whiting	(3)	5,073	(3)	[1] 5,216
Strontium: Mineral	6,897	124	3,291	53

For footnotes, see end of table.

TABLE 8.—Principal minerals imported for consumption in the United States, 1953–54—Continued

Mineral	1953		1954	
	Short tons (unless otherwise stated)	Value (thousand dollars)	Short tons (unless otherwise stated)	Value (thousand dollars)
NONMETALLIC—continued				
Sulfur and pyrites:				
Sulfur:				
Ore ... long tons	525	18	110	2
Other forms, n. e. s. ... do	704	33	1,104	[1] 56
Pyrites ... do	190,474	664	[4] 46,649	[4] 292
Talc: Unmanufactured	22,803	717	22,157	[1] 678
FUELS				
Asphalt and related bitumen	2,699	71	4,244	102
Carbon black:				
Acetylene black ... pounds	9,007,816	1,435	7,715,875	1,282
Gas black and carbon black ... do	1,153,801	178	74,657	[1] 9
Coal:				
Anthracite	31,443	547	5,831	105
Bituminous, slack and culm, lignite	226,900	1,610	198,799	[1] 1,608
Briquets	97	1	239	2
Coke	157,318	1,715	115,781	[1] 1,258
Peat:				
Fertilizer grade	180,996	6,489	220,768	[1] 7,911
Poultry and stable grade	18,891	845	22,593	[1] 925
Petroleum:				
Crude ... thousands of barrels	237,908	509,851	242,531	[1] 544,381
Gasoline [5] ... do	587	3,130	1,349	6,967
Kerosine ... do	(6)	(6)	(6)	(6)
Distillate oil [7] ... do	4,005	11,054	4,258	13,062
Residual oil [8] ... do	134,824	225,876	132,283	240,225
Unfinished oil ... do	2,922	6,391	8,257	17,107
Asphalt ... do	2,550	5,364	3,420	6,610
Miscellaneous ... do	1	57	4	100

[1] Due to changes in tabulating procedures by the U. S. Department of Commerce data known not to be comparable to earlier years.
[2] Revised figure.
[3] Data not available.
[4] In addition to data shown an estimated 232,920 long tons ($627,620) were imported.
[5] Includes naphtha but excludes benzol: 1953—490,000 barrels ($7,408,000); 1954—291,000 barrels ($3,968,000).
[6] Less than 1,000.
[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, 1953–54

(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	1953		1954	
	Short tons (unless otherwise stated)	Value (thousand dollars)	Short tons (unless otherwise stated)	Value (thousand dollars)
METALLIC				
Arsenic: Calcium arsenate pounds	3,890,246	273	1,975,894	125
Aluminum:				
Ingots, slabs, crude	2,376	937	4,044	1,691
Scrap	4,581	1,476	39,338	12,985
Plates, sheets, bars, etc	7,764	6,107	6,050	4,803
Castings and forgings	622	1,661	619	1,795
Antimony: Metals and alloys, crude	[1] 25	23	44	26
Bauxite, including bauxite concentrates long tons	27,907	886	16,174	666
Aluminum sulfate	14,373	534	14,503	576
Other aluminum compounds	6,084	931	6,390	1,674
Beryllium pounds	[1] 19,333	[1] 92	21,151	68
Bismuth:				
Metals and alloys do	[1] 127,010	[1] 301	137,856	186
Salts and compounds do	51,570	247	62,581	268
Cadmium do	65,866	60	998,959	1,422
Calcium chloride	11,572	371	10,987	374
Chrome:				
Ore and concentrate:				
Exports	1,166	56	864	50
Reexports	6,071	252	427	8
Chromic acid	312	171	397	216
Ferrochrome	607	286	2,105	996
Cobalt pounds	382,630	[1] 363	3,067,386	1,173
Columbium metals, alloys and other forms do	9	(2)	278	15
Copper:				
Ore, concentrate, composition metal, and unrefined copper (copper content)	495	290	2,369	1,309
Refined copper and semimanufactures	[1] 171,393	[1] 116,213	312,461	196,070
Other copper manufactures	294	352	250	308
Copper sulfate or blue vitriol	32,659	6,250	29,762	5,781
Copper base alloys	(3)	32,964	(3)	57,086
Ferroalloys:				
Ferrosilicon pounds	3,395,617	288	4,160,243	365
Ferrophosphorus do	45,918,473	1,148	48,683,806	793
Gold:				
Ore and base bullion troy ounces	1,124	41	3,495	122
Bullion, refined do	853,126	32,319	490,462	19,230
Iron ore long tons	[1] 4,251,955	[1] 32,422	3,145,714	24,784
Iron and steel:				
Pig iron	18,837	1,074	10,247	762
Iron and steel products (major):				
Semimanufactures	[1] 1,813,542	[1] 281,344	1,867,711	303,791
Manufactured steel mill products	1,515,707	[1] 299,623	1,204,679	247,471
Advanced products	(3)	[1] 123,081	(3)	122,733
Iron and steel scrap: Ferrous scrap, including rerolling materials	316,542	11,219	1,683,103	51,256
Lead:				
Ore, matte, base bullion (lead content)	1,038	269	102	25
Pigs, bars, anodes:				
Exports	803	263	596	208
Reexports	799	188		
Scrap	2,706	523	3,894	838
Magnesium:				
Metal and alloys	2,722	1,718	3,096	1,738
Semifabricated forms, n. e. c	227	771	161	605
Powder	21	42	34	45
Manganese:				
Ore and concentrate	6,894	552	6,112	592
Ferromanganese	1,112	389	1,732	615
Mercury:				
Exports flasks	546	106	890	183
Reexports do	916	158	1,436	257
Molybdenum:				
Ore and concentrate pounds	7,037,436	7,308	13,546,510	13,989
Metals and alloys, crude and scrap do	21,826	13	34,358	37
Wire do	15,980	235	10,563	196
Primary forms, mainly rods, sheets, and tubes do	13,078	21	26,001	34
Powder do	17,290	46	15,423	20
Ferromolybdenum do	646,411	549	247,763	238

For footnotes, see end of table.

TABLE 9.—Principal minerals and products exported from the United States, 1953–54—Continued

Mineral	1953		1954	
	Short tons (unless otherwise stated)	Value (thousand dollars)	Short tons (unless otherwise stated)	Value (thousand dollars)
METALLIC—continued				
Nickel:				
Alloys and scrap (including Monel metal)........do....	22,846,005	8,868	27,517,514	10,865
Ingots, bars, sheet, etc........do....	6,578,740	806		
Nickel-chrome electric resistance wire........do....	356,222	609	299,186	522
Manufactures........do....	555,993	936	671,151	1,069
Platinum:				
Ore and concentrate........troy ounces..	30	(2)	29	2
Bars, ingots, sheets, wire, sponge, and other forms including scrap........troy ounces..	2,522	238	13,470	1,148
Palladium, rhodium, iridium, osmiridium, ruthenium and osmium metals and alloys, including scrap troy ounces..	23,206	591	11,443	287
Platinum group manufactures except jewelry........	(3)	1,555	(3)	1,801
Radium metal (radium content)........milligrams..	1,056	35	419	15
Rare earths:				
Cerium ores, metal and alloy........pounds..	83,659	278	29,461	129
Lighter flints........do....	11,254	70	7,954	56
Silver:				
Ore and base bullion........troy ounces..	....	....	29,917	25
Bullion, refined........do....	1,022,773	871	1,672,618	1,451
Tantalum:				
Ore, metal, and other forms........pounds..	172,246	119	52,461	93
Powder........do....	62	3	110	5
Tin, ingots, pigs, bars, etc.:				
Exports........long tons..	128	298	271	467
Reexports........do....	75	142	551	1,125
Tin scrap and other tin-bearing material except tinplate scrap........long tons..	5,237	2,418	8,269	3,341
Tin cans, finished or unfinished........do....	29,841	12,917	23,878	11,022
Tin compounds........pounds..	183,328	353	342,146	511
Titanium:				
Ore and concentrate........	[1] 1,368	[1] 110	663	86
Metal and alloys in crude form and scrap........	[1] 2	[1] 12	48	1,108
Semifabricated forms, n. e. c........	31	[1] 798	164	3,567
Ferrotitanium........	185	49	172	40
Dioxide and pigments........	39,780	11,716	63,802	23,281
Tungsten, ore and concentrate:				
Exports........	13	31	39	111
Reexports........	22	61	149	239
Zinc:				
Ore, concentrate, dross (zinc content)........	2,953	759	....	....
Slabs, pigs or blocks........	[1] 17,969	[1] 1,462	24,994	5,394
Sheets, plates, strips or other forms, n. e. s........	4,628	2,637	4,045	2,183
Scrap (zinc content)........	1,000	170	16,689	2,023
Dust........	502	181	509	151
Semifabricated forms, n. e. c........	286	151	543	257
Zirconium:				
Ore and concentrate........	1,110	89	692	43
Metals and alloys and other forms........pounds..	6,745	9	39,680	6
NONMETALLIC MINERALS				
Abrasives:				
Grindstones and pulpstones........pounds..	864,357	53	714,227	47
Diamond dust and powder........carats..	65,853	183	90,665	238
Diamond grinding wheels........do....	110,847	546	129,868	554
Other natural and artificial metallic abrasives and products........	....	17,754	....	19,856
Asbestos, unmanufactured:				
Exports........	2,780	540	1,847	276
Reexports........	296	52	47	15
Boron: Boric acid, borates, crude and refined........pounds..	278,634,186	8,972	411,228,805	12,904
Bromine, bromides, and bromates........do....	3,414,065	1,865	5,082,437	2,308
Cement........376-pound barrels.	[1] 2,550,788	[1] 9,347	1,844,012	6,622
Clay:				
Kaolin or china clay........	43,590	795	49,199	946
Fire clay........	90,897	920	77,913	815
Other clays........	167,901	5,316	200,602	6,582
Cryolite........long tons..	117	35	72	24
Fluorspar........	767	49	643	50
Graphite:				
Amorphous........	1,571	154	608	67
Crystalline flake, lump or chip........	94	38	49	19
Natural, n. e. s........	95	8	141	20

For footnotes, see end of table.

TABLE 9.—Principal minerals and products exported from the United States, 1953–54—Continued

Mineral	1953		1954	
	Short tons (unless otherwise stated)	Value (thousand dollars)	Short tons (unless otherwise stated)	Value (thousand dollars)
NONMETALLIC MINERALS—continued				
Gypsum:				
Crude, calcined, crushed	23,690	694	22,384	762
Plasterboard, wallboard, and tile ... square feet	45,767,496	1,195	20,968,956	689
Manufactures, n. e. c.	(3)	105	(3)	150
Iodine, iodide, iodates ... pounds	274,690	452	338,258	488
Kyanite and allied minerals	1,032	41	1,147	58
Lime	79,934	1,422	73,246	1,300
Mica:				
Unmanufactured ... pounds	45,046	28	318,518	79
Manufactured:				
Ground or pulverized ... do	4,560,883	240	6,058,118	343
Other ... do	197,370	842	280,415	1,093
Mineral-earth pigments: Iron oxide, natural and manufactured	4,173	688	3,554	682
Nitrogen compounds (major)	[1] 133,538	[1] 9,245	332,655	14,867
Phosphate rock ... long tons	2,100,798	18,368	2,385,013	21,169
Phosphatic fertilizers ... do	259,215	6,611	393,114	11,752
Pigments and salts (lead and zinc):				
Lead pigments	2,473	799	2,570	872
Zinc pigments	6,898	1,468	6,124	1,352
Lead salts	152	83	355	162
Potash:				
Fertilizer	83,412	2,894	111,184	4,134
Chemical	4,796	1,042	6,202	1,330
Quartz crystal (raw)	(3)	5	(3)	41
Radioactive isotopes, etc.	(3)	[1] 533	(3)	536
Salt:				
Crude and refined	249,521	2,328	380,609	3,054
Shipments to noncontiguous Territories	8,980	632	9,650	782
Sodium and sodium compounds:				
Sodium sulfate	28,192	805	24,965	823
Sodium carbonate	165,405	5,819	163,548	5,527
Stone:				
Limestone, crushed, ground, broken	411,196	960	466,177	1,009
Marble and other building and monumental ... cubic feet	153,105	2,204	127,341	2,396
Stone, crushed, ground, broken	691,811	704	508,940	703
Manufactures of stone	(3)	465	(3)	406
Sulfur:				
Crude ... long tons	1,241,536	34,554	1,647,725	50,446
Crushed, ground, flowers of ... do	29,475	[1] 2,020	30,130	2,162
Talc:				
Crude and ground	23,071	602	23,348	745
Manufactures, n. e. c.	159	96	259	111
Powders—talcum (face and compact)	(3)	1,296	(3)	1,076
FUELS				
Asphalt and bitumen, natural:				
Unmanufactured	20,513	1,098	29,868	1,474
Manufactures, n. e. c.	(3)	437	(3)	716
Carbon black ... thousands of pounds	358,620	32,054	402,777	36,163
Coal:				
Anthracite	2,724,270	51,882	2,851,239	51,699
Bituminous	33,760,263	283,231	31,040,564	252,621
Briquets	102,907	1,677	98,908	1,627
Coke	520,252	9,269	384,377	6,248
Petroleum:				
Crude ... thousands of barrels	19,932	59,970	13,599	45,026
Gasoline [4] ... do	30,045	192,348	26,618	184,626
Kerosine ... do	6,418	25,467	4,001	16,102
Distillate oil ... do	29,661	105,758	21,931	80,876
Residual oil ... do	19,810	39,116	20,338	39,438
Lubricating oil ... do	12,258	178,532	14,482	197,854
Asphalt ... do	1,525	10,384	1,598	10,013
Liquefied petroleum gases ... do	2,955	12,786	3,912	15,692
Wax ... do	1,127	19,125	1,340	25,983
Coke ... do	3,612	14,042	3,214	12,175
Petrolatum ... do	244	4,449	293	5,793
Miscellaneous products ... do	986	14,510	1,014	16,152

[1] Revised figure.
[2] Less than $1,000.
[3] Weight not recorded.
[4] Includes naphtha but excludes benzol: 1953—30,000 barrels ($583,000); 1954—140,000 barrels ($1,889,000).

TABLE 10.—Comparison of world and United States[1] production of principal metals and minerals, 1953–54

(Compiled under the supervision of Berenice B. Mitchell, Division of Foreign Activities, Bureau of Mines)

Mineral	1953			1954		
	World	United States		World	United States	
	Thousand short tons		Percent of world	Thousand short tons		Percent of world
Fuels:						
Coal:						
Bituminous	1,512,700	454,439	30	1,482,900	391,040	26
Lignite	495,000	2,851	(2)	517,000	2,843	(2)
Pennsylvania anthracite	151,300	30,949	20	152,100	29,083	19
Coke (excluding breeze):						
Gashouse	[3] 46,500	237	(2)	[3] 47,000	256	(2)
Oven and beehive	248,000	78,837	32	232,000	59,662	26
Fuel briquets and packaged fuel	118,000	1,860	2	117,000	1,701	1
Natural gas ... million cubic feet	(4)	8,396,916	(4)	(4)	8,742,546	(4)
Peat	59,000	204	(2)	59,000	243	(2)
Petroleum (crude) ... thousand barrels	4,770,779	2,357,082	49	4,990,899	2,316,323	46
Nonmetallic minerals:						
Asbestos	1,500	54	4	1,525	48	3
Barite	2,150	920	43	2,200	947	43
Cement ... thousand barrels	1,042,400	267,669	26	1,142,900	275,857	24
Corundum	10	-------	-------	10	-------	-------
Diamonds ... thousand carats	20,096	-------	-------	20,440	-------	-------
Diatomite	660	300	45	660	300	45
Feldspar[5] ... thousand long tons	780	453	58	810	411	51
Fluorspar	1,340	318	24	1,300	246	19
Graphite	200	6	3	185	(6)	(6)
Gypsum	27,900	8,293	30	29,600	8,943	30
Magnesite	4,300	553	13	4,100	284	7
Mica (including scrap) ... thousand pounds	255,000	147,367	58	285,000	162,808	57
Nitrogen, agricultural[5, 7]	5,400	1,419	26	5,732	1,515	26
Phosphate rock ... thousand long tons	26,000	12,504	48	29,200	13,821	47
Potash ... K_2O equivalent	7,400	1,912	26	8,100	1,949	24
Pumice	3,200	1,348	42	3,600	1,647	46
Pyrites ... thousand long tons	13,600	923	7	13,500	909	7
Salt	63,200	20,789	33	63,400	20,380	32
Sulfur, native ... thousand long tons	5,800	5,155	89	6,200	5,516	89
Talc, pyrophyllite, and soapstone	1,690	632	37	1,840	592	32
Vermiculite[5]	224	190	85	243	196	81
Metals, mine basis:						
Antimony (content of ore and concentrate)[5]	35	(8)	1	40	(8)	2
Arsenic[5]	45	11	24	50	13	26
Bauxite ... thousand long tons	13,425	1,580	12	15,550	1,995	13
Beryllium concentrate[5]	9	(9)	8	6	(9)	10
Bismuth ... thousand pounds	4,200	(6)	(6)	3,800	(6)	(6)
Cadmium ... do	15,380	9,767	64	15,540	9,552	61
Chromite	4,200	59	1	3,600	163	5
Cobalt (contained)	13	(10)	7	14	1	7
Columbium-tantalum concentrate thousand pounds	5,780	15	(2)	9,625	33	(2)
Copper (content of ore and concentrate)	3,050	926	30	3,100	835	27
Gold ... thousand fine ounces	33,700	1,970	6	35,100	1,859	5
Iron ore ... thousand long tons	331,000	118,000	36	299,000	78,000	26
Lead (content of ore and concentrate)	2,090	343	16	2,230	325	15
Manganese ore (35 percent or more Mn)	10,600	158	1	9,700	206	2
Mercury ... thousand 76-pound flasks	160	14	9	177	19	11
Molybdenum (content of ore and concentrate) ... thousand pounds	62,600	57,243	91	65,500	58,668	90
Nickel (content of ore and concentrate)	223	(11)	(2)	242	3	1
Platinum group (Pt, Pd, etc.) thousand troy ounces	775	26	3	825	24	3
Silver ... thousand fine ounces	221,600	37,736	17	213,400	35,585	17
Tin (content of ore and concentrate)[5] thousand long tons	180	(12)	(2)	179	(12)	(2)
Titanium concentrates:						
Ilmenite	1,081	514	48	1,092	548	50
Rutile	50	7	14	58	7	12
Tungsten concentrate ... 60 percent WO_3	79	10	13	77	14	18
Vanadium (content of ore and concentrate)[5]	6	5	83	6	5	83
Zinc (content of ore and concentrate)	2,920	547	19	2,920	467	16

For footnotes, see end of table.

TABLE 10.—Comparison of world and United States [1] production of principal metals and minerals, 1953–54—Continued

Mineral	1953			1954		
	World	United States		World	United States	
	Thousand short tons		Percent of world	Thousand short tons		Percent of world
Metals, smelter basis:						
Aluminum	2,710	1,252	46	3,050	1,461	48
Copper	3,275	1,048	32	3,275	946	29
Iron, pig (incl. ferroalloys)	186,000	77,201	42	175,000	59,752	34
Lead	2,010	468	23	2,120	487	23
Magnesium	170	93	55	140	70	50
Steel ingots and castings	259,500	111,610	43	246,200	88,312	36
Tin thousand long tons	184	38	21	186	28	15
Zinc	2,560	916	36	2,650	802	30

[1] Including Alaska and Puerto Rico.
[2] Less than 1 percent.
[3] Includes low- and medium-temperature and gashouse coke.
[4] Data not available.
[5] World total exclusive of U. S. S. R.
[6] Bureau of Mines not at liberty to publish United States figure separately.
[7] Year ended June 30 of year stated (United Nations).
[8] In 1953 United States production of antimony was 372 short tons and in 1954, 764 short tons.
[9] In 1953 United States production of beryl was 751 short tons and in 1954, 642 short tons.
[10] In 1953 United States production of cobalt was 888 short tons.
[11] In 1953 United States production of nickel was 602 short tons.
[12] In 1953 United States production of tin was 56 long tons and in 1954, 200 long tons.

Employment and Injuries in the Metal and Nonmetal Industries

By Seth T. Reese[1]

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

Since 1911 the Bureau of Mines has been collecting data on the injury experience at metal and nonmetal mines and quarries, in order that these industries may cooperate in the Bureau's endeavor to reduce mining injuries. The first direct request to the operators for information on injuries and related employment was made early in 1912. Operators at that time ranged from lone prospectors to mines with many employees; however, the Bureau made no distinction regarding the size of the operation, since the lone prospectors and employees at the larger mining operations were exposed to the same hazards.

Responses to the first requests for information were gratifying; and some operators submitted detailed reports, which, when compiled, were fairly representative of the industry from the production point of view. At present, owing to the fact that coverage has grown, the data in this chapter of the Minerals Yearbook represent approximately full coverage of the industry. All responses to the Bureau's requests are voluntary, as no Federal law compels the companies to submit data, such as must be supplied by the coal-mining industry. Therefore, the mining companies who contributed information have aided materially in promoting safety in the mineral industries of the United States.

METAL MINES

The overall injury experience at metal mines in 1954 improved, as fewer men were killed and injured than in the previous year, and the combined (fatal and nonfatal) frequency rate declined slightly. The number of fatal injuries was decreased by 6, or 6.5 percent, and the number of nonfatal injuries dropped to 4,994—a decrease of 1,170, or approximately 20 percent. The combined (fatal and nonfatal)

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frequency rate of 38.93 for 1954, compared with the 39.95 overall rate for the previous year, showed a 3-percent improvement. Table 2 shows improvements in the fatal and nonfatal frequency rates for the lead-zinc industry and in the nonfatal rate at iron, gold-silver, and gold-placer operations. Fewer fatal injuries were reported in the lead-zinc and iron-mining industries, with decreases of 37 and 26 percent, respectively. Employment, measured by the average number of men working daily, dropped to 66,610, the greatest decline (8 percent) being at iron and lead-zinc operations. The 8.01-hour shift worked was approximately the same as that reported in the previous year, and the average employee accumulated 1,959 hours of worktime during 1954, a decline of 200 hours or 9 percent from the previous year.

TABLE 1.—Employment and injury experience at metal mines in the United States, 1931–54 [1]

Year	Men working daily	Average active mine days	Man-days worked (in thousands)	Man-hours worked (in thousands)	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

[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.

Copper.—The injury experience at copper mines was not as favorable as that reported in 1953. Fatal injuries increased 7 or 28 percent over 1953; but nonfatal injuries were 97 less, or a drop of 8 percent from the 1,212 reported in 1953. The increased injury-frequency rate for the number of workers killed did not influence the overall rate greatly; the 1953 rate was 31.32 and the 1954 rate 31.74 per million man-hours. The average number of men working daily increased slightly, but the number of days worked was fewer by 30 or 10 percent. Copper mines worked a straight 8-hour shift, and each worker had 2,248 hours to his credit, or 236 less than in the previous year.

TABLE 2.—Employment and injury experience at metal mines in the United States, by industry groups, 1945–49 (average) and 1950–54

Industry and 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
Copper:								
1945–49 (average)	15, 094	293	4, 419, 168	35, 354, 887	24	1, 481	0. 68	41. 89
1950	15, 383	305	4, 688, 299	37, 345, 430	17	1, 176	. 46	31. 49
1951	16, 274	305	4, 959, 135	39, 676, 673	19	1, 304	. 48	32. 87
1952	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
Gold placer:								
1945–49 (average)	3, 298	213	701, 881	5, 959, 816	1	176	. 17	29. 53
1950	3, 457	218	753, 922	6, 037, 624	-------	184	-------	30. 48
1951	2, 649	210	557, 482	4, 475, 624	3	198	. 67	44. 24
1952	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
Gold-silver:								
1945–49 (average)	5, 018	265	1, 327, 333	10, 330, 908	10	980	. 97	94. 86
1950	5, 112	261	1, 333, 387	10, 328, 735	10	1, 270	. 97	122. 96
1951	4, 261	251	1, 070, 753	8, 294, 331	15	963	1. 81	116. 10
1952	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
Iron:								
1945–49 (average)	25, 910	264	6, 846, 435	54, 975, 604	30	1, 307	. 55	23. 77
1950	27, 686	268	7, 407, 111	59, 406, 348	23	1, 126	. 39	18. 95
1951	30, 576	276	8, 446, 483	67, 931, 038	33	1, 264	. 49	18. 61
1952	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
Lead-zinc:								
1945–49 (average)	15, 931	266	4, 237, 252	33, 866, 030	28	2, 995	. 83	88. 44
1950	14, 038	257	3, 612, 051	28, 878, 165	28	2, 411	. 97	83. 49
1951	14, 520	271	3, 937, 874	31, 488, 680	18	2, 497	. 57	79. 30
1952	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
Miscellaneous: [1]								
1945–49 (average)	2, 919	275	801, 714	6, 434, 762	4	488	. 62	75. 84
1950	2, 616	278	727, 325	5, 768, 379	6	444	1. 04	76. 97
1951	3, 323	283	941, 591	7, 550, 962	7	598	. 93	79. 20
1952	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
Total:								
1945–49 (average)	68, 170	269	18, 333, 783	146, 922, 007	97	7, 427	. 66	50. 55
1950	68, 292	271	18, 522, 095	147, 764, 681	84	6, 611	. 57	44. 74
1951	71, 603	278	19, 913, 318	159, 417, 308	95	6, 824	. 60	42. 81
1952	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

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

Gold Placer.—Gold-placer operations reported improvement in their safety record for 1954. Although 1 worker was killed, the same as reported in 1953, the nonfatal injuries dropped to 84 from 188, resulting in a sharply improved overall frequency rate from 42.98 in 1953 to 24.15 in 1954. The average number of men working daily decreased 21 percent, the number of days worked increased 3, an 8-hour shift was worked, and each employee accumulated 19 more hours during 1954 than in 1953.

Gold-Silver Lode.—The frequency rate for fatal injuries at gold-silver lode mines was approximately the same as that reported in 1953, and the same number of fatal injuries was reported for each year. Nonfatal injuries were 87 less, and the rate at which these occurred dropped from 104.14 in 1953 to 95.87. The combined (fatal and nonfatal) rate declined 8 percent. Days worked increased 3, and the number of hours each employee worked also increased slightly—from 2,032 in 1953 to 2,054 in 1954.

Iron.—The safety record at iron mines improved substantially in 1954. Fatal injuries decreased 5 and nonfatal injuries 418; the overall frequency rate of 14.78 was 14 percent lower than in 1953. Employment decreased, as did the number of days worked. The mines worked an 8.02-hour shift, the same as in 1953, and the average employee had 1,766 hours of work to his credit.

Lead-Zinc.—Notable improvement was made in the safety record of the lead-zinc industry in 1954, as indicated by decreases in number of injuries and in fatal and nonfatal rates. There were 30 fatal injuries in 1953, and 19 were reported in 1954. Similarly, nonfatal injuries dropped from a total of 2,135 in 1953 to 1,421 in 1954. The number of fatalities decreased 37 percent and the frequency rate 23 percent, whereas nonfatal injuries decreased 33 percent in number and 19 percent in rate of occurrence. The average number of men working daily dropped from 13,503 in 1953 to 10,755 in 1954, the days active were 8 more, and the length of shift worked was 8 hours for each year. The average employee worked 2,049 hours during the year.

Miscellaneous Metals.—This group had a safety record for 1954 worse than that for the previous year. Three more men were killed, and the frequency rate rose from 0.87 in 1953 to 1.04. Nonfatal injuries increased 250 in number, and the frequency rate rose to 79.56 from the 64.81 rate for 1953. Employment increased slightly, 1 more day was worked during the year, the length of shift was approximately the same as in the previous year, and in each year 1,951 hours of work was done by the average employee.

NONMETAL MINES (EXCEPT STONE QUARRIES)

Tables 3 and 4 show the injury and related employment experience at nonmetallic mineral operations, such as those that produce barite, feldspar, fluorspar, gypsum, magnesite, mica, phosphate rock, rock salt, sulfur, and other miscellaneous nonmetallic minerals. The average number of men working daily rose slightly, while the number of active days and the number of man-hours worked showed slight recessions. Fatal injuries were reduced 13, or 59 percent, and the nonfatal injuries reported for 1954 totaled 956, a 33-percent reduc-

TABLE 3.—Employment and injury experience at nonmetal mines (except stone quarries) in the United States, 1931–54 [1]

Year	Men working daily	Average active mine days	Man-days worked (in thousands)	Man-hours worked (in thousands)	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

[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, 1945–49 (average) and 1950–54 [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
1945–49 (average)	11,577	287	3,328,059	27,006,237	16	1,225	0.59	45.36
1950	11,977	293	3,512,094	28,455,936	19	1,238	.67	43.51
1951	12,500	298	3,728,821	30,130,424	17	1,351	.56	44.84
1952	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

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

tion from the number reported in 1953. The overall (fatal and nonfatal) frequency rate fell 31 percent or from 47.26 to 32.64 injuries per million man-hours in 1954. Days active were 8 fewer, and the length of shift was approximately the same in each year. Each worker accumulated 2,308 hours of work during the year.

METALLURGICAL PLANTS

The overall injury experience at metallurgical plants in 1954 was more favorable than in 1953, regardless of the fact that 4 more employees were killed. Sixteen were reported fatally injured in 1954, while in 1953 12 men were killed. The nonfatal group had fewer injuries, however, and the combined frequency rate improved 5 percent (20.43 in 1953 and 19.41 in 1954). Employment at metallurigcal plants dropped slightly, and the number of active mine days worked was lowered by 11. Both years reported about the same length of shift, and the average employee worked 2,457 hours during the year. Historic and current data on metallurgical plants are included in table 5.

TABLE 5.—Employment and injury experience at metallurgical plants in the United States, 1931–54 [1]

Year	Men working daily	Average active plant days	Man-days worked (in thousands)	Man-hours worked (in thousands)	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

[1] Man-hours not available before 1931.

ORE-DRESSING PLANTS

Ore-dressing plants, include the crushing, screening, washing, jigging, magnetic separation, flotation, and other milling of metallic ores. The injury experience was not as favorable in 1954 as in the previous year, when employment was the highest recorded for the past 5 years and only 4 men lost their lives. In 1954 employment dropped, 10 men were killed, and the nonfatal injuries were increased by 4. The fatality rate rose to 0.24 for 1954, an increase of 167 percent above the 1953 rate of 0.09 per million man-hours of worktime; the nonfatal injury rate increased 12 percent. Except at copper plants, employment declined, as measured by the average number of men working daily. The injury experience at all plants was not favorable when compared with that of the past year. Each employee worked an 8.01-hour shift, and 21 less days were worked in 1954 than in 1953. The average worker accumulated 2,206 hours during the year.

TABLE 6.—Employment and injury experience at ore-dressing plants in the United States, by industry groups, 1945–49 (average) and 1950–54 [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:								
1945–49 (average)	6,041	308	1,860,641	14,900,168	2	291	0.13	19.53
1950	5,828	337	1,966,475	15,731,325	2	243	.13	15.45
1951	6,033	336	2,025,542	16,205,429		226		13.95
1952	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
Gold-silver:								
1945–49 (average)	915	282	257,806	2,016,424	1	93	.50	46.12
1950	769	285	219,266	1,707,555		75		43.92
1951	708	287	203,161	1,579,353	2	55	1.27	34.82
1952	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
Iron:								
1945–49 (average)	3,374	235	792,868	6,438,461	1	97	.16	15.07
1950	3,401	239	814,406	6,568,250	3	74	.46	11.27
1951	3,756	250	937,338	7,588,231		69		9.09
1952	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
Lead-zinc:								
1945–49 (average)	4,231	270	1,143,862	9,168,181	3	286	.33	31.19
1950	3,489	259	903,009	7,223,114	2	226	.28	31.29
1951	3,441	270	930,091	7,444,528	2	222	.27	29.82
1952	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
Miscellaneous metals: [2]								
1945–49 (average)	1,368	275	375,708	3,012,313	1	114	.33	37.84
1950	1,469	303	444,660	3,584,752		167		46.59
1951	2,401	331	793,658	6,361,298	2	206	.31	32.38
1952	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
Total:								
1945–49 (average)	15,929	278	4,430,885	35,535,547	8	881	.23	24.79
1950	14,956	291	4,347,816	34,814,996	7	785	.20	22.55
1951	16,339	299	4,889,790	39,178,839	6	778	.15	19.86
1952	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

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

NONFERROUS REDUCTION PLANTS AND REFINERIES

The reduction plants and refineries are engaged in the primary extraction of nonferrous metals from ores and concentrates and the refining of crude primary nonferrous metals, the only exclusion being iron and steel plants. The safety record was most favorable in this group for 1954. Fatal injuries decreased by 2, or 25 percent, and the nonfatal injuries were fewer by 250—a 13-percent decrease. The combined (fatal and nonfatal) frequency rate per million man-hours of worktime likewise decreased 12 percent. Lead operations had the best safety record (11.49), and copper plants were second, having a combined rate (fatal and nonfatal) of 11.97. Six less days were

TABLE 7.—Employment and injury experience at primary nonferrous reduction and refinery plants in the United States, by industry groups, 1945–49 (average) and 1950–54 [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:								
1945–49 (average)	11,409	318	3,630,806	29,069,880	5	575	0.17	19.78
1950	11,756	323	3,799,981	30,401,750	7	521	.23	17.14
1951	11,928	325	3,874,388	31,198,141	3	506	.10	16.22
1952	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
Lead:								
1945–49 (average)	3,861	307	1,187,058	9,494,127	2	177	.21	18.64
1950	3,946	305	1,202,755	9,606,222	4	166	.42	17.28
1951	3,939	302	1,189,986	9,520,909	2	112	.21	11.76
1952	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
Zinc:								
1945–49 (average)	9,952	339	3,373,319	26,712,456	2	880	.07	32.94
1950	9,106	350	3,187,484	25,314,896	9	779	.36	30.77
1951	9,160	353	3,236,675	25,744,087	2	788	.08	30.61
1952	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
Miscellaneous metals: [2]								
1945–49 (average)	6,035	313	1,888,894	14,971,237	1	410	.07	27.39
1950	6,513	307	2,001,201	16,292,286	2	323	.12	19.83
1951	6,653	309	2,056,024	16,445,647	3	530	.18	32.23
1952	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
Total:								
1945–49 (average)	31,257	322	10,080,077	80,247,700	10	2,042	.12	25.45
1950	31,321	325	10,191,421	81,615,154	22	1,789	.27	21.92
1951	31,680	327	10,357,073	82,908,784	10	1,936	.12	23.35
1952	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

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

worked at the reduction plants and refineries in 1954, and the average worker accumulated 2,594 hours during the year.

STONE QUARRIES

The quarrying industries for 1954 show a favorable decline in the number of fatal and nonfatal injuries reported for the year. The combined injury-frequency rate of 22.00 per million man-hours of worktime was 7 percent lower than the corresponding rate of 23.68 reported for 1953. The number of fatal injuries dropped 21 percent (43 in 1953 and 34 in 1954). Similarly, the number of nonfatal injuries decreased from 4,450 in 1953 to 3,834 in 1954, or 14 percent. Fewer men were employed than in the previous year; the man-shifts and the man-hours worked were also lower. The average employee worked 273 days, and the average number of hours worked by each was 2,228 or 41 hours less than in 1953.

Cement.—The cement industry, including quarry and mill employees, had a record-breaking year for safety. Only 6 fatalities and

322 nonfatal injuries were reported. The combined injury-frequency rate of 4.61 per million man-hours was a record low for the industry. The number of active days worked was 320, or 9 less than the previous year; and the number of men employed decreased approximately 4 percent, accompanied by a 6-percent decline in the number of man-hours of work performed. Each employee worked a straight 8-hour shift and accumulated 2,564 hours of worktime during the year.

Granite.—The overall injury experience at granite quarries and related plants improved in 1954, as shown by the combined (fatal and nonfatal) injury-frequency rate of 35.41, compared with 41.02 for 1953. Fatal injuries increased, but the nonfatal injuries were fewer by 95. The number of men employed was 15 less than in the previous year, days active were reduced by 9, and the number of man-hours worked was 4 percent lower than those reported for 1953. The average employee worked 2,012 hours during 1954.

Lime.—The fatality rate at lime plants and quarries increased sharply in 1954, although the nonfatal-injury rate showed little change. The overall (fatal and nonfatal) injury-frequency rate rose from 24.42 in 1953 to 24.83 in 1954. The number of men employed dropped substantially; however, the number of days worked by lime operations were the same as that reported for the previous year. The total number of man-shifts and man-hours each showed a decrease of approximately 13 percent, and each employee worked 2,356 hours during the year.

Limestone.—Improvement in the injury experience for the limestone-quarrying industry and related plants is reflected in both the number of fatal and nonfatal injuries reported. Fatalities were 4 less than the previous year, and the nonfatal injuries were reduced by 291. The overall injury rate (fatal and nonfatal) for 1954 was 33.70, whereas the rate for 1953 was 36.81 per million man-hours. Although the average number of men working daily decreased 5 percent, the days worked were approximately the same, and the aggregate of man-shifts and man-hours each was reduced 6 percent. The average employee accumulated 1,990 hours of work during the year.

Marble.—The marble-quarrying industry, with its associated plants, reported a highly favorable injury record for the year 1954. No fatalities were reported and the nonfatal injuries were reduced by two from the previous year. The injury-frequency rate dropped to 29.85 from 32.52 in 1953. There were 116 more men employed daily in 1954, the average employee worked 4 more days, and the man-shifts and man-hours increased 6 and 7 percent, respectively. The average workman worked 2,082 hours during the year.

Sandstone.—The safety record in the sandstone-rock-quarrying industry improved in 1954. No fatal injuries were reported, and there were 106 fewer nonfatal disabling injuries. The average number of men employed daily was reduced by 696, or 17 percent, and the number of man-hours of employment 25 percent. The average number of days worked was 221, and each employee's worktime totaled 1,810 hours.

Slate.—There were no fatalities in the slate industry in 1954, and the number of nonfatal injuries was reduced slightly. However, the injury-frequency rate rose to 55.25 from 51.73 in 1953, owing to a slight reduction in the number of man-hours worked. Slate plants were operated 2 days less than in 1953, and each employee worked 2,175 hours during 1954.

Traprock.—The injury record of the traprock quarries and their related plants was not as favorable as that for the preceding year. Although the same number of fatalities occurred, nonfatal injuries increased 18 over the previous year. Those, accompanied by little change in plant activity increased the injury-frequency rate from 38.65 in 1953 to 43.00 in 1954. Employment declined slightly and the plants operated the same number of days. Man-hours of worktime decreased 3 percent, and the average employee worked 1,966 hours during the year.

TABLE 8.—Employment and injury experience at stone quarries in the United States, 1924–54 [1]

Year	Men working daily	Average active mine days	Man-days worked (in thousands)	Man-hours worked (in thousands)	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

[1] Man-hours not available before 1924.

TABLE 9.—Employment and injury experience at stone quarries in the United States, by industry groups, 1945–49 (average) and 1950–54

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]								
1945–49 (average)	26,409	315	8,314,678	66,067,965	18	727	0.27	11.00
1950	29,003	324	9,383,895	73,758,750	17	548	.23	7.43
1951	29,096	329	9,561,969	75,325,959	15	480	.20	6.37
1952	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
Granite:								
1945–49 (average)	5,552	251	1,392,778	11,646,480	5	541	.43	46.45
1950	7,400	249	1,842,512	15,237,563	2	587	.13	38.52
1951	7,211	247	1,777,947	14,775,534	7	596	.47	40.34
1952	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
Lime:[1]								
1945–49 (average)	8,951	297	2,658,119	21,230,895	7	945	.33	44.51
1950	8,837	295	2,607,969	20,970,469	6	677	.29	32.28
1951	9,085	296	2,688,965	21,674,253	9	692	.42	31.93
1952	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
Limestone:								
1945–49 (average)	21,555	238	5,128,144	43,349,879	26	1,742	.60	40.18
1950	28,588	232	6,621,221	55,337,191	22	1,922	.40	34.73
1951	27,626	236	6,528,367	54,952,659	21	2,055	.38	37.40
1952	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
Marble:								
1945–49 (average)	2,569	260	668,674	5,551,698	1	186	.18	33.50
1950	2,600	246	640,281	5,330,295	3	168	.56	31.52
1951	2,584	254	656,579	5,486,709		191		34.81
1952	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
Sandstone:								
1945–49 (average)	3,576	245	876,339	7,304,440	3	351	.41	48.05
1950	4,204	242	1,015,370	8,437,247	1	365	.12	43.26
1951	4,199	240	1,009,415	8,288,499	2	389	.24	46.93
1952	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
Slate:								
1945–49 (average)	1,565	264	413,707	3,675,751	2	189	.54	51.42
1950	2,032	268	544,213	4,633,830	1	203	.22	43.81
1951	2,093	270	565,624	4,773,785		239		50.07
1952	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
Traprock:								
1945–49 (average)	2,472	237	586,986	4,981,723	3	235	.60	47.17
1950	3,066	225	691,022	5,829,466	2	292	.34	50.09
1951	2,908	234	680,826	5,835,796	3	303	.51	51.92
1952	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
Total:								
1945–49 (average)	72,649	276	20,039,425	163,808,831	65	4,916	.40	30.01
1950	85,730	272	23,346,483	189,534,811	54	4,762	.28	25.12
1951	84,802	277	23,469,692	191,113,194	57	4,945	.30	25.87
1952	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

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

Abrasive Materials

By Henry P. Chandler [1] and Gertrude E. Tucker [2] [3]

DURING 1954 sales in the United States of the more widely used types of abrasive products declined from the previous year. The sales value of bonded grinding wheels and similar products decreased 24 percent; metallic abrasives, 26 percent; and surface-coated abrasives, 9 percent. However, during the fourth quarter an upturn in the sales of these abrasive materials was noted. Other abrasive commodities gained during 1954. The value of abrasive materials imported was 7 percent lower, and exports of abrasives increased 12 percent in value.

By weight, industrial diamond imports in 1954 were the largest on record, although the total value was slightly less than in 1953. Production of aluminum oxide in the United States and Canada declined, whereas that of silicon carbide increased. Corundum imports were lower. Emery was imported for the first time in 3 years.

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.

TABLE 1.—Salient statistics of the abrasives industries in the United States, 1953–54

	1953		1954		Percent of change in—	
	Short tons	Value	Short tons	Value	Short tons	Value
Natural abrasives (domestic) sold or used by producers:						
Tripoli	36,183	$1,138,635	41,625	$1,458,762	+15	+28
Quartz, ground sand, and sandstone [1]	188,019	1,421,682	214,152	1,651,335	+14	+16
Grindstones	2,499	169,951	2,218	163,995	−11	−4
Millstones	(2)	18,375	(2)	(3)	-------	(3)
Tube-mill liners	1,219	68,688	933	59,471	−23	−13
Grinding pebbles	2,472	81,159	3,070	99,491	+24	+23
Garnet	10,520	988,797	14,183	971,353	+35	−2
Emery	10,562	143,974	9,758	132,313	−8	−8
Artificial abrasives:						
Silicon carbide [4]	62,301	8,190,431	66,972	8,787,445	+7	+7
Aluminum oxide [4]	244,136	23,807,806	219,308	22,420,833	−10	−6
Metallic abrasives (steel shot and grit)—shipments	160,500	18,038,046	118,096	13,271,832	−26	−26
Foreign trade (natural and artificial abrasives):						
Imports	---------	[5] 77,683,963	---------	72,022,620	-------	−7
Exports	---------	18,535,491	---------	20,693,708	-------	+12

[1] For abrasive purposes.
[2] Tonnage not recorded.
[3] Figure withheld to avoid revealing individual company operations.
[4] Production (United States and Canada).
[5] Revised figure.

[1] Commodity-industry analyst.
[2] Statistical assistant.
[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 2.—Properties of the more commonly used abrasive materials

Abrasive	Composition of pure material	Hardness		Toughness	Specific gravity	Melting point, ° C.	Supply	Application
		Wooddell scale [1]	Mohs scale					
Pumice	Aluminum silicate		5-6	Friable	0.9		Domestic	Polishing, soap and scouring compounds.
Cerium oxide	CeO_2		6		7.0	1,950	Domestic and Canada	Glass polishing.
Diatomite	SiO_2		7	Friable	2.2		Domestic	Polishes.
Tripoli	SiO_2		7	do	2.2		do	Do.
Quartz	SiO_2	7	7	Brittle to tough	2.6	1,500 to 1,600	do	Coated abrasives, sand blasting.
Flint	SiO_2		7	Tough	2.6		Domestic and imported	Coated abrasives, grinding pebbles.
Garnet	$Fe_3Al_2(SiO_4)_3$		7-7.5	Brittle	3.5-4.0	1,315	Domestic	Coated abrasives, sand blasting, glass polishing.
Emery	$Al_2O_3+Fe_2O_3$		8-8.5	Tough	3.7-4.0	2,200	Domestic and imported	Grinding wheels, coated abrasives.
Corundum	Al_2O_3	9	9	Brittle to tough	3.9-4.0	2,050	Imported	Grinding wheels, glass polishing.
Aluminum oxide	Al_2O_3	10-11	9+	Tough	3.9-4.0	2,050 to 2,350	Domestic and imported	Grinding wheels, coated abrasives, polishing.
Silicon carbide	SiC	13.4-14	9+	Brittle	3.1-3.2	2,700	do	Grinding wheels, coated abrasives, refractories.
Boron carbide	B_4C	19.7	9+	do	2.5	2,350	Domestic	Polishing.
Diamond	C	40-42	10	do	3.5	3,700	Imported	Grinding wheels, diamond tools, wire-drawing dies.

[1] Wooddell scale is based on relative resistance to abrasion.

NATURAL SILICA ABRASIVES

Tripoli.—Sales of tripoli, amorphous silica, and rottenstone increased 15 percent in tonnage and 28 percent in value in 1954 over 1953. Illinois, Missouri, Oklahoma, and Pennsylvania were the only States reporting output of these materials.

An important tripoli-producing property was acquired by one of the larger abrasive-manufacturing companies as part of its diversification in the field of related nonmetallic materials.[4]

As in the previous 5 years, about three-quarters of the tripoli, amorphous silica, and rottenstone mined during 1954 was used for abrasive purposes. No importations of these materials were reported during the year.

Companies producing tripoli, amorphous silica, or rottenstone in 1954 were: Ozark Minerals Co., Cairo, Ill. (amorphous silica); Tamms Industries, Inc., Tamms, Ill. (amorphous silica); American Tripoli Division of Carborundum Co., Seneca, Mo., and Ottawa County, Okla. (tripoli); Penn Paint & Filler Co., Antes Fort, Pa. (rottenstone); and Keystone Filler & Manufacturing Co., Muncey, Pa. (rottenstone).

Price quotations on tripoli in E&MJ Metal and Mineral Markets during 1954 remained unchanged from the previous year and were as follows (per short ton, paper bags, minimum carload 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 air-floated through 200-mesh, $35. Quotations appearing in Oil, Paint and Drug Reporter were: Tripoli, air-floated, 2 cents a pound; double-graded 1.85 cents a pound; single-graded, 1.75 cents a pound; all in bags, carlots, works. Amorphous silica, dry, graded, 325-mesh, bags, carlots, works, was quoted at $25 a ton; bags less than carlots, works, $30 to $40 a ton; rottenstone, bags, 5-ton lots, ex warehouse, 3 cents a pound; ton lots, ex warehouse, 4 cents a pound.

TABLE 3.—Ground tripoli[1] sold or used by producers in the United States, 1945–49 (average) and 1950–54, by uses[2]

Year	Abrasives		Filler		Other, including foundry facings		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1945–49 (average)	21,070	$488,551	3,307	$60,374	2,453	$51,762	26,830	$600,687
1950	34,865	968,497	6,744	147,379	2,111	57,771	43,720	1,173,647
1951	28,000	869,000	7,000	155,000	2,476	81,135	37,476	1,105,135
1952	25,000	771,000	7,000	156,000	3,459	116,124	35,459	1,043,124
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

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

Quartz.—Information on the 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

[4] Steel, Buys Silica Property: Vol. 134, No. 5, Feb. 1, 1954, p. 84.
Chemical and Engineering News, Carborundum Buys Capital Stock of American Tripoli: Vol. 32, No. 6, Feb. 8, 1954, pp. 476–478.
Rock Products, Change of Ownership: Vol. 57, No. 3, March 1954, p. 64.

included in the Stone and Sand and Gravel chapters of this volume. However, the portion of the production of these materials reported used for abrasive purposes is given in table 4.

The operations of one of the larger silica sand producers, whose product was used extensively by the abrasive industry, were described.[5] An informative article on abrasive quartz for the sandpaper and soap industries, an important part of the silica industry, was published during the year.[6]

TABLE 4.—Quartz, ground sand, and sandstone used for abrasive purposes, 1952–54

	1952		1953		1954	
	Short tons	Value	Short tons	Value	Short tons	Value
Ground sand	150, 509	$1, 208, 276	171, 974	$1, 328, 577	182, 046	$1, 466, 762
Sandstone, quartz, and quartzite	39, 104	158, 968	16, 045	93, 105	32, 106	184, 573
Total	189, 613	1, 367, 244	188, 019	1, 421, 682	214, 152	1, 651, 335

Synthetic silica, much harder and tougher than quartz, was produced by an abrasive firm.[7]

Data on the production of silica sand and similar abrasive materials in Canada were included in an article describing the natural abrasive industry in Canada.[8]

Abrasive Sands.—Glass grinding, stone polishing, sand blasting, and similar industries used substantial tonnages of natural sands with a high silica content as abrasive materials. Sales of these sands in 1954 totaled 1,343,742 short tons valued at $3,835,780, compared with 1,492,000 short tons valued at $3,375,000 in 1953. The 1954 figures include 589,021 short tons of blast sand valued at $2,513,731, a decrease of 10 percent in tonnage and an increase of 17 percent in value compared with 1953. 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 1954 decreased 11 percent in tonnage and 4 percent in value from 1953. No sales of pulpstones were reported. Ohio was the only State reporting sales.

Oilstones and Other Sharpening Stones.—The quantity of natural sharpening stones produced in 1954 declined 58 percent from 1953. However, the average value per ton increased over 100 percent, resulting in a decline of only 10 percent in total value for the same period. Producing States in 1954 were: Arkansas—oilstones and whetstones; Indiana—whetstones; and New Hampshire—scythestones.

Millstones.—Ulster County, N. Y., and Rowan County, N. C., were the only areas reporting production of millstones in 1954, and no production of chasers was reported.

Grinding Pebbles and Tube-Mill Liners.—Production of grinding pebbles in 1954 increased 24 percent in tonnage and 23 percent in value over 1953; production of tube-mill liners decreased 23 percent

[5] Gutschick, K. A., Ottawa Silica Co.: Pit and Quarry, vol. 40, No. 4, February 1954, pp. 83–87, 108.
[6] Bor, Leslie, Silica Rocks in Industry: Mine and Quarry Eng., vol. 20, No. 4, April 1954, pp. 164–170.
[7] The Manufacturing Jeweler, vol. 113, No. 10, May 20, 1954, p. 18.
[8] Janes, T. H., Natural Abrasives in Canada: Min. Eng., vol. 6, No. 10, October 1954, pp. 1010–1015.

in tonnage and 13 percent in value for the same period. Grinding-pebble production was reported from Minnesota, North Carolina, Texas, Washington, and Wisconsin. Tube-mill liners were produced in Minnesota, North Carolina, and Wisconsin.

TABLE 5.—Grindstones and pulpstones sold by producers in the United States, 1945–49 (average) and 1950–54

Year	Grindstones		Pulpstones		
			Quantity		
	Short tons	Value	Pieces	Equivalent short tons	Value
1945–49 (average)	8,932	$405,038	[1] 16	[1] 52	[1] $3,233
1950	4,435	230,462	12	33	2,100
1951	5,549	313,901	6	22	1,970
1952	3,962	246,526	4	12	908
1953	2,499	169,951			
1954	2,218	163,995			

[1] Represents 1946–49 average.

TABLE 6.—Value of millstones and chasers sold by producers in the United States, 1945–49 (average) and 1950–54 [1]

Year	Number of producers	Value	Year	Number of producers	Value
1945–49 (average)	3	$16,024	1952	1	$9,285
1950	2	11,300	1953	2	18,375
1951	1	6,000	1954	2	(2)

[1] Produced in Minnesota (1945 only), New York (1945–48 and 1953–54), North Carolina, and Virginia (1945–50 only).
[2] Figure withheld to avoid disclosure of individual company operations.

TABLE 7.—Grinding pebbles and tube-mill liners sold or used by producers in the United States, 1945–49 (average) and 1950–54

Year	Grinding pebbles		Tube-mill liners		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1945–49 (average)	5,106	$118,471	1,663	$43,826	6,769	$162,297
1950	1,923	53,007	1,523	62,535	3,446	115,542
1951	3,062	84,306	1,408	77,027	4,470	161,333
1952	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

NATURAL SILICATE ABRASIVES

Garnet.—The tonnage of garnet sold in the United States during 1954 increased 35 percent, but the value declined 2 percent as a result of inclusion in the total production of a substantial quantity of low-priced garnet used primarily for sand blasting. The Idaho garnet

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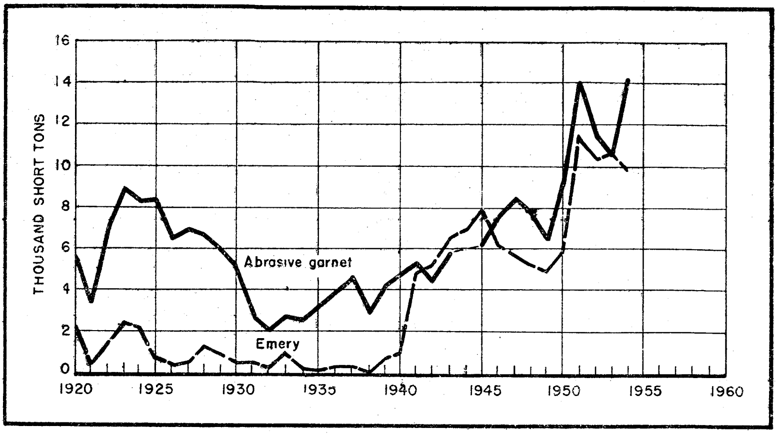

FIGURE 1.—Marketed production of abrasive garnet and domestic emery in the United States, 1920–54.

deposits were described.[9] The use of garnet from deposits in California for sand blasting was reported for the first time.[10] Although garnet was produced as a byproduct of the concentration of other minerals, the larger portion of the production was from deposits mined for their garnet content only. Garnet producers reporting sales in 1954 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, with Idaho second, California third, and Florida fourth.

A small quantity of garnet for industrial purposes continued to be exported from Madagascar.[11]

TABLE 8.—Abrasive garnet sold or used by producers in the United States, 1945–49 (average) and 1950–54

Year	Short tons	Value	Year	Short tons	Value
1945–49 (average)	7,478	$530,497	1952	11,390	$981,841
1950	9,304	793,558	1953	10,520	988,797
1951	14,050	1,246,947	1954	14,183	971,353

NATURAL ALUMINA ABRASIVES

Corundum.—The Union of South Africa continued to be the largest producer of abrasive-grade corundum. The Southern Rhodesian production was used almost entirely for manufacturing refractories. The export value of South African corundum in 1954 was $67 a short ton, whereas that of refractory-grade corundum from Southern Rhodesia averaged $19 a short ton.[12]

[9] Mineralogist, Idaho Garnets: Vol. 22, No. 2, February 1954, p. 49.
[10] California Mining Journal, Shipping Garnet Abrasives to Navy From Inyo County: Vol. 23, No. 11, July 1954, p. 16.
[11] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 6, June 1954, p. 42.
[12] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 2, August 1955, p. 36.

There was no commercial production of corundum in North America in 1945–54, and the United States relied principally on the Union of South Africa for its supply. Corundum exports from the Union of South Africa in 1954 fell to their lowest point since 1938, and imports of corundum into the United States decreased proportionately. Data on the corundum production in India [13] and the Union of South Africa [14] were published.

New corundum deposits were reported in Mozambique,[15] Canada,[16] and Namaqualand.[17]

The occurrences, methods of recovery, and strategic importance of corundum were discussed.[18]

Prices for crude corundum were quoted in E&MJ Metal and Mineral Markets c. i. f. United States ports, at $100 to $120 per short ton. No significant changes in the price of the various sizes of graded corundum were noted during 1954.

TABLE 9.—World production of corundum by countries,[1] 1945–49 (average) and 1950–54, in short tons [2]

(Compiled by Helen L. Hunt)

Country [1]	1945–49 (average)	1950	1951	1952	1953	1954
Argentina	47	(3)	(3)	(3)	(3)	(3)
Australia	2	-----	-----	61	-----	-----
Brazil	[4] 28	(3)	(3)	(3)	(3)	(3)
Canada	412	-----	-----	-----	-----	-----
French Equatorial Africa	42	-----	-----	-----	-----	-----
India	543	335	614	713	305	(3)
Kenya	-----	2	-----	-----	-----	-----
Madagascar	19	-----	-----	-----	-----	-----
Malaya, Federation of [4]	-----	11	28	-----	-----	-----
Mozambique	35	18	-----	(3)	1	(3)
Rhodesia and Nyasaland, Federation of:						
Nyasaland	181	206	111	52	-----	17
Southern Rhodesia	28	-----	-----	-----	843	2,840
South-West Africa	-----	11	-----	-----	-----	-----
Union of South Africa	2,986	3,528	5,030	4,179	1,865	1,444
World total (estimate) [1]	9,500	10,000	11,000	11,000	10,000	10,000

[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 pubished in previous Abrasive Materials chapters.
[3] Data not available; estimate by senior author of chapter included in total.
[4] Estimate.

Emery.—Domestic production of emery in 1954 declined 8 percent in quantity and value from 1953. Imports of 560 short tons of emery, valued at $12,625 or $22.54 a ton, were reported. The average value of domestic emery ore at the mine was $13.56 a ton. The sales of emery since 1920 are presented graphically in figure 1.

Domestic commercial emery producers in 1954 were Joe DeLuca emery mines and DiRubbo & Ellis, both of Peekskill, N. Y. A plant for processing emery ore was operated at Peekskill.

The emery industry in Greece was discussed briefly.[19]

[13] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 1, January 1954, p. 37.
[14] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 2, August 1954, p. 49.
[15] Mining World, Vol. 16, No. 8, July 1954, p. 80.
[16] Engineering and Mining Journal, Vol. 155, No. 8, August 1954, p. 152.
[17] South African Mining and Engineering Journal, Namaqualand's Mineral Wealth: Vol. 64, No. 3184, Part II, Feb. 20, 1954, p. 890.
[18] Mining Journal (London), Natural Corundum: Vol. 242, No. 6198, June 4, 1954, p. 672.
Janes, T. H., Natural Abrasives: Department of Mines and Technical Services, Ottawa, Canada; pres. at annual meeting, AIME, New York, February 1954, 17 pp.
[19] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 6, December 1954, pp. 39–40.

TABLE 10.—Emery sold or used by producers in the United States, 1945–49 (average) and 1950–54

Year	Short tons	Value	Year	Short tons	Value
1945-49 (average)	6,031	$67,066	1952	10,352	$141,911
1950	5,949	75,308	1953	10,562	143,974
1951	11,634	160,212	1954	9,758	132,313

INDUSTRIAL DIAMONDS

Nearly all diamond-producing areas of the world continued to increase their output during 1954. The total production, including all types, was about 20,400,000 metric carats, or 1½ percent more than the 1953 production. The industrial fraction of this production remained at about 82 percent, amounting in 1954 to some 16,800,000 metric carats.

Industrial diamonds, including all classifications, imported into the United States during 1954 totaled 13,991,000 metric carats, valued at $48,703,000, an increase of 3 percent in weight but a reduction of 1 percent in total value from 1953.

Purchases of industrial diamonds for the National Stockpile by the United States Government continued during 1954.

Almost 99 percent of the world supply of industrial diamonds originates in Africa. The producing areas in 1954, in order of their importance, were: Belgian Congo, with 72 percent of the total; Union of South Africa, with 11 percent; Gold Coast, with 10 percent; Angola, with 2 percent; all others, 5 percent.

In the past 3 years native African miners in both Sierra Leone and in certain parts of Gold Coast have found diamonds in substantial quantities. These operations usually lack Government supervision, and data regarding their magnitude or sales methods are not available; their output is not included in the world industrial diamond table.

The Gold Coast Government during 1954 established a diamond market where the local miners could sell their diamonds. A relatively large proportion of all diamonds found in West Africa were of industrial quality, and sales through a Government-controlled market were expected to keep the material available for Free World consumers.[20]

Diamond-mining operations in Sierra Leone [21] and in Tanganyika [22] were described, and an export of diamonds from Liberia was noted.[23]

Notices regarding the diamond output of Venezuela appeared in mining magazines.[24]

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[20] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 6, June 1954, pp. 35–36; vol. 39, No. 1, July 1954, p. 48.
Foreign Commerce Weekly, U. S. Dept. of Commerce, Gold Coast Plans Diamond Market: Vol. 51, No. 24, June 14, 1954, p. 21.
Mining Journal (London), Gold Coast Government Diamond Market Opened: Vol. 243, No. 6204, July 16, 1954, p. 66.
Engineering and Mining Journal, vol. 155, No. 8, August 1954, p. 168.

[21] Mining World and Engineering Record (London), Mining in Sierra Leone; Vol. 166, No. 4340, June 5, 1954, p. 325.

[22] Mining Magazine, The Tanganyika Mining Industry: 1953: Vol. 90, No. 4, April 1954, p. 206.
Engineering and Mining Journal, vol. 155, No. 7, July 1954, p. 157.

[23] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 4, October 1954, p. 53.

[24] Engineering and Mining Journal, Venezuela: Vol. 155, No. 4, April 1954, p. 174.
Mining World, Venezuela: Vol. 16, No. 10, September 1954, p. 101.

TABLE 11.—Industrial diamonds (including diamond dust and manufactured bort) imported for consumption in the United States, 1953–54, by countries

[U. S. Department of Commerce]

Country	Bort manufactured (diamond dies)		Crushing bort (including all types of bort suitable for crushing)		Other industrial diamonds (including glaziers' and engravers' diamonds unset and miners')		Carbonado and ballas		Dust and powder	
	Carats	Value	Carats	Value	Carats	Value	Carats	Value	Carats	Value
1953										
North America:										
Bermuda					5, 467	$50, 513				
Canada			254, 084	$739, 270	566, 926	2, 711, 169			15, 121	$34, 087
Total			254, 084	739, 270	572, 393	2, 761, 682			15, 121	34, 087
South America:										
Brazil					[1] 49, 962	[1] 954, 001	1, 813	$15, 414	50	160
British Guiana					162	2, 669				
Venezuela					13, 391	341, 410				
Total					63, 515	1, 298, 080	1, 813	15, 414	50	160
Europe:										
Belgium-Luxembourg	3, 084	$10, 550	2, 550	7, 643	173, 428	1, 224, 331			8, 000	25, 146
France	2, 968	176, 725	268	1, 116	14, 516	127, 531			400	1, 200
Germany, West	538	17, 555			179	3, 585				
Netherlands	766	69, 641	9, 025	28, 380	440, 706	6, 930, 184			705	2, 068
Sweden					100	265				
Switzerland	20	3, 907			1, 984	11, 917				
United Kingdom	509	13, 622	1, 679, 290	3, 925, 796	[1] 2,294,389	[1] 12,354,536			510,509	1,451,468
Total	7, 885	292, 000	1, 691, 133	3, 962, 935	2, 925, 302	20, 652, 349			519, 614	1,479,882
Asia:										
India					599	24, 059				
Israel and Palestine					1, 988	17, 053				
Portuguese Asia, n. e. c.					157	1, 800				
Total					2, 744	42, 912				
Africa:										
Belgian Congo			6, 175, 633	13, 901, 119	350, 794	1, 327, 076			189, 805	517, 396
British West Africa, n. e. c.					48	520				
French Equatorial Africa					16, 614	151, 134	29	450		
Gold Coast					815	7, 432				
Nigeria					11	108				
Union of South Africa	6	525	606, 073	1, 560, 337	[1] 107, 594	[1] 461, 126			24, 700	75, 928
Total	6	525	6, 781, 706	15, 461, 456	475, 876	1, 947, 396	29	450	214, 505	593, 324
Grand total, 1953	7, 891	292, 525	8, 726, 923	20, 163, 661	[1] 4,039,830	[1] 26,702,419	1, 842	15, 864	749, 290	2,107,453
1954										
North America:										
Bermuda					97, 053	493, 272				
Canada			172, 495	490, 410	657, 361	3, 339, 940			11, 986	22, 707
Mexico			571	1, 250	1, 180	1, 921				
Total			173, 066	491, 660	755, 594	3, 835, 133			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		

[1] Revised figure.

TABLE 11.—Industrial diamonds (including diamond dust and manufactured bort) imported for consumption in the United States, 1953–54, by countries—Con.

Country	Bort manufactured (diamond dies)		Crushing bort (including all types of bort suitable for crushing)		Other industrial diamonds (including glaziers' and engravers' diamonds unset and miners')		Carbonado and ballas		Dust and powder	
	Carats	Value	Carats	Value	Carats	Value	Carats	Value	Carats	Value
1954—Continued										
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	181,766	9,025,777	20,736,216	4,778,197	27,251,455	3,370	30,533	181,418	502,896

TABLE 12.—Industrial diamonds (excluding diamond dust and manufactured bort) imported for consumption in the United States, 1945–49 (average) and 1950–54

[U. S. Department of Commerce]

Year	Carat	Value		Year	Carat	Value	
		Total	Average			Total	Average
1945–49 (average)	7,217,094	$18,103,288	$2.51	1952	13,469,198	$51,117,163	$3.80
1950	11,039,036	36,792,832	3.33	1953	[1] 12,768,595	[1] 46,881,944	3.67
1951	12,120,647	46,327,622	3.82	1954	13,807,344	48,018,204	3.48

[1] Revised figure.

More interest was shown in the recovery of small diamonds from mining operations.[25] Processes designed to save diamond material in the very small sizes, usually lost by previous recovery methods, achieved some success.[26]

[25] Optima, Recovery of Small Diamonds: Vol. 4, No. 1, March 1954, pp. 33–34.
Linari-Linholm, A. A., Recovery of Alluvial Diamonds by Electrostatic Separation: Gems and Gemology, (winter 1953–54), vol. 7, No. 12, pp. 374–375.

[26] Mining and Industrial Magazine, Recovery of Small Diamonds: Vol. 44, No. 4, April 1954, p. 119.

TABLE 13.—World production of industrial diamonds, by countries, 1952–54, in metric carats [1]

Country	1952	1953	1954
Africa:			
Angola	305,000	307,000	300,000
Belgian Congo	11,200,000	12,000,000	12,060,000
French Equatorial Africa	147,000	92,000	100,000
French West Africa	110,000	120,000	140,000
Gold Coast	1,860,000	1,515,000	1,670,000
Sierra Leone	[2] 311,000	322,000	260,000
South-West Africa	[2] 100,000	[2] 100,000	100,000
Tanganyika	62,000	73,000	160,000
Union of South Africa:			
"Pipe" mines:			
Premier	1,000,000	978,000	1,100,000
DeBeers group	393,000	564,000	560,000
Others	7,000	59,000	60,000
"Alluvial" mines	140,000	90,000	90,000
Total Africa	15,635,000	16,220,000	16,600,000
Other areas:			
Brazil [3]	100,000	100,000	100,000
British Guiana	19,000	21,000	18,000
Venezuela	60,000	60,000	68,000
Australia, Borneo, India, and U. S. S. R.[3]	3,000	3,000	3,000
World total	15,800,000	16,400,000	16,800,000

[1] Prepared jointly by the Bureau of Mines and Dr. George Switzer of the Smithsonian Institution.
[2] Revised figure.
[3] Estimate.

In its annual report dated March 31, 1954, the DeBeers Consolidated Mines, Ltd., reviewed the world diamond industry and described various improvements and changes made during the past year.[27]

The increased use of cemented carbides in industry, both in quantity and the number of applications, resulted in a corresponding increase in the demand for diamond grinding wheels.[28]

The importance of quality in the diamond material used and the correct sizes necessary to obtain the best results were stressed.[29]

Economic factors involved in proper selection of diamond grinding wheels for grinding cemented carbides were investigated.[30] Specifications covering the manufacture of diamond grinding wheels for different kinds of grinding were discussed, and methods of use and causes of failure were cited.[31]

The advantages of using diamond drills for blast-hole drilling under certain conditions were discussed.[32] Further experiments with oriented diamonds in core-drill bits showed that substantial savings in bit costs could be expected by using this method.[33] A diamond grinding wheel costing about $25,000 and said to be the most expen-

[27] South African Mining and Engineering Journal, DeBeers Consolidated Mines, Ltd.: Vol. 65, part I, No. 3198, May 29, 1954, p. 495.
Mining Journal (London), DeBeers Excellent Report: Vol. 242, No. 6196, May 21, 1954, p. 613.
Mining Magazine, Diamonds: Vol. 90, No. 6, June 1954, pp. 355–356.
[28] Lennon, F. J., Step Up Efficiency in Carbide Grinding: Steel, vol. 135, No. 6, Aug. 9, 1954, pp. 92–95.
Steel, Diamonds; Keystone of Industry: Vol. 134, No. 4, July 26, 1954, pp. 50–51.
Lennon, F. J., Cemented Carbides: Iron Age, vol. 174, No. 16, Oct. 14, 1954, pp. 142–144.
[29] Myer, C. B., Quality—the Key to Economical Use of Diamond Abrasives: Ind. Diamond Rev., vol. 14, No. 167, October 1954, pp. 209–210.
[30] Lennon, F. J., Machine and Tool Blue Book: Vol. 49, No. 11, November 1954, pp. 216–219.
[31] Gros, G., Quality Factors in Diamond Grinding Wheels: Ind. Diamond Rev., vol. 14, No. 165, August 1954, pp. 173–174.
[32] Adamson, Patrick, Diamond Drills' Place in Pit Blasting: Eng. Min. Jour., vol. 155, No. 7, July 1954, pp. 96–98.
[33] Ross, A. E., Experiments With Oriented Diamonds Indicate 42 Percent Savings in Bit Costs: Eng. and Min. Jour., vol. 155, No. 10, pp. 94–95.

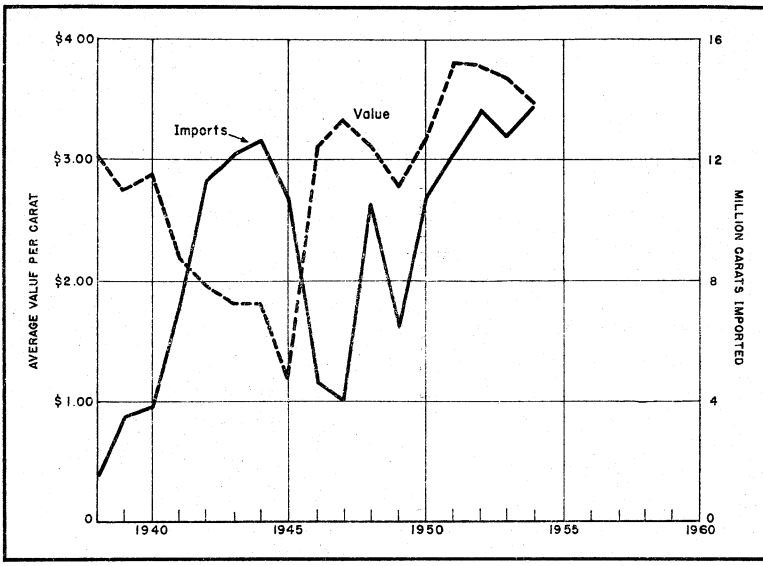

FIGURE 2.—United States imports and average price per carat of industrial diamonds, 1938–54.

sive made to date was described.[34] A handbook listing the various types of diamond tool shanks was prepared.[35] Advantages to be gained by using diamond tools for many machining operations were explained.[36] An electrically operated device using diamonds was developed to true single and multiwheel thread grinders.[37]

Inspection of wire-drawing dies was speeded by the use of two instruments combining simplicity and accuracy.[38]

Because the available supply of industrial diamonds did not seem to increase in proportion to industry demand, users of diamond grinding wheels were urged to adopt facilities for recovering diamond from grinding sludges and dusts.[39] However, recovery of diamond from grinding dusts was not considered economical if the diamond content was less than 1 carat a pound.[40] A report on the reclamation of diamond from manufacturing processes was issued by the United States Department of Commerce.[41]

An extensive survey of contemporary knowledge of the structure of diamond was published during the year.[42] Various hard materials

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[34] Modern Machine Shop, Expensive Grinding Wheel: Vol. 26, No. 10, March 1954, p. 414.

[35] Industrial Diamond Association of America, Pompton Plains, N. J., Diamond and Tool Shanks: November 1954, 32 pp.

[36] Industrial Diamond Review, Diamond Tools for Productivity: Vol. 14, No. 164, July 1954, pp. 145–146.

[37] Industrial Diamond Review, Diamond Truing Device for Thread Grinders: Vol. 14, No. 165, August 1954, pp. 170, 172.

[38] Iron Age, New Instrument Inspects Diamond Dies Easier: Vol. 173, No. 23, June 10, 1954, pp. 130–132.

[39] Lennon, F. J. Jr., Diamond Sludge Recovery: Ind. Diamond Rev., vol. 14, No. 158, January 1954, pp. 18–19.

[40] Hunter, R. H., Save Dollars by Saving Swarf: Plant Engineering, vol. 8, No. 1, January 1954, pp. 52, 54. Iron Age, Salvaging Diamonds: Vol. 173, No. 15, Apr. 15, 1954, p. 112.

[41] U. S. Dept. of Commerce, Conservation of Industrial Diamonds; Bibliography of Technical Reports: Vol. 21, No. 4, Apr. 2, 1954, p. 110.

[42] Ruzicka, P., The Diamond as a Technical Raw Material: Ind. Diamond Rev., vol. 14, No. 163, June 1954, pp. 125, 130.

were being studied in an effort to find possible substitutes for industrial diamonds.[43]

A report on the diamond industry of the world in 1953 was published.[44]

ARTIFICIAL ABRASIVES

During 1954 the production of most artificial abrasives, both in crude and manufactured form, declined from that in 1953. A noteworthy exception was the manufacture of crude silicon carbide in the United States and Canada, which increased 7 percent, both in tonnage and value.

Aluminum oxide production in the United States and Canada during 1954 decreased 10 percent in tonnage and 6 percent in value from 1953; metallic abrasives, in the United States only, decreased 26 percent in tonnage and value during the same period. The 1954 aluminum oxide output included 14,403 short tons of "white high-purity" material, valued at $2,032,680, a decrease for that product of 27 percent in tonnage and 24 percent in value. Of the artificial abrasives, 3 percent of the aluminum oxide and 45 percent of the silicon carbide were used for refractories or other nonabrasive purposes. These percentages represented a slight decline from the previous year.

The ratio of production to annual plant capacity for aluminum oxide was 78 percent in 1954, compared with 89 percent in 1953; for silicon carbide, 56 percent for both 1954 and 1953; and for metallic abrasives, 47 percent in 1954 and 62 percent in 1953.

Sales of abrasive grinding wheels during 1954 declined 24 percent in value from the comparable 1953 figure, and coated abrasives declined 10 percent both in quantity and value during the same period. However, during the fourth quarter of 1954 an upturn in the sales of these abrasive products was noted.

Machining processes using endless coated-abrasive belts increased in number and in the variety of their applications. The operation of a wide, waterproof, abrasive belt used by the aircraft industry was described.[45]

A manufacturing process for synthetic abrasives was described.[46]

Use of silicon carbide in the metallurgy of steel was discussed.[47]

Articles on new applications for the use of abrasives in sand blasting appeared during the year.[48]

Combination work feeding techniques were designed to cut time and cost in centerless-grinding manufacturing processes.[49]

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[43] Cotter, P. G., and Kohn, J. A., Industrial Diamond Substitutes: 1, Physical and X-Ray Study of Hafnium Carbide: Jour. Am. Ceram. Soc., vol. 37, No. 9, Sept. 1, 1954, pp. 415–420.

[44] Switzer, George, Diamond Industry 1953: Jewelers Cir. Keystone, July 1954, 10 pp.

[45] Modern Metals, World's Biggest Abrasive Belt Grinder: Vol. 10, No. 10, November 1954, pp. 66–67.

[46] Wilkinson, A. W., Production of Synthetic Abrasives: Canadian Metals, vol. 17, No. 11, October 1954, pp. 47–48, 50.

[47] Chemical and Engineering News, Silicon Carbide Deoxidizer: Vol. 23, No. 22, May 31, 1954, p. 2228.
Iron Age, Silicon Carbide: Vol. 173, No. 22, June 3, 1954, p. 154.
Metal Industry (London), A Silicon Carbide Furnace Element: Vol. 243, No. 6213, Sept. 17, 1954, p. 322.

[48] Compressed Air Magazine, Industrial Notes: Vol. 59, No. 2, February 1954, p. 56.
Iron and Steel Engineer, Abrasive Material: Vol. 31, No. 111, March 1954, p. 206.
Metal Industry (London), Wet Abrasive Blasting: Vol. 84, No. 13, Mar. 26, 1954, p. 250.
Steel, Airless Abrasive Blasting: Vol. 134, No. 26, June 28, 1954, p. 134.
Steel, Abrasives; New Uses to Bombard New Markets: Vol. 135, No. 5, Aug. 2, 1954, p. 59.

[49] Hyler, J. E., Modern Centerless Grinding Speeds Output of Precision Parts: Iron Age, vol. 174, No. 23, Dec. 3, 1954, pp. 117–119; vol. 174, No. 24, Dec. 10, 1954, pp. 157–159.

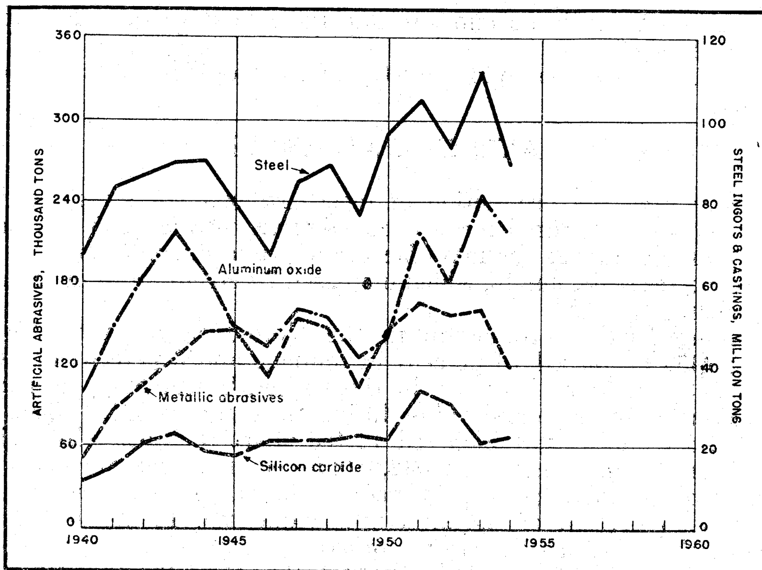

FIGURE 3.—Relationship between ingot-steel and artificial abrasive production, 1940–54.

TABLE 14.—Crude artificial abrasives produced in the United States and Canada, 1945–49 (average) and 1950–54

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
1945–49 (average)	62,384	$5,452,172	143,980	$9,287,068	132,894	$10,369,778	339,258	$25,109,018
1950	65,004	7,303,671	140,352	11,958,035	144,333	11,699,764	349,689	30,961,470
1951	100,498	11,734,812	216,329	21,444,343	165,138	17,923,301	481,965	51,102,456
1952	91,531	12,040,946	180,375	17,813,760	157,034	17,582,275	428,940	47,436,981
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

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

TABLE 15.—Stocks of crude artificial abrasives and capacity of manufacturing plants, as reported by producers in the United States and Canada, 1945–49 (average) and 1950–54, 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
1945–49 (average)	8,112	74,080	35,133	234,052	9,399	227,605
1950	8,766	84,398	22,025	238,500	7,291	209,850
1951	11,786	106,741	32,428	249,000	9,843	244,178
1952	25,347	111,200	60,354	255,100	9,801	226,427
1953	18,587	110,900	25,165	273,200	11,913	255,624
1954	27,852	120,000	29,924	280,200	14,180	254,950

[1] Figures pertain to United States plants only.

MISCELLANEOUS MINERAL-ABRASIVE MATERIALS

In addition to the natural and manufactured abrasive materials for which data are included herein, many other minerals 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, expecially 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.

TABLE 16.—Abrasive materials (natural and artificial) imported for consumption in the United States, 1952–54, by kinds

[U. S. Department of Commerce]

Kind	1952		1953		1954	
	Quantity	Value	Quantity	Value	Quantity	Value
Burrstones:						
Unmanufactured .... short tons..	----------	----------	152	$3,022	----------	----------
Bound up into millstones ...... do....	7	$1,236	3	594	(1)	$1,066
Grindstones, finished or unfinished do....	195	16,367	286	12,974	----------	----------
Hones, oilstones, and whetstones.. do....	17	39,058	2 22	2 35,549	(3)	22,599
Corundum (including emery):						
Corundum ore .... do....	4,571	273,527	2,675	205,208	1,108	74,072
Emery ore .... do....	----------	----------	----------	----------	560	12,625
Grains, ground, pulverized, or refined short tons..	13	1,791	33	3,269	243	52,643
Paper and cloth coated with emery or corundum .... reams..	2,005	106,133	11,908	173,133	38,024	358,337
Wheels, files, and other manufactures of emery .... short tons..	5	10,591	10	19,153	10	18,122
Wheels of corundum or silicon carbide short tons..	3	16,523	3	9,962	4	17,318
Garnet in grains, ground, etc ...... do....	2	250	----------	----------	----------	----------
Tripoli, rottenstone, and diatomaceous earth .... short tons..	1,636	116,407	372	39,451	----------	----------
Diamonds:						
Bort, manufactured .... carats..	11,631	391,400	7,891	292,525	2,389	181,766
Crushing bort (including all types of bort suitable for crushing) ... carats..	8,806,473	19,920,968	8,726,923	20,163,661	9,025,777	20,736,216
Other industrial diamonds (including glaziers' and engravers' diamonds unset and miners') .... carats..	4,650,256	31,039,633	2 4,039,830	2 26,702,419	4,778,197	27,251,455
Carbonado and ballas .... do....	12,469	156,562	1,842	15,864	3,370	30,533
Dust and powder .... do....	224,429	792,951	749,290	2,107,453	181,418	502,896
Flint, flints, and flintstones, unground short tons..	7,871	186,688	9,103	195,055	5,021	116,321
Grit, shot, and sand, of iron and steel short tons..	217	194,689	699	244,521	492	156,085
Artificial abrasives:						
Crude, not separately provided for:						
Carbides of silicon (carborundum, crystalon, carbolon, and electrolon) short tons..	50,684	4,862,990	46,294	5,326,018	38,935	4,679,202
Aluminous abrasives, alundum, aloxite, exolon, and lionite.. short tons..	133,271	9,164,982	239,722	21,796,319	184,177	17,603,570
Other .... do....	801	70,063	549	54,485	1,002	85,081
Manufactures:						
Grains, ground, pulverized, refined, or manufactured ...... short tons..	596	125,221	1,287	271,928	521	115,749
Wheels, files, and other manufactures, not separately provided for short tons..	12	22,624	7	11,400	5	6,964
Total	----------	67,510,654	----------	2 77,683,963	----------	72,022,620

1 Less than 1 ton.
2 Revised figure.
3 Beginning January 1, 1954, reported in number (22,740).

FOREIGN TRADE

Imports.—The total value of abrasive materials imported into the United States during 1954 declined 7 percent from 1953. Dollarwise, industrial diamonds were the most important abrasive commodity imported, increasing in quantity but decreasing slightly in value from the preceding year. Imports of artificial abrasives, almost entirely from Canada, decreased 22 percent in tonnage and 18 percent in value from 1953. Corundum imports decreased, but for the first time since 1951 an importation of emery was recorded. Imports of the other materials classed as abrasives showed little change from the preceding years and were relatively unimportant.

Exports.—The value of abrasive materials and manufactured abrasive products exported from the United States during 1954 was 12 percent higher than in 1953. Substantial gains were made in the export of artificial abrasive grain and coated abrasives, while the export of grinding wheels and industrial diamonds increased to a lesser extent. Reductions were noted in the quantity of natural abrasives exported and in the quantity and value of metallic abrasives and abrasive pastes and compounds.

TABLE 17.—Abrasive materials exported from the United States, 1952–54

[U. S. Department of Commerce]

Commodity	1952		1953		1954	
	Quantity	Value	Quantity	Value	Quantity	Value
Natural abrasives:						
Diamond grinding wheels____carats__	[1] 96,700	$501,239	110,847	$545,618	129,868	$553,643
Diamond dust and powder____do____	79,183	216,115	65,853	182,838	90,665	237,657
Grindstones and pulpstones short tons__	395	59,258	432	52,971	357	46,560
Emery powder grains and grits (natural)________pounds__	1,528,455	110,952	2,268,056	133,361	2,599,462	169,749
Corundum (natural)________do____	313,139	45,723	476,035	74,682	301,878	49,701
Whetstones, sticks, etc., (natural) pounds__	186,685	95,834	157,923	78,738	130,765	70,764
Natural abrasives [2] not elsewhere classified________pounds__	71,941,845	2,276,968	111,661,593	3,577,630	104,688,654	3,743,691
Manufactured abrasives:						
Aluminum oxide, fused, crude and grains________pounds__	19,968,509	2,632,113	18,937,931	2,434,239	22,631,036	2,776,940
Silicon carbide, fused, crude, and grain________pounds__	15,358,289	2,476,960	10,536,436	1,640,229	13,185,745	2,188,640
Alumina, unfused________do____	176,093	23,520	520,194	41,367	387,180	39,901
Manufactured abrasives, not elsewhere classified________pounds__	68,396	49,216	49,796	29,913	34,404	14,356
Abrasive pastes, compounds, and cake________pounds__	573,418	126,960	709,464	145,125	463,267	136,331
Grinding wheels, except diamond wheels________pounds__	4,517,518	3,600,477	3,586,861	3,093,227	4,288,194	3,436,676
Pulpstones of manufactured abrasives________pounds__	1,822,046	434,027	1,625,106	372,930	2,437,279	557,148
Whetstones, etc., of manufactured abrasives________pounds__	360,454	513,209	382,232	437,798	405,861	458,431
Abrasive paper and cloth (natural abrasives)________reams__	66,892	1,192,829	67,474	1,188,192	72,607	1,160,692
Abrasive paper and cloth (artificial abrasives)________reams__	133,045	4,207,693	131,016	3,883,073	133,225	4,478,249
Metallic abrasives (except steel wool) pounds__	9,246,855	633,107	8,966,622	623,560	8,202,157	574,579
Total________	________	19,196,200	________	18,535,491	________	20,693,708

[1] Estimate.
[2] Includes: Flint, garnet, tripoli, rottenstone, natural rouge, polishing rouge, pumice, diatomaceous earth, infusorial earth, and kieselguhr.

Aluminum

By Horace F. Kurtz,[1] R. August Heindl,[2] and C. I. Wampler[3]

THE ALUMINUM INDUSTRY celebrated its centennial in Paris during 1954. It was in 1854 that Henri Sainte-Claire Deville announced his improved method of producing aluminum, arousing much interest in the new light metal and beginning a period of experimental activity. One hundred years later, world aluminum production had risen from virtually nothing to over 3 million short tons per year.[4]

The aluminum industry in the United States in 1954 was featured by an aggressive program to develop civilian markets. Primary aluminum production increased over 200,000 tons from 1953. One new reduction plant and many new fabricating facilities were put into operation during 1954. There was one price increase of 0.7 cent a pound on the base price of primary ingot.

TABLE 1.—Salient statistics of the aluminum industry, in the United States, 1945–49 (average) and 1950–54

	1945–49 (average)	1950	1951	1952	1953	1954
Primary production short tons..	540,672	718,622	836,881	937,330	1,252,013	1,460,565
Value	$157,872,000	$235,977,000	$305,074,000	$344,320,000	[1]$496,315,000	$592,837,000
Average ingot price per pound cents..	15.5	17.7	19.0	19.4	20.9	21.8
Secondary recovery short tons..	277,767	243,666	292,608	304,522	368,566	[2] 292,041
Imports (crude and semicrude) short tons..	142,784	255,692	161,834	150,738	359,481	243,750
Exports (crude and semicrude) short tons..	36,714	23,236	14,817	10,614	15,355	50,096
World production short tons..	1,170,000	[1] 1,640,000	[1] 1,980,000	2,260,000	[1] 2,710,000	3,050,000

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

DOMESTIC PRODUCTION

PRIMARY

Production of primary aluminum in the United States during 1954 reached 1,461,000 short tons, the highest in the history of the industry. The 17-percent increase in production from the preceding year reflected the operation at capacity of most of the new facilities planned

[1] Commodity-industry analyst.
[2] Assistant chief, Branch of Light Metals.
[3] Statistical assistant.
[4] Bostzen, Dr. F. W., Some Aspects of the Development of the Aluminum Industry in the First Half-Century of Its Existence: Published in Dutch; available from editor, Excelsior, N. V., Oranjeplein 96, The Hague, Holland, $4.30. Condensed in American Metal Market, vol. 42, No. 32, Feb. 15, 1955, and No. 33, Feb. 16, 1955.

during the Korean War. Domestic production has increased every year since 1949, when the total production was only 41 percent of the 1954 output.

TABLE 2.—Production of primary aluminum in the United States, 1950–54, by quarters,[1] in short tons

Quarter	1950	1951	1952	1953	1954
First	161,213	200,716	226,377	287,004	349,069
Second	180,353	202,875	235,158	311,687	366,330
Third	185,973	215,943	240,425	329,163	371,789
Fourth	191,083	217,347	235,370	324,159	373,377
Total	718,622	836,881	937,330	1,252,013	1,460,565

[1] Quarterly production adjusted to final annual totals.

One new alumina-reduction plant, the Patterson plant of the Reynolds Metals Co., began operation in February 1954. The new plant was built at Arkadelphia, Ark., and was to have a rated annual capacity of 55,000 tons. Of the total domestic production of primary aluminum in 1954, the Aluminum Co. of America produced about 46 percent and Kaiser Aluminum & Chemical Corp. and the Reynolds Metals Co., each about 27 percent.

The following shows the location of plants operated during 1954:

Alcoa	*Kaiser*	*Reynolds*
Alcoa, Tenn.	Chalmette, La.	Jones Mills, Ark.
Badin, N. C.	Spokane, Wash.	Listerhill, Ala.
Massena, N. Y.	Tacoma, Wash.	Longview, Wash.
Point Comfort, Tex.		Arkadelphia, Ark.
Rockdale, Tex.		San Patricio, Tex.
Vancouver, Wash.		Troutdale, Oreg.
Wenatchee, Wash.		

The State of Washington continued to be the leading aluminum producer in the United States. A report on the effect of the aluminum industry on the economy of the Pacific Northwest was prepared for the Aluminum Co. of America and published during 1954.[5]

All of the new facilities of Alcoa, Kaiser, and Reynolds, which were planned under the Government-programed expansion, were in operation by the end of 1954. Construction of the Anaconda Aluminum Co. plant at Columbia Falls, Mont., was interrupted for 10 weeks in the spring of 1954 because of a carpenters' strike. As a result of this delay, the expected completion date of the plant was estimated as July 1955. The proposed plant of the Harvey Machine Co. at The Dalles, Oreg., and the facilities for which Olin Industries, Inc., received Government approval had not been started by the end of 1954. The so-called "third round" of the Government's aluminum-expansion program, of which the Harvey and Olin plants were a part, originally called for an additional 200,000 tons of annual capacity, but only part of this tonnage was approved. On August 19, 1954, the Office of Defense Mobilization (ODM) announced that the "third round" would be discontinued but that programs already certified would not be affected. The announcement followed a review of all mobilization supply and demand figures.

[5] Green, Carleton, The Impact of the Aluminum Industry on the Economy of the Pacific Northwest: Stanford Research Inst., June 1954, 38 pp.

There were no serious interruptions to primary-aluminum production in the United States because of power shortages or strikes in 1954. However, several companies expressed apprehension regarding the long-range power supply, particularly for reduction plants in the Northwest. Kaiser and Alcoa reached agreements for new contracts with the Congress of Industrial Organizations (CIO) during August 1954. The new contracts provided for wage increases of approximately 5 cents an hour, and increased insurance and pension benefits.

Progress on the installation of forge and extrusion presses as part of the Air Force heavy-press program continued through 1954. Installation of all 10 presses in the heavy-press program was scheduled to be completed by November 1955. Upon completion, Alcoa will operate 2 of the forging presses and 1 extrusion press; Kaiser will operate 2 extrusion presses; Harvey Machine Co., 2 extrusion presses; Wyman-Gordon, 2 forging presses; and Curtiss-Wright, 1 extrusion press. The overall cost of the program was estimated at $279 million. Alcoa's 14,000-ton extrusion press at Lafayette, Ind., was the only press in operation during 1954. The plant started making aircraft extrusions in May 1954.

In addition to its participation in the heavy-press program, Alcoa installed two new extrusion presses and enlarged its wire, rod, and cable plant at Vancouver, Wash. Tapered sheet-and plate-rolling facilities at the Davenport, Iowa, plant, and new foil-rolling equipment to produce welded tube at the Alcoa, Tenn., plant were also put into operation in 1954. Alcoa's new Lancaster, Pa., plant for producing screw machine products and fasteners was completed during 1954. Construction was begun for the installation of an 8,000- and a 1,500-ton forging press at Vernon, Calif.

Kaiser announced that it had produced aluminum alloy ingots weighing 2½ tons each and that it had been successful in press-forging tests. The large ingots were developed for use in the Air Force heavy-press program. Kaiser also announced that it had completed a fume-control system for its Spokane reduction plant at a cost of over $5 million. By the end of 1954 final plans were being completed for the construction of a multimillion-dollar aluminum sheet- and foil-rolling mill near Ravenswood, W. Va. Construction of the new plant was scheduled to begin in the early part of 1955. In the latter part of 1954 Kaiser obtained a 20-year lease from the General Services Administration on the Erie, Pa., forging plant constructed during World War II. It was announced that Kaiser intended to enlarge the operations at Erie, Pa. Kaiser also announced further expansion of its rolling facilities at the Trentwood, Wash., plant.

Reynolds announced two plans for significant expansion of fabricating facilities during 1954. The first included expansion and modernization of furnace facilities at the Louisville, Ky., aluminum sheet mill. Another program included installation of a large plate stretch leveler and 2 aluminum skin milling machines at the McCook, Ill., plant and a 6,000-ton press at the Phoenix, Ariz., plant.

In other developments in the aluminum-fabricating industry the American Brass Co., subsidiary of Anaconda Copper Mining Co., announced plans to construct a mill near Terre Haute, Ind.; operations at the plant will include ingot and billet casting, rolling of sheet and strip, and extrusion of rods, tubes, and special shapes. In addition, Anaconda, through Anaconda Wire & Cable Co., has expanded its mill in Great Falls, Mont., which is also the site of the Anaconda Aluminum Co.'s new reduction plant. The expansion included addition of a new aluminum rod-rolling mill. Quaker State Metals Co. put into operation a complete new rolling mill at Lancaster, Pa., early in 1954. A new press, reported to be the first in the United States for the production of direct-extruded aluminum-sheathed cables, was being installed at Perth Amboy, N. J., for General Cable Corp.

SECONDARY

The pure aluminum content of aluminum recovered from nonferrous scrap metal in the United States in 1954 was 292,000 short tons. Recovery from new scrap was 232,000 tons and from old scrap 60,000.

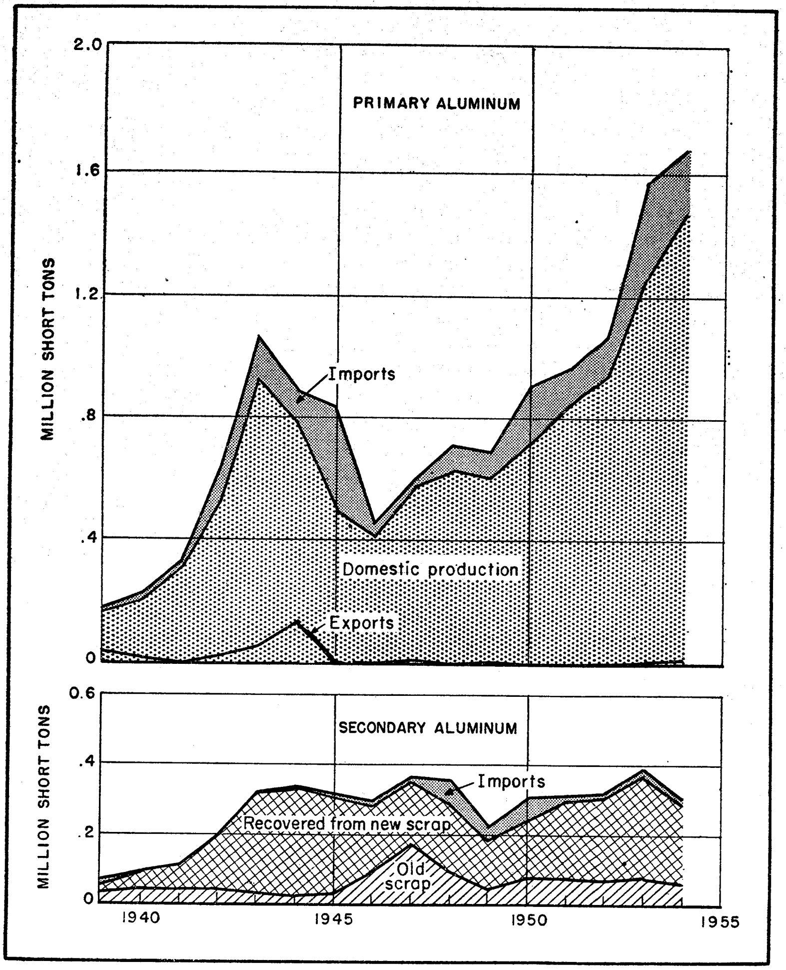

FIGURE 1.—United States production, imports, and exports of primary- and secondary-aluminum pig and ingot, 1940–54.

This aluminum was recovered from 351,000 tons of aluminum scrap (272,000 tons of new scrap and 79,000 tons of old scrap) and also included the aluminum contained in copper-, zinc-, and magnesium-base alloys produced from scrap. Recovery was calculated by the Bureau of Mines from reported consumption of purchased and toll-treated scrap and excluded all home scrap (scrap produced and consumed by the same company). Scrap consumption was reported by nonintegrated secondary-aluminum producers, three primary producers, foundries, fabricators, and chemical producers. Consumption was also reported by military smelters and reclaimers that usually melt scrap into pig form, requiring further processing to obtain specification ingot. Recovery declined 21 percent in 1954 compared with the previous year owing to a shortage of scrap and the greater availability of primary aluminum.

Foreign prices for aluminum scrap advanced during the latter part of 1953 and continued to advance through 1954 to a point which, in many instances, made it unprofitable for domestic secondary smelters to use normal tonnages of scrap in the production of secondary ingot for sale in competition with primary aluminum. Exports of aluminum scrap in 1954 totaled 39,000 tons compared with 5,000 tons in 1953.

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

CONSUMPTION AND USES

An aggressive drive for new and expanded markets for the aluminum industry resulted in increased consumption and the development of many new uses for aluminum in 1954. Apparent consumption of primary aluminum increased 10 percent from 1953, extending the trend begun in 1950. Apparent consumption was calculated by adding pig aluminum sold or used by primary producers to imports of pig, ingot, slab, plate, sheet, bar, and other crude and semifabricated forms and subtracting exports of the same materials. Therefore, any aluminum shipped to the National Strategic Stockpile would be part of the apparent consumption figure. The figure does not reflect stock changes by consumers of pig aluminum.

In addition to primary production and imports, aluminum was also recovered from domestic and imported scrap. Recovery from domestic scrap, as shown in tables 3 and 4, has been broken down into old scrap and new scrap. Old scrap is comprised of used or obsolete items that have been remelted, and new scrap includes scrap generated in fabrication or rejected products. The data do not include "home scrap" or "runaround" but do include scrap purchased or treated on a toll basis. Imported scrap was received in both pig and unmelted form. An estimated recovery factor of 90 percent was used to compensate for imported scrap that may have also been included as domestic scrap and for losses occurring in remelting. Scrap exports exceeded imports during 1954 for the first time since the beginning of World War II. The total new supply of aluminum pig and ingot increased 2 percent to approximately 2 million short tons during 1954. In comparison, shipments of aluminum cast and wrought products declined from the preceding year. No data on shipments for the other major consumption classification—destructive uses—were available for 1954. Although exports were unusually high in 1954 and part of the metal was shipped to the National Stockpile, aluminum was in adequate supply throughout most of the year. By the end of the year, however, the situation began to change, and there were signs of an impending aluminum shortage.

TABLE 3.—Apparent consumption of primary aluminum and ingot equivalent of secondary aluminum in the United States, 1945–49 (average) and 1950–54, in short tons

Year	Primary			Secondary		
	Sold or used by producers	Imports (net) [1] [2]	Apparent consumption [2]	Domestic Recovery: From old scrap	Domestic Recovery: From new scrap	Imports (net) [3]
1945-49 (average)	537,818	77,242	615,060	84,387	193,380	25,945
1950	731,087	165,297	896,384	76,358	167,308	60,443
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

[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 data are recoverable aluminum content; previous years' data are recoverable aluminum-alloy content.

TABLE 4.—Sources of aluminum supply—crude and scrap,[1] 1945–49 (average) and 1950–54, in short tons

Year	Primary production	Recovery from scrap: Old	Recovery from scrap: New	Imports [2]	Total supply	Exports [2]
1945-49 (average)	540,672	84,387	193,380	136,504	954,943	5,498
1950	718,622	76,358	167,308	237,941	1,200,229	1,382
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

[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 data are recoverable aluminum content; previous years' data are recoverable aluminum-alloy content.

Industry spokesmen at the end of 1954 reported increased consumption in virtually all civilian uses, particularly in the fields of construction materials, packaging, automobiles, irrigation pipe, and electrical equipment. Although no industrywide data were published regarding consumption of aluminum by uses, those 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 1953	Percent 1954
Plate, sheet and strip:		
Non-heat-treatable	38.5	36.8
Heat-treatable	14.5	11.7
Foil	5.3	7.3
Rolled structural shapes:		
Rod, bar, etc	9.8	6.9
Wire, bare (nonconductor)	2.1	2.0
Cable, bare (including steel—reinforced)	6.0	7.0
Wire and cable, covered or insulated	1.1 (combined)	1.2
Bare wire conductor		.2
Extruded shapes (including tube blooms):		
Soft alloys	14.0	18.5
Hard alloys	3.6	3.1
Tubing:		
Soft alloys	2.5	2.6
Hard alloys	.6	.5
Powder, flake, and paste:		
Atomized and grained	2.0 (combined)	1.4
Flaked		.2
Paste		.6

TABLE 5.—Net shipments [1] of aluminum wrought and cast products by producers, 1950–54, in short tons

[U. S. Department of Commerce]

	1950	1951	1952	1953	1954
Wrought products:					
Plate, sheet and strip	581,567	536,683	542,849	684,083	582,538
Rolled structural shapes, rod, bar, and wire	134,890	172,582	221,773	211,023	180,641
Extruded shapes, tube bloom, and tubing	129,038	156,472	173,771	225,961	256,650
Powder, flake, and paste	11,230	12,385	23,982	22,366	23,452
Total	856,725	878,122	962,375	1,143,433	1,043,281
Castings:					
Sand	92,391	96,689	97,308	107,277	79,237
Permanent mold	90,683	80,005	73,442	100,012	107,204
Die	83,600	75,733	84,866	119,665	122,645
Other	4,867	5,139	3,874	2,057	3,401
Total	271,541	257,566	259,490	329,011	312,487
Grand total	1,128,266	1,135,688	1,221,865	1,472,444	1,355,768

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

The stable price of aluminum, in contrast to other nonferrous metals, and the vitality of this comparatively young industry promoted the design of many new products during 1954. Engineers utilized aluminum's light weight, corrosion resistance, heat conductivity and reflectivity, electrical conductivity, and nontoxic and other properties. An extensive study by the United Nations on the competition between steel and aluminum appeared in the early part of the year.[6]

Some of the more spectacular innovations in the use of aluminum during the year occurred in the automotive industry. The experimental Hudson "Italia," unveiled in 1954, had an all-aluminum body and frame. The new Greyhound "Scenicruiser" bus, which appeared in 1954, employed over 5,500 pounds of aluminum in such uses as

[6] European Office of the United Nations, Competition Between Steel and Aluminum: Sales Section, Industry Division, Economic Commission for Europe, Palais des Nations, Geneva, Switzerland, 1954, 155 pp.

exterior side panels, bumpers, cowl, interior trim, luggage lofts, and windowframes. The Chrysler Corp. finished an all-aluminum-body experimental truck for the Army that was 6,000 pounds lighter than the conventional model. Designated as T55, the 2½-ton truck weighed 9,000 pounds compared with 14,000 to 15,000 pounds for the standard truck. Reynolds announced it was now manufacturing floor for refrigeration trucks, featuring a new type of interlocking joint that prevents leakage to the insulation below. More and more trailers for tractor-trailers were appearing with almost the entire body of aluminum. An article published in December traced the history of aluminum in the automotive industry.[7]

Interest in the A. C. F.-Talgo train, a lightweight, low-slung streamliner whose car bodies are made of aluminum, was revived in the United States. Four years of daily service in Spain indicated that the Talgo is safe, economical, and fast. The New York Central and the New York, New Haven & Hartford lines were considering this type of train in 1954, while the Rock Island Railroad is said to have placed an order for one of these trains.

The United States Navy adopted porcelain-coated aluminum for nonstructural bulkheads in many of its ships. In 1954 this material was being used in constructing the supercarriers *Saratoga* and *Forrestal* and on a number of smaller fighting ships. The S. S. *Sunrip*, the first vessel built especially to carry alumina from Jamaica to Kitimat, Canada, was launched in Quebec in June. The ship contained 110 tons of aluminum in its superstructure and various auxiliary uses, thus increasing the payload of the ship 160 tons. A review of the marine uses of aluminum appeared in September.[8] According to an article on aluminum in the fishing industry, aluminum is finding widespread acceptance aboard fishing boats, not only in the superstructure but in applications where its nonabsorbent nature is of value. Aluminum is replacing wood in fish holds, deckboards, fish crates, and barrels because the metal does not absorb fish slime and odors.[9]

The volume production of Kaiser's aluminum "Nest-A-Bin" was of special interest to the transportation industry. This product was a lightweight, bottom-dispensing bin, capable of being nested inside other bins when empty.

A dramatic demonstration of the application of aluminum curtain walls took place on June 21, when 2 sides of a 22-story New York City skyscraper were clad with an aluminum facade in 10 hours.[10] In June an official of Alcoa summarized the uses of aluminum in the Alcoa building in Pittsburgh, Pa., which also has facing panels of aluminum.[11] He stated that in 1954 over 100 large buildings were on the drawing board, under construction, or being completed that would use aluminum curtain walls. Late in the year Alcoa announced that building panels were available in special metallic colors for architectural exteriors. The Alcoa district sales office in Cincinnati, Ohio, was reported to be the first structure to utilize these anodized

[7] Modern Metals, The History of Aluminum in the Automotive Industry: Alcoa Sales Development Div., December 1954, pp. 58–70.

[8] Dorey, S. F., Metals and Marine Engineering: Am. Metal Market, vol. 61, No. 169, Sept. 2, 1954, p. 9.

[9] Modern Metals, Aluminum in the Fishing Industry: Vol. 10, No. 9, October 1954, pp. 42–50.

[10] Engineering News-Record, How a Skyscraper was Enclosed in 10 Hours: Vol. 153, No. 1, July 1, 1954, p. 23.

[11] Ennor, William T., Aluminum in the Alcoa Building: Am. Metal Market, vol. 61, No. 115, June 17, 1954 pp. 11, 15.

color panels. Completed in 1954, the building used gold-colored aluminum panels on the front and blue panels on the rear walls. The Alcoa sales office building in Los Angeles, Calif., completed in 1954 employed aluminum panels with a blue porcelain-enamel finish.

A novel, dome-shaped aluminum auditorium, called the LeTourneau Semisphere, was constructed in Longview, Tex., by R. G. LeTourneau, Inc. The building is 85 feet high and 300 feet in diameter, has a capacity of 12,000 people, and has no interior supports. Details of construction of the semisphere were given in an article published in March 1954.[12] It was reportedly easy to assemble and cost far less than standard structures built to serve similar purposes.

A glass-aluminum honeycomb sandwich for structural purposes was put on the market by Hexcel Products Co. of Oakland, Calif. The sandwich consisted of a honeycomb of aluminum between two pieces of facing glass and was said to be both translucent and have good insulation properties. Alcoa developed an aluminum sandwich curtain-wall material made up of 1 inch of glass fiber between 2 sheets of corrugated aluminum. This material was claimed to have twice the insulation value of a 12-inch masonry wall.

Kaiser Aluminum & Chemical Corp. began producing corrugated aluminum roofing in 48-inch rather than the standard 26-inch width. This development will result in savings to the user owing to a 50-percent reduction in sidelap in the installed sheets. Another roofing material developed was an asphalt shingle with aluminum pigments. The purpose of the aluminum was to reflect the infrared rays of the sun, resulting in lower temperatures inside the building during the summer. The Colonial Refining & Chemical Co. initiated the manufacture of an asphalt-roof-coating material that contained aluminum pigment. Brushed onto the old roof in one application, the roof-coating material had good insulating properties owing to the ability of the aluminum to reflect the sun's rays. More aluminum was going into all types of buildng hardware, including locks, doorknobs, doorstops, and window latches.

Aluminum pipe was being installed to run temporary oil, gas, and water lines to oil-drilling rigs. The seamless, extruded pipe, besides weighing only 30 pounds per section as compared with 200 pounds for a similar steel pipe, was equipped with special coupling devices. As a result of these 2 features, the aluminum pipe could be laid down and picked up about 10 times as fast as a comparable steel pipe.

Kaiser Aluminum & Chemical Sales, Inc., issued a comprehensive book during the year on aluminum as an electrical conductor.[13]

The American Chain & Cable Co. Inc., began producing an aluminum-coated wire that was supposed to have the physical properties of galvanized strand but to have superior resistance to corrosion. Aluminized clothing, in the form of aprons, ponchos, leggings, coats, and boots, was replacing asbestos cloth in many hot jobs in the steel industry because of the ability of this cloth to reflect heat. Aluminum motion-picture screens were finding widespread acceptance in drivein theaters, as they were credited with reflecting three times as much light as the standard white-paint screens. An article in Modern

[12] Modern Metals, Aluminum Semisphere: Vol. 10, No. 2, March 1954, p. 35.
[13] Kaiser Aluminum & Chemical Sales, Inc., Kaiser Aluminum Electrical Conductor Technical Manual: Chicago, Ill., 1954, 190 pp.

Metals outlined the "Metalphoto" process for making photographic reproductions on aluminum.[14] Typical applications of the sensitized aluminum plates were as nameplates, instruction panels, wiring diagrams, badges, signs, and dial faces. The uses of aluminum in the food-and-chemical-processing industries were summarized by Alcoa in Chemical Week.[15] Multicolored printing on aluminum foil for magazine advertising was an innovation introducted by Reynolds in 1954.

Reynolds' "do-it-yourself aluminum," which was first introduced in late 1953, continued to grow in consumer popularity in 1954. The various forms of sheet, rod, extrusions and fasteners produced for this use could be fabricated into end products by amateur craftsmen employing only standard woodworking tools.

STOCKS

Aluminum continued to be on the Government's purchase list of strategic materials for the National Stockpile throughout 1954. Although it was made known that metal was added by the three producers during the year, the exact figures were classified security information.

Inventories of pig aluminum at reduction plants declined from 39,300 short tons on January 1, 1954, to 21,100 tons by December 31. Based on the December rate of production, the year-end stocks were equivalent to approximately 5 days' production. Stocks reached a high level for the year during the summer, when they were equivalent to over half of the monthly production. In addition to pig aluminum, reduction plants also had inventories of ingot and aluminum in process. Inventories of secondary-aluminum ingot at independent smelters changed little throughout 1954. Smelters' stocks at the close of the year were reported at 13,000 tons compared with 15,000 tons at the beginning of the year. Stocks of aluminum-base scrap at consumers declined from 22,000 short tons to 18,000 tons during 1954. Information on inventories at scrap collectors and dealers was not available.

PRICES

One price increase of 0.5 cent per pound for 99 percent pure aluminum pig, 0.7 cent per pound for 99 plus percent pure aluminum ingot, and proportional increases for other ingot and fabrications occurred during 1954. The base price, f. o. b. shipping point, at the end of 1954 was 20.5 cents per pound for pig aluminum and 22.2 cents per pound for ingot. The increase in prices, which occurred in August, followed conclusion of negotiations for a new wage contract. The secondary-aluminum ingot combined average price for copper-silicon casting alloys No. 108 and AXS–679 and variations was 20.61 cents per pound in 1954, as compiled from quotations published in the American Metal Market. The average represented a decline of 1.58 cents per pound compared with 1953 and 5.23 cents per pound from the average price in 1951, which was the high point since 1942.

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14 Modern Metals, Photographs in Aluminum: Vol. 10, No. 11, December 1954, pp. 55–57.
15 Chemical Week, Alcoa Aluminum in the Process Industries: Vol. 75, No. 13, Sept. 25, 1954, pp. 33–38.

TABLE 6.—Prices of aluminum, other selected metals, and the Bureau of Labor Statistics' wholesale price index, 1936–54 [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	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:					
First quarter	21.50	29.66	5.24	9.59	110.6
Second quarter	21.50	29.86	5.24	10.50	110.6
Third quarter	21.93	29.87	5.40	11.15	110.3
Fourth quarter	22.20	29.87	5.42	11.50	109.7
Average	21.78	29.82	5.33	10.69	110.3
Increase from 1936–40 average to 1954 average percent	9.7	169.1	100.4	94.4	111.3

[1] Source: Metal Statistics, 1955 (American Metal Market).

Dealers' buying prices for new aluminum clippings, computed from monthly averages in 1954, was 13.12 cents per pound and represented a 0.55-cent increase compared with 1953. Cast-aluminum-scrap prices increased 1.04 cents per pound. The highest prices, 14.50 cents for clippings and 11.00 cents for cast scrap, occurred during the fourth quarter. These prices were 4.00 and 3.25 cents per pound, respectively, higher than in the last quarter of 1951, when prices were controlled by the Office of Price Stabilization.

FOREIGN TRADE [16]

Imports.—United States imports of crude and semicrude aluminum decreased markedly during 1954 owing mainly to increased domestic production and reduced military consumption rather than to a decrease in civilian demand. As shown in table 7, the biggest drop, in terms of volume, occurred in the imports of crude metal. Imports of pig and ingot from all of the countries listed in table 8 decreased during the year, with shipments from European countries declining 73 percent from 1953, shipments from Canada 12 percent, and shipments from Asian countries 96 percent. Canada continued to be the chief source of both primary aluminum and scrap, supplying 91 percent of the total pig and ingot and 93 percent of the scrap imported for consumption. Scrap imports increased sharply toward the end of 1954, as about 60 percent of the total was received during the fourth quarter. Most of this increase and about 46 percent of the total annual scrap imports were "starter metal" from the new smelter at Kitimat, British Columbia. Although the Kitimat plant was a primary smelter, the "starter metal" was classified as scrap because of its low quality. The United Kingdom suffered the biggest cutback of the suppliers of semifabricated shapes as United States imports from the United Kingdom dropped from 17,623 short tons in 1953 to 3,774 in 1954. Forty-four percent of the semifabricated shapes was received from Canada, 28 percent from the United King-

[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.

dom, and most of the remaining 28 percent from other European countries. The average value of crude metal brought into the United States in 1954 was 19.4 cents per pound; the average value of scrap was 15.7 cents per pound; and the average value of semifabricated shapes was 29.4 cents per pound.

TABLE 7.—Aluminum imported for consumption in the United States, 1952–54, by classes

[U. S. Department of Commerce]

Class	1952		1953		1954	
	Short tons	Value	Short tons	Value	Short tons	Value
Crude and semicrude:						
Metal and alloys, crude	128,233	$43,504,881	300,928	$115,761,297	215,250	[1] $83,573,141
Scrap	6,998	2,591,609	26,621	8,072,379	14,845	[1] 4,674,654
Plates, sheets, bars, etc	15,507	8,551,176	31,932	18,636,894	13,655	[1] 8,042,188
Total	150,738	54,647,666	359,481	142,470,570	243,750	[1] 96,289,983
Manufactures:						
Bronze powder and powdered foil	8	11,970	16	18,438	11	13,578
Foil less than 0.006 inch thick	950	1,426,607	909	1,871,863	918	[1] 1,671,880
Leaf (5½ by 5½ inches)	(2)	7,209	(2)	7,122	(2)	[1] 12,315
Table, kitchen, hospital utensils, etc	1,614	2,734,627	2,271	3,747,379	1,716	[1] 2,908,513
Other manufactures	(3)	2,921,035	(3)	3,112,512	(3)	[1] 2,617,119
Total	(3)	7,101,448	(3)	8,757,314	(3)	[1] 7,223,405
Grand total	(3)	61,749,114	(3)	151,227,884	(3)	[1] 103,513,388

[1] Due to changes in tabulating procedures by the U. S. Department of Commerce data known not to be comparable to earlier years.
[2] Leaves: 1952, 1,690,814; 1953, 1,896,436; 1954, 3,748,428.
[3] Quantity not recorded.

In April the United States Department of Justice dropped an action taken in 1953 to cancel the sale of 600,000 tons of Canadian aluminum to the Aluminum Co. of America in 1953–58. The Department of Justice claimed that the agreement gave Alcoa competitive advantages in the United States aluminum industry. In an order entered in the Federal District Court of New York, the contract between Alcoa and Aluminium, Ltd., was allowed to be carried out, providing that Aluminium, Ltd., agreed to make available 110,000 tons of aluminum per year to nonintegrated users in the United States.[17]

Import duties on aluminum remained unchanged throughout 1954 at 1½ cents per pound for ingot and pig and 3 cents per pound for semifabricated aluminum. Public Law 678, 83d Congress, extended the suspension of the 1½-cent-per-pound duty on aluminum scrap through June 30, 1955.

[17] United States District Court for the Southern District of New York, United States of America, Plaintiff v. Aluminum Co. of America et al., Defendants, and Aluminum Import Corporation, Intervenor: Equity No. 85-73, Order. Apr. 23, 1954, 7 pp.

TABLE 8.—Aluminum imported for consumption in the United States, 1953–54, by classes and countries, in short tons

[U. S. Department of Commerce]

Country	1953			1954		
	Metal and alloys, crude	Plates, sheets, bars, etc.	Scrap	Metal and alloys, crude	Plates, sheets, bars, etc.	Scrap
North America:						
Canada	224,017	10,779	10,428	196,283	6,069	13,735
Other North America		22	16			6
Total	224,017	10,801	10,444	196,283	6,069	13,741
South America			7			10
Europe:						
Austria	13,608	201	50		77	
Belgium-Luxembourg	330	718	53		676	
France	10,827	1,023	3,024	1,653	243	614
Germany, West	23,124	555	1,471	9,673	1,967	83
Italy	6	348	16		349	
Netherlands		375	1,614		191	28
Norway	16,439		1,021	6,594	(1)	102
Switzerland	4,485	278	479	177	251	
United Kingdom	394	17,623	6,955	2	3,774	250
Other Europe	125	10	150	592		
Total	69,338	21,131	14,833	18,691	7,528	1,077
Asia:						
Japan	6,795		1,071	276	56	
Taiwan	772					
Total	7,567		1,071	276	56	
Africa			30			
Oceania	6		236		2	17
Grand total: Short tons	300,928	31,932	26,621	215,250	13,655	14,845
Value	$115,761,297	$18,636,894	$8,072,379	[2] $83,573,141	[2] $8,042,188	[2] $4,674,654

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

Exports.—The increased rate of aluminum-scrap exports that began in the latter half of 1953 continued through 1954. As a result, 39,338 short tons of scrap was exported during 1954, about 8.6 times scrap exports in 1953. Complaints by secondary smelters of the tight domestic supply of scrap for their operations caused the Bureau of Foreign Commerce to tighten export controls on aluminum scrap. As of June 1954 applications for licenses to export aluminum scrap would only be considered when supported by one of the following: A copy of an irrevocable letter of credit or a copy of a domestic bank's assurance that a letter of credit had been opened for the account of the purchaser or consignee; a copy of the purchase contract if payment was not to be made by letter of credit; or certification that the applicant had received United States funds from the foreign purchaser to cover the purchase price. The purpose of the new regulations was to enable the Bureau of Foreign Commerce to keep a closer watch over the volume of scrap exports under the open-end licensing policy then in effect.

TABLE 9.—Aluminum exported from the United States, 1952–54, by classes

[U. S. Department of Commerce]

Class	1952		1953		1954	
	Short tons	Value	Short tons	Value	Short tons	Value
Crude and semicrude:						
Ingots, slabs, and crude	1,388	$519,071	2,376	$937,207	4,044	$1,691,059
Scrap	1,027	163,987	4,581	1,475,904	39,338	12,984,970
Plates, sheets, bars, etc	7,847	5,853,746	7,764	6,106,922	6,050	4,803,109
Castings and forgings	352	780,199	622	1,660,656	619	1,795,482
Semifabricated forms, n. e. c	(1)	66,600	12	18,412	45	87,200
Total	(1)	7,383,603	15,355	10,199,101	50,096	21,361,820
Manufactures:						
Foil and leaf	152	255,941	257	464,260	237	432,444
Powders and pastes (aluminum and aluminum bronze) (aluminum content)	196	227,281	195	213,912	403	456,052
Cooking, kitchen, and hospital utensils	574	1,191,171	1,101	2,274,421	1,190	2,448,110
Sash sections, frames (door and window)	258	594,481	342	732,892	285	551,836
Venetian blinds and parts	490	697,241	721	920,483	853	1,029,397
Wire and cable	2,425	900,684	7,158	4,487,954	2,234	1,359,388
Construction materials, n. e. c	704	1,558,068	1,446	3,003,840	2,051	3,751,050
Other manufactures	(2)	79,543	(2)	97,086	(2)	108,286
Total	(1)	5,504,410	(1)	12,194,848	(1)	10,136,563
Grand total	(1)	12,888,013	(1)	22,393,949	(1)	31,498,383

1 Quantity not recorded.
2 Weight not recorded.

As shown in table 10, West Germany was the chief buyer of United States scrap, purchasing 63 percent of the total exported. Other major customers were Italy which bought 23 percent, India which bought 6 percent, and Japan which bought 5 percent of all the aluminum scrap shipped from the United States. Exports of ingots and pig almost doubled those of 1953, but exports of semifabricated shapes declined slightly in 1954. The average value of exported crude aluminum was 20.9 cents compared with 19.7 cents in 1953. The value of exported scrap averaged 16.5 cents per pound as opposed to 16.1 cents per pound in 1953.

TABLE 10.—Aluminum exported from the United States, 1953–54, by classes and countries, in short tons

[U. S. Department of Commerce]

Country	1953			1954		
	Ingots slabs, and crude	Plates, sheets, bars, etc.[1]	Scrap	Ingots, slabs, and crude	Plates, sheets, bars, etc.[1]	Scrap
North America:						
Canada	61	3,609	124	111	2,951	193
Cuba	5	588		40	444	2
Mexico	2,272	200		1,841	155	16
Other North America		236	55		256	82
Total	2,338	4,633	179	1,992	3,806	293
South America:						
Brazil		398		601	59	
Venezuela		1,189		33	1,348	
Other South America	21	206		65	147	
Total	21	1,793		699	1,554	
Europe:						
Finland		881				
Germany, West		(2)	905	77	41	24,694
Italy		24	543		12	9,191
United Kingdom	1	3	155	587	16	
Other Europe	16	41	129	601	36	631
Total	17	949	1,732	1,265	105	34,516
Asia:						
India		230		26	453	2,391
Japan		12	2,660	2	15	2,136
Philippines		497	10	38	499	
Other Asia		63			125	
Total		802	2,670	66	1,092	4,527
Africa		209		22	136	2
Oceania		12			21	
Grand total: Short tons	2,376	8,398	4,581	4,044	6,714	39,338
Value	$937,207	$7,785,990	$1,475,904	$1,691,059	$6,685,791	$12,984,970

1 Includes plates, sheets, bars, rods, extrusions, castings, forgings, and unclassified "semifabricated forms."
2 Revised to less than 1 ton.

TECHNOLOGY

A new system of alloy designations for wrought aluminum and aluminum alloys was adopted by the Aluminum Association on October 1, 1954.[18] Each alloy is designated by a 4-digit number, of which the first indicates 1 of 8 groups. The digit 1 is for aluminum, 99.00 percent minimum or greater, and the others indicate the major alloying element, as follows: 2 for copper, 3 for manganese, 4 for silicon, 5 for magnesium, 6 for magnesium and silicon, 7 for zinc, and 8 for other elements. In the case of aluminum, the lxxx group, the last two digits express the minimum aluminum percentage to the right of the decimal point, while the second digit indicates special control of one

18 Modern Metals, for Wrought Aluminum: A New Alloy Designation System: Vol. 10, No. 10, August 1954, pp. 72–75.
Metal Progress, New Numbering System for Wrought Aluminum Alloys: Vol. 65. No. 3, September 1954, p. 112–B.
American Metal Market, Aluminum Association Announces New Wrought Alloy Designation System: Vol. 61, No. 151, Aug. 7, 1954, pp. 1, 5.
Steel, Aluminum Specs Are Standardized: Vol. 135, No. 6, Aug. 9, 1954, pp. 94–95.

or more individual impurities. For alloys, the last two digits identify the alloy and usually are the same as the previous alloy number. The second digit on the designation indicates alloy modifications, experimental alloys are prefixed by the letter X, and temper designations follow the previous pattern of using a letter following the alloy designation and separated from it by a hyphen. Typical of these changes, the alloy formerly designated as 75S–T6 became alloy 7075–T6.

As in previous years, a number of new alloys having specific properties for specialized uses were introduced by different companies. Among the more interesting ones, Kaiser Aluminum & Chemical Corp. announced alloy 5086 as having superior welding characteristics, alloy 5357 for applications requiring an anodized finish similar to polished chrome plate, and alloy 55 EC for high-strength electrical conductors. Harvey Machine Co.'s new alloy XZM 100 was said to have shown typical ultimate tensile strengths of around 100,000 p. s. i., and its alloy 6066 is said to be a high-strength, low-cost, general-purpose alloy. Aluminum Co. of America also brought out a new electric-conductor alloy, 2 EC, with superior mechanical properties, and a new experimental aluminum forging alloy, X7079 containing zinc, magnesium, and copper, to meet the high-strength demands of advanced aircraft design. A nickel-aluminum bronze, having a high strength-weight ratio and extremely high corrosion and cavitation resistance especially desirable for ship propellers, was announced by Ampco Metal, Inc. United States Naval Ordnance Laboratory developed Thermenol, a nonstrategic iron-base alloy containing 16 percent aluminum and 3.3 percent molybdenum, which might be suitable for temperatures up to 1,200° F.[19] Apex Smelting Co. issued engineering information on mechanical and physical properties of its Ternalloy series of aluminum-base alloys for high-strength castings that are machinable at high speed. Bearing tests and preliminary engine trials revealed that aluminum alloys containing up to 7 percent tin and a little copper and nickel were very satisfactory bearing materials.[20] Studies of the corrosion resistance of aluminum alloys continued to receive attention.[21]

The extensive use of aluminum powder for preparing sintered-aluminum powder (SAP) called attention to the fact that aluminum is flammable when ignited and explosive when finely divided. It is also very reactive with chlorinated hydrocarbons under some conditions.[22]

Many new applications of aluminum alloys as materials of construction for chemical-engineering purposes were reviewed in detail, and an extensive bibliography was cited.[23] The British journal, Metallurgia, carried an excellent review and bibliography on some aspects of research and technical progress reported for 1954, including both European and American practices.[24]

Research on the recovery of columbium (Niobium) from bauxitic products in the Arkansas area was described. Materials tested in-

[19] Materials and Methods, Properties of High-Temperature Iron-Aluminum Alloy: Vol. 40, No. 5, November 1954, pp. 168, 170.

[20] Cuthbertson, J. W., and Ellwood, E. C., Improved Aluminium-Tin Bearing Alloys: Metal Ind. (London), vol. 85, No. 5, July 30, 1954, pp. 83–86.

[21] Pryor, M. J., Anticorrosion Practices for Wrought Aluminum Alloys: Light Metal Age, vol. 11, Nos. 11 and 12, December 1954, pp. 18–21, 33.

[22] Chemical and Engineering News, Aluminum Should be Recognized as a Hazardous Material: Vol. 32, No. 3, Jan. 18, 1954, p. 258.

[23] Fritts, Harry W., Aluminum Alloys: Ind. Eng. Chem., vol. 46, 1954, pp. 2045–2052.

[24] Elliott, E., Aluminium and Its Alloys in 1954: Metallurgia, vol. 51, No. 304, February 1955, pp. 65–74.

cluded bauxite ore before processing and intermediate waste products, such as black sands and red mud.[25] A method developed in Bureau of Mines laboratories for treating high-silica bauxite through calcination followed by a caustic leach and finally caustic pressure digestion was described in another report.[26] Information developed under the aluminum expansion program of 1951 was used in preparing a Bureau of Mines publication on the raw materials consumed in producing aluminum.[27]

Increased interest in the consumption of aluminum by the automotive industry was indicated by installation during the year of the world's largest die-casting machine. This machine was built by the Dohler-Jarvis Division of National Lead Co. with the cooperation of Kaiser Aluminum & Chemical Corp. The machine is capable of turning out aluminum die castings weighing up to 75 pounds each, and it was anticipated that engine blocks for the automotive industry will be cast in the machine.[28] Aluminum foil up to 54 inches wide, equal to the widest produced in the Nation, was being produced by a new mill installed at Kaiser Aluminum & Chemical Corp. plant, Permanente, Calif. In this mill cold-rolled coil aluminum sheet 0.026 inch thick is reduced to 0.00025 inch in thickness at a rate of 3,000 feet per minute.[29]

Chemical milling of aluminum in which the part to be etched is masked and immersed in a suitable solution or corrosive medium appeared to have application in the production of aircraft structures. The benefits to the air-frame industry would result through weight savings, production of a number of parts in a single batch, and a comparatively small investment in equipment. A number of methods of masking the part to be etched were described. The greatest savings were realized when no masking was required. Mechanical masking resulted in some increase in cost, and if tape, paint spray, or silk-screen masking were required costs were increased further.[30]

Electrolysis of pure alumina was the only commercial method used for producing aluminum in 1954. A study leading to an analysis of thermal insulation of linings for the bottom of reduction cells was made. An energy balance was made, and heat losses were calculated.[31] The zone melting method for purification, which had been applied to many metals, was applied to aluminum. Starting with metal analyzing 99.99 percent aluminum it was possible to upgrade the metal to a purity of 99.998 percent, reducing such impurities as copper, sodium, iron, and silicon to a few parts per million.[32]

Aluminum alloys used in such high-stress applications as the B-47 Stratojet bombers require precision heat treatment. Methods of heat

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[25] Nieberlein, V. A., Fine, M. M., Calhoun, W. A., and Parson, E. W., Progress Report on Development of Columbium in Arkansas for 1953: Bureau of Mines Rept. of Investigations 5064, 1954, 23 pp.

[26] Calhoun, W. A., and Powell, A. T., Jr., Investigations of Low-Grade Bauxites As Potential Sources of Aluminum by Caustic Desilication and Alumina Extraction: Bureau of Mines Rept. of Investigations 5042, 1954, 23 pp.

[27] Blue, D. D., Raw Materials for Aluminum Production: Bureau of Mines Inf. Circ. 7675, 1954, 11 pp.

[28] Modern Metals, The World's Biggest Die-Casting Machine: Vol. 10, No. 6, July 1954, p. 66.

[29] Light Metal Age, vol. 12, Nos. 9 and 10, October 1954, p. 32.

[30] Light Metal Age, Chemical Milling: Vol. 12, Nos. 7 and 8, August 1954, p. 20.

[31] Wleugel, J., and Böockman, O. C., The Problem of Correct Thermal Insulation of Bottom Linings of Aluminum Furnaces: Jour. Electrochem. Soc., vol. 101, No. 6, June 1954, pp. 145c-150c.

[32] Montariol, F., Reich, R., Albert, P., and Chaudron, G., [On the Application of the Method of Zone Melting to Obtain Progressive Purification of Aluminum]: Compt. rend., vol. 238, No. 7, Feb. 15, 1954, pp. 815-817.

treating and aging these alloys and the equipment required for such operations were described.[33]

The growing interest in the use of aluminum in architecture resulted in increased study of the use of porcelain enamel on aluminum. Reports indicated that porcelain enamel can be readily applied to aluminum by standard enameling procedures, and the aluminum can be sawed and drilled without damage to the coating. Aluminum Co. of America established a research team to study both the fundamental research problems and the practical and economic problems connected with this field. Ingram-Richardson Manufacturing Co. of Beaver Falls, Pa., announced completion of a program that adapted some of its facilities to the production of porcelain-enamel aluminum for architectural and other purposes.[34]

A new welding rod developed especially for both carbon-arc and torch welding of aluminum was announced by All-State Welding Alloys Co., Inc. The rod was specially designed for work on aluminum alloys 3S, 14S, 43S, 52S, 53S, and 61S. A new type solder, trade-named AluTin 51, was developed by Eutectic Welding Alloys Corp. for production and repair operations upon wrought- and cast-aluminum alloys. The solder melted between 400° and 500° F., had a specially compounded liquid-flux core of exceptional wetting properties, and was suitable for virtually any type of heat source.[35]

A process was announced by Olin Mathieson Chemical Corp. for producing metal-tubing circuits of any degree of complexity. The process uses the art of silk-screen printing and the technique of roll-bonding metals. Tubing formed by this method was first applied to the refrigeration industry, but it was expected that it would be applicable in design and production concepts wherever temperature control was involved.[36]

The high price and scarcity of certain material widely used in the communications and electrical industries resulted in research directed toward substitution of aluminum for other materials. In communications the Western Electric Co., Inc., developed a laminated sheath of aluminum steel, and polyethylene having a trade name "Stalpeth." This was intended to replace lead sheath used in producing local telephone cable. In the new sheath a layer of corrugated aluminum was surrounded by a layer of corrugated steel. The entire unit was then flooded with a thermoplastic cement, and a jacket of polyethylene was extruded over it.[37] A method of producing transformer coils in which aluminum foil served as a substitute for copper wire was announced by Sylvania Electric Products, Inc. Besides eliminating the use of more costly copper, this method, through the use of a wafer coil system, eliminated much of the hand labor required when copper wire was used. Another advantage claimed for the process was that, by using the foil, it was possible, in effect, to have an aluminum conductor equivalent to wire sizes as small as No. 44.

[33] Andrews, S. G., and Smith, H. H., Sinews for Stratojets: Ind. Heating, vol. 21, No. 1, January 1954, p. 26.
[34] American Metal Market, Alcoa Sets Up Research Team to Study Porcelain Enamel on Aluminum Base: Vol. 61, No. 201, Oct. 20, 1954, p. 9. Ingram-Richardson Co. Begins Production of Porcelained Aluminum: Vol. 61, No. 19, Jan. 28, 1954, p. 9.
[35] American Metal Market, Specially Coated Welding Rod for Aluminum Alloys Announced by All-State: Vol. 61, No. 17, Jan. 26, 1954, p. 8. Eutectic Welding Alloys Develops New Solder for Wrought, Cast Aluminum: Vol. 61, No. 94, May 18, 1954, p. 11.
[36] Modern Metals, Print-Roll-Inflate: Vol. 10, No. 10, November 1954, pp. 86, 88.
[37] Reynolds, E. W., Aluminum in Telephone Cable Sheath: Modern Metals, vol. 10, No. 7, August 1954, pp. 76–79.

When aluminum wire was used in transformer coil it had been necessary to use sizes above No. 26 owing to the low strength of the wire and limitations of the present equipment.[38]

WORLD REVIEW

The steady upward trend in world aluminum production that began in 1947 continued through 1954. The 1954 production of 3,050,000 short tons was 13 percent over the total for 1953 an

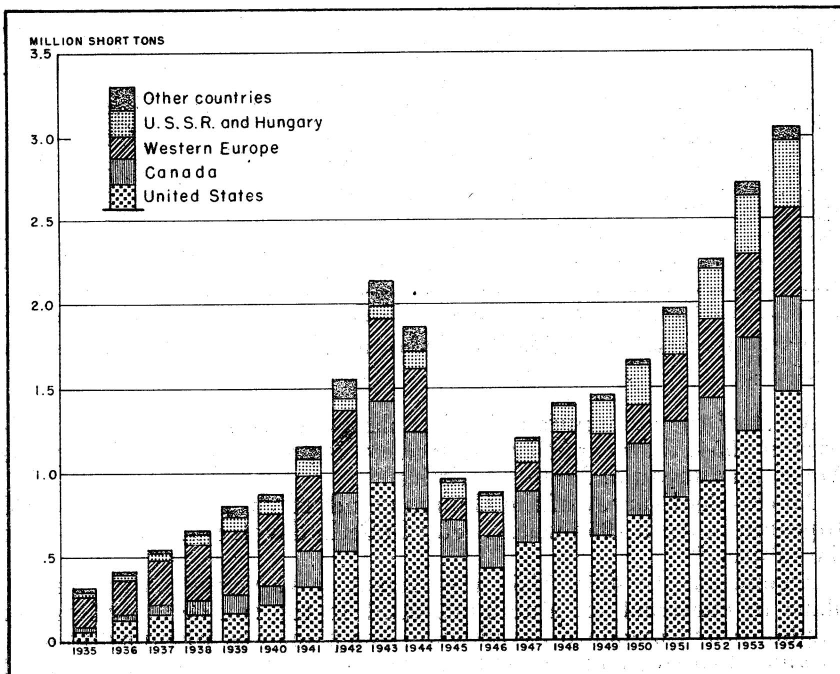

FIGURE 2.—Trends in world production of primary aluminum, 1935–54.

86 percent over production in 1950. The largest increases during the year were made by the United States (208,552 tons), U. S. S. R. (estimated 50,000 tons), West Germany (24,558 tons), and Canada (15,086 tons). The rise in German production resulted in that country superseding France and becoming the world's fourth largest producer. Switzerland was the only country to report a decline in production in 1954.

A number of new aluminum-reduction plants were completed during the year. The largest of these—at Kitimat, British Columbia—had a rated capacity of 91,500 tons per year. A plant at Sunndalsora, Norway, started production with a rated capacity of 44,000 tons per year. Poland reportedly became a producer for the first time during 1954 with completion of a reduction plant, and Yugoslavia finished a new plant in the latter part of the year.

[38] Zack, A., Aluminum Foil and Transformer Coils: Modern Metals, vol. 10, No. 9, October 1954, pp. 35-37.

TABLE 11.—World production of aluminum, by countries,[1] 1945–49 (average) and 1950–54, in short tons[2]

(Compiled by Pearl J. Thompson)

Country [1]	1945-49 (average)	1950	1951	1952	1953	1954
Austria	8, 585	19, 828	29, 079	40, 468	47, 924	52, 920
Brazil	106	----------	444	1, 196	1, 322	[3] 1, 900
Canada	288, 942	396, 882	447, 095	499, 758	545, 800	560, 88
China (Manchuria)	331	----------	----------	(4)	(4)	(4)
France	56, 486	66, 842	99, 578	117, 020	123, 653	132, 340
Germany, West	12, 380	30, 686	81, 719	110, 756	117, 881	142, 439
Hungary	7, 350	18, 350	24, 000	26, 000	[3] 33, 000	[3] 35, 000
India	3, 490	4, 023	4, 311	3, 994	4, 209	5, 472
Italy	21, 916	40, 832	54, 840	58, 235	61, 130	63, 471
Japan	11, 565	27, 298	40, 682	47, 025	50, 145	58, 544
Korea, North [3]	1, 529	1, 100	----------	----------	(4)	(4)
Norway	24, 199	51, 870	55, 403	56, 330	59, 043	67, 584
Spain	956	2, 389	4, 583	4, 532	4, 823	5. 159
Sweden (includes alloys)	3, 726	4, 451	7, 401	9, 089	10, 635	12, 041
Switzerland	17, 057	21, 164	29, 762	32, 518	30, 865	29, 762
Taiwan (Formosa)	977	1, 941	3, 289	4, 251	5, 407	7, 861
U. S. S. R [3]	135, 000	200, 000	225, 000	275, 000	325, 000	375, 000
United Kingdom	34, 221	33, 004	31, 052	31, 366	34, 626	35, 395
United States	540, 672	718, 622	836, 881	937, 330	1, 252, 013	1, 460, 565
Yugoslavia	1, 368	2, 129	3, 117	2, 825	3, 078	3, 854
World total (estimate)[1]	1, 170, 000	1, 640, 000	1, 980, 000	2, 260, 000	2, 710, 000	3, 050, 000

[1] Aluminum is also produced in Czechoslovakia and East Germany, but estimates are not included in total.
[2] This table incorporates a number of revisions of data published in previous Aluminum chapters.
[3] Estimate.
[4] Negligible.

A list of the aluminum-reduction plants operating in various countries in 1954, their capacity and location is published annually by the American Bureau of Metal Statistics.[39]

An excellent survey of the aluminum industry throughout the world appeared in April 1954 when Metal Bulletin devoted an entire issue to the subject.[40]

Argentina.—In July 1954 the Argentine Government announced plans to construct an aluminum plant in the southern territory of Chubut near Comodoro Rivadavia. The plant was scheduled to have an annual capacity of 10,000 tons and to be completed by the end of 1957. The Government intends to use high-aluminum clays found in the neighboring territory of Neuquen as a raw material.

Australia.—The alumina plant and primary-aluminum-reduction facilities being constructed at Bell Bay, Tasmania, neared completion at the end of 1954. Production from the alumina plant was scheduled to begin in early 1955, and it was planned that the reduction plant would be in operation by mid–1955. By 1956 the reduction plant should be producing at a rate of 10,000 short tons per year. Although the plant will have a 13,000-ton capacity, a shortage of electricity due to a scarcity of water in the area may prevent the plant from running at full capacity for several years. The alumina plant will use Malayan bauxite but may eventually employ lower grade Australian bauxite from the Wessell Islands. Cryolite, petroleum coke, anthracite, and carbon black, for use in the reduction plant, will also be imported.

[39] American Bureau of Metal Statistics, Yearbook of the American Bureau of Metal Statistics: Thirty-fourth Annual Issue for the Year 1954, 50 Broadway, New York, N. Y., June 1955, pp. 98–100.
[40] Metal Bulletin (London), Special Aluminium Issue. April 1954, 128 pp.

Austria.—Primary-aluminum production continued to rise for the eighth consecutive year, with an output of 53,000 short tons, as compared with the production of 48,000 tons in 1953. This production was extended to 63,093 tons by adding plant scrap to the aluminum tapped from the reduction cells. Power allocations during 6 months of 1954 to Ranshofen Aluminum Works, the largest of the 2 Austrian producers, allowed its reduction plant to operate at capacity for the first time since the erection of the plant. The other producer, the Swiss-owned firm, Austrian Salzburger Aluminium G. m. b. H., completed a second powerplant in the early part of 1954 which enabled it to increase production.

Exports of virgin and semifabricated aluminum declined in 1954 to 30,537 short tons from the 1953 exports of 33,448 tons. The decline was due largely to virtual cessation of orders from the United States. During the year three nationalized firms and the Government-established company, Austrian Metal Works, organized a study group to create new uses for aluminum in Austria. Their study resulted in the announcement in December of Government plans to construct a plant for producing aluminum goods in lower Austria at Berndorf.

Brazil.—The estimated production of aluminum was about 1,900 short tons compared with 1,322 tons in 1953. Construction work continued on the plant of Cia. Brasileira de Aluminio, which is to have an initial capacity of 10,000 tons of aluminum a year.

Canada.—Production of primary aluminum increased 3 percent over 1953 to give a new production high of 561,000 short tons. The new smelter, which went into production at Kitimat, British Columbia in August 1954, produced about 20,500 tons of this total. The rest of the production was accounted for by the four smelters of the Aluminium Company of Canada, Ltd., in Quebec. The rated capacity of Alcan's smelter at Kitimat was 91,500 tons per year. An eventual capacity of 550,000 tons was planned. In October 1954, Alcan announced that work was to begin immediately to expand the Kitimat smelter by 60,000 tons of aluminum ingot. This also involved the installation of a fourth generator of 150,000-hp capacity in the Kemano powerhouse. The expanded capacity was to cost $45 million and was expected to come into operation in early 1956.

The Aluminium Company of Canada, Ltd., published a booklet in the latter half of 1954 dealing with various aspects of building the Kitimat plant.[41]

The Kaiser Aluminum & Chemical Corp. obtained an agreement with the Province of British Columbia to conduct an engineering and geological investigation of sites for the construction of a dam at the foot of Arrow Lakes on the Columbia River. The dam would be used to control flow downstream and prevent power interruptions. The plan was opposed by the Canadian Government in Ottawa, but the Government of British Columbia planned to fight the case in court.

Approximately 74 percent of Canada's shipments of aluminum ingots in 1954 were made under long-term commitments to the United Kingdom and the United States. Shipments of Canadian aluminum

[41] Aluminium Company of Canada, Ltd., The Kitimat Project: Publicity Release, Aluminium Ltd., Montreal, Canada.

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in ingot form during the past 5 years are given in short tons as follows:[42]

	1950	1951	1952	1953	1954
United Kingdom	146,300	199,750	257,750	184,600	221,800
United States	162,250	103,100	114,500	237,000	192,560
Canada	66,000	86,350	88,550	90,200	80,000
Other countries	41,600	53,800	39,150	37,900	60,840
Total	416,150	443,000	499,950	549,700	555,200

In August the price of aluminum ingot exported to the United States was raised from 20 to 20½ cents (United States currency) to keep in line with the higher prices announced by United States producers. It is customary for the Canadian producer to absorb United States tariffs in this price as well as allowing freight on shipments as far west as the Mississippi River and as far south as the Mason-Dixon line.

During the year the price on aluminum for sale in Canada or for export markets other than the United States remained at 19 cents (Canadian currency) delivered to any Canadian destination.

France.—The production of primary aluminum in 1954 rose to a new peak of about 132,000 short tons, representing a 7-percent increase over the previous peak. An expansion program completed in 1954 raised the combined capacities of the 2 French producers to about 154,000 tons per year. The producers do not foresee any more major aluminum-smelting plants being constructed in France owing to the high cost of any additional electric power.

The two French aluminum firms, Compagnie de Produits Chimiques et Électrométallurgiques Alais, Froges et Camarque (Pechiney) and the Société d'Électrochimie, d'Électrométallurgie et des Aciéries Électriques d'Ugine (Ugine), reached an agreement in 1954 to exploit the abundant supply of hydroelectric power in the French Cameroons to produce aluminum. They formed the company Cie Camerounaise de l'Aluminium Pechiney-Ugine (Alucam), which plans to have a reduction plant at Edea, Cameroons, in operation by 1956 with an annual capacity of about 50,000 tons in operation by 1959.

The two companies also decided to set up an aluminum industry in French Guinea, utilizing the large bauxite reserves of that country. An earthen dam will be erected on the Konkource River to supply the power for the alumina and aluminum plants.

The aluminum industry celebrated its centennial with meetings and ceremonies in Paris in 1954. Tribute was paid to Henri Sainte-Claire Deville, who first published his findings on the production of aluminum in 1854.

The history of the aluminum industry in France was summarized in an article that appeared in May 1954.[43]

Exports declined to 17,000 metric tons in 1954 owing to French producers giving domestic consumers priority and to a declining demand from foreign purchasers. Shipments to both the United Kingdom and to the United States were reduced markedly. In July

[42] Aluminium, Ltd., Twenty-seventh Annual Report for the Year Ending Dec. 31, 1954: Montreal, Canada. Mar. 16, 1955, 31 pp.
[43] Modern Metals, The First Century; Aluminum in France: Vol. 10, No. 4, May 1954, pp. 82–86.

the domestic price for primary aluminum was reduced from 180 francs per kilogram (23.3 cents per pound) to 176.773 francs per kilogram to absorb an increase in taxes to the consumer.

Germany, West.—With an advance in production to 142,000 short tons of primary aluminum in 1954, Germany became the third largest producer in the Free World. This represented a 21-percent increase over 1953 production. Part of it was due to completion of the reconstructed Erftwerk plant at Grevenbroich of the Vereinigte Aluminium Werk. This company's 3 plants at Grevenbroich, Luenen and Toeging produced about 97,000 tons of the total, and the Aluminium G.m.b.H. at Rheinfelden, Baden, accounted for about 45,000 tons.[44] In addition, about 16,500 tons of primary aluminum was imported, and only about 12,000 tons was exported, leaving an import balance of 4,500 tons. These figures reflect an increasing consumption of aluminum in Germany, and producers believed that any increases in production could be readily absorbed by domestic consumers. Growing German consumption made itself felt in Austria as imports from that country rose from 550 tons per month during the first half of the year to 1,400 tons per month in the latter part of the year. Production of aluminum from remelted scrap increased to about 62,000 short tons as a result of more scrap being generated and imported.

Hungary.—The Hungarian News and Information Service reported in June 1954 that a second furnace had been installed at the Maszobal aluminum smelter about 30 miles west of Budapest. The capacity of the plant was about 5,000 to 6,000 tons per year, and power for the operation was supplied by a thermal power station at Inota.

India.—Both primary producers in India completed expansion programs in 1954, increasing the Indian capacity from 4,800 to 8,400 short tons per year. The largest producer, the Indian Aluminium Co., Ltd., brought its capacity at Alupuram up to 5,600 tons per year in June 1954. The Government of Travancore-Cochin had planned to have additional power-generating facilities available by June, but delays in the installation of low-pressure pipes leading to the storage reservoir resulted in the power suppliers not being able to meet their commitments. Consequently, the aluminum plant at Alupuram was not able to run at full capacity during the remainder of 1954, and the company was reported to have operated at a loss throughout the year.[45] The Indian Aluminium Co., Ltd., announced that negotiations were under way for further expansion, since it had received a license for constructing a smelter having an 11,000-short-ton capacity at Hirakud, Orissa.

The Aluminium Corp. of India, Ltd., installed a third boiler and accessories at its Jaykaynagar plant, thus raising its productive capacity from 2,000 to 2,800 tons per year.

The aluminum industry in India was beset by a number of problems, the chief of which were the high cost of electricity and high labor cost per unit of production. One source estimated that it took 120 to 140 man-hours to produce 1 ton of aluminum in India compared with 20 to 30 man-hours in the United States.

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[44] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 6, June 1955, pp. 3–4.
[45] Nayar, V. G. G., A Survey of the Aluminium Industry in India: Eastern Metals Review, Ann. Number, Vol. 8, No. 1, sec. B, Feb. 7, 1955, pp. 49–62.

Japan.—In 1954 output of primary metal in Japan hit a new postwar peak of 59,000 short tons, representing a 17-percent increase over the production in 1953. Deliveries of metal, however, declined to 51,058 tons compared with 55,952 in 1953, owing to a decrease both in domestic consumption and in exports to other countries. Exports in 1954 dropped to 8,047 tons from the 1953 total of 9,921 tons. In October the Japanese aluminum producers concluded a barter agreement with Argentina for exporting 6,000 tons of primary aluminum in exchange for Argentine raw wool. Of this total 2,200 tons would be paid for at about 22 cents per pound, while the remainder would be paid for by an equivalent value of wool. Other trade agreements in effect in 1954 provided for the shipment of 4,400 short tons of primary aluminum to Brazil and 1,100 tons to Uruguay by March 1955.

Because of the decreased demand for aluminum in 1954, the export price for Japanese aluminum declined from 27 cents per pound in April to as low as 21 cents per pound toward the latter part of the year.

Mexico.—In January 1954 it was announced that for the first time in 25 years the Aluminum Co. of America had built an extrusion plant outside of the United States. The plant, on the outskirts of Mexico City, will be operated by Alcomex, S. A., which is owned jointly by Alcoa and a group of Mexican businessmen. A 1,600-ton extrusion press, 1 draw bench, and supporting equipment have been installed, enabling the plant to produce a full line of extruded and drawn products.

Norway.—The production of primary aluminum increased markedly in 1954 to 68,000 short tons from 59,000 produced in 1953. This increase was due mainly to the opening in April of the new State-owned aluminum-reduction plant at Sunndalsora, Norway. Initially the plant was scheduled to have a capacity of 44,000 tons per year, which may be stepped up to 55,000 tons when additional power becomes available from the nearby Aura hydroelectric plant. Norway received a $24 million loan from the United States Economic Cooperation Administration in 1951 to aid in constructing the plant. Bearing 2½-percent interest, the loan is to be repaid by 1964 through delivery of aluminum ingots to the United States. The director general of the company estimated that, at prices prevailing in 1954, this would call for a shipment of about 72,000 tons of ingot over the 10-year period. Shipments to the United States were to begin in 1955. The first 1,100 tons produced by the Sunndalsora plant was shipped to the U. S. S. R. in September under the Soviet-Norwegian trade agreement.

Poland.—In August 1954 it was reported that construction had been completed on the aluminum-reduction plant of the Metallurgical Works of Skawina near Krakow. Built according to Russian blueprints, supplied with equipment and experts from the U. S. S. R., the plant supposedly went into operation in the latter part of 1954.

Spain.—Spanish production of primary aluminum increased from 4,823 short tons in 1953 to 5,159 in 1954. Expansion underway in 1954 at the Valladolid works of the Empresa Nacional del Aluminio and the Sabinanigo works of the Aluminio Espanol S. A. is expected to increase 1955 production to about 8,800 tons. Imports in 1954, coupled with domestic production, made 12,700 tons of aluminum available for consumption by the Spanish market.

Taiwan (Formosa).—In 1954 the United States Foreign Operations Administration advanced $333,500 to the Taiwan Aluminum Co. to aid it in the following expansion program: Aluminum-ingot capacity to be advanced from 7,700 to 9,300 short tons per year; aluminum-sheet capacity to be expanded from 2,600 to 6,600 tons per year; and fabricating facilities to be increased by 400 tons. In April the Taiwan Aluminum Co. also received a loan of $300,000 from the Central Trust of China to enable it to import an aluminum-foil-rolling machine. The United Nations published a report dealing with the history and operation of the Taiwan aluminum industry in October 1954.[46]

United Kingdom.—Production of primary aluminum in the United Kingdom increased somewhat over 1953, resulting in a total of over 35,000 short tons. This occurred despite the fact that the British Aluminium Co., Ltd., plant at Foyers, Scotland, had been completely converted to the manufacture of superpurity aluminum. Work continued throughout the year on modernizing and reconstructing the other reduction plants at Kinlochleven and Lochaber, Scotland.[47]

In January 1954 the price for primary aluminum rose from £150 per long ton (18.8 cents per pound) to £156 per long ton (19.5 cents per pound), at which price it remained stable for the rest of the year.

Yugoslavia.—It was reported that regular commercial production began at the Kidricevo plant at Strnisce, Dalmatia, in December 1954. The reduction plant is scheduled to have an initial capacity of 16,500 tons per year, which may eventually be expanded to 33,000 tons per year when electrical power becomes available. Another aluminum plant at Razine, Croatia, with a scheduled capacity of 5,000 tons per year, was said to be nearing completion. Future production at these 2 plants should considerably increase the 1954 output of 3,854 tons.

[46] Committee on Industry and Trade, The Aluminum Industry in Taiwan Province, China: Economic Commission for Asia and the Far East, Sub. 3/1, Annex D, Oct. 6, 1954, 4 pp.
[47] British Aluminium Co. Ltd., The Chairman's Speech at the Annual General Meeting: May 1955, 16 pp.

Antimony

By Abbott Renick[1] and E. Virginia Wright[2]

ESTIMATED world mine production of 40,000 short tons of antimony in 1954, though 14 percent higher than in 1953, failed to reach the high level held in the period 1948–52.

Domestic mine output (antimony content) was 770 tons in 1954 compared with 400 tons in 1953. The Sunshine Mining Co. of Idaho was the principal domestic producer; it recovered impure cathode metal from complex silver-lead-copper ore in Shoshone County. Their output was stockpiled. United States smelter production was 7,900 tons, an 11 percent increase over 1953.

The price of domestic antimony metal, RMM brand, 99½ percent, f. o. b. Laredo, Tex., was unchanged throughout the year at 28.50 cents per pound. The corresponding price at New York remained steady at 30.47 cents per pound. Comparative prices for 1953 were 33.93 and 35.90 cents, respectively.

The United States "new supply" of primary antimony in 1954, in terms of recoverable metal[3] was 11,100 short tons compared with 14,000 tons in 1953. A breakdown of this supply shows that domestic antimony ore and concentrate contributed 6 percent (700 tons); domestic and foreign silver-lead ores, 18 percent (2,000 tons); and imports, 76 percent (8,400 tons). The types of antimony materials imported for consumption arrived as follows: Ore and concentrate (in terms of recoverable metal) 4,400 short tons; metal, 2,800 tons; oxide, 1,200 tons; and a small quantity of antimony sulfide. The supply from secondary sources was 22,000 short tons.

Total consumption of antimony in the United States during 1954 was 36,200 short tons and was comprised of 12,200 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 22,000 tons of secondary antimony.

On March 23, 1954, antimony was reinstated on the list of minerals eligible for exploration benefits under provisions of the Defense Production Act of 1950, as amended. On September 21 the Office of Defense Mobilization issued a release announcing that antimony was to be purchased on the open market from domestic sources for the "long-term" stockpile and that antimony was on the suggested list of commodities to be obtained from foreign sources for the "supplemental" stockpile through the use of foreign currencies acquired from the sale of surplus agricultural products or by barter of such products.

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[1] Commodity-industry analyst.
[2] Statistical assistant.
[3] Calculated at 92 percent of gross metal content.

TABLE 1.—Salient statistics of antimony in the United States, 1945–49 (average) and 1950–54, antimony content, in short tons

	1945–49 (average)	1950	1951	1952	1953	1954
Production:						
Primary:						
Mine (shipments)	3,575	2,497	3,472	2,160	372	766
Smelter	13,922	9,471	13,800	11,860	7,100	7,912
Secondary	19,780	21,862	23,943	23,089	22,360	22,358
Antimony content of antimonial lead produced by primary lead refineries from domestic and foreign ores	2,062	2,850	2,356	2,777	2,790	1,956
Imports for consumption	14,676	15,354	15,673	12,789	11,478	8,772
Ore and concentrate	11,748	9,746	11,746	7,945	7,778	4,722
Metal	2,831	4,632	2,231	3,354	2,612	2,802
Oxide	9	963	1,692	1,466	1,076	1,225
Sulfide	88	13	4	24	12	23
Exports of ore, metal, and alloys [1]	483	154	168	161	[5] 25	44
Consumption of primary antimony [2]	17,329	15,167	17,370	14,988	14,300	12,180
Average price of antimony at New York [3] cents per pound	28.40	29.41	44.17	44.02	35.90	30.47
World production [4]	40,000	[5] 50,000	[5] 70,000	[5] 50,000	[5] 35,000	40,000

[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.
[5] Revised figure.

DOMESTIC PRODUCTION [4]

MINE PRODUCTION

During 1954 domestic mine production totaled 770 tons of antimony, of which 700 tons was estimated as recoverable. Production was confined almost entirely to the Sunshine Mining Co., Shoshone County, Idaho, where impure antimony metal was recovered as a byproduct of processing silver-lead ore and stockpiled. The antimony was leached from silver-copper-antimony concentrate and recovered in an electrolytic plant.

In addition, 2,000 tons of antimony contained in domestic and foreign silver-lead ores was recovered by primary lead refineries in producing antimonial lead.

TABLE 2.—Antimony-bearing ore and concentrate produced (shipments) in the United States,[1] 1945–49 (average) and 1950–54, in short tons

Year	Gross weight	Antimony content: Quantity	Antimony content: Average percent	Year	Gross weight	Antimony content: Quantity	Antimony content: Average percent
1945–49 (average)	14,089	3,575	25.4	1952	4,854	2,160	44.5
1950	6,888	2,497	36.3	1953	2,161	372	17.2
1951	9,401	3,472	37.0	1954	4,686	766	16.3

[1] Includes Alaska.

SMELTER PRODUCTION

Primary.—United States smelter production of antimony in 1954 was 7,900 tons, 11 percent above the 7,100 tons produced in 1953.

[4] Production data for 1954 were collected jointly with the Bureau of the Census (U. S. Department of Commerce); production totals will be compared with the Bureau of the Census totals when they are available and differences adjusted or explained.

Of the total output, 28 percent was metal; 62 percent oxide; 9 percent primary residues and slags; and 1 percent sulfides.

During 1954, 2,000 tons of antimony was recovered as antimonial lead by primary lead refineries from domestic and foreign silver and lead ores. Recovery decreased 30 percent from that of 1953. A detailed discussion of antimonial lead production is given in the Lead chapter of this volume.

Secondary.—Total output of secondary antimony in 1954 was 22,000 short tons, comprising 20,400 tons from secondary metal plants and 1,600 tons recovered from scrap at primary lead refineries. Production for the year remained virtually unchanged from the 1953 output. A detailed review appears in the Secondary Metals—Nonferrous chapter of this volume.

TABLE 3.—Smelter production of antimony, 1945–49 (average) and 1950–54, by type of material, antimony content, in short tons

Year	Metal	Oxide	Sulfide [1]	Residues	Total
1945–49 (average)	6,363	7,395	164	(2)	13,922
1950	2,899	6,492	80	(2)	9,471
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

[1] Also includes ground high-grade sulfide ore.
[2] Not reported separately.

TABLE 4.—Antimony metal, alloys, and compounds produced in the United States, 1945–49 (average) and 1950–54, 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	
1945–49 (average)	13,922	67,043	1,569	493	2,240	4,302	6.4	19,780
1950	9,471	61,912	2,253	597	1,654	4,504	7.3	21,862
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

[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 decreased for the third consecutive year and was 36,200 tons or 7 percent less than the 39,100 tons consumed in 1953. Primary antimony used totaled 12,200 tons (14,300 in 1953); the antimony content of lead-silver ores consumed by primary lead refineries in manufacturing antimonial lead was 2,000 tons (2,800 in 1953); and secondary antimony totaled 22,000 tons (22,000 in 1953).

Consumption of primary antimony in manufacturing finished products decreased 15 percent from 1953; of the total, 56 percent was in the form of nonmetal products, and 44 percent was in the form of metal products. Antimony consumed in nonmetallic products increased 4 percent, with larger quantities of oxide entering into flameproofed textiles and in paints, lacquers, glass, and pottery.

TABLE 5.—Industrial consumption of primary antimony, 1945–49 (average) and 1950–54, by types of material, antimony content, in short tons

Year	Ore and concentrate	Metal	Oxide	Sulfide	Residues	Total
1945–49 (average) [1]						17,329
1950	3,065	6,330	5,600	172	(2)	15,167
1951	3,007	4,645	8,872	162	684	17,370
1952	1,776	4,321	7,465	117	1,309	14,988
1953 [3]	2,100	5,400	5,800	100	900	14,300
1954	768	4,609	5,885	94	824	12,180

[1] Breakdown by type of material not available.
[2] Not reported separately.
[3] 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, 1945–49 (average) and 1950–54, antimony content, in short tons

Product	1945–49 (average) [1]	1950	1951	1952	1953 [2]	1954
Metal products:						
Ammunition	38	9	4	3	3	5
Antimonial lead	5,955	4,440	2,282	2,196	2,300	1,531
Battery metal	(3)	1,738	2,774	2,253	3,000	1,583
Bearing metal and bearings	2,088	1,518	1,308	1,119	1,000	816
Cable covering	130	72	95	43	60	156
Castings	151	126	79	80	80	70
Collapsible tubes and foil	89	23	18	32	60	47
Sheet and pipe	262	300	180	70	170	238
Solder	168	162	123	145	200	148
Type metal	1,194	766	709	624	700	613
Other	(3)	145	52	61	127	118
Total metal products	10,075	9,299	7,624	6,626	7,700	5,325
Nonmetal products:						
Ammunition primers	22	9	18	24	30	22
Antimony sulfide (precipitated)	(4)	(4)	68	67	50	37
Fireworks	(5)	(5)	20	36	50	27
Flameproofed coatings and compounds	(5)	(5)	463	980	450	316
Flameproofed textiles	1,728	369	2,590	2,059	780	950
Frits and ceramic enamels	1,444	1,462	1,476	959	1,000	706
Glass and pottery	345	579	570	579	700	763
Matches	27	56	31	22	20	15
Paints and lacquers	1,642	267	962	853	340	681
Pigments	(5)	(5)	705	766	780	700
Plastics	176	737	747	632	560	620
Rubber products	27	103	19	66	20	49
Other [6]	1,843	2,286	2,077	1,319	1,820	1,969
Total nonmetal products	7,254	5,868	9,746	8,362	6,600	6,855
Grand total	17,329	15,167	17,370	14,988	14,300	12,180

[1] Data 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.

Consumption of antimony in metal products decreased 31 percent, with antimonial lead and battery metal showing the largest decreases. Consumption of secondary antimony, chiefly in metallic products, remained virtually unchanged.

STOCKS

At the end of 1954 industry stocks amounted to 7,400 short tons, a 4-percent increase from the 7,100 tons reported on hand December 31, 1953. Mine stocks, which are included in industry stocks, continued unchanged at 200 tons.

TABLE 7.—Industry stocks of primary antimony in the United States at end of year, 1953–54, antimony content, in short tons

Raw material	December 31, 1953			December 31, 1954		
	Mine [1]	Other [2]	Total [2]	Mine [1]	Other	Total
Ore and concentrate	200	2,032	2,232	200	2,221	2,421
Metal		1,254	1,254		1,577	1,577
Oxide		2,851	2,851		2,751	2,751
Sulfide		142	142		135	135
Residues and slags		584	584		522	522
Total	200	6,863	7,063	200	7,206	7,406

[1] Includes Alaska.
[2] Revised figures.

PRICES

The price of antimony metal, RMM brand, 99½ percent, f. o. b. Laredo, Tex., was 28.50 cents per pound in 1954, unchanged since November 27, 1953. The corresponding New York price remained at 30.47 cents per pound throughout the year.

TABLE 8.—E&MJ Metal and Mineral Markets openings and subsequent changes in nominal quotations for antimony ore, 1954, antimony content, per unit (20 pounds)

Date	50–55 percent	55–60 percent	60–65 percent
Jan. 1	$2.55–$2.65	$2.80–$3.00	$3.50–$3.60
Mar. 11	2.60– 2.70	2.80– 3.00	3.50– 3.60
May 6	2.70– 2.80	2.90– 3.00	3.60– 3.70
June 17	3.25– 3.35	3.65– 3.75	4.15– 4.25
July 1	3.50– 3.60	3.75– 3.85	4.25– 4.35
July 22	3.80– 3.90	4.10– 4.20	4.65– 4.75
Nov. 18	3.40– 3.50	3.60– 3.80	4.30– 4.40
Nov. 25	3.25– 3.35	3.50– 3.60	4.30– 4.40
Dec. 16	2.80– 3.00	3.00– 3.20	4.00– 4.35
Dec. 30	2.80– 3.00	3.00– 3.20	4.00– 4.20

TABLE 9.—Foreign metal prices, New York, 1954, antimony content, cents per pound

[E&MJ Metal and Mineral Markets]

Date	99.6 percent	99.5 percent	99 percent
Jan. 7	26.00–26.50	25.50–26.00	25.00–25.50
June 15	27.75–28.25	27.25–27.75	26.75–27.25
Dec. 31	28.00–28.50	27.00–28.00	26.00–27.00

TABLE 10.—Antimony oxide prices, New York, 1954, cents per pound

[Oil, Paint and Drug Reporter]

Date	Carlots, in bags	Less than carlots, in bags
Jan. 4	26.00	27.50
July 5	29.00	30.50
Dec. 27	29.00	30.50

FOREIGN TRADE[5]

Imports.—During 1954 imports of contained antimony for consumption totaled 8,800 tons, a decrease for the third consecutive year and the lowest recorded since 1946. In terms of recoverable metal, total imports were 8,400 short tons, comprising 4,700 tons of ore and concentrate, 2,800 tons of metal, 1,200 tons of oxide, and a small quantity of sulfide.

Imports of ore and concentrate, principally from Bolivia and Mexico, decreased 46 percent; the average grade was 37 percent antimony, an 8-percent decrease. Imports of metal, chiefly from Mexico, Belgium-Luxembourg, and Yugoslavia, increased 8 percent. Imports of oxide, 70 percent of which came from United Kingdom, increased 14 percent, and imports of sulfide, 85 percent of which came from Belgium-Luxembourg, increased 120 percent.

TABLE 11.—Antimony imported for consumption in the United States, 1945–49 (average) and 1950–54[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	Antimony content: Value	Short tons (gross weight)	Value	Short tons	Value		Short tons (gross weight)	Value
1945–49 (average)	31,412	11,748	$3,088,343	126	$73,052	2,831	$1,551,728	807	11	$5,458
1950	22,307	9,746	1,850,162	19	8,895	4,632	2,204,091	1,936	1,160	428,386
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

[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.

Exports.—In 1954 exports (gross weight) of metal and alloys totaled 44 short tons valued at $25,600 and of salts and compounds, 330 tons valued at $203,000. There were no exports of ore and concentrate. By comparison, exports in 1953 of metal and alloys totaled 24 tons valued at $23,000 and of salts and compounds, 120 tons valued at $69,500.

[5] 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, 1945–49 (average), 1950–52 (totals), and 1953–54, 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						
1945–49 (average)	31,447	11,768	$3,087,836	126	$73,052	2,900	$1,592,082	11	$5,458
1950	24,095	10,367	1,957,699	19	8,895	4,488	2,121,499	1,160	428,386
1951	26,320	[2] 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									
North America:									
Honduras	1	1	200						
Mexico	7,556	1,662	365,596			815	570,543		
Total	7,557	1,663	365,796			815	570,543		
South America:									
Bolivia [3]	8,696	5,558	1,518,466						
Chile [3]	395	261	74,324						
Peru [3]	431	212	49,200						
Total	9,522	6,031	1,641,990						
Europe:									
Belgium-Luxembourg						548	244,616	365	163,879
France	55	22	3,762			253	113,690		
Germany, West								16	7,080
Greece	91	50	15,682						
Italy						11	5,768		
Netherlands						6	2,501		
United Kingdom	17	12	7,895	15	7,582	361	172,205	915	408,641
Yugoslavia						627	294,126		
Total	163	84	27,339	15	7,582	1,806	832,906	1,296	579,600
Asia: Japan						6	3,975		
Grand total	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 [3]	3,493	2,244	719,702						
Chile [3]	230	139	52,383						
Peru [3]	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						178	66,837	27	11,925
Netherlands						59	25,256		
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

[1] Data are general imports; that is, they include antimony imported for immediate consumption, plus material entering the country under bond. Table does not include antimony contained in lead-silver ores.
[2] Revised figure.
[3] Imports shown from Chile probably were mined in Bolivia or Peru and shipped from a port in Chile.

TECHNOLOGY

A new method that represents an advance toward the production of high-purity antimony was described in the Journal of Metals;[6] it stated, in part:

To prepare antimony with an extremely low arsenic content, chemical purification was used. Chemically pure antimony trichloride was distilled from a hydrochloric acid solution and reduced with carbonyl iron. The metallic antimony was then zone refined. After ten zone passes, the only impurities found, by mass spectroscopy, were zinc and arsenic in concentrations of about 1 part in 10 million.

The abstract of a technical paper on the electrical properties of the compound aluminum-antimony follows:[7]

Measurements of some of the electrical properties of the compound AlSb indicate semiconducting characteristics comparable with those reported for silicon. Data were taken on the electrical resistivity, thermoelectric power, and Hall voltage as a function of temperature over the range from 80° to 1200° K. The energy band separation, as determined from the temperature dependence of the conductivity, is 1.5 to 1.6 ev. Mobilities of electrons and holes are approximately equal and are greater than 100 cm²/volt-sec at room temperature. Rectification characteristics are given for both P- and N-type samples of various resistivities. Both photovoltaic and photodiode effects were observed.

A patent for the electrodeposition of antimony was issued during 1954.[8]

WORLD REVIEW

Bolivia.—In 1954 Bolivia was the third largest antimony producer in the free world, having a production of antimony contained in concentrates estimated at 2,706 short tons.[9] Exports totaled 5,751 short tons valued at US$1,695,558.

Canada.—The sole producer in 1954, was the Consolidated Mining & Smelting Co. of Canada, Ltd., Trail, B. C., which recovers antimony as an antimonial lead alloy from residues of lead refining. Preliminary data for 1954 report Canada's production of antimony as 600 short tons valued at C$321,150 compared with 744 short tons valued at C$291,862 in 1953.

French Morocco.—A report stated:[10]

The total production of antimony during 1954 was 627 metric tons with a metal content of 389 metric tons, compared to a production of 106 metric tons of concentrate in 1953 and 1,490 tons in 1952.

The antimony deposits of French Morocco are largely exploited by small operators lacking the necessary capital to modernize production methods. An upward movement in antimony prices during 1954, while responsible for increased production during that year, was not sufficient to prevent the further closing of mines. Mines in production declined from 18 in number in 1952 to 8 in 1953 and to 2 in 1954, the last mentioned being the Masser Amane and Enta-Hadda deposits of the Omnium de Gerance Industrielle at Miniere Company which yielded 265 and 362 metric tons respectively. Antimony exports continued to benefit from a temporary suspension of the 5 percent *ad valorem* export tax, while still subject to a 0.5 percent *ad valorem* statistical service tax.

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6 Tanenbaum, N., Goss, A. J. and Pfann, W. G., Purification of Antimony and Tin by a New Method of Lone Refining: Jour. Metals, vol. 6, No. 6, June 1954, pp. 762–763.

7 Willardson, R. K., Beer, A. C., and Middleton, A., Electrical Properties of Semiconducting AlSb: Jour. Electrochem. Soc., vol. 101, No. 7, July 1954, pp. 354–358.

8 Little, John D., Process Relates to the Electrodeposition of Antimony: U. S. Patent 2,683,114, July 6, 1954.

9 State Department Dispatch 448, American Embassy, La Paz, Bolivia, Apr. 8, 1955, p. 3.

10 Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 4, April 1955, pp. 5–6.

TABLE 13.—World production of antimony (content of ore),[1] by countries, 1945–49 (average) and 1950–54, in short tons [2]

(Compiled by Pauline Roberts)

Country	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Canada [3]	394	322	3,351	1,165	744	600
Honduras	9	(4)	(4)			
Mexico [3]	7,801	6,468	7,522	6,097	4,726	4,610
United States	3,575	2,497	3,472	2,160	372	766
Total	11,779	9,287	14,345	9,422	5,842	5,976
South America:						
Argentina	[5] 25	31	[5] 45	(6)	(6)	(6)
Bolivia [7]	10,117	9,679	13,025	10,809	6,376	5,751
Peru	1,478	1,070	1,220	557	1,062	933
Total	[5] 11,620	10,780	[5] 14,290	[5] 11,420	[5] 7,500	[5] 6,700
Europe:						
Austria [8]	220	451	549	429	342	397
Czechoslovakia	3,111	[5] 2,200	[5] 1,800	[5] 1,800	[5] 1,800	(6)
France	265	455	674	518	331	(6)
Germany, West	(6)	(6)	53	52	55	(6)
Greece	11	386	551	386	[5] 606	(6)
Hungary	[5] 55	(6)	(6)	(6)	(6)	(6)
Italy	518	740	799	692	441	317
Portugal	21	17	21	155	1	(6)
Spain	209	220	184	288	254	[5] 176
Yugoslavia (metal)	1,377	2,001	1,355	1,465	1,554	1,711
Total [5]	6,000	6,900	6,600	6,300	5,800	5,400
Asia:						
British Borneo: Sarawak	1	2				
Burma [5]	243	7	220	55	22	55
China [5]	2,100	6,600	8,800	8,800	8,800	8,800
Iran	[9] 39	[9] 254	[5] [9] 254	176	265	(6)
Japan	152	177	247	230	354	291
Thailand (Siam)	114	96	72	77	50	78
Turkey	291	1,775	2,984	1,274	951	1,080
Total [5]	3,000	9,000	13,000	11,000	10,000	10,000
Africa:						
Algeria	586	1,318	1,391	1,456	1,995	2,535
French Morocco	493	759	1,055	925	64	429
Southern Rhodesia	42	26	68	110	26	72
Spanish Morocco	163	389	235	475	341	[5] 330
Union of South Africa	3,713	9,161	17,480	7,949	3,009	9,480
Total	4,997	11,653	20,229	10,915	5,435	[5] 12,800
Oceania:						
Australia	283	250	463	268	209	126
New Zealand	2			7	12	(6)
Total	285	250	463	275	251	[5] 140
World total (excluding U. S. S. R.) (estimate)	40,000	50,000	70,000	50,000	35,000	40,000

[1] Approximate metal content of ore produced, exclusive of antimonial lead ores.
[2] This table incorporates a number of revisions of data published in previous Antimony chapters.
[3] Includes antimony content of antimonial lead.
[4] Negligible.
[5] Estimate.
[6] Data not available; estimate by senior author of chapter included in total.
[7] Exports.
[8] Excludes Soviet zone, data for which are not available, but estimates for which are included in the totals.
[9] Year ended March 20 following year stated.

Total exports of antimony concentrate during 1954 amounted, according to customs statistics, to 1,246 metric tons with a value of 44,377,000 francs, compared to 245.5 metric tons with a value of 11,691,000 francs in 1953. * * *

* * * There was no production or exportation of antimony metal, the Casablanca Smeltering plant of the company Metaux et Produits Chimiques remaining idle throughout 1954.

Mexico.—Production of antimony concentrate (metal content) decreased from 4,726 short tons in 1953 to 4,610 tons in 1954. Exports increased and totaled 3,528 tons, 85 percent of which went to the United States and the remainder to Brazil, Chile, and the United Kingdom.[11]

Peru.—Output of antimony in Peru during 1954 was 933 short tons, a 12-percent decrease from 1953. The Cerro de Pasco Corp. was one of the larger producers; its output in 1954 was 228 short tons and entered trade in the form of bars containing 95 percent antimony.

Union of South Africa.—The Consolidated Murchison (Transvaal) Goldfields & Development Co., Ltd., continued during 1954 in its position as the world's largest antimony producer. A statement, circulated with the company Financial Report for 1954, reported:[12]

A comparison of operations in the years 1953 and 1954, shows that there was an increase in the tonnage milled from 71,300 tons to 85,188 tons with a corresponding increase in expenditure from £274,718 to £281,465 but resulting in the costs per ton decreasing from 77.06s. to 66.08s. During the year the demand for antimony improved and * * * activities were directed chiefly to the extraction of this product. The total revenue from all sources increased from £564,781 to £1,021,001, and the gross profit increased from £290,063 in 1953 to £739,536 in 1954.

The Company has concluded no long-term contracts for antimony, but the demand has been well maintained up to the present date. Stocks of ore and concentrates are being kept at the level necessary to ensure that orders can readily be fulfilled and, in order to be in a position to meet any additional future demands, development work designed to open up the lower levels of the Gravelotte Section and to provide additional ore reserves, was commenced.

United Kingdom.—In 1954 consumption of primary antimony in the United Kingdom was 5,622 short tons. This represented an increase of about 700 tons or 15 percent over the previous year. Consumption of antimony in scrap was 5,171 short tons, representing an increase of 12 percent over 1953.[13]

Yugoslavia.—Antimony smelter production in Yugoslavia was 1,711 short tons, representing a 10-percent increase over 1953.

Occurrences of antimony ores are widespread throughout Yugoslavia and are known in Bosnia, Serbia, and Macedonia as far south as the Greek frontier. The Bosnian deposits are west of Sarajevo. They include the complex ore veins of Cemernica, near the town of Fojnica, that occur in Paleozoic schists and carry stibnite as the main ore mineral. The most numerous and important deposits are in Serbia, where they form a northwesterly belt that can be traced from the Drina district in western Serbia to northeast of Skoplje. Far southward in the region of Macedonia, near the border of Greece, are the antimony-arsenic deposits of Alsar.[14]

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[11] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 5, May 1955, p. 3.
[12] Mining Journal (London), vol. 244, No. 6248, May 20, 1955, p. 570.
[13] British Bureau of Non-Ferrous Statistics, Bulletin Statistics: Vol. 7, No. 12, December 1954, p. 65.
[14] Economic Geology, vol. 49, No. 5, August 1954, pp. 478–479.

Arsenic

By Abbott Renick[1] and E. Virginia Wright[2]

ESTIMATED world production of 50,000 short tons of white arsenic in 1954 was 5,000 tons higher than in 1953 but 6 percent less than the 1945–49 average (53,000 tons).

Production of white arsenic in the United States in 1954 increased 21 percent over that in 1953 but decreased 4 percent from the 1949–53 average (13,760 short tons). Domestic production exceeded shipments and increased producers' stocks on hand at the end of 1954 to a historical high of 12,500 tons.

Of the total white arsenic available for United States consumption in 1954, domestic refinery production (from domestic and foreign ores) constituted 73 percent and imports 27 percent. Apparent consumption was about 1,600 short tons less than supply.

Consumer preference for organic chemical pesticides over arsenicals strengthened in 1954; moreover, the generally hot and dry weather that prevailed in the cotton belts reduced infestations and the need for pesticides.

Apparent consumption of white arsenic in 1954 was about 16,400 tons compared with 16,000 tons in 1953. Data are not available on total domestic consumpion of various arsenic insecticides and fungicides; however, domestic producers of white arsenic reported that production exceeded shipments. The chief uses of arsenic in 1954 were as an insecticide and a weed killer; substantial quantities also were consumed in the manufacture of glass, as a wood preservative, for chemical debarking of pulpwood, and in the manufacture of sheep dip, poisoned baits, acid-resistant copper, and antimonial lead alloys.

The price of white arsenic (arsenic trioxide) in 1954 was steady through the year at 5½ cents a pound in barrels, carlots, delivered.

TABLE 1.—Salient statistics of the white arsenic industry in the United States, 1945–49 (average) and 1950–54, in short tons

Year	Production	Shipments	Imports	Exports[1]	Apparent consumption[2]	Producers' stocks end of year	Price per pound[3]
1945–49 (average)	16,950	16,037	10,988	572	26,453	3,169	$0.05–$0.06
1950	13,273	17,330	14,774		32,104	2,479	.05–.06½
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

[1] Figures for 1945 from U. S. Department of Commerce. Figures for other years reported by producers to Bureau of Mines.
[2] Producers' shipments, plus imports, minus exports.
[3] Refined white arsenic, carlots, as quoted by E&MJ Metal and Mineral Markets.

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

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DOMESTIC PRODUCTION

Reports from producers indicate that the output of crude and refined white arsenic in the United States totaled 13,200 tons in 1954, an increase of 2,300 tons over 1953.

White arsenic was produced in 1954 by Anaconda Copper Mining Co. at Anaconda, Mont. (copper smelter); United States Smelting, Refining & Mining Co. at Midvale, Utah (lead smelter); and American Smelting & Refining Co. at Tacoma, Wash. (copper smelter). Arsenic metal was not produced during 1954.

TABLE 2.—Production and shipments of white arsenic by United States producers, 1945–49 (average) and 1950–54

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
1945–49 (average)	15,496	14,619	$975,823	1,454	1,418	$106,312	16,950	16,037	$1,082,135
1950	11,903	15,778	955,739	1,370	1,552	113,240	13,273	17,330	1,068,979
1951	15,485	13,656	972,832	705	695	69,242	16,190	14,351	1,042,074
1952	15,046	8,719	563,719	627	525	46,751	15,673	9,244	610,470
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

[1] Excludes crude consumed in making refined.

CONSUMPTION AND USES

During 1954 the apparent consumption of 16,400 short tons of white arsenic was virtually unchanged from the previous year. In the insecticide industry, however, 1954 was a poor year for arsenicals. A United States Department of Agriculture annual release on the pesticide situation reported: [3]

> The 1954 season was notable for the drought conditions which prevailed throughout the South and Southwest. Dry weather reduced sales of insecticides to one-half to two-thirds of the 1953 volume. Infestations elsewhere and the growing practice of chemical control were responsible in part for a higher overall consumption of insecticides in 1954 than in either 1952 or 1953.
>
> Lead arsenate consumption has been rather uniform at about 16,000,000 pounds annually for the last three seasons. Calcium arsenate production dropped to a new low in 1954 and producers' stocks were reduced from 6,000,000 pounds to 4,100,000 pounds by the end of the calendar year. Actual consumption in the United States was probably about 3,300,000 pounds in 1954.

In 1954 the major uses of arsenic and its compounds, in order of importance were: As insecticides and weed killers, in the manufacture of glass, and in wood preservatives. Sodium arsenite is used as a weed killer and grasshopper bait. The principal arsenic insecticides are lead arsenate ($Pb_3(AsO_4)_2$), calcium arsenate ($Ca_3(AsO_4)_2$), and paris green (copper acetoarsenite). Refined white arsenic (As_2O_3) is used in the glass industry. Wolman salts (25 percent sodium arsenate) and, to a smaller extent, zinc meta-arsenate, are used as wood preservatives.

[3] Shepard, Harold H., The Pesticide Situation for 1954-55: U. S. Department of Agriculture, Commodity Stabilization Service, Agricultural Chemicals Staff Report, April 1955, 13 pp.

TABLE 3.—Production of arsenical insecticides and consumption of arsenic wood preservatives in the United States, 1945–49 (average) and 1950–54

Year	Production of insecticides [1] (short tons)		Consumption of wood preservatives [2] (pounds)
	Lead arsenate (acid and basic)	Calcium arsenate (100 percent $Ca_3(AsO_4)_2$)	Wolman salts (25 percent sodium arsenate)
1945–49 (average)	19,888	15,147	1,169,837
1950	[3] 19,717	[3] 22,674	1,197,617
1951	12,708	20,450	1,544,181
1952	7,143	3,817	1,658,426
1953	[3] 7,098	[3] 3,630	1,900,692
1954	[4] 7,810	[4] 1,379	1,966,790

[1] U. S. Department of Commerce.
[2] Forest Service, U. S. Department of Agriculture.
[3] Revised figure.
[4] Preliminary figure.

STOCKS

Year-end producers' stocks of white arsenic reached 12,500 short tons compared with 10,800 tons at the end of 1953 and were the highest since 1939, the first year the Bureau of Mines compiled such data. Data are not available on stocks of calcium and lead arsenate held by producers.

PRICES

White arsenic was quoted at 5½ cents a pound (powdered, in barrels, carlots) throughout 1954. The pesticide industry experienced relatively stable prices in 1954. 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 (in 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 1954. The domestic price for arsenic metal, quoted at 70 cents per pound in January, declined to 60 cents per pound in June and to 54 cents in December. The London price of white arsenic per long ton, 98–100 percent, opened in January at £ 45–£ 50 nominal (equivalent to 5.63 to 6.25 cents per pound) and remained unchanged throughout the year, according to The Metal Bulletin (London). The London price for arsenic metal, per long ton, was steady throughout the year at £ 475 (equivalent to 59.38 cents per pound).

FOREIGN TRADE [4]

Imports.—White arsenic imports for 1954 totaled 4,800 short tons and were 2 percent above 1953 receipts and 44 percent below the 5-year average, 1949–53.

Mexico continued to be the principal supplier of white-arsenic imports, accounting for 87 percent of the total; Canada supplied 12 percent and France 1 percent. In 1954 there were no transactions in

[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.

arsenic sulfide; arsenical sheep dips came exclusively from the United Kingdom.

Imports of metallic arsenic totaled 59 short tons; Sweden supplied 98 percent and West Germany 2 percent.

TABLE 4.—White arsenic (As_2O_3 content) imported for consumption in the United States, 1945–49 (average) and 1950–54, by countries

[U. S. Department of Commerce]

Country	1945–49 (average)		1950		1951		1952		1953		1954	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
North America:												
Canada	113	$10,531	179	$16,194	742	$69,036	121	$14,470	292	$26,018	592	$48,690
Mexico	8,465	604,361	12,659	1,290,712	10,899	1,147,395	4,252	520,112	4,378	543,443	4,212	493,681
Total	8,578	614,892	12,838	1,306,906	11,641	1,216,431	4,373	534,582	4,670	569,461	4,804	542,371
South America:												
Bolivia	2	208	—	—	—	—	—	—	—	—	—	—
Peru	1,215	56,108	—	—	61	6,468	—	—	—	—	—	—
Total	1,217	56,316	—	—	61	6,468	—	—	—	—	—	—
Europe:												
Belgium-Luxembourg	7	592	952	43,544	—	—	—	—	—	—	—	—
France	11	1,246	497	39,397	1,919	247,443	110	12,992	47	4,605	44	2,597
Germany	—	—	11	755	—	—	—	—	—	—	—	—
Italy	67	11,496	—	—	—	—	—	—	—	—	—	—
Poland-Danzig	45	5,958	39	2,950	—	—	—	—	—	—	—	—
Portugal	17	2,523	50	3,204	—	—	—	—	—	—	—	—
Sweden	617	73,021	387	29,427	621	72,317	—	—	—	—	—	—
U. S. S. R.	429	44,922	—	—	—	—	—	—	—	—	—	—
United Kingdom	—	—	—	—	—	—	—	—	(1)	3	—	—
Total	1,193	139,758	1,936	119,277	2,540	319,760	110	12,992	47	4,608	44	2,597
Asia: Japan	—	—	—	—	276	39,180	—	—	—	—	—	—
Grand total	10,988	810,966	14,774	1,426,183	14,518	1,581,839	4,483	547,574	4,717	574,069	4,848	544,968

1 Less than 1 ton.

TABLE 5.—Arsenicals imported into and exported from the United States by classes, 1945–49 (average) and 1950–54, in pounds

[U. S. Department of Commerce]

Class	1945–49 (average)	1950	1951	1952	1953	1954
Imports for consumption:						
White arsenic (As_2O_3 content)	21,976,802	29,547,402	29,036,555	8,966,906	9,434,212	9,695,722
Metallic arsenic	48,890	137,533	220,668	60,220	141,472	117,085
Sulfide	498,307	147,055	148,299	—	20,018	—
Sheep dip	75,244	77,219	62,050	102,415	52,436	55,700
Lead arsenate	24,110	—	13,669	161,316	—	—
Arsenic acid	40	2,000	5,600	—	—	—
Calcium arsenate	—	228,000	1,554,207	192,205	—	42,544
Sodium arsenate	—	110,152	180,040	65,221	79,520	173,565
Paris green	—	88,640	—	41,255	—	—
Exports:						
Calcium arsenate	4,792,195	3,857,107	5,356,867	5,606,613	3,890,246	1,975,894
Lead arsenate	3,027,269	1,040,100	626,184	255,268	303,030	709,752

Exports.—Producers of white arsenic reported no direct foreign sales in 1954. Exports of calcium arsenate decreased 49 percent from those in 1953; however, exports of lead arsenate increased 134 percent. Peru was the principal recipient of calcium arsenate; Canada, Nicaragua, Cuba, Philippines, and others followed in order. Colombia was the principal recipient of lead arsenate; Peru, Canada, Cuba, Lebanon, and others followed in 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 a pound, lead arsenate at 1½ cents a pound, and metallic arsenic at 3 cents a pound. Compounds of arsenic not specified in the tariff act were dutiable at 12½ percent of their foreign market value.

TECHNOLOGY

Radioactive arsenic was used at the Harvard Medical School, Cambridge, Mass., to locate a brain tumor.[5] A small quantity of radioactive arsenic was injected into a girl's veins, and 2 hours later her head was placed between 2 scintillation counters that recorded the positrons emitted by the arsenic carried to the brain. The scintillation counters were mounted on a carriage that swept backward and forward automatically beside the head, dropping about a third of an inch at each sweep. In this manner a complete map of the brain tumor was made. The tumor stood out on the radiation map like mountains on a flat landscape.

Research in the herbicidal properties of arsenic trioxide was reported.[6] The report stated:

> Arsenic trioxide is the most economical chemical to use where sterilization of 5 to 10 years' duration is desired. The grade known as gray arsenic, assaying 90 to 95 percent As_2O_3, is satisfactory for soil sterilization purposes.

The use of calcium arsenate against cotton insects was described in an article on cotton insecticides.[7] It stated:

> Although calcium arsenate has been largely displaced by organic insecticides, especially the chlorinated hydrocarbons, it is still a useful cotton insecticide.

Four United States patents were issued during 1954 relative to arsenic.[8]

Producing peeled pulpwood by chemical debarking was the subject of a pamphlet.[9] It stated:

> Chemical debarking is the process of applying a toxic chemical (sodium arsenite) to the living tree during the sap-peeling season, which causes the tree to die and the bark to loosen after a few months.

A training guide describing the process [10] stated:

> The application of chemicals to living trees to facilitate bark removal is achieving widespread acceptance throughout the pulpwood industry.

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[5] Science News Letter, Radio Active Arsenic: Vol. 65, No. 14, Apr. 3, 1954, p. 211.
[6] California Agricultural Experiment Station, Herbicidal Properties of Arsenic Trioxide: Bull. 739, February 1954, 28 pp.
[7] Agricultural Chemicals, Cotton Insecticides: Vol. 10, No. 4, April 1955, p. 44.
[8] Stoertz, A., Processes Relate to Improvements in Storage Batteries of the Lead-Acid Type and Particularly to the Grid Composition: U. S. Patents 2,678,340 and 2,678,341, May 11, 1954.
McGauley, Patrick G., and Schaufelberger, Felix A., Process for the Elimination of Arsenic from Metallic Arsenide-Sulfide Concentrates: U. S. Patent 2,686,114, Aug. 10, 1954.
Schwerdle, Arthur, Improvements in the Control of Weeds and Lawns, Gardens, and More Specifically in the Use of Disodium-Monomethyl-Arsenate: U. S. Patent 2,678,265, May 11, 1954.
[9] State University of New York, College of Forestry at Syracuse, Producing Peeled Pulpwood by Chemical Debarking: Feb. 10, 1955, 4 pp.
[10] American Pulpwood Association (220 East 42d Street, New York 17, N. Y.), Chemical Debarking of Trees: Training Guide 5, 18 pp.

WORLD REVIEW

Canada.—Arsenical ores are widely distributed throughout Canada, in association with gold, silver, cobalt, and certain sulfide ores. Recovery of arsenic as arsenious oxide (As_2O_3), however, was confined to Beattie-Duquesne Mines, Ltd., and O'Brien Gold Mines, Ltd., in Quebec and Deloro Smelting & Refining Co., Ltd., in Ontario.

Production of about 200 short tons of refined white arsenic valued at Can$18,800 was reported in 1954 compared with 700 short tons valued at Can$56,200 in 1953.

Mexico.—Output of arsenic in Mexico [11] during 1954 included 2,111 metric tons of refined white arsenic, 161 tons of crude white arsenic, and 155 tons of arsenic in other forms, a total of 2,427 tons. Output of arsenic in 1953 was 3,686 tons. Exports during 1954 totaled 3,450 tons, all of which was destined for the United States.

TABLE 6.—World production of white arsenic, by countries,[1] 1945–49 (average) and 1950–54, in short tons [2]

(Compiled by Pauline Roberts)

Country [1]	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Canada	527	397	1,177	854	702	222
Mexico	10,030	9.906	14,072	3,159	2,204	2,675
United States	16,949	13,273	16,190	15,673	10,873	13,167
South America:						
Argentina	[3] [4] 53	(5)	(5)	(5)	(5)	(5)
Brazil	1,052	1,176	1,456	1,062	411	(5)
Peru	1,228	----	----	17	----	(5)
Europe:						
Austria	[4] 249	(5)	(5)	(5)	(5)	(5)
Belgium (exports)	[4] 481	2,104	358	1,106	1,903	1,979
France	2,831	3,864	5,844	6,934	6,217	(5)
Germany:						
East	[4] 926	(5)	(5)	(5)	(5)	(5)
West (exports)	[4] 776	1,239	3,862	122	675	239
Greece	13	36	62	97	68	(5)
Italy	658	800	1,754	2,209	1,179	(5)
Portugal	958	281	618	1,452	1,301	[4] 661
Spain	444	175	332	173	60	(5)
Sweden	12,844	15,997	20,427	17,189	(5)	(5)
United Kingdom	[4] [6] 122	(5)	(5)	(5)	(5)	(5)
Asia:						
Iran [7]	[4] 34	28	----	----	----	(5)
Japan	1,318	1,463	1,515	1,545	1,576	(5)
Africa:						
Southern Rhodesia	371	126	84	568	417	459
Union of South Africa	29	----	----	----	----	----
Oceania:						
Australia	1,248	180	134	134	----	----
New Zealand	15	11	----	----	----	----
Total (estimate)[1]	53,000	52,000	69,000	54,000	45,000	50,000

[1] Arsenic is also believed to be produced in China, Czechoslovakia, Finland, Hungary, and U. S. S. R.; but data are not available, and there is too little information for making estimates.
[2] This table incorporates a number of revisions of data published in previous Arsenic chapters.
[3] Arsenic content of ore mined.
[4] Estimate.
[5] Data not available; estimate by senior author of chapter included in total.
[6] White arsenic, including arsenic soot.
[7] Year ended March 20 of year following that stated.

Peru.—Byproduct white arsenic was recovered by the Cerro de Pasco Corp. In 1954 production of calcium arsenate was about 1,100 short tons.

[11] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 5, May 1955, p. 5.

Southern Rhodesia.—An article on a central roasting plant in Southern Rhodesia described plant operation and treatment methods for refractory arsenical gold-bearing concentrates.[12]

Sweden.—Modernization of the smelter of Boliden Mining Co., Skelleftehamn, Sweden, was described in considerable detail.[13] The Boliden Mining Co. is the largest individual producer of white arsenic in the world. The company deposits of gold-copper ore contain, on the average, about 7 percent arsenic.

[12] Mining Journal (London), The Central Roasting Plant for Southern Rhodesia's Mining Industry: Vol. 243, No. 6211, Sept. 3, 1954, pp. 258–259.

[13] Journal of Metals, Copper Smelting in Boliden's Ronnskar Works Described: Vol. 6, No. 3, March 1954, pp. 330–337.

Asbestos

By Donald O. Kennedy[1] and Annie L. Marks[2]

TOTAL OUTPUT of asbestos in the United States declined in 1954 from the record level attained in 1953. However, production in Arizona increased, principally because of a substantial rise in the sale of short fibers. Imports, consumption, and exports declined compared with 1953, continuing the downward trend begun in 1952. Imports of low-iron chrysotile of spinning grade from Southern Rhodesia decreased to less than 25 percent of the 1953 imports, but imports from British Columbia increased almost enough to compensate for the loss of Rhodesian fiber. Total imports of Canadian spinning-grade fibers decreased 4 percent compared with 1953.

Prices of Arizona chrysotile were advanced approximately 5 percent in February 1954, but other prices remained unchanged from the 1952 level.

TABLE 1.—Salient statistics of the asbestos industry in the United States, 1945–49 (average) and 1950–54

	1945–49 (average)	1950	1951	1952	1953	1954
Domestic asbestos:						
Produced.........short tons..	26, 662	41, 358	51, 730	53, 888	57, 950	45, 813
Sold or used..............do....	26, 163	42, 434	51, 645	53, 864	54, 456	47, 621
Value....................	$1, 258, 009	$2, 925, 050	$3, 912, 500	$4, 713, 032	$4, 857, 359	$4, 697, 962
Imports (unmanufactured) short tons..	516, 421	705, 458	761, 873	709, 469	692, 245	678, 390
Value....................	$27, 364, 752	$47, 284, 205	$58, 521, 046	$61, 604, 601	$59, 753, 583	[1] $55,856,606
Exports (unmanufactured) [2] short tons..	10, 410	20, 890	16, 526	10, 724	3, 076	1, 894
Value....................	$1, 725, 159	$4, 084, 384	$3, 662, 270	$2, 670, 970	$592, 222	$291, 157
Apparent consumption...short tons..	532, 281	727, 002	796, 992	752, 609	743, 625	724, 117
Exports of asbestos products [2] [3]......	$8, 982, 900	$8, 147, 141	$14, 321, 278	$13, 028, 857	$10, 627, 293	$11, 484, 735

[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

Chrysotile was produced in Arizona and Vermont during 1954 and amphibole in California, Georgia, and North Carolina. So few companies have produced chrysotile and amphibole that detailed figures cannot be published. Domestic sales of chrysotile in 1954 were 10 percent below 1953 and amphibole sales 38 percent below,

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

resulting in a decline of 13 percent in total domestic sales from 1953.

Production in Arizona was 63 percent higher than in 1953, but the increase was confined to the shorter grades. The following firms and individuals produced chrysotile in the Globe district of Arizona during 1954: American Fiber Co., Arizona Asbestos Mining Co., Bear Canyon Mining Co., Crown Asbestos Mines, Inc., Arthur Enders, Jacquays Mining Corp., Jack Kennedy, Kyle Asbestos Mines, Metate Asbestos Corp., W. B. Patterson, Phillips Asbestos Mines, Triple Star Mining Co., and Western Chemical Co.

The Materials Branch, Emergency Procurement Service, General Services Administration, has a receiving depot in Globe, Ariz., and purchases domestic low-iron chrysotile for defense and other essential uses. Reports of purchases made at the Globe depot show 79 percent of the production of crudes Nos. 1, 2, and 3 in Arizona was sold to the Government. The Government was paying $1,500 a ton for crude No. 1, $900 for crude No. 2, and $400 for crude No. 3. The program was scheduled to run until October 1, 1957, or until a total of 1,500 tons, crudes Nos. 1 and 2 combined, had been purchased.

The Mount Shasta Mining Co., Mount Shasta, Calif., reported a small sale of chrysotile fibers that probably came from stock, since no mining was reported in 1954. W. Zimdars and J. Delmue, Auburn, Calif., mined and sold a small quantity of tremolite asbestos from Placer County. Calasbestos Corp., South San Gabriel, Calif., shipped a small quantity of amphibole asbestos from Riverside County.

The Powhatan Mining Co., Baltimore, Md., reported a small production of amphibole asbestos from Rabun County, Ga.

Amphibole asbestos was produced in North Carolina by the Powhatan Mining Co. in Transylvania County and the Mining & Milling Corp., Spruce Pine, N. C., in Spruce Pine County. The Powhatan Mining Co. shipped the asbestos rock to its plant in Baltimore, Md., where it was milled and processed to produce asbestos. The Mining & Milling Corp., a subsidiary of Mastic Tile Corp. of America, shipped the crude ore to California, where it was processed and the recovered fibers sold.

The Vermont Asbestos Mines Division of the Ruberoid Co. produced less chrysotile asbestos in 1954 than in 1953. The Vermont quarry remained the only sizable asbestos producer in the United States.[3]

CONSUMPTION AND USES

The consumption of asbestos in the United States, as shown in table 2, decreased 3 percent in quantity and 6 percent in value in 1954 as compared with 1953.

TABLE 2.—Apparent consumption of raw asbestos in the United States, 1945–49 (average) and 1950–54

Year	Short tons	Value	Year	Short tons	Value
1945–49 (average)	532,281	$26,897,602	1952	752,609	$63,646,663
1950	727,002	46,124,871	1953	743,625	64,018,720
1951	796,992	58,771,276	1954	724,117	60,263,411

[3] Briggs, Marion L., More Efficient Mining and Modern Plant Double Asbestos Production: Rock Products, vol. 57, No. 7, July 1954, pp. 74–78.

The consumption of chrysotile, which represented 96 percent of the total United States consumption of asbestos, also decreased 3 percent in 1954 as compared with 1953. Consumption of spinning-grade chrysotile fibers decreased 13 percent, while consumption of short-fiber chrysotile decreased only 2 percent. The consumption of amosite and amphibole asbestos decreased 4 percent and 38 percent, respectively; consumption of crocidolite increased 19 percent. Asbestos was employed extensively in building materials, such as asbestos-cement shingles and siding, floor tile, and various heat-insulating products. Trends in asbestos consumption, industrial production, and volume of new construction are compared graphically in figure 1.

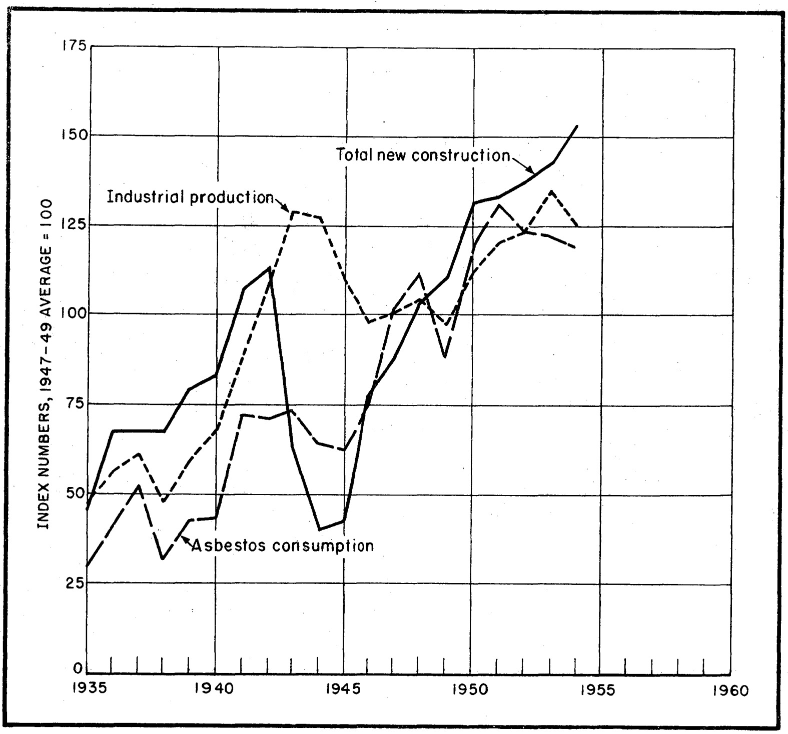

FIGURE 1.—Consumption of asbestos compared with total new construction and industrial production, 1935–54. Statistics on value of construction from Bureau of Foreign and Domestic Commerce and on industrial production from Federal Reserve Board.

PRICES

Prices of asbestos continued unchanged during 1954. No changes occurred in Canadian or Vermont quotations from those recorded in 1952. Trade-journal quotations follow:

Crude No. 1	$1, 100–$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

The Arizona quotations were increased in February 1954 as follows:

	Per ton of 2,000 lbs., f. o. b. Globe	
	January 1954	*February 1954*
No. 1 crude	$1,200–$1,500	$1,600–$1,700
No. 2 crude	900– 1,000	1,000– 1,050
No. 3 crude	375– 450	450– 500
Filter fiber	425– 450	250– 450

There were no market quotations for African asbestos. It was sold by negotiation with individual purchasers. Department of Commerce reports show the following average figures for imports in 1953 and 1954, per short ton:

	1953	*1954*
Amosite:		
South Africa	$117.26	$132.73
Crocidolite:		
Bolivia	446.85	450.21
Australia	352.18	316.83
South Africa	224.55	209.61

FOREIGN TRADE [4]

Imports.—Since 1950 the United States has consumed about half the asbestos produced in the world, but in 1954, as in 1953, only 7 percent of its requirements came from domestic sources. In 1954 imports were 2 percent less than in 1953. Over 94 percent of the 1954 imports originated in Canada; 4 percent came from the Union of South Africa, Southern British Africa, and British East Africa; and 1 percent came from Southern Rhodesia. On a value basis, these percentages were 86, 9, and 4, respectively. These figures reveal that most of the relatively cheaper short fibers were imported from Canada and that oversea shipments consisted generally of the higher priced fibers.

Supplies of chrysotile of spinning grade were of most interest strategically. Tables 4 and 5 were therefore prepared to show imports of chrysotile from Canada and Southern Rhodesia, by grades.

TABLE 3.—Asbestos (unmanufactured) imported for consumption in the United States, 1945–49 (average), 1950–52 (totals), and 1953–54, by countries and classes

[U. S. Department of Commerce]

Country	Crude (including blue fiber)		Mill fibers		Short fibers		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1945–49 (average)	29,305	$4,228,651	151,563	$13,192,477	335,553	$9,943,626	516,421	$27,364,754
1950	27,803	5,857,687	177,951	21,381,704	499,704	20,044,814	705,458	47,284,205
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								
North America: Canada	842	423,949	169,096	27,129,703	482,179	23,129,921	652,117	50,683,573
South America:								
Bolivia	828	369,992					828	369,992
Venezuela	4	2,233	52	20,020			56	22,253
Total	832	372,225	52	20,020			884	392,245

See footnotes at end of table.

[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 3.—Asbestos (unmanufactured) imported for consumption in the United States, 1945–49 (average), 1950–52 (totals), and 1953–54, by countries and classes—Continued

[U. S. Department of Commerce]

Country	Crude (including blue fiber)		Mill fibers		Short fibers		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1953—Continued								
Europe:								
France			(2)	$188			(2)	$188
Italy	1	$1,340	3	6,321			4	7,661
Portugal	5	558					5	558
U. S. S. R.	108	12,000	217	24,000			325	36,000
United Kingdom	[3] 110	[3] 30,641	10	3,241			120	33,882
Total	224	44,539	230	33,750			454	78,289
Africa:								
Madagascar	1	371					1	371
Southern British Africa	619	186,116					619	186,116
Southern Rhodesia	9,157	3,155,355	833	247,373			9,990	3,402,728
Union of South Africa	25,778	4,253,838	481	90,592	171	$49,195	26,430	4,393,625
Total	35,555	7,595,680	1,314	337,965	171	49,195	37,040	7,982,840
Oceania: Australia	1,748	615,614			2	1,022	1,750	616,636
Grand total	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	[3] 28	[3] 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	166	36,499			53	5,394	219	41,893
Federation of Rhodesia and Nyasaland [4]	6,699	1,832,596	156	94,626	364	199,824	7,219	2,127,046
Southern British Africa	990	213,944	125	31,688			1,115	245,632
Union of South Africa	27,045	4,592,379	194	107,400	110	25,607	27,349	4,725,386
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	[5] 7,502,358	148,962	[5] 24,556,953	491,967	[5] 23,797,295	678,390	[5] 55,856,606

[1] Includes 11 tons ($1,632) classified by U. S. Department of Commerce as amosite, crude; reclassified by the Bureau of Mines as mill fibers.

[2] Less than 1 ton.

[3] Data includes 7 tons of blue (crocidolite) crude, valued at $3,924 in 1953 and 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.

[4] Believed to be all from Southern Rhodesia.

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

TABLE 4.—Asbestos (chrysotile) imported for consumption in the United States from Canada, by grades, 1945–49 (average) and 1950–54, in short tons

[U. S. Department of Commerce]

Grades	1945–49 (average)	1950	1951	1952	1953	1954
Crude No. 1	210	390	126	144	168	82
Crude No. 2	300	260	226	332	207	181
Other crudes	134	1,114	384	79	467	844
Spinning and textile fiber	17,822	24,417	22,463	24,112	19,417	18,319
Shingle fiber	69,695	83,640	104,419	98,577	86,540	72,242
Paper fiber	62,304	69,171	97,888	87,644	63,139	57,465
Short fiber	335,545	499,704	501,264	458,012	482,179	491,149
Total	486,010	678,696	726,770	668,900	652,117	640,282

TABLE 5.—Asbestos (chrysotile) imported for consumption in the United States from Southern Rhodesia,[1] by grades, 1945–49 (average) and 1950–54, in short tons

[U. S. Department of Commerce]

Grades	1945–49 (average)	1950	1951	1952	1953	1954 [1]
Crude No. 1	1,042	2,124	678	462	1,039	181
Crude No. 2	3,063	1,844	1,239	1,363	814	275
Spinning and textile fiber	40	556	25	177	730	156
Other crude	[2] 3,647	4,940	5,783	8,296	7,304	6,243
Shingle fiber	45			245	103	
Short fiber	6					364
Total	7,843	9,464	7,725	10,543	9,990	7,219

[1] Effective July 1, 1954, reported by the 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.

Exports.—Exports of raw asbestos in 1954 declined 38 percent compared with 1953, showing that the needs of foreign customers were being supplied more readily from foreign sources.

TABLE 6.—Asbestos and asbestos products exported from the United States, 1945–49 (average) and 1950–54

[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
1945–49 (average)	9,150	$1,466,584	1,260	$270,451	$8,978,844	$4,056
1950	18,980	3,646,828	1,910	437,556	8,097,192	49,949
1951	14,298	3,216,810	2,228	445,460	14,320,389	889
1952	10,265	2,550,065	459	120,905	13,027,739	1,118
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

[1] Material of domestic origin or foreign material that has been milled, blended, or otherwise processed in the United States.
[2] Material that has been imported and subsequently exported without change.

TABLE 7.—Asbestos and asbestos products exported from the United States, 1953–54, by kinds

[U. S. Department of Commerce]

Product	1953		1954	
	Quantity	Value	Quantity	Value
Unmanufactured asbestos:				
Crude and spinning fibers......short tons..	752	$252,748	286	$58,726
Nonspinning fibers......do....	1,260	242,182	438	100,227
Waste and refuse......do....	768	45,343	1,123	116,825
Total unmanufactured......do....	2,780	540,273	1,847	275,778
Asbestos products:				
Brake lining and blocks:				
Molded, semimolded, and woven......	(1)	4,268,736	(1)	4,620,416
Clutch facing and lining......number..	1,241,409	900,725	1,138,760	879,450
Construction materials......short tons..	14,809	2,457,973	15,056	2,521,652
Pipe covering and cement......do....	2,161	592,054	2,094	635,224
Textiles, yarn, and packing......do....	1,006	2,013,852	1,387	2,434,904
Manufactures, n. e. c......	(2)	382,492	(2)	383,436
Total products......	......	10,615,832	......	11,475,082

[1] Owing to changes in classification, values have been summarized; quantities not shown.
[2] Quantity not recorded.

TECHNOLOGY

A report stressed the need in Africa for better methods of removing grit and dust from asbestos fibers and for better methods of testing the dust content. The report [5] stated:

> It is important that separation and removal of impurities be accomplished with minimum breakage or weakening of the fibers. There is generally a penalty on grit and dust contents over 5 percent, and shipments are rejected as a rule if the impurities exceed 8 percent.

It was reported that sintered metal friction disks consisting chiefly of copper and graphite are being substituted to some extent for asbestos in brake linings of military tanks.

Details of the modern mill operated by Vermont Asbestos Mines Division of the Ruberoid Co. near Hyde Park, Vt., were described.[6]

At the Canadian Johns-Manville Corp. new mill at Asbestos, Quebec, an elaborate dust-collecting system has been developed. Dust control is a difficult problem facing asbestos-mill operators. Milling asbestos is a dry process, and the fiber and rock pass through a long succession of breakers, pulverizers, and screens. The dust consists of both granular and fibrous particles. All machines at the new Johns-Manville mill are so well equipped that the air within the mill is virtually dust free. Dust is so plentiful that its disposal requires a shed 200 feet long and 60 feet high in which floats settle in 8 graded sections at a rate of 140 tons a day. Over 1½ million cubic feet per minute of dusty air moves through the shed. From 80 to 95 percent of the microscopic dust that is not caught in the dust shed is removed with a Cottrell-type electric precipitator, which recovers about 60 tons per day of fine dust. A foreman and a staff of 10 men

[5] Rhodesian Mining Review, Reducing Impurities in Asbestos Fiber: Vol. 19, No. 3, March 1954, pp. 39–40.
[6] Work cited in footnote 3, p. 2.

are regularly employed to install and maintain dust-control equipment. A detailed description of the system was published.[7]

Much technical research has also been devoted to dust problems in the asbestos mills of Southern Rhodesia. The principal phases of the problem are control of dust inside the mill buildings, removal of dust by means of an exhaust system, and filtration of the dust-laden exhaust air. The design and operation of dust-control equipment at a Rhodesian plant was described.[8]

Further progress was reported in the manufacture of electric insulating tapes consisting of purified asbestos fiber reinforced with fiberglass. Several "Novabestos" tapes have been designed for special uses.[9]

WORLD REVIEW

World production of asbestos by countries for 1954 is shown in table 8. Official statistics are not complete, but estimates are included for unreported countries. Revisions for previous years have been made where new information has become available. World output for 1954 was slightly less than in 1953.

TABLE 8.—World production of asbestos by countries,[1] 1945–49 (average) and 1950–54, in short tons[2]

(Compiled by Helen L. Hunt)

Country [1]	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Canada (sales) [3]	595,715	875,344	973,198	929,339	911,226	924,116
United States (sold or used by producers)	26,163	42,434	51,645	53,864	54,456	47,621
Total	621,878	917,778	1,024,843	983,203	965,682	971,737
South America:						
Bolivia (exports)	117	183	348	513	810	33
Brazil	2,090	930	1,456	1,439	[4] 794	(5)
Chile	325	190	(5)	(5)	(5)	(5)
Venezuela	154	209	287	434	44	743
Total [6]	2,700	1,700	2,400	2,700	2,000	2,500
Europe:						
Finland [7]	8,297	12,069	13,062	6,724	12,047	7,853
France	950	8,219	7,814	8,338	10,251	11,795
Greece	18	33	37	28	----------	2
Italy	11,854	23,626	24,925	26,387	22,484	25,955
Portugal	141	283	344	185	105	(5)
Spain	17	45	45	33	----------	(5)
U. S. S. R. [6]	141,400	240,000	240,000	240,000	240,000	240,000
Yugoslavia	[8] 797	1,056	1,679	2,762	4,131	3,598
Total [6]	165,000	290,000	290,000	290,000	295,000	295,000
Asia:						
Cyprus	7,668	16,523	18,938	18,250	15,966	[9] 20,343
India	340	233	580	765	637	(5)
Iran	----------	----------	----------	3	55	(5)
Japan	5,854	6,243	6,767	3,373	4,495	6,916
Korea	[6] 1,300	(5)	(5)	(5)	(5)	[10] 233
Taiwan (Formosa)	277	238	39	26	----------	163
Turkey	196	270	88	----------	----------	50
Total [6]	19,000	25,000	29,000	25,000	28,000	35,000

See footnotes at end of table.

[7] Rozovsky, H., Air Handling and Dust Control at the Jeffrey Mine of Canadian Johns-Manville Company: Canadian Min. Jour., vol. 75, No. 11, November 1954, pp. 59–65.

[8] Benham, M. G., The Problem of Dust in Asbestos Milling: Rhodesian Min. Rev., vol. 19, No. 5, May 1954, pp. 47–49; No. 6, June 1954, pp. 47–53.

[9] Materials and Methods, Asbestos and Glass Form New Insulating Tapes: Vol. 40, No. 6, December 1954, p. 143.

TABLE 8.—World production of asbestos by countries,[1] 1945–49 (average) and 1950–54, in short tons [2]—Continued

Country [1]	1945-49 (average)	1950	1951	1952	1953	1954
Africa:						
Bechuanaland	----------	----------	41	528	548	729
Egypt	640	287	1,375	66	220	(5)
French Morocco	560	563	666	635	600	597
Kenya	520	252	418	390	166	224
Madagascar	1	1	19	3	8	(5)
Southern Rhodesia	62,923	71,527	77,662	84,834	87,738	79,962
Swaziland	29,982	32,667	34,964	34,769	30,103	30,142
Union of South Africa	39,047	87,413	107,367	133,838	94,816	109,151
Total	133,674	192,710	222,511	255,064	214,200	[6] 221,000
Oceania:						
Australia	2,011	1,811	2,865	4,546	5,566	5,279
New Zealand	----------	46	911	764	----------	----------
Total	2,011	1,857	3,776	5,310	5,566	5,279
World total (estimate) [1]	950,000	1,425,000	1,575,000	1,550,000	1,500,000	1,525,000

[1] In addition to countries listed, asbestos is produced in Argentina, China, and Czechoslovakia. Estimates by authors of the chapter are included in the total.
[2] This table incorporates a number of revisions of data published in previous Asbestos chapters.
[3] Exclusive of sand, gravel, and stone (waste rock only), production of which is reported as follows: 1950, 48,007 tons; 1951, 33,762 tons; 1952, 35,317 tons; 1953, 21,118 tons; 1954, 26,429 tons.
[4] Produced in Bahia only (incomplete figure).
[5] Data not available; estimate by authors of chapter included in total.
[6] Estimate.
[7] Includes asbestos flour.
[8] Average for 1947–49.
[9] Exports.
[10] Excluding North Korea.

NORTH AMERICA

Canada.—Shipments of Canadian asbestos increased 1.4 percent in 1954 as compared with 1953; the increase was mainly in sale of shorts (table 9). As their average value was lower than in 1953, the total value increased less than 0.5 percent.

TABLE 9.—Sales of asbestos in Canada, 1953–54, by grades

[Dominion Bureau of Statistics]

	1953 [1]			1954 [1]		
	Short tons	Value [1]		Short tons	Value [1]	
		Total	Average per ton		Total	Average per ton
Grade:						
Crudes	781	$837,623	$1,072.50	725	$645,608	$890.49
Fibers	326,340	56,226,083	172.29	326,653	56,724,585	173.65
Shorts	584,105	28,989,189	49.63	596,738	29,039,019	48.66
Total	911,226	86,052,895	94.44	924,116	86,409,212	93.50
Rock mined	13,912,839	----------	----------	14,793,760	----------	----------
Rock milled	11,189,027	----------	----------	11,394,571	----------	----------

[1] Canadian currency.

Lake Asbestos of Quebec, Ltd., subsidiary of American Smelting & Refining Co., started draining Black Lake. The asbestos deposit which lies beneath the lake has been explored extensively. It will be mined by open-pit methods.

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Mill capacity was increased considerably in Quebec. The new Johnson's Co. mill came into production in 1954, and the new Normandie mill of the Asbestos Corp., Ltd., was nearly completed by the end of the year. A large area of the Normandie deposit had been stripped, and open-cut mining had begun on two benches.

Further progress was made in 1954 on the new Jeffrey mill of Canadian Johns-Manville Corp., Ltd., the largest asbestos mill in the world. It is in operation although not completed. When completed, it will have an annual capacity of 600,000 tons of fiber. It has been described in some detail in the press.[10]

Quebec Asbestos Corp. reported discovery of a new extensive asbestos deposit about 3 miles from its present East Broughton operation. Production facilities were in the planning stage.

A crocidolite (blue asbestos) deposit was discovered in New Quebec. No information was available concerning the extent or nature of the deposit.

Deposits of asbestos of the low-iron Arizona type, consisting of cross-fiber chrysotile veins in limestones of the Grenville Series, have been found at various points in the Ottawa River Valley between Montreal and Ottawa. On one of these deposits, about 24 miles from Buckingham, Quebec, Eastern Asbestos Co., Ltd., of Montreal began an extensive drilling and drifting exploratory program. Asbestos veins over a wide area and to a depth of at least 200 feet are reported.

The Munro mine of the Canadian Johns-Manville Corp. near Matheson, Ontario, has been operated since 1950 as an open pit, but considerable progress was made in 1954 on a shaft-sinking project for development of underground facilities.

A new mill having a daily capacity of 500 tons of mill rock was completed by Cassiar Asbestos Corp., Ltd., and began operation in 1954, at McDame Creek in northern British Columbia. The deposit worked by this company contains an exceptionally high content of spinning-grade asbestos of the low-iron type. Substantial quantities are reaching United States markets. According to press reports, an aerial tramway 15,000 feet long, to carry rock from mine to mill, was under construction in 1954.[11]

EUROPE

Yugoslavia.—Since World War II the Yugoslav Government stimulated development of several asbestos deposits, the most important of which is the Stragari. The asbestos industry of the country has been described in some detail.[12]

ASIA

Cyprus.—Short-fiber chrysotile was produced in Cyprus in substantial quantities. A description of the asbestos mining industry has appeared.[13]

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[10] Walkom, L. K., New Shaft, Unusual New Mill Feature Expansion at World's Largest Asbestos-Producing Property: Canadian Min. Jour., vol. 75, No. 10, October 1954, pp. 57–63.
Western Miner and Oil Review, The Story of Asbestos: Vol. 27, No. 11, November 1954, pp. 79–81.
[11] Northern Miner, Toronto, Impressive News for Cassiar Asbestos: Vol. 41, No. 30, Oct. 14, 1954, pp. 1,
[12] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 3, September 1953, pp. 42–47.
[13] See work cited in footnote 12, p. 38.

AFRICA

Southern Rhodesia.—Production of asbestos in Southern Rhodesia was nearly 9 percent less in 1954 than in 1953 (table 10). The decline in demand for asbestos in the latter part of 1953 continued into 1954 and is reflected in the decrease in value of the production for 1954.

TABLE 10.—Asbestos produced in Southern Rhodesia, 1950–54

Year	Short tons	Value	Year	Short tons	Value
1950	71,527	£4,615,490	1953	87,739	£6,542,731
1951	77,663	5,452,108	1954	79,962	5,922,724
1952	84,834	6,651,975			

A new asbestos mill at the Temeraire mine, Mashaba, was formally opened in November 1954. It is the second largest asbestos mill in Southern Rhodesia. The Canadian Johns-Manville Corp. has the controlling interest in this operation.[14]

Canadian Overseas Asbestos Corp. was being organized in 1954. A plan contemplated was to erect a custom mill to clean and grade the output of the smaller Rhodesian asbestos mines and to ship the asbestos so prepared to India. The project had not advanced beyond the planning stage.[15]

Union of South Africa.—In 1953 and early in 1954 the supply of asbestos in the Union exceeded the demand, and buying became increasingly selective. As most of the small producers lacked the milling facilities necessary to meet specifications, many mines and mills suspended activity. However, during 1954 the demand for asbestos from the Union of South Africa improved, resulting in a 15-percent increase in production and a 31-percent increase in exports.

TABLE 11.—Asbestos produced in and exported from the Union of South Africa, 1950–54

Year	Production (short tons)			Exports	
	Transvaal	Cape Province	Total	Short tons	Value
1950	72,203	15,211	87,414	70,609	£3,475,200
1951	89,290	18,078	107,368	89,735	5,056,143
1952	109,398	24,441	133,839	106,576	6,899,086
1953	73,934	20,883	94,817	71,791	4,158,476
1954	81,015	28,136	109,151	94,322	5,453,116

The South African Bureau of Standards appointed a committee to establish better grading and classification of fibers in an effort to improve service to overseas markets.

An article [16] on economic problems facing the smaller asbestos producers in the Union was published. Improved processing and grading, better marketing facilities, and development of new uses were some of the problems discussed.

[14] Mining World, J-M Opens Asbestos Mines in Rhodesia: Vol. 17, No. 1, January 1955, p. 51.
[15] Chemical Age (London), Canadian Investment in Rhodesia: Vol. 70, No. 1820, May 29, 1954, p. 1204. Rhodesian Mining Review, Canadian Interest in S. R. Asbestos: Vol. 19, No. 5, May 1954, p. 24.
[16] Sinclair, W. E., The Economic Aspect of Asbestos Production in the Union: South African Min. and Eng. Jour., vol. 65, p. 1, No. 3203, June 1954, pp. 643–649.

TABLE 12.—Asbestos produced in the Union of South Africa, 1950–54, by varieties and sources, in short tons

Variety and source	1950	1951	1952	1953	1954
Amosite (Transvaal)	42,393	54,053	63,280	38,258	45,922
Chrysotile (Transvaal)	14,334	19,509	24,970	18,840	19,373
Blue (Transvaal)	15,387	15,581	20,294	16,824	15,610
Blue (Cape)	15,211	18,078	24,441	20,883	28,136
Anthophyllite (Transvaal)	89	147	854	12	110
Total	87,414	107,368	133,839	94,817	109,151

Bechuanaland.—The Marline Chrysotile Asbestos Corp., Ltd., had a substantial investment in mining and milling facilities at Lobatsi. The deposit consists of cross-fiber veins in dolomite associated with intrusive diabase. Drill records indicated that rock over a large area contains about 4 percent fiber. About 25 percent of that produced was of spinning grade. A mill built on the property has a capacity of 200 tons of fiber a month.

Swaziland.—The Havelock mine was first worked as an open pit but was converted to underground operation in 1948. The fiber-bearing rock is hoisted from stopes through a 1,280-foot shaft dipping 40° S. Details of the operation were published.[17]

OCEANIA

Australia.—Production of crocidolite (blue asbestos) at Wittenoom Gorge, Western Australia, was considerably higher in 1953 than in 1952. Output could have been increased further if marketing conditions were more favorable. Mining and transportation costs were so high that prices comparable with those of imported fibers were difficult to maintain. Australian Blue Asbestos, Ltd., applied for a protective tariff, which was opposed by asbestos consumers.

[17] Mining Journal (London), Operation at the Havelock Asbestos Mine, Swaziland: Vol. 243, No. 6212, September 1954, pp. 288–289.

Barite

By Joseph C. Arundale [1] and Annie L. Marks [2]

NEARLY 1 MILLION TONS of ground barite was required by oil- and gas-well drillers in the United States to complete a record number of wells in 1954. This demand kept domestic production and imports close to an alltime high.

TABLE 1.—Salient statistics of the barite and barium-chemical industries in the United States, 1945–49 (average) and 1950–54

	1945–49 (average)	1950	1951	1952	1953	1954
Barite:						
Primary:						
Produced.....short tons..	762,184	693,424	845,579	1,012,811	920,025	946,744
Sold or used by producers:						
Short tons	754,333	695,414	860,669	941,825	944,212	912,895
Value	$5,819,678	$6,193,906	$7,968,023	$8,797,944	$9,435,749	$8,723,610
Imports for consumption:						
Short tons	46,832	58,381	52,755	107,918	334,788	317,093
Value	$333,710	$431,879	$419,494	$923,336	$2,514,828	[1] $2,274,834
Consumption..short tons..	778,529	[2] 786,131	[2] 950,893	[2] 1,033,843	[2] 1,149,451	[2] 1,215,678
Ground and crushed sold by producers:						
Short tons	531,919	573,359	703,014	839,428	920,084	1,037,590
Value	$9,011,861	$11,305,209	$14,590,000	$16,608,546	$20,372,002	$29,407,921
Barium chemicals sold by producers:						
Short tons	70,121	73,689	86,032	83,156	97,508	86,745
Value	$6,641,354	$7,885,586	$11,656,497	$12,101,474	$13,347,359	$11,599,394
Lithopone sold or used by producers:						
Short tons	133,311	105,650	102,837	61,832	52,439	44,011
Value	$12,996,332	$13,129,363	$14,470,742	$8,475,200	$6,923,487	$5,929,789

[1] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data known not to be comparable with previous years.
[2] Includes some witherite.

DOMESTIC PRODUCTION

Output of nearly 947,000 short tons of primary barite from domestic mines in 1954 was the second largest tonnage on record and was exceeded only in 1952. Although production at one operation in Arkansas was curtailed during a strike and output for the year decreased slightly, the State again ranked first. Output in Missouri, the second largest producer, decreased slightly.

In the southeastern States increased output of primary barite in Georgia and South Carolina more than offset a small decrease in

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[2] Statistical clerk.

TABLE 2.—Domestic barite sold or used by producers in the United States, 1945–49 (average) and 1950–54, by States

State	1945–49 (average)		1950		1951		1952		1953		1954	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Arkansas [1]	330,163	$2,395,308	343,168	$3,088,512	407,085	$3,765,536	428,522	$3,963,828	380,763	$3,945,583	370,621	$3,488,483
Georgia	70,783	700,553										
South Carolina	(2)	(2)	72,888	766,711	73,117	841,440	97,540	1,162,249	81,846	1,066,368	75,492	1,062,016
Tennessee	27,415	245,428										
Missouri	250,580	2,065,412	212,736	1,924,520	281,895	2,697,200	304,080	2,919,795	330,763	3,338,395	312,791	3,047,436
Nevada	44,279	253,617	47,608	268,874	63,201	387,026	68,062	391,242	99,525	614,686	83,833	517,492
Other States [3]	31,113	159,359	19,014	145,289	35,371	276,821	43,621	360,830	51,315	470,717	70,158	608,183
Total	754,333	5,819,677	695,414	6,193,906	860,669	7,968,023	941,825	8,797,944	944,212	9,435,749	912,895	8,723,610

[1] Value partly estimated.
[2] Included with "Other States."
[3] Includes Arizona (1946–54), California (1946, 1948–54), Idaho (1949–54), Montana (1951–54), Nevada (1946 and 1948), New Mexico (1949–54), North Carolina (1945), South Carolina (1949), and Washington (1953).

Tennessee. In the West increases in Arizona, Nevada, New Mexico, and Idaho far exceeded the decrease in California.

Completion of several new barite-grinding facilities along the gulf coast of Texas and Louisiana resulted in greatly increased tonnages of ground material from that area. Most of the crude barite ground in these plants was of foreign origin, and grinders were searching for additional sources.

Magnet Cove Barium Corp. began producing barite from the Greystone group of claims near Elko, Nev. The ore was mined by an open-pit method and shipped to Beowawe for crushing.[3] The company was reported to be planning a mill either at the mine site or the railroad shipping point.[4]

The J. R. Simplot Co. was reported to have been preparing to mine a considerable tonnage of barite at its open-pit operation on Deer Creek in Blaine County, Idaho.[5]

A small quantity of barium metal is produced occasionally by King Laboratories, Inc., Syracuse, N. Y., and by Kemet Laboratories Co., Cleveland, Ohio.

Four vein-type barite deposits in San Bernardino County, Calif., were described in detail.[6]

TABLE 3.—Ground (and crushed) barite produced and sold by producers in the United States, 1945–49 (average) and 1950–54

Year	Plants	Production (short tons)	Sales	
			Short tons	Value
1945–49 (average)	22	534,874	531,919	$9,011,861
1950	26	569,129	573,359	11,305,209
1951	24	704,709	703,014	14,590,000
1952	24	839,457	839,428	16,608,546
1953	29	924,392	920,084	20,372,002
1954	29	1,038,649	1,037,590	29,407,921

CONSUMPTION AND USES

Sales of barite were larger than in any previous year. Although consumption of barite in the manufacture of barium chemicals decreased and its use in making lithopone continued to decline, more ground barite was shipped to the well-drilling trade than in any year on record.

In 1954 the number of oil and gas wells drilled reached a new high, totaling 53,930 completions.[7] Drilling-depth records were broken in several areas. Average depth of holes increased, and total footage of completed holes was more than 219 million feet. The drilling industry uses barite as a weighting agent in drilling fluids. These fluids carry cuttings up the hole, cool the bit, and coat the sides of the hole to prevent loss of the fluid. Finely ground barite is added to the drilling

[3] Mining Record, vol. 65, No. 19, May 13, 1954, p. 1.
[4] Mining World, vol. 16, No. 10, September 1954, p. 105.
Engineering and Mining Journal, vol. 155, No. 9, September 1954, p. 170.
[5] Engineering and Mining Journal, vol. 155, No. 10, October 1954, p. 140.
[6] Durrell, C., Barite Deposits Near Barstow, San Bernardino County, Calif.: Calif. Div. Mines, Special Rept. 39, April 1955, 8 pp.
[7] Oil and Gas Journal, vol. 53, No. 39, Jan. 31, 1955, p. 138.

fluid in some areas to increase the weight and thereby help prevent gas pressures from blowing the fluid out of the drill hole. Barite is the preferred weighting material because it is inert, soft, and relatively heavy.

An analysis was made of the economics of barite in concrete for oil- and gas-pipeline coating. Results showed that the negative buoyancy achieved by using barite as aggregate in concrete was twice that of sand concrete and that the cost per pound of negative buoyancy was less when barite was used. Since about twice the volume of sand concrete is required to provide the same negative buoyancy, the sand concrete was about 50 percent heavier in air than the barite concrete, and thus increased the difficulty of handling the pipe in air.[8]

Consumption of barite and witherite in manufacturing barium chemicals decreased from 1953 but exceeded the tonnage consumed for this purpose in any year preceding 1953. Of the barium chemicals produced, only the oxide and hydroxide increased. These materials were consumed in larger quantities for lubricating-oil additives.

Barium metal and various barium alloys were used as getters in electronic tubes to improve the vacuum and thereby increase the life and efficiency of the tube.

TABLE 4.—Crude barite (domestic and imported) used in the manufacture of ground barite and barium chemicals in the United States, 1945–49 (average) and 1950–54, in short tons

Year	In manufacture of—			Total	Year	In manufacture of—			Total
	Ground barite [1]	Lithopone	Barium chemicals			Ground barite [1]	Lithopone	Barium chemicals	
1945–49 (average)	543,335	137,294	97,900	778,529	1951	711,531	107,094	[2] 132,268	950,893
1950	578,078	99,703	[2] 108,350	786,131	1952	849,246	61,000	[2] 123,597	1,033,843
					1953	933,673	52,308	[2] 163,470	1,149,451
					1954	1,044,094	35,866	[2] 135,718	1,215,678

[1] Includes some crushed barite.
[2] Includes some witherite.

[8] Oil and Gas Journal, vol. 52, No. 43, Mar. 1, 1954, p. 9.

TABLE 5.—Ground (and crushed) barite sold by producers, 1945–49 (average) and 1950–54, by consuming industries

Industry	1945–49 (average)		1950		1951		1952		1953		1954	
	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	461,532	86	483,519	84	594,668	85	758,240	90	824,050	90	968,429	94
Glass	26,786	5	24,638	4	25,779	4	24,604	3	24,853	3	23,208	2
Paint	23,600	5	28,000	5	28,000	4	25,000	3	24,000	2	22,000	2
Rubber	15,800	3	19,000	3	15,000	2	18,000	2	21,000	2	20,000	2
Concrete aggregates			15,784	3	38,143	5	12,000	2	25,000	3	(1)	(1)
Undistributed	4,201	1	2,418	1	1,424	(2)	1,584	(2)	1,181	(2)	3,953	(2)
Total	531,919	100	573,359	100	703,014	100	839,428	100	920,084	100	1,037,590	100

[1] Included with "Undistributed."
[2] Less than 1 percent.

TABLE 6.—Lithopone sold or used by producers in the United States, 1945–49 (average) and 1950–54

	1945–49 (average)	1950	1951	1952	1953	1954
Plants	8	7	6	5	5	5
Short tons	133,311	105,650	102,837	61,832	52,439	44,011
Value	$12,996,332	$13,129,363	$14,470,742	$8,475,200	$6,923,487	$5,929,789

TABLE 7.—Distribution of lithopone shipments, 1945–49 (average) and 1950–54, by consuming industries

Industry	1945–49 (average)		1950		1951		1952		1953		1954	
	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]105,619	79	78,177	74	76,614	75	45,267	73	37,452	72	32,177	73
Floor coverings	16,460 (Floor coverings and Coated fabrics and textiles combined)	13	5,297	5	4,620	4	3,009	5	2,575	5	2,351	9
Coated fabrics and textiles			7,945	8	4,814	5	5,698	9	5,806	11	3,995	5
Paper	(2)	(2)	2,290	2	6,462	6	3,089	5	2,096	4	1,841	4
Rubber	2,621	2	4,092	4	3,295	3	1,523	3	1,723	3	1,701	4
Other	8,611	6	7,849	7	7,032	7	3,246	5	2,787	5	1,946	5
Total	133,311	100	105,650	100	102,837	100	61,832	100	52,439	100	44,011	100

[1] Includes a quantity, not separable, used for printing ink.
[2] Included with "Other."

TABLE 8.—Barium chemicals produced and used or sold by producers in the United States, 1945–49 (average) and 1950–54, 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]					
1945–49 (average)	15	147, 293	146, 868	343	$19, 432
1950	12	130, 967	130, 305	499	33, 084
1951	12	152, 792	150, 434	455	28, 361
1952	12	121, 061	120, 562	649	42, 475
1953	11	138, 980	137, 801	1, 126	81, 647
1954	11	116, 246	112, 863	1, 020	73, 902
Carbonate (synthetic):					
1945–49 (average)	5	42, 082	18, 828	23, 493	1, 565, 644
1950	4	49, 299	13, 063	36, 266	2, 746, 628
1951	4	60, 181	18, 541	40, 568	3, 322, 276
1952	4	57, 935	21, 591	37, 214	3, 175, 080
1953	4	74, 122	26, 116	46, 846	4, 223, 525
1954	4	65, 319	29, 150	43, 325	3, 985, 674
Chloride (100 percent $BaCl_2$):					
1945–49 (average)	3	13, 377	3, 675	9, 385	911, 627
1950	3	12, 285	3, 324	8, 874	992, 722
1951	4	17, 959	4, 911	12, 364	1, 830, 070
1952	4	14, 157	3, 979	10, 409	1, 407, 986
1953	4	14, 838	2, 186	12, 303	1, 703, 796
1954	3	12, 167	45	10, 733	1, 407, 811
Hydroxide:					
1945–49 (average)	3	4, 002	302	3, 627	570, 799
1950	4	7, 927	82	7, 888	1, 540, 046
1951	5	13, 483	231	12, 757	3, 185, 405
1952	5	11, 759	585	10, 848	2, 211, 998
1953	5	12, 454	304	11, 843	2, 258, 279
1954	5	12, 616	326	11, 697	2, 200, 510
Oxide:					
1945–49 (average)	3	6, 624	6, 057	542	110, 470
1950	3	8, 129	6, 021	2, 162	451, 277
1951	3	9, 347	6, 334	3, 073	729, 379
1952	3	9, 843	6, 081	3, 818	907, 762
1953	3	14, 578	7, 604	6, 820	1, 678, 969
1954	3	15, 195	7, 035	7, 400	1, 853, 449
Sulfate (synthetic):					
1945–49 (average)	8	26, 052	10, 120	16, 048	1, 318, 895
1950	6	15, 821	----------	15, 676	1, 505, 628
1951	6	14, 237	----------	13, 426	1, 448, 628
1952	7	13, 035	----------	13, 274	1, 492, 324
1953	7	14, 390	----------	13, 448	1, 653, 507
1954	6	10, 495	----------	10, 486	1, 356, 346
Other barium chemicals: [5]					
1945–49 (average)	(6)	21, 041	3, 942	16, 683	2, 144, 487
1950	(6)	5, 049	2, 878	2, 324	616, 201
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
Total: [7]					
1945–49 (average)	20	----------	----------	70, 121	6, 641, 354
1950	17	----------	----------	73, 689	7, 885, 586
1951	18	----------	----------	86, 032	11, 656, 497
1952	19	----------	----------	83, 156	12, 101, 474
1953	18	----------	----------	97, 508	13, 347, 359
1954	17	----------	----------	86, 745	11, 599, 394

[1] Of any barium chemical.
[2] Includes purchased material.
[3] Exclusive of purchased material and exclusive of sales by 1 producer to another.
[4] Black-ash data includes 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.

PRICES

According to E&MJ Metal and Mineral Markets, the following prices were quoted for barite in 1954: Barytes—f. o. b. mines: Georgia, crude, jig and lump, quoted at \$13–\$13.50 per short ton at the beginning of the year and increased to \$15 per short ton by the end of the year; beneficiated, in paper bags, quoted at \$19–\$20 per short ton at the beginning of the year and increased to \$21.50 per short ton by the end of the year. Missouri barite, water ground and floated, bleached, quoted at \$41.35 per short ton, carlots, f. o. b. works, throughout the year. Crude ore, minimum 94 percent, $BaSO_4$, less than 1 percent iron, was quoted at \$13.25 per short ton throughout the year.

Prices for barium metal were not quoted in the trade journals.

TABLE 9.—Range of quotations on barium chemicals in 1954

[Oil, Paint and Drug Reporter]

Barium carbonate, precipitated, bags, carlots, works ... short ton	\$92.50
Barium chlorate, kegs, works ... pound	\$0.32–.36
Barium chloride, technical, bags, carlots, works ... short ton	158.00
Barium chromate, bags, freight equaled ... pound	.35
Barium dioxide (peroxide), drums, carlots, works ... do	.16
Barium hydrate, crystals, bags ... short ton	180.00–200.00
Barium nitrate, barrels, carlots, works ... pound	.12½
Barium oxide, ground, drums, carlots, works ... short ton	255.00
Blanc fixe (dry):	
Direct process, bags, carlots, works ... do	100.00
Byproduct, bags, carlots, works ... do	155.00–190.00
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 [9]

Imports of barite into the United States were lower than in 1953 but exceeded those in any preceding years. Yugoslavia, the only country to increase shipments to the United States in 1954, was becoming a major supplier of crude barite.

[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 10.—Barite imported for consumption in the United States, 1951–54, by countries

[U. S. Department of Commerce]

	1951		1952		1953		1954	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Crude barite:								
North America:								
Canada	51,447	$409,506	67,854	$571,196	204,362	$1,652,076	165,612	$1,177,616
Mexico	1,308	9,988	12,188	97,347	63,450	344,211	43,750	130,384
Total	52,755	419,494	80,042	668,543	267,812	1,996,287	209,362	1,308,000
South America: Brazil			3,180	14,425	6,365	42,031	6,184	35,461
Europe:								
Italy					9,830	52,989	5,600	37,000
Yugoslavia			24,696	240,368	50,781	423,521	95,947	894,373
Total			24,696	240,368	60,611	476,510	101,547	931,373
Grand total	52,755	419,494	107,918	923,336	334,788	2,514,828	317,093	[1] 2,274,834
Ground barite:								
North America: Canada			6,440	112,265				
Europe:								
Germany, West					40	1,368	63	2,346
Greece	31	337						
Italy	17	435	1	25	23	434		
Total	48	772	1	25	63	1,802	63	2,346
Asia: India	28	925						
Africa: Algeria	84	2,870	179	5,900	196	6,295	189	6,351
Grand total	160	4,567	6,620	118,190	259	8,097	252	8,697

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

TABLE 11.—Barium chemicals imported for consumption in the United States, 1945–49 (average) and 1950–54

[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
1945–49 (average)	2	$428	(1)	$11	(1)	$2	7	$618
1950	1,201	179,197	53	6,174				
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

Year	Barium nitrate		Barium carbonate precipitated		Other barium compounds	
	Short tons	Value	Short tons	Value	Short tons	Value
1945–49 (average)	58	$6,964			6	$2,268
1950	149	21,083	286	$28,222	35	11,669
1951	368	62,277	794	72,977	32	12,503
1952	456	80,654	499	30,427	82	36,944
1953	235	36,433	4,219	297,187	513	103,100
1954	164	24,516	325	26,402	1,344	265,472

[1] Less than 1 ton.

TABLE 12.—Lithopone exported from the United States, 1945–49 (average) and 1950–54

[U. S. Department of Commerce]

Year	Short tons	Value		Year	Short tons	Value	
		Total	Average			Total	Average
1945–49 (average)	[1] 14, 088	[1]$1,728,031	[1] $122.66	1952	9, 985	$1, 632, 106	$163. 46
1950	9, 357	1, 248, 538	133. 43	1953	3, 927	584, 279	148. 79
1951	20, 473	3, 615, 915	176. 62	1954	3, 013	454, 461	150. 83

[1] Includes zinc sulfide.

Imports of witherite, all from United Kingdom, were slightly less than during the previous year.

TABLE 13.—Witherite, crude, unground, imported for consumption in the United States, 1945–49 (average) and 1950–54

[U. S. Department of Commerce]

Year	Short tons	Value [1]	Year	Short tons	Value [1]
1945–49 (average)	1, 465	$48, 454	1952	5, 174	$184, 003
1950	2, 089	51, 381	1953	4, 928	178, 846
1951	2, 016	51, 673	1954	4, 415	153, 139

[1] Valued at port of shipment.

TECHNOLOGY

The trend in well drilling was to increase the number of wells with fewer drilling rigs. This meant improvements in drilling equipment and techniques. Because of its direct effect on drilling rate, improvement of quality and use of drilling fluids was given more attention. There were also improvements in the methods of delivering ground barite to drilling rigs, particularly offshore rigs. New bulk-handling processes were developed.

The operations of Magnet Cove Barium Corp. at Magnet Cove, Ark., were described in an article.[10] Although previously mined as an open pit, the deposit was worked by underground methods after an inclined shaft was sunk in 1947. A sketch of an underground layout showed ore trains loading a measuring cartridge to fill 10-ton skips. Fifteen-horsepower slushers handled ore from shrinkage stopes through timbered scraper drifts. Some top slicing was done in soft ground.

The results of tests performed by the Bureau of Reclamation on barite to determine its physical properties and value as an aggregate in high-density concrete were published.[11] The researchers found that barite behaved similarly to ordinary crushed aggregate in concrete. Densities of as much as 232 pounds per cubic foot were obtained by using barite as aggregate. Exceptionally high compressive strengths were developed by conventional barite concrete, but prepacked barite

[10] Wilson, T., Magcobar—Mud Is Their Business: Min. Eng., vol. 6, No. 5, May 1954, pp. 494–496.
[11] Witte, L. P., and Backstrom, J. E., Properties of Heavy Concrete Made With Barite Aggregates: Jour. Am. Concrete Inst., vol. 26, No. 1, September 1954, pp. 65–88.

concrete did not develop these high strengths. The coefficient of thermal expansion was found to be higher than for ordinary aggregate concrete, and values of specific heat, thermal conductivity, and diffusivity were lower.

The technique of using barite as a heavy aggregate in grout-intruded concrete radiation shields was outlined.[12] It was concluded that the grout-intruded method offered advantages in placing heavy-aggregate concrete in complicated forms containing numerous items, which must be set to close tolerances. Great care was recommended in handling and placing the barite aggregate.

Research on the production, properties, and applications of barium titanate ceramics and macrocrystalline materials has been intensified in recent years. Interest in these materials was created by their unusual electromechanical properties. These properties are utilized in transducers, phonograph pickup cartridges, thickness gages, accelerometers, high-frequency response loudspeaker units, electromedical instruments, digital computors, telephone-switching systems, and great potential applications in electronics and ultrasonics.

A method of preparing large, clear, single crystals of barium titanate was described.[13] The method involved firing a mixture of barium titanate, ferric oxide, and potassium fluoride, cooling the resulting melt at a controlled rate to obtain the crystals in the form of thin plates, and annealing by slow cooling.

A method was developed for producing barium titanate bodies of good quality and uniformity of performance.[14] Best results required the use of a lubricant, binder, and wetting agent intimately mixed with the barium titanate by wet grinding and a carefully controlled dry-pressing procedure.

WORLD REVIEW

Deposits of barite of various types, sizes, and grades are widespread throughout the world. As may be seen in table 14, barite has been produced in many countries. In some countries it is produced largely for domestic consumption and in others largely for export.

Canada.—Shipments of barite from mines in Canada declined slightly in 1954.[15] The bulk of production came from the mine of Canadian Industrial Minerals, Ltd., near Walton, Hants County, Nova Scotia. Smaller tonnages were produced by Mountain Minerals, Ltd., at Parson and Brisco in the Columbia Valley, British Columbia.

In Hants County the barite was mined by open pit, but because of the depth of the pit the company was considering underground methods. The barite was trucked a few miles to the mill on the Bay of Fundy where it was crushed or ground and loaded directly onto boats.

Underground development work was done at Parsons, but most of the barite from this area came from an open pit near Brisco. This

[12] Narrow, L., Barytes: Handle With Care: Eng. News-Record, vol. 152, No. 19, May 13, 1954, pp. 36–37, 40.

[13] Remeika, J. P., Method of Growing Barium Titanate Single Crystals: Jour. Am. Chem. Soc., vol. 76, No. 1, Feb. 5, 1954, pp. 940–941.

[14] Callahan, R. M., and Murray, J. F., Preparation of Reproducible Barium Titanate: Bull. Am. Ceram. Soc., vol. 33, No. 5, May 1954, pp. 131–133.

[15] Department of Mines and Technical Surveys, Ottawa, Barite in Canada, 1954 (Prelim.), 5 pp.

TABLE 14.—World production of barite, by countries,[1] 1945–49 (average) and 1950–54, in short tons [2]

(Compiled by Helen L. Hunt)

Country [1]	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Canada	106,314	77,177	98,113	136,002	247,227	222,519
Cuba (exports)	534				4,904	(3)
Leeward Islands: Antigua	95					
United States	762,184	693,424	845,579	1,012,811	920,025	946,744
Total [1] [4]	871,600	776,100	949,200	1,161,000	1,234,000	1,208,000
South America:						
Argentina	17,105	15,432	19,842	17,637	[4] 14,000	[4] 16,500
Brazil	9,022	7,562	55	[5] 7,605	[5] 15,863	[4] [5] 7,700
Chile	2,852	1,499	1,207	2,619	[4] 2,800	[4] 2,800
Colombia	1,318	346	2,240	4,480	8,543	9,921
Peru	5,760	3,341	25,370	10,035	17,129	13,228
Total	36,057	28,180	48,714	42,376	[4] 58,000	[4] 50,000
Europe:						
Austria	3,497	11,154	10,632	5,688	2,116	4,802
France	41,744	31,536	43,535	31,360	26,455	48,061
Germany:						
East [4]	[4] 136,500	16,500	22,000	22,000	27,600	27,600
West		[6] 314,379	428,618	314,513	334,422	414,542
Greece	11,973	22,927	32,407	23,897	28,064	[4] 24,300
Ireland	12,390	5,314	9,081	2,008		(3)
Italy	49,622	59,994	84,372	62,031	76,411	79,254
Portugal	591	141	793	685	347	(3)
Spain	14,056	7,878	13,723	17,491	19,727	11,984
Sweden	1,303	55	165			(3)
U. S. S. R.[4]	90,000	105,000	110,000	110,000	110,000	110,000
United Kingdom [7]	120,509	108,203	97,909	78,563	77,175	(3)
Yugoslavia	14,351	32,772	27,362	38,381	89,457	(3)
Total [1] [4]	499,000	720,000	890,000	700,000	800,000	870,000
Asia:						
India	27,399	13,399	11,727	8,401	4,544	(3)
Japan	4,910	15,696	18,415	15,687	19,350	20,815
Korea, Republic of				874	1,012	336
Total [1] [4]	38,000	39,000	41,000	36,000	36,000	35,000
Africa:						
Algeria	16,370	25,232	23,172	10,852	14,154	14,961
Egypt	55		45	33	33	35
French Morocco	[8] 336	5,415	3,589	3,429	55	10,246
Southern Rhodesia	161	288	94	299	268	
South-West Africa	[8] 53					
Swaziland	149	486	526	444	455	362
Tunisia	399	28	11	28		
Union of South Africa	2,464	2,500	2,247	1,894	2,092	2,342
Total	19,987	33,949	29,684	16,979	17,057	27,946
Oceania: Australia	5,753	6,645	6,919	5,537	6,358	7,696
World total (estimate) [1]	1,470,000	1,600,000	2,000,000	2,000,000	2,150,000	2,200,000

[1] In addition to countries listed, barite is produced in China, Czechoslovakia, Mexico, and North Korea but data on production are not available. Estimates by author of chapter included in total.
[2] This table incorporates a number of revisions of data published in previous Barite chapters.
[3] Data not available; estimate included in total.
[4] Estimate.
[5] Exports.
[6] Beginning in 1950, marketable production is shown.
[7] Includes witherite.
[8] Average for 1 year only, as 1949 was first year of commercial production.

material was ground in a plant at Lethbridge for use principally in drilling mud.

A witherite occurrence at Liard River Crossing in northern British Columbia was investigated by stripping. The deposit appears to be a flat-lying vein between shales and limestone. The vein in places reaches 20 feet in thickness and is composed of an intimate mixture of witherite, fluorite, quartz, and barite. The property was acquired by Conwest Exploration Co., Ltd.

A barite occurrence on McKellar Island near Port Arthur in Lake Superior and one in the Lake Ainslie district of Nova Scotia were investigated. In the latter deposit the barite is associated with fluorite.

Consumption of barite in Canada in 1954 (in short tons) was as follows: Paint, 1,200; rubber, 437; glass, 238; oilwell drilling, 2,000 (estimated); miscellaneous, 279.

French Morocco.—Two operators, Cie. Miniere et Industrielle du Maroc at Djebel, Irhoud, and Louis Delpech at Tessaout produced barite during 1954.[16]

Yugoslavia.—It was reported that a barite-grinding plant with an annual capacity of 20,000 metric tons would be built at Turcin.[17]

[16] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 4, April 1955, p. 36.
[17] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 2, February 1955, p. 45.

Bauxite

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

WORLD production of bauxite reached 15.6 million long tons in 1954, the highest ever recorded. As a result of continued expansion of the aluminum industry domestic production of bauxite increased to 2.0 million long tons, a new peak for production in peacetime. Domestic consumption, totaling 6.4 million long tons, and imports of 5.3 million long tons represented alltime records.

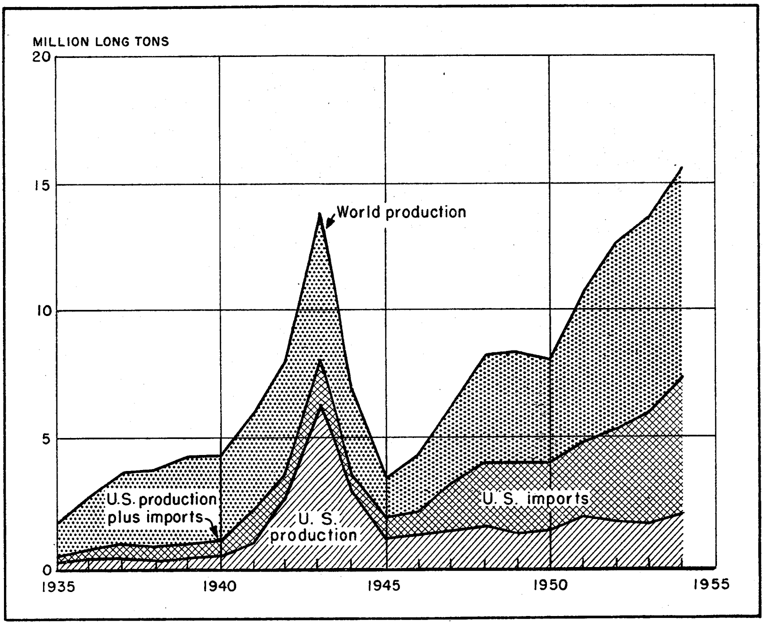

FIGURE 1.—United States supply and world production of bauxite, 1935–54.

In 1954 Arkansas was still the leading bauxite-producing State, and one new producer started operations there. The alumina industry increased its consumption of both foreign and domestic ores. Aluminum producers consumed approximately 85 percent of the ore. The ratio of the domestic bauxite consumption to the domestic aluminum production was 4.9 in 1954 compared with 5.0 in 1953 and 5.1 in 1952. Imports comprised 73 percent of the total new supply for the year. Thirty-eight percent of all the imports were shipments from Jamaica as compared with 27 percent in 1953. Total exports of bauxite from the United States decreased for the sixth consecutive year.

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

Six plants with a total capacity of 3.5 million short tons produced 3.0 million short tons of alumina. The aluminum industry consumed 92 percent of this production. All of the planned expansion of these plants was in operation in 1954. One new chemical plant was completed at Bauxite, Ark., and one new reduction plant at Arkadelphia, Ark.

Aluminum is discussed in the Aluminum chapter of this volume.

TABLE 1.—Salient statistics of the bauxite industry in the United States, 1945–49 (average) and 1950–54, in long tons

	1945–49 (average)	1950	1951	1952	1953	1954
Crude-ore production (dry equivalent)	1,178,612	1,334,527	1,848,676	1,667,047	1,579,739	1,994,896
Imports	1,718,049	2,516,247	2,819,676	3,497,939	[1] 4,390,576	5,283,888
Exports	81,439	45,406	89,948	41,330	27,907	16,174
Consumption (dry equivalent)	2,457,977	3,325,304	3,945,667	4,228,404	5,628,276	6,427,785
World production	6,025,000	[1] 8,050,000	[1] 10,675,000	[1] 12,525,000	[1] 13,425,000	15,550,000

[1] Revised figure.

DOMESTIC PRODUCTION [4]

Production of crude bauxite in the United States during 1954 totaled 2 million long tons (dry basis), a new record for peacetime production. Total domestic mine production increased 26 percent over 1953; only during the war years 1942–44 was this production exceeded. Nevertheless, the total output comprised only 31 percent of the domestic consumption and only 27 percent of the total new supply calculated by adding production to imports. Shipments from mines and processing plants to consumers remained about the same as in 1953, as did the quantity of crude ore treated in producing dried, calcined, and activated bauxite. The dried-bauxite equivalent of the processed bauxite recovered also was essentially unchanged.

The combined bauxite production in Alabama and Georgia decreased 9 percent from 1953 to 45,528 long tons, dried-equivalent basis. The Aluminum Co. of America and the D. M. Wilson Bauxite Co. operated mines in Barbour County, Ala. The Aluminum Co. of America dried its crude output at its plant nearby, while the D. M. Wilson Bauxite Co. shipped its production crude. The American Cyanamid Co., operating mines in Bartow and Macon Counties, was the only producer of bauxite in Georgia. The crude ore was dried at the Halls Station plant in Bartow County and used in the production of chemicals.

Production from Arkansas mines, representing 98 percent of the total domestic output, increased 27 percent from 1953 to 1954. Most of the ore was mined in Saline County and the remainder in Pulaski County. Open-pit operations provided approximately 87 percent of the Arkansas production.

The Reynolds Mining Corp. was the largest producer of bauxite in Arkansas in 1954, followed by the Aluminum Co. of America. Both companies, mining in Saline County, shipped crude ore for alumina production. The American Cyanamid Co. operated the Lewis and

[4] Production data for 1954 were collected jointly with the Bureau of the Census (United States Department of Commerce). Production totals will be compared with the Census totals when they are available and differences adjusted or explained.

Rauch mines in Pulaski County and the Quapaw mine in Saline County. Crude ore was received at the company mill in Pulaski County for drying before consumption in the production of chemicals.

The Confederate Home pit, Dixon pit, and Illing shaft in Pulaski County and the 400 B. C. mine in Saline County were operated by the Dulin Bauxite Co. Although some dried bauxite was reported produced, the largest part of this company's production was shipped crude. Dickinson-McGeorge, Inc., was a new producer in 1954 and operated the Townsend mine in Saline County. The Norton Co. mined in Saline County. Some of its production was sold undried, and a smaller quantity was calcined. Consolidated Chemical Industries, Inc., shipped crude ore from stocks to its concentrating plant in Pulaski County and reported production of dried bauxite. The Crouch Mining Co. did not mine in Saline County in 1954 but shipped the balance of its crude and calcined stocks. The Campbell Bauxite Co., in Pulaski County, used purchased crude ore for preparing dried and activated bauxite. Activated bauxite was also produced by the Porocel Corp. in Pulaski County.

TABLE 2.—Mine production of bauxite in the United States, 1950–54, by quarter years, in long tons [1]

(Dried-bauxite equivalent)

Quarter ended—	1950	1951	1952	1953	1954
March 31	322,006	378,031	426,269	378,806	399,300
June 30	368,256	502,088	458,612	411,070	367,750
September 30	293,724	453,564	312,370	387,054	686,323
December 31	350,541	514,993	469,796	402,809	541,523
Total	1,334,527	1,848,676	1,667,047	1,579,739	1,994,896

[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, 1950–54, 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:						
1950	32,706	27,192	$161,274	35,741	35,473	$272,320
1951	38,807	33,402	217,774	39,122	38,123	363,602
1952	76,582	63,214	541,000	50,670	48,463	520,550
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
Arkansas:						
1950	1,552,047	1,307,335	7,531,535	1,416,724	1,301,374	9,277,076
1951	2,153,786	1,815,274	12,259,742	1,583,320	1,493,557	11,994,882
1952	1,903,101	1,603,833	10,235,254	2,067,241	1,849,287	14,084,274
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
Total United States:						
1950	1,584,753	1,334,527	7,692,809	1,452,465	1,336,847	9,549,396
1951	2,192,593	1,848,676	12,477,516	1,622,442	1,531,680	12,358,484
1952	1,979,683	1,667,047	10,776,254	2,117,911	1,897,750	14,604,824
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

[1] Computed from selling prices and values assigned by producers.

TABLE 4.—Recovery of processed bauxite in the United States, 1945–49 (average) and 1950–54, in long tons

Year	Crude ore treated	Processed bauxite recovered		Total	
		Dried	Calcined or activated	As recovered	Dried bauxite equivalent
1945–49 (average)	705,056	453,591	94,100	547,691	596,804
1950	657,798	480,623	63,713	544,336	579,884
1951	1,059,645	756,060	103,588	859,648	914,433
1952	576,430	397,067	56,191	453,258	481,705
1953	200,970	100,632	34,288	134,920	155,248
1954	201,894	125,511	24,686	150,197	161,638

CONSUMPTION

Bauxite consumption in the United States increased 14 percent from 1953 to 6.4 million long dry tons. The 1954 record consumption represented a 35-percent increase over the previous high of 4.8 million long tons in 1943. The ratios of domestic ore used (27.1 percent) and foreign ore used (72.9 percent) to the total bauxite consumed remained the same as in 1953. To meet the demand of the expanding aluminum program the alumina industry used 20 percent more domestic ore and 16 percent more foreign ore than in the preceding year. The other major consuming industries, however, decreased their use of both domestic and foreign bauxite.

Bauxite consumption data by industries are given in table 5 and illustrated in figure 2. The consumption of crude and processed ore by grades is shown in table 6. The figures in these tables are compiled from consumer reports and do not include bauxite sold for the National Stockpile.

TABLE 5.—Bauxite consumed in the United States, 1953–54, by industries, in long tons

(Dried-bauxite equivalent)

Industry	Domestic	Percent	Foreign	Percent	Total	Percent
1953						
Alumina	1,332,419	87.4	3,652,915	89.0	4,985,334	88.6
Abrasive [1]	36,267	2.4	317,824	7.7	354,091	6.3
Chemical	79,726	5.2	89,455	2.2	169,181	3.0
Refractory	13,979	.9	40,225	1.0	54,204	1.0
Others	62,412	4.1	3,054	.1	65,466	1.1
Total [1]	1,524,803	100.0	4,103,473	100.0	5,628,276	100.0
Percent	27.1		72.9		100.0	
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	

[1] Includes consumption by Canadian abrasives industry.

TABLE 6.—Consumption of crude and processed bauxite in the United States by grades, 1954, in long tons

(Dried-bauxite equivalent)

	Domestic origin	Foreign origin	Total	Percent
Crude	1,600,616	4,194	1,604,810	25.0
Dried	111,979	4,344,266	4,456,245	69.3
Calcined	21,061	334,647	355,708	5.5
Activated	11,022		11,022	.2
Total	1,744,678	4,683,107	6,427,785	100.0
Percent	27.1	72.9	100.0	

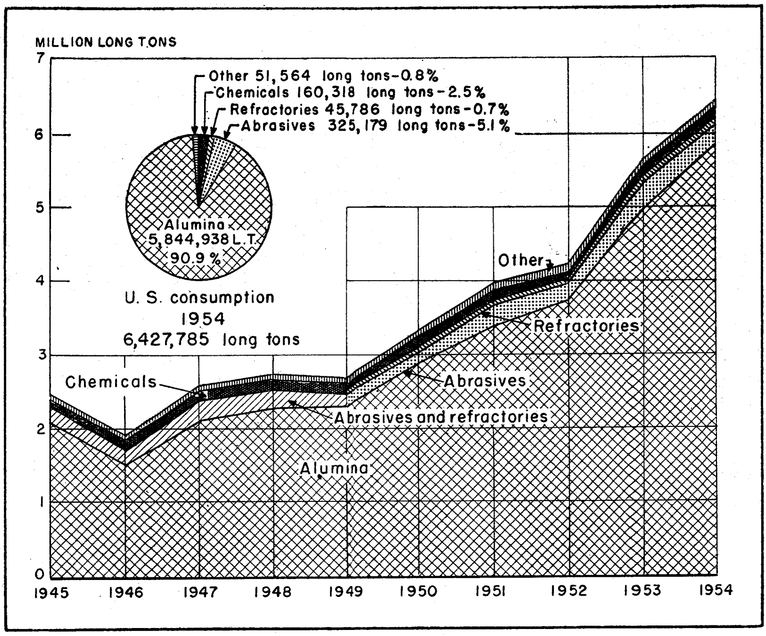

FIGURE 2.—Domestic consumption of bauxite by uses, 1945–54.

All facilities designed to increase the capacity for alumina production in the United States to approximately 3.5 million tons per year were operating in 1954. The La Quinta, Tex., alumina plant of the Reynolds Metals Co. on the north shore of Corpus Christi Bay was substantially completed early in 1954. The new plant, with a rated annual capacity of 365,000 tons of alumina, was built in 2 sections, to be operated independently or jointly as desired. Operating on the Bayer process it was designed to use Jamaica bauxite and with the nearby San Patricio reduction plant provided Texas with an integrated facility for converting bauxite to aluminum.

It was announced in October 1954 that the $27 million, 3-year expansion program at Kaiser Aluminum & Chemical Corp. Baton Rouge, La., plant was nearing completion. The increase in the plant's annual capacity to over 800,000 tons of alumina increased the supply of alumina to Kaiser's 3 reduction plants at Tacoma and Mead, Wash., and Chalmette, La. This expansion program included facilities for processing Jamaica bauxite and made possible handling over 2 million tons of bauxite annually at the plant.

The Aluminum Co. of America new $54 million alumina plant with an annual capacity of 401,500 tons continued operating at Bauxite, Ark., in 1954. It was the second domestic plant to produce alumina by the Combination process developed for use on high-silica bauxites. In this process the soda and alumina that would be lost in the "red mud" following use of the Bayer process is recovered by means of a lime-soda sinter treatment of the residue. At Bauxite, Ark., a new chemical products plant was completed. Each of the four units of the plant was designed to produce a different type of product: Hydrated aluminas, calcined aluminas, ground and blended special aluminas, and tabular aluminas. The Aluminum Co. of America continued to make the remainder of its alumina chemicals, including the fluoride chemicals, at its East St. Louis, Ill., plant.

In March 1954 expansion of the Aluminum Co. of America, Mobile, Ala., plant was completed, thereby increasing its capacity 33 percent and making it the largest alumina plant in the United States.

The 6 alumina plants in the United States had a combined production of 3 million short tons, which represented 87 percent of their rated capacity. Ninety-four percent of all aluminum oxide products was calcined alumina, which went mainly to the aluminum, abrasive, ceramic, and refractory industries. The remaining 6 percent was commercial aluminum trihydrate, activated and tabular aluminas, most of which was shipped to the chemical industry. Ninety-five percent of the alumina shipments went to the aluminum industry. Compared with 1953 production, calcined alumina increased 17 percent to 2.9 million short tons in 1954, and all the other forms of alumina combined increased 15 percent to 175,000 short tons.

In February 1954 the Reynolds Metals Co. started operation of a new aluminum-reduction plant. The Patterson plant, at Arkadelphia, Ark., was scheduled for an annual capacity of 55,000 tons.

The 16 reduction plants consumed 2.8 million short tons of calcined alumina, an 18-percent increase from 1953. The increases in the

TABLE 7.—Alumina plants in operation in the United States, 1954

Company and plant	Capacity (short tons per year)	Percent
Aluminum Co. 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

TABLE 8.—Production and shipments of selected aluminum salts in the United States, 1953–54

Type of salt	1953: 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)	[2] 722,839	[2] 38	[2] 699,478	[2] $23,344,000	[2] 19,178
Municipal (17 percent Al_2O_3)	13,577	7	----------	----------	13,577
Iron-free (17 percent Al_2O_3)	31,577	9	23,672	1,478,000	7,359
Sodium aluminate (62.2 percent Al_2O_3)	13,252	5	11,150	1,149,000	(1)
Aluminum chloride:					
Liquid (32° B.)	13,295	8	13,295	[2] 799,000	(1)
Crystal (32° B.)		3			
Anhydrous (100 percent $AlCl_3$)	35,139	8	30,534	9,663,000	(1)
Aluminum fluoride, technical	(1)	----------	(1)	(1)	----------
Aluminum trihydrate (100 percent $Al_2O_3 \cdot 3H_2O$)	(1)	----------	(1)	(1)	----------
Other aluminum salts	----------	----------	----------	[2] [4] 27,636,000	----------
Total	----------	----------	----------	[2] 64,069,000	----------

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)	[3] 27,625	6	(1)	(1)	----------
Aluminum chloride:					
Liquid (32° B.)	11,337	8	10,725	774,000	(1)
Crystal (32° B.)		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	----------	----------	----------	[5] 12,565,000	----------
Total	----------	----------	----------	67,945,000	----------

[1] Included with "Other aluminum salts."
[2] Revised figure.
[3] Includes an unspecified amount produced and consumed but previously not reported.
[4] Includes in order of value, cryolite, aluminum fluoride, aluminum hydrate, sodium-aluminum sulfate, aluminum nitrate, ammonium-aluminum sulfate, and potassium-aluminum sulfate.
[5] Includes in order of value, cryolite, sodium-aluminum sulfate, sodium aluminate, potassium-aluminum sulfate, ammonium-aluminum sulfate, and aluminum hydroxide, (light or litho).

SOURCE: 1953 figures based on MA-19E reports, Annual Report on Shipments and Production of Inorganic Chemicals and Gases, Bureau of the Census.
1954 figures based on 1954 Census of Manufactures, Bureau of the Census.

production and consumption of calcined alumina corresponded to the 17-percent increase in the production of primary aluminum for 1954.

The 1954 calculations indicated that an average of 1.95 long dry tons of bauxite was needed to yield 1 short tons of calcined alumina; an average of 3.73 long dry tons of bauxite was required to produce 1 short ton of aluminum; and an average of 1.91 short tons of alumina was needed to produce 1 short ton of aluminum.

Separate production, value, and consumption figures for ammonium, potassium, and sodium-aluminum sulfates cannot be shown without disclosing the operations of individual companies. The total value only is included under "Other aluminum salts" in table 8. Bauxite was the principal source of the aluminum salts shown, although clay, alumina, aluminum, and alunite also were used.

STOCKS

According to the reports received by the Bureau of Mines, 5 million long dry tons of bauxite was stocked in the United States on December 31, 1954. This represented a 5-percent increase compared with the total stock figure of the previous year. Consumers' inventories increased 14 percent, while those at mines and processing plants were 21 percent greater than in 1953. There were no withdrawals from the Government-held Nonstrategic Stockpile in Arkansas. All stock figures in this chapter exclude bauxite held for the National Strategic Stockpile. 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.

TABLE 9.—Stocks of bauxite in the United States December 31, 1950–54, 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
1950	543,284	17,392	42,150	723,103	3,061,034	4,386,963	3,809,765
1951	890,336	18,552	44,169	1,008,767	2,630,792	4,592,616	4,069,796
1952	755,536	35,440	473,850	1,518,641	2,454,584	5,238,051	4,680,615
1953	759,165	44,097	697,653	1,405,587	[3] 2,261,392	5,167,894	4,787,765
1954	964,162	5,810	762,944	1,637,920	2,261,392	5,632,228	5,041,936

[1] Excludes National Strategic 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 established open-market price for bauxite actually existed. The average values of bauxite produced and shipped in the United States in 1954 and 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 1954 reports, the average values of bauxite, as shipped and delivered to the 6 domestic alumina plants, were $8.83 per long ton for domestic ore and $15.09 per long ton for imported ore.

Table 11 summarizes the market quotations on bauxite in the United States as they were published in the E&MJ Metal and Mineral Markets. There was no change in the quoted prices of either the domestic or imported ore during 1954.

Again in 1954 there were no sales of crude bauxite from the Government Stockpile at Hurricane Creek, Ark. In 1952, the last time a sale was made, the average price was $6.63 per long ton, dry basis.

TABLE 10.—Average value of bauxite produced and shipped in the United States, 1954

Type	Average value per long ton: As produced at mines or plants	Average value per long ton: Shipments f. o. b. mines or plants
Crude (undried)	$6.97	$6.98
Dried	11.57	11.82
Calcined	18.22	18.29
Activated	74.31	74.31

TABLE 11.—Market quotations on bauxite in the United States in 1954

[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] 56–59	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.

Table 12 lists the average values of bauxite imported into the United States in 1954 as reported by the United States Department of Commerce. There was little change in these values from the preceeding year, except for the average value of the bauxite imported from British Guiana, which was $6.83 in 1952, $5.72 in 1953, and $6.78 in 1954. Exports from the United States had an average value of $41.21 per long ton, compared with $31.76 in 1953.

The following market price quotations for alumina and aluminum compounds were published in the Oil, Paint and Drug Reporter in 1954:

Alumina, calcined bags, carlots, works	per pound	$0.0385
Aluminum hydrate:		
Heavy bags, carlots, freight equalized	per ton	60.00
Light, bags, delivered	per pound	0.17

Aluminum sulfate:	
Commercial, bulk, carlots, works per 100 pounds	$1.85
Iron-free, bags, carlots, works, freight equalized per 100 pounds	3.55

The December 20, 1954, issue noted a decrease of $4 per ton for heavy aluminum hydrate. The reduction was a result of increased production from improved facilities in the new Aluminium Co. of America chemical plant at Bauxite, Ark. The new price was 2.8 cents per pound, bags, carlots, works. The prices of light hydrate for calcined alumina and aluminum sulfate remained unchanged.

TABLE 12.—Average value of bauxite imported into the United States, 1954, in long tons

[U. S. Department of Commerce]

Type and country:	*Average value, port of shipment*
Crude and dried:	
British Guiana	$6.78
Jamaica	7.34
Surinam	6.62
Average	6.90
Calcined: British Guiana [1]	23.74

[1] For refractory use.

In 1954 the average value of shipments of calcined alumina was $0.0285 per pound, as determined from the producers' reports. Shipments of commercial aluminum trihydrate had an average value of $63.92 per short ton, according to the same source.

FOREIGN TRADE [5]

United States imports of bauxite have been increasing since 1950. The 1954 figure of 5.3 million long tons represented a 20-percent increase over 1953 and set a new alltime record. Imports from Surinam comprised 59 percent of the total, compared with 71 percent in 1953. Imports from Jamaica (which were 38 percent of the total) increased 69 percent over the preceding year and have been steadily increasing in importance since production was begun in 1952.

Thirty-nine percent of the bauxite imports entered the United States through the Mobile (Ala.) customs district, 38 percent through the New Orleans (La.) customs district, 22 percent through the Galveston (Tex.) customs district, and 1 percent through other districts. About 92 percent of the imports of alumina were from Canada and France, and most of the other aluminum compounds came from Canada and West Germany.

Public Law 499, effective July 16, 1954, suspended for 2 years the duty on crude bauxite, not refined or otherwise advanced in condition in any manner, and the duty on calcined bauxite when imported for use in the manufacture of firebrick or other refractories. The suspension was limited to 2 years to allow a periodic review to determine if a continuation of the duty-free status was advisable. The following duties on imports remained unchanged throughout 1954: Other calcined bauxite, 15 percent ad valorem; alumina and aluminum hydroxide, ¼ cent per pound.

[5] 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.

Bauxite exports (aluminum ore and concentrate) continued to decline in 1954 and were 42 percent less than 1953. Shipments to Canada were 91 percent of the total. The remainder went to 13 other countries. Approximately three-fourths of the aluminum sulfate exports went to Canada, Colombia, and Venezuela and three-fourths of other aluminum compounds exported to Canada and Mexico.

TABLE 13.—Bauxite (crude and dried [1]) imported for consumption in the United States, 1945–49 (average) and 1950–54, in long tons

[U. S. Department of Commerce]

Country	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Jamaica	300			264,988	1,176,494	1,987,759
Trinidad and Tobago	925	9,190	18,226	12,002		
Other North America	829	147				
Total	2,054	9,337	18,226	276,990	1,176,494	1,987,759
South America:						
British Guiana	77,894	91,381	127,477	178,379	101,911	174,492
Surinam	1,448,283	1,967,581	2,308,664	3,023,145	[2] 3,099,554	3,121,637
Other South America	3,936	491			2,360	
Total	1,530,113	2,059,453	2,436,141	3,201,524	3,203,825	3,296,129
Europe	(3)				10,257	
Asia: Indonesia	185,882	447,457	365,309	19,425		
Africa	(3)					
Grand total: Long tons	1,718,049	2,516,247	2,819,676	3,497,939	[2] 4,390,576	5,283,888
Value	$11,056,384	$15,729,855	$17,794,192	$23,193,991	[2] $29,585,129	$36,437,334

[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 99,931 tons ($2,372,483).
[2] Revised figure.
[3] Less than 1 ton.

TABLE 14.—Bauxite (including bauxite concentrates [1]) exported from the United States, 1945–49 (average) and 1950–54, in long tons

[U. S. Department of Commerce]

Country	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Canada	79,949	44,003	89,038	40,012	26,880	14,777
Other North America	631	883	722	1,105	379	1,014
Total	80,580	44,886	89,760	41,117	27,259	15,791
South America	25	2	57		95	27
Europe	738	31	81	171	553	133
Asia	83	487	19	42		172
Africa	13		31			51
Oceania	(2)					
Grand total as exported	81,439	45,406	89,948	41,330	27,907	16,174
Dried bauxite equivalent [3]	113,810	72,014	138,916	62,979	43,256	25,070
Total value	$1,523,005	$1,155,673	$2,217,426	$845,452	$886,275	$666,459

[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.

The international flow of bauxite for 1952 is given in table 15. Ninety-five percent (7.9 million long tons) of the total bauxite exported was received by the United States, Canada, West Germany, U. S. S. R., and United Kingdom. The United States and Canada received 5.8 million long tons or 70 percent of the total exports, and the remaining 3 countries received 2.1 million long tons (25 percent of the total).

TABLE 15.—Production and trade of bauxite in 1952, by major countries, in thousand long tons

(Compiled by John E. McDaniel)

Exports, by countries of origin	Production	Exports, by countries of destination									
		Exports	North America		Europe					Asia	
			Canada	United States	Germany, West	Italy	U. S. S. R.	United Kingdom	Other European	Japan	Other
North America:											
Jamaica	376	376		376							
United States	1,667	41	40								1
South America:											
British Guiana	2,388	2,285	2,036	211				11	2		25
Surinam	3,104	3,105	21	3,060					11		13
Europe:											
France	1,097	334			98	30		165	22		19
Greece	343	296			230			35	31		
Hungary	1,153	[1] 886					[1] 886				
Yugoslavia	568	603			467	130			6		
Other European	1,189	10			10						
Asia:											
Indonesia	338	216			[2] 111					[2] 105	
Other Asia	89	31			3					6	22
Africa:											
French West Africa	108	58	58								
Gold Coast	74	75			8			67			
Undistributed	31	2									2
Total	12,525	8,318	2,155	3,647	927	160	[1] 886	278	72	111	82

[1] Estimate. [2] Imports.

TECHNOLOGY

Operation of the Laramie, Wyo., alumina plant by the Bureau of Mines ceased in 1954. Continuous operation of the plant which was built to study the production of alumina from anorthosite, began in September 1953 with 4 tests lasting 10 days each. Completion of these tests early in 1954 was followed by a 35-day test during which all units were operated at least 30 days continuously. The maximum daily rate of production was approximately 30 tons of alumina. The combined plant production from these tests totaled 760 tons of calcined alumina. Most of this was sold to refractory or abrasive producers, but 2 lots of the highest grade material totaling 80 tons were sold to an aluminum company for metal production. Operation of the Laramie plant demonstrated conclusively that the production of alumina from anorthosite (a sodium feldspar rock averaging about 27 percent alumina) using commercial-size equipment was technically feasible.

In March 1954 General Services Administration issued invitations for bids for the sale of the Laramie plant. The first bids, submitted by three companies, were rejected on the grounds that none was responsive to the invitation. Following discussion, the bidders were asked to submit new bids that would meet the objectives both of Office of Defense Mobilization and Joint Congressional Resolution, S. J. Res. 120, of the 83d Congress, 2d session. Bids were again submitted and following further negotiations the General Services Administration (GSA) announced in September that the bid submitted by Ideal Cement Co. appeared to be favorable from the Government's view, in that it achieved the highest dollar return ($1 million) to the Government; precluded the use of the plant for cement production, thus preventing a windfall to the buyer; assured availability of the plant for the experimental production of alumina for a period of 10 years from the date of sale; and provided for continued local employment and development of natural resources.

GSA therefore accepted the Ideal bid subject to final review by the Attorney General as to whether the sale would tend to create or maintain a situation inconsistent with the antitrust laws. The sale had not been finalized by December 31, 1954.

The new $54 million plant at Bauxite, Ark., in which Alcoa produced aluminum oxide using the Combination process was described.[6] The chemical reactions were given, as well as the plant flowsheet. Raw materials used and process data were also shown.

Tests were continued at the Northwest Electrodevelopment Experiment Station of the Bureau of Mines at Albany, Oreg., during 1954 on direct smelting of silicious aluminum ores in an electric furnace with wood chips and some coke as the reducing agents. Using suitable ores from Washington, Oregon, and California "master" aluminum-silicon alloys were produced. These alloys could be used in place of silicon as a means of adding silicon to secondary casting alloys.

Costs in the production of aluminum were described in an article concerned with the utilization of foreign bauxite. The transportation costs of hauling bauxite, by ship, and alumina and aluminum pig by rail and truck were discussed.[7]

WORLD REVIEW

Estimated world production of bauxite was 16 percent more than in 1953. Jamaica, with an estimated production of 2.3 million tons of bauxite (exports of 2 million tons of bauxite plus the bauxite equivalent of the 124,116 tons of alumina exported), became the second largest producer, slightly exceeding British Guiana for the first time. Other notable increases were reported by Yugoslavia, 47 percent; Gold Coast, 42 percent; French West Africa, 32 percent; and the United States, 26 percent.

North and South America supplied 62 percent of the total output, Europe 31 percent, and Asia, Africa, and Australia the remaining 7 percent.

Bauxite discoveries were reported in Nyasaland and Sierre Leone by the British Aluminum Co.; the first high-grade deposit in Spain was found in Catalonia; and one deposit was reported in Bolivar, Venezuela.

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[6] Chemical Engineering, Sinter Operation on Red-Mud Residue Highlights Process to Increase Yield of Alumina: Vol. 61, No. 11, November 1954, pp. 112, 114, 334–337.

[7] Johnson, A. F., Cost Factors in the Utilization of Foreign Bauxite to Make Aluminum: Min. Eng., vol. 6, No. 6, June 1954, pp. 598–603.

TABLE 16.—Relationship of world production of bauxite and aluminum

(Million long tons)

Commodity	1947	1948	1949	1950	1951	1952	1953	1954	Total
Bauxite	6.2	8.2	8.1	8.1	10.7	12.5	13.4	15.6	82.8
Aluminum	1.1	1.2	1.3	1.5	1.8	2.0	2.4	2.7	14.0
Ratio of bauxite to aluminum-production	5.6	6.8	6.2	5.4	5.9	6.2	5.6	5.8	5.9

TABLE 17.—World production of bauxite, by countries, 1945–49 (average) and 1950–54, in long tons [1]

(Compiled by Pearl J. Thompson)

Country	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Haiti	118	--------	--------	--------	--------	--------
Jamaica (exports)	--------	--------	--------	375,875	1,203,208	1,998,144
United States (dried equivalent of crude ore)	1,178,612	1,334,527	1,848,676	1,667,047	1,579,739	1,994,896
Total	1,178,730	1,334,527	1,848,676	2,042,922	2,782,947	3,993,040
South America:						
Brazil	12,132	18,277	18,732	14,093	15,178	[2] 14,800
British Guiana	1,343,202	1,583,428	2,002,757	2,387,953	2,261,166	2,300,000
Surinam	1,499,342	2,047,803	2,629,150	3,103,992	3,222,630	3,371,703
Total	2,854,676	3,649,508	4,650,639	5,506,038	5,498,974	5,686,503
Europe:						
Austria	4,062	2,960	8,877	14,940	17,932	16,993
France	595,689	795,086	1,127,429	1,097,394	1,146,605	1,249,947
Germany, West	6,779	4,100	5,243	5,851	7,724	[2] 6,900
Greece	22,996	76,225	193,948	343,087	325,526	[2] 325,000
Hungary	292,614	563,362	722,410	1,153,494	[2] 1,180,000	[2] 1,280,000
Italy	102,453	150,962	171,266	261,353	267,930	290,423
Rumania [2]	603	1,000	9,800	9,800	12,500	14,800
Spain	6,818	11,994	10,414	11,512	5,106	4,626
U. S. S. R.[2]	507,000	738,000	837,000	886,000	886,000	984,000
United Kingdom: Northern Ireland	7,279	--------	--------	--------	--------	--------
Yugoslavia	135,516	202,807	476,048	568,082	455,009	669,850
Total [2]	1,683,000	2,549,000	3,563,000	4,350,000	4,306,000	4,842,000
Asia:						
India	22,707	64,400	67,047	63,505	70,848	[2] 79,700
Indonesia	137,799	[2] 320,500	[2] 387,500	338,326	147,191	170,504
Malaya	--------	--------	--------	21,796	152,171	165,622
Taiwan (Quemoy)[2]	--------	--------	9,800	2,900	4,900	1,000
Total [2]	160,506	384,900	464,347	426,527	375,110	416,826
Africa:						
French West Africa	[3] 10,200	9,965	--------	108,017	332,760	439,208
Gold Coast (exports)	126,614	114,949	129,329	74,369	115,076	163,517
Mozambique	2,201	3,339	3,276	2,448	3,058	[2] 2,900
Total	139,015	128,253	132,605	184,834	450,894	605,625
Oceania: Australia	4,596	3,467	5,084	7,235	4,052	[2] 3,900
World total (estimate)	6,025,000	8,050,000	10,675,000	12,525,000	13,425,000	15,550,000

[1] This table incorporates a number of revisions of data published in previous Bauxite chapters.
[2] Estimate.
[3] Average for 1 year only, as 1949 was the first year of commercial production.

Australia.—Of the 1954 output of bauxite, New South Wales supplied 44 percent and Victoria 42 percent. The ore from New South Wales was consumed mostly as a flux in steel plants at Port Kembla and Newcastle, and that from Victoria was used in the manufacture of aluminum salts. Although relatively small quantities of bauxite have been mined in Queensland and used for water purification, production had not been reported until recently. The Queensland Government reported that the mine at Mount Tamborine produced 5,540 long tons of bauxite from 1941 to 1954.

No further development of the Wessel Island deposit was reported in 1954.

A comprehensive report on the bauxite deposits of Australia, Tasmania, and Manus Island was published by the Australia Bureau of Mineral Resources.[8]

Austria.—The Unterlaussa mine of Ranshofen Aluminium Works produced 17,000 long tons of bauxite in 1954, of which 9,237 tons was shipped to West Germany for conversion into alumina on a toll basis. Of the 7,167 tons of bauxite imported during the year, Yugoslavia supplied 3,707 tons, South America 3,307 tons, and the United States 153 tons. Imports of alumina totaled 104,476 tons, mostly from West Germany (73,746 tons), France (14,197 tons), Italy (12,295 tons), and Yugoslavia (3,459 tons).

Brazil.—Exports of calcined bauxite totaled 120 long tons in 1954. An estimated 5,600 tons of bauxite was consumed by Electroquimica Brasileira in the production of aluminum.

The Carborundum Co. of Niagara Falls, N. Y., began to manufacture aluminum oxide abrasives at a plant in Vinhedos near Campinas, São Paulo, in July 1954.

British Guiana.—The Demerara Bauxite Co., Ltd., the principal bauxite producer, reported an output of 1,713,000 tons of dried ore and 211,000 tons of calcined ore in 1954, which was slightly less than that reported for the previous year. The company ascribed the decrease to increasing mining difficulties, both from the standpoint of the accessibility of ore deposits and the depth at which the ore is now mined. In July 1954 a second dragline was put into operation at Ituni. The company's first dragline began operations at Mackenzie in 1952.

Plantation Bauxite Co., partly owned by Demerara Bauxite Co., continued to mine its properties across the river from Mackenzie and produced 50,640 tons of bauxite.

Reynolds Metals Co. produced 145,289 tons of bauxite from the now-liquidated Berbice Co., Ltd., properties at Kwakwani. Reynolds litigation with the Harvey Machine Co. over liquidation terms of the Berbice Co. was settled in favor of the Reynolds Metals Co. during the year.

Harvey Aluminum Co. continued prospecting in the Essequibo River region, but the Kennecott Copper Co. discontinued its activities.

Bauxite exports listed in table 18 were subject to an export duty of $1 per ton on calcined bauxite and $0.45 on other bauxite, plus a royalty on bauxite produced on crown lands.

[8] Owen, H. B., Bauxite in Australia: Australia Bureau of Mineral Resources, Geology, and Geophysics, Bull. 24, 1954, 234 pp.

TABLE 18.—Bauxite exported from British Guiana, 1953–54 [1]

Country of destination	1953		1954	
	Long tons	Value BW$ [2]	Long tons	Value BW$ [2]
Canada	1, 874, 582	18, 080, 266	1, 787, 300	16, 926, 463
United States	205, 168	4, 664, 629	303, 155	5, 328, 493
United Kingdom	14, 995	216, 309	12, 490	239, 055
Other	17, 330	578, 654	22, 590	740, 596
Total	2, 112, 075	23, 539, 858	2, 125, 535	23, 234, 607

[1] Commercial Review (Georgetown), vol. 38, No. 2, March 1955, p. 50.
[2] 1 BW$=US $0.58.

Colombia.—Compania de Bomba, according to the Ministeria de Minas y Petroleos, was developing the country's first bauxite mine. The deposits cover an area of 5,000 hectares northeast of Medellin between Santa Rosa and Yaruma. The granting of contracts for exploiting other deposits was being considered by the Ministeria.

France.—A record output of 1.25 million long tons of bauxite was eported in 1954. Mines in the Department of Var furnished 79 percent and those in the Department of Hérault and Ariège the remaining 21 percent. Output was sufficient to meet domestic requirements (except for some special grade ores), and to provide for a surplus for export.

Imports of bauxite during the year totaled 11,848 tons and included 1,284 tons from the French West Africa, 6,364 tons from British Guiana for abrasive and refractory manufacture, and 4,200 tons from Greece for use in cement.

Domestic consumption of bauxite was estimated at 949,000 long tons for 1954, distributed as follows: Alumina, 866,000 tons (91 percent); abrasives, 27,000 tons (3 percent); cement, 44,000 tons (5 percent); and refractories, 12,000 tons (1 percent).

There were no restrictions on exports of bauxite, except to West Germany; however, the existence of a quota for West Germany did not hamper exports to that country. Export prices were somewhat higher than the domestic base price of 1,200 francs per ton. Exports increased about 44,000 tons in 1954 to 325,000 tons, of which 157,500 tons went to West Germany, 145,417 to the United Kingdom, 7,337 to Spain, 2,598 to Canada, 2,579 to Italy, and the remainder to other countries.

Germany, West.—Paralleling the increase in West German aluminum production between 1953 and 1954, imports of bauxite also increased. Comparative figures for 1953 and 1954 imports of bauxite. in long tons, were:

Country of origin:[1]		1953	1954
Austria		13,956	17,988
British Guiana		11,101	5,608
France		146,716	160,534
French West Africa		----------	11,496
Gold Coast		7,780	----------
Greece		256,694	240,421
Indonesia		55,859	109,174
Surinam		20	8,099
United Kingdom		1,498	1,289
Yugoslavia		373,695	469,894
Other countries		12	148
Total		867,331	1,024,651
Value	DM[2]	43,572,000	48,291,000

[1] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 6, June 1955, p. 6.
[2] DM equals US $0.238.

Haiti.—Reynolds Metals Co. completed construction of housing and other facilities ancillary to mining on its properties in Haiti; but major installations, including a drying plant, power plant, loading facilities, a pier, and mining equipment, were held up pending acquisition of necessary lands. After these lands were acquired it was expected that the installations would be completed in 1955 and the early part of 1956.

Hungary.—Hungary was participating in the construction of a reduction works in Czechoslovakia, where Hungarian bauxite was to be processed.

The Hungarian aluminum industry had been recovering iron from red mud on a moderate scale for some time. Construction of facilities for recovering the alumina and soda content from the red mud was expected to be completed in the fall of 1955.

India.—Indian output of bauxite was estimated at 79,700 long tons in 1954—a 12-percent increase over 1953. During the year, 28,398 tons of bauxite was consumed in producing 11,425 tons of alumina, of which 9,803 tons was used in manufacturing aluminum.

Reserves of workable bauxite deposits are estimated at 28 million tons and distributed as follows: Bihar, 8.1 million; Madhya Pradesh, 11.6 million; Orissa, 0.8 million; Madras, 2.6 million; Bombay, 2.8 million; and Jammu and Kashmir, 2 million.[9]

Indonesia.—Continued Japanese demand and the entry of West Germany into the market resulted in an increase of 16 percent in production and 52 percent in exports and a 48-percent decrease in stocks. Nederlands Indonesische Bauxite Exploitatie Mij. N. V. (Netherlands Indonesia Bauxite Exploration Co., Ltd.), the only producer, reported a production of 170,504 long tons of bauxite in 1954. Of the 242,913 tons exported, 138,938 tons went to Japan and 103,955 to West Germany via the Netherlands. Stocks on hand at the end of the year totaled 77,247 tons. Domestic consumption was 20 tons.

[9] Eastern Metals Review, India's Ore Reserves: Vol. 8, No. 1, Feb. 7, 1955, pp. 50–52.

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Italy.—The 1954 output of 290,423 long tons of bauxite was the highest since the loss of the Istrian mines to Yugoslavia. Imports (100,453 tons) included 96,325 from Yugoslavia, 2,574 from France, and the remainder from other countries. The output of calcined alumina increased from 136,891 tons in 1953 to 150,679 in 1954, whereas exports decreased from 32,219 tons to 27,283 (14,921 to Switzerland, 12,303 to Austria, and 59 to other countries).

Jamaica.—Reynolds Jamaica Mines, Ltd., and the Kaiser Bauxite Co. exported 2 million long tons of bauxite to their plants in the United States in 1954, an increase of 66 percent over the 1.2 million tons exported in 1953.

Bauxite deposits are reported to have been found 5 miles from the Good Hope ranch in Trelawny Parish.

A report on bauxite resources of Jamaica was published.[10]

The new port of Esquivel was completed, and shipment of alumina was begun. The first shipment to the Kitimat plant in British Columbia was made on May 17. Total exports of alumina by Alumina Jamaica, Ltd., totaled 124,116 tons, an increase of 332 percent over the 28,731 tons exported in 1953. The alumina plant, which began operations in 1953, reached an annual capacity of 230,000 tons in 1954. To meet the expanded capacity of the Kitimat smelter to produce an additional 60,000 tons of aluminum a year, the alumina plant in Jamaica was being expanded to 300,000 tons a year; upon completion of the expansion program it was to have a capacity of 500,000 tons a year.

Japan.—Imports of bauxite increased in 1953 and 1954, after having declined in 1952. The following table shows, in long tons, the trend of imports since 1951.

Country of origin	1951	1952	1953	1954
Malaya	33,743		103,029	116,485
Indonesia	289,518	105,152	132,944	169,300
Other countries	5,835	7,712	7,478	3,732
Total	329,096	112,864	243,451	289,517

The Japan Light Metal Co. contracted to ship 20,000 tons of alumina to the Kitimat, British Columbia, plant of the Aluminum Co. of Canada in 1955.

Production of alumina increased from 89,864 long tons in 1953 to 105,313 in 1954.

Malaya.—Ramunia Bauxite Mining Co. produced 165,622 long tons of bauxite in 1954 and was the only producer. This company was still negotiating for the purchase of a lease on the rich bauxite land about 1 mile west of its property at Telok Ramunia. Exploration for bauxite in the Batang Berjunt area of Selangor was underway during the second half of the year; but there was no immediate prospect for another bauxite producer, as security conditions in the area have prevented large-scale tests.

[10] Zans, V. A., Bauxite Resources of Jamaica and Their Development: Colonial Geol. and Mineral Resources (England), vol. 3, No. 4, 1952, pp. 307–333.

A new contract with the Japanese in July 1954 resulted in increased exports during the second half of the year. The contract called for the shipment of 127,000 tons (dry weight) of ore with 10 percent more or less to be shipped at the buyer's option between July 1954 and July 1955. The price set was 75 shillings c.i.f. a ton.

Exports of bauxite totaled 167,290 tons valued at M$3,449,168, of which 118,236 tons valued at M$2,383,035 was shipped to Japan, 39,264 tons valued at M$866,813 to Formosa, and 9,785 tons valued at M$199,223 to Australia.[11]

Pakistan.—The Pakistan Geological Survey tentatively estimated bauxite-ore reserves at 7 million tons; most of them were in Azad Kashmir.

Rhodesia and Nyasaland, Federation of.—It was announced late in 1954 that the British Aluminium Co., Ltd., had obtained options on bauxite deposits in the Mlanje Mountains of Nyasaland, said to contain about 60 million tons of ore with an average content of 42.73 percent Al_2O_3. Cheap hydroelectric power would be available for the production of alumina when the Shire project is completed.

Sierra Leone.—An exclusive license to prospect for bauxite in an area covering 147 square miles in Freetown and other areas in Sierra Leone has been granted to British Aluminium, Ltd.

Spain.—La Alquima S. A. reported the discovery of metallurgical-grade bauxite deposits in Catalonia, estimated to contain 6 to 7 million metric tons of 60-percent ore. Other known deposits contained only low-grade ore.

Surinam.—Exports of bauxite reached an alltime high of 3,367,000 long tons in 1954. Exports in 1953 and 1954 by mining area, in long tons were as follows:

Mining area:	*1953*	*1954*
Moengo	1, 916, 700	1, 963, 000
Paranam	572, 300	768, 700
Billiton	735, 700	635, 300
Total	3, 224, 700	3, 367, 000

The first full year's operation of the new drying and calcining plant at Moengo resulted in an increase in exports of calcined ore from 36,800 tons in 1953 to 127,500 tons in 1954. All mining activities at the Paranam mine were shifted toward the Rorac Hill and Truly Hill deposits on the east bank of the Surinam River. Drilling continued on the eastern part of the Moengo concession and resulted in the outlining of subsurface deposits in the Paranam area. Dredging to divert the Paranam Creek, which flows over one of the deposits, was undertaken. Research on the treating of low-grade bauxite also began in 1954.

Guiana Exploration Co., Ltd., which began drilling for bauxite in 1953, discontinued operations at the end of 1954.

A description of the new mines and plants in Surinam was published.[12]

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[11] M$1 equals US$0.33.

[12] Mining World; New Mines and Plants in Surinam Assure Bauxite Supply for Alcoa: Vol. 16, No. 11, October 1954, pp. 46–49.

Turkey.—German experts exploring the Antalya region of Turkey reported promising bauxite deposits containing an estimated 65 million tons. A report on the geology and reserves of bauxite deposits was published in 1954.[13]

Venezuela.—Exploration for bauxite continued in 1954. One deposit, estimated to contain 3.6 million long tons, was reported near the town of Upata, Bolivar State.

Yugoslavia.—Bauxite production reached a postwar high of 669,850 long tons in 1954, after having declined in 1953 to 455,009 tons from the previous high of 568,082 tons in 1952. The new plant at Kidricevo began to produce alumina in June and aluminum in October. Exports increased in 1954 to 553,221 tons valued at 1,113 million dinars.[14] West Germany was the largest recipient, taking 454,188 tons valued at 901 million dinars; and Italy ranked next, with 94,610 tons valued at 196 million dinars.

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[13] Göksu, Ekrem, [Geology and Genesis of Bauxite Deposits in Turkey]: Congr. Geol. Internat., Compt. rend, 19th sess., Algiers, 1952 (1954); Chem. Abs., vol. 49, No. 8, Apr. 25, 1955, p. 5225.

[14] 1 dinar equaled US$0.033.

Beryllium

By Horace T. Reno [1]

WORLD BERYL production in 1954 declined 32 percent from the alltime high of 9,300 tons in 1953. Domestic production, although supported by Government buying at an average price of $47 per unit of BeO, decreased from 751 to 669 tons. The world price dropped from $47 to $38 a short-ton unit, reflecting abundant supplies of beryl in the hands of consumers. United States imports of 5,998 short tons of beryl in 1954 were more than 3 times as large as the 1954 consumption. Industrial stocks decreased almost 900 tons during the year.

Emphasis in 1954 centered on civilian use of beryllium and beryllium alloys. Apparently atomic scientists believed that beryllium was not only too difficult to form and shape but also too expensive to be used in nuclear powerplants if other metals would serve the purpose. Primary producers, backed by large beryl inventories and surplus world beryl production, were able to recapture part of the civilian market lost to substitution during the apparent beryl shortage in the period 1950–53. Beryllium-copper production in the first half of 1954 was at a moderate level, following the pattern of the general economy, but picked up rapidly in the last 6 months. Part of the increase was due to Government maintenance-of-plant contracts, but the largest part was caused by increased civilian consumption. Beryllium oxide was used more widely in specialty refractories.

TABLE 1.—Salient statistics on beryl[1] in the United States, 1945–49 (average) and 1950–54, in short tons

Year	Mine shipments	Imports	Total supply	Exports		Consumption	Stocks		Average price per unit BeO	
				Beryl	Metal and alloys (compounds)		Industry	Government	Domestic [2]	Foreign
1945–49 (average)	172	1,737	1,909	0.4	73.8	1,497	943	2,219	21.98	14.95
1950	559	4,860	5,419	.1	110.5	3,007	2,621	(3)	30.51	25.43
1951	484	4,316	4,800	.3	94.8	3,388	1,417	(3)	33.34	31.67
1952	515	5,978	6,493	[4] 1.9	[5] 94.7	3,476	2,492	(3)	38.55	38.55
1953	751	8,245	8,996	.0	[5] 9.7	2,661	4,987	(3)	47.00	47.00
1954	669	5,816	6,485	6.8	3.8	1,948	4,101	(3)	47.00	43.00

[1] Estimated 10 percent BeO.
[2] F. o. b. mine.
[3] Restricted.
[4] Does not include an undisclosed quantity of secondary material exported to United Kingdom.
[5] Revised figure.

[1] Commodity-industry analyst.

TABLE 2.—Beryl shipped from mines in the United States, 1945–49 (average) and 1950–54, by States, in short tons [1]

State	1945–49 (average)	1950	1951	1952	1953	1954
Colorado	(2)	97	97	54	75	60
New Hampshire	(2)	106	50	(2)	57	12
New Mexico	(2)	(2)	141	101	89	117
South Dakota	78	96	138	334	392	337
Other [3]	65	260	58	26	138	143
Total: Short tons	172	559	484	515	751	669
Value	$45,644	$170,550	$161,361	$233,757	$354,487	$303,649
Average value per ton	$265.37	$305.10	$333.39	$453.90	$472.02	$453.88

[1] Estimated 10 percent BeO.
[2] Included with "Other" to avoid disclosure of individual company operations.
[3] Arizona (1949–51, 1953, 1954), Connecticut (1947, 1953, 1954), Georgia (1952–54), Idaho (1954), New York (1954), Maine (1947–54), North Carolina (1949, 1951, 1954), Maryland (1954), and States indicated by footnote 2.

DOMESTIC PRODUCTION

Mine Production.—Domestic beryl production in 1954 decreased more than 14 percent below the record high established in 1953. Production declined about 75 percent in New Hampshire and Connecticut, 50 percent in Colorado and Maine, and 16 percent in South Dakota. Maryland and Tennessee produced beryl for the first time in history. Production increased greatly in Georgia and moderately in New Mexico.

The Harding mine in Taos County, N. Mex., continued to be the principal beryl-producing mine in the United States, and the Hogg mine in Troup County, Ga., developed through Defense Minerals Exploration Administration exploration aid, was an important steady beryl producer. Mines of the Custer-Pringle and Keystone districts in the Black Hills, S. Dak., producing beryl as a byproduct with other minerals, again supplied more than 50 percent of the beryl mined domestically.

The Government purchased 76 percent of domestic beryl produced in 1954. Private companies, although able to buy foreign beryl for less money in the last half of the year, did not completely withdraw from the domestic market but continued to maintain their contacts with domestic mines.

Refinery Production.—The Beryllium Corp. plant at Reading, Pa., and the Brush Beryllium Co. plant at Elmore, Ohio, were the only plants in the United States that processed beryl to beryllium-metal products. Beryllium-copper was by far the principal product of both plants. During the first half of 1954 the market for beryllium-copper was sluggish, as was the National economy, but recovered in the last half of the year in advance of the economy. Government maintenance-of-plant contracts for producing beryllium-copper were awarded to both companies in the second half of 1954. Domestic production of pure beryllium, beryllium-copper, beryllium-nickel, and beryllium-aluminum for civilian use in 1954 apparently increased compared with the quantity produced for civilian use in 1953. Beryl Ores Co., Arvada, Colo., supplied ground beryl and ceramic beryllium frit to manufacturers of end-use ceramic items. Production of these items was about the same as in 1953.

CONSUMPTION AND USES

Beryl consumption dropped 27 percent in 1954 compared with 1953, owing to decreased use in the production of beryllium-copper in the first part of the year. Government maintenance-of-plant contracts and consumption of beryllium-copper in new applications in the latter part of the year prevented further decline.

According to information furnished by leading producers and consumers, 83.6 percent of the beryl consumption was utilized in beryllium-copper, 9.0 percent in ceramics and chemicals, 3.8 percent in beryllium-aluminum, 3.3 percent in beryllium metal, 0.2 percent in beryllium-nickel, and 0.1 percent in beryllium oxide.

Most of the beryllium metal produced was used in making metal alloys; little was used in pure metal form. A small quantity of beryllium added to molten magnesium prevents flashing and oxidation in the melt and reduces flammability in the finished products. Beryllium was used in X-ray windows and as a target in cyclotrons. Its use in nuclear energy apparatus has been erratic, being retarded by its brittleness, relatively low-tensile strength, and high cost. The role of beryllium in the atomic energy program has been described.[2]

STOCKS

Industrial beryl stocks decreased 886 short tons from the alltime high established in 1953. Government beryl stocks were increased, absorbing part of the Free World excess beryl supply. Through December 1954, 557 short tons of beryl had been acquired under the Government's domestic beryl purchasing program; however, part of the beryl acquired under this program was below the accepted commercial grade of 10 percent BeO. Stocks of beryllium alloys and compounds held by primary producers decreased about 20 percent. Quantitative data on industrial inventory of beryllium products and the quantity of beryl in the National Stockpile were not available for publication.

PRICES

Domestic beryl, 10–12 percent BeO, was quoted throughout 1954 by E&MJ Metal and Mineral Markets at $46–$48 per short-ton unit, f. o. b. mine, Colorado. General Services Administration depots bought beryl, containing 8 percent or more BeO, at an average price of about $47 per short-ton unit. The GSA purchasing schedule was detailed in the 1953 Minerals Yearbook. EM&J Metal and Mineral Markets quoted foreign beryl per short-ton unit of BeO, 10–12 percent BeO, c. i. f. United States ports, as follows: January through June 17, $46; June 18 through July 8, $43–$44; July 9 through August 12, $42–$44; August 13 through September 16, $43–$44; September 17 through October 21, $42–$43; and October 22 to the end of the year, $39–$40.

American Metal Market quoted beryllium and beryllium alloys as follows: Beryllium, 97 percent, lump or beads, f. o. b. Reading, Pa., and Cleveland, Ohio, $71.50 per pound; beryllium-copper master

[2] Pahler, R. E., The Role of Beryllium in the Atomic Energy Program: Metal Progress, vol. 65, No. 4 April 1954, pp. 86–91.

alloy, f. o. b. Reading, Pa., or Elmore, Ohio, $40 per pound of contained Be with balance as Cu at market price on date of shipment; and beryllium-aluminum, 5-pound ingot, f. o. b. Reading, Pa., at $72.75 per pound of contained Be through June 11 and $72.25 per pound to the end of the year, plus aluminum at market price.

The Brush Beryllium Co. quoted beryllium-oxide, high-fired, refractory-grade, at $15–$18, depending on quantity, and beryllium-nitrate at $4.95–$5.95, depending on quantity.

FOREIGN TRADE[3]

United States imports decreased 27 percent from the alltime high established in 1953. Brazil continued to be the principal supplier, although the Brazilian Government did not authorize exports until

TABLE 3.—Beryllium ore (beryl concentrates) imported for consumption in the United States, by countries, 1951–54, in short tons

[U. S. Department of Commerce]

Country	1951	1952	1953	1954	Total (short tons)	Percent of total
South America:						
Argentina		550	[1] 1,459		2,009	8.4
Brazil	1,094	2,590	[1] 2,614	1,828	8,126	33.7
Surinam				10	10	.0
Total	1,094	3,140	4,073	1,838	10,145	42.1
Europe:						
Finland	6	3			9	0
Portugal	97	105	[1] 332	338	872	3.6
Sweden				5	5	.0
Total	103	108	332	343	886	3.6
Asia:						
Afghanistan				11	11	.0
India	449	196	199	392	1,236	5.1
Japan [2]	12				12	.1
Korea		3	8	4	15	.1
Total	461	199	207	407	1,274	5.3
Africa:						
Belgian Congo				11	11	.0
British East Africa (principally Uganda)	47	18	22	23	110	.5
Federation of Rhodesia and Nyasaland	[3] 692	[3] 931	[3] 1,296	957	3,876	16.1
French Morocco	23	118	23		164	.7
Madagascar			330	77	407	1.7
Mozambique	174	308	[1] 392	1,295	2,169	9.0
Union of South Africa (includes South-West Africa)	1,722	1,156	[1] 1,323	865	5,066	21.0
Total	2,658	2,531	3,386	3,228	11,803	49.0
Grand total: Short tons	4,316	5,978	[1] 7,998	5,816	24,108	100.0
Value	$1,366,772	$2,548,423	$3,752,718	$2,574,061		

[1] Revised figure.
[2] Country of export only; ore produced principally in Brazil and Argentina before or during World War II.
[3] Southern Rhodesia.

June, when a quota of 4,000 tons at $46 per metric ton, f. o. b., was established. Mozambique and India were the only regular suppliers

[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.

that shipped more beryl to the United States in 1954 than in 1953. Beryl imports from Mozambique totaled 1,295 short tons, triple those in 1953 and more than the total of all past imports. Surinam and Afghanistan shipped beryl to the United States for the first time in history.

Beryl concentrates valued at $22.385 were exported from the United States to Canada and Portugal. Considering Portugal's position as a beryl producer and exporter, it is believed that Portugal was the country of transshipment. Beryllium-metal alloys in crude form and scrap valued at $40,155 were exported principally to Germany and the United Kingdom.

TECHNOLOGY

The low neutron absorption factor of beryllium stimulated interest in the metal on the part of designers of nuclear reactors, despite its brittleness, low tensile strength, and high cost. Zirconium competes with beryllium in nuclear equipment because of workability and cost, but beryllium has a lower neutron absorption factor (0.009 barn compared with 0.18 barn for zirconium) and a better strength to weight ratio. The role of beryllium in the atomic energy program has been described.[4]

Beryllium crystalizes in a close-packed hexagonal lattice. When cast, the metal is extremely coarse grained and brittle. Powder metallurgy therefore is used, to impart strength and ductility to beryllium-metal shapes. The powder metallurgical behavior of beryllium and zirconium has been compared.[5] Beryllium, even when sintered close to the melting point, is not completely dense, whereas zirconium sinters to perfect density at an extremely low temperature. Beryllium powder metallurgical production techniques have been described.[6]

Investigations of the properties of commercially pure beryllium indicated that vacuum hot-pressed beryllium powder exhibits nearly isotropic physical properties and has low but significant ductility at room temperature.[7] Source, preparation, properties, and uses of beryllium, including reduction, vacuum melting, crushing, and hot-pressing were discussed at a meeting on nuclear engineering sponsored by the American Institute of Chemical Engineers and the University of Michigan at Ann Arbor, Mich.[8]

The mechanical properties of beryllium-copper alloys over low temperature ranges have been published.[9] The alloys were tested at successive temperature levels from room temperature to −300° F. A general improvement in physical characteristics, except for an

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[4] Work cited in footnote 2.

[5] Hausner, H. H., and Michaelson, H. B., Powder Metallurgy of Zirconium and Beryllium: Chem. Eng. Progress Symposium, ser. 50, No. 11, 1954, pp. 11–21.

[6] Beaver, W. W., Fabrication of Beryllium by Powder Metallurgy: Metal Progress, vol. 65, No. 4, April 1954, pp. 92–97, 168–173.

Pinto, N. P., The Warm Pressing of Beryllium Powder: Jour. Metals, vol. 6, 1954, pp. 629–633; Trans. AIME, vol. 200, 1954.

[7] Beaver, W. W., and Wikle, K. G., Mechanical Properties of Beryllium Fabricated by Powder Metallurgy: Trans. AIME, vol. 200, 1954, pp. 559–573.

Baldwin, E. E., and Koenig, R. F., Mechanical Properties of Beryllium: Knolls Atomic Power Lab., Sub. No. 4, Contract W-31-109-eng-52 (KAPL-1049), Feb. 15, 1955, 65 pp.

[8] Boyle, E. J., and Cregg, J. L., Preparation, Properties, and Uses of Beryllium: Nuclear Eng., pt. I, Chem. Eng. Progress Symposium, ser. 11, 1954, pp. 53–56.

[9] Richards, J. T., and Brick, R. M., Mechanical Properties of Beryllium Copper at Subzero Temperatures: Jour. Metals, vol. 6, No. 5, May 1954, pp. 574–580.

anomalous drop in ductility and impact strength for unaged specimens, was observed.

The Bureau of Mines conducted extensive investigations of possible methods for beneficiating beryl ore. A pilot plant at Rapid City, S. Dak., was operated to prove beryl flotation techniques developed in the laboratory. Although progress was made during the year, a satisfactory beneficiation process was not developed. In investigating processes applicable to the beryl-bearing deposits of the tin-spodumene belt of North Carolina, a flotation process was developed that made possible the recovery of a 3-percent BeO concentrate from spodumene mill tailings. Efforts to upgrade the concentrate were not successful.

WORLD REVIEW

Argentina.—Argentine Trade Promotion Institute (IAPI) was obligated to purchase all domestic beryl of suitable grades at prices fixed monthly, which until December 31, 1957, cannot be less than 4.20 pesos per kilogram for a 10-percent BeO concentrate. Beryl was not exported to the United States in 1954.

Brazil.—Beryl was mined by numerous small operators, who, owing to shortage of capital, must sell to mineral brokers; a permit from the Brazilian Federal Government has been required for brokers to export the ores. Consequently, it was not unusual for beryl to pass through 3 or 4 intermediates before being exported. In 1954 this situation was further complicated by the Government's waiting to authorize exports until June, when a quota of 4,000 tons at $46 per metric-ton unit, f. o. b., was set. Beryl exports to the United States, embargoed from January to June, totaled 1,828 tons.

French Morocco.—Société des Mines de Zenaga, the only producer of beryl in French Morocco, suspended operation in August 1954. Output during the year was 15 metric tons compared with 33 tons in 1953. Stocks at the end of the year totaled 18 tons as against 13 tons at the beginning of the year. Exports, all to France, totaled 10 tons in 1954; 45 tons was exported in 1953, 25 tons of which was shipped to the United States.[10]

India.—Production of beryl reportedly increased owing to discovery and development of new deposits in Bihav and Rajasthan. The chief producing areas were near Bhilwara, Amet, Kaunthal, Jahazpur, Sahara, Asind, Jaipur, Kishengarh, Malpura, and Tonk.

Madagascar.—A decree to encourage small producers was published by the High Commissioner in the Journal Officiel de Madagascar on April 17, 1954, fixing the selling price of beryllium ore in the island's 5 major centers—Tamatare, Tananarive, Antsivabe, Fianarantsoa, and Majunga—at 700 to 825 CFA francs per kilogram of contained BeO, depending on quality. The Director of the Service of Mines estimated the potential annual production at 1,500 metric tons[11] of 12 to 13.2 percent BeO beryl ore.

Mozambique.—Production reached an alltime high in 1954 owing to more efficient management of existing mines. No new discoveries were reported.

[10] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 5, May 1955, p. 5.
[11] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 4, October 1954, p. 5.

Portugal.—Beryl production from pegmatite mining for columbium and tantalum minerals continued at the high rate established in 1953.

Southern Rhodesia.—Large deposits of beryl, tantalite, and monazite were reported to have been found at Bikita.[12]

TABLE 4.—World production of beryl, by countries,[1] 1945–49 (average) and 1950–54, in short tons [2]

(Compiled by Augusta W. Jann)

Country [1]	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Canada	----	[3] 29	----	----	----	----
United States (mine shipments)	172	559	484	515	751	669
Total	172	588	484	515	751	669
South America:						
Argentina	84	----	----	[3] 550	[3] 1,459	----
Brazil (exports)	1,695	2,894	1,690	2,781	2,381	1,506
Surinam	----	----	----	----	2	10
Total	1,779	2,894	1,690	3,331	3,842	1,516
Europe:						
France	[4] 2	3	2	----	([5])	([5])
Norway	[3] [8] 10	----	----	----	----	----
Portugal	[6] 4	57	112	103	414	332
Total (estimate)	127	171	220	215	524	441
Asia:						
Afghanistan	----	8	2	----	----	[6] 30
India	93	([5])	237	[6] 600	[3] 199	[3] 392
Korea, Republic of	2	----	----	([7])	4	[3] 4
Total	95	[6] 120	239	[6] 600	203	[6] 430
Africa:						
Belgian Congo (including Ruanda-Urundi)	----	----	----	----	8	50
French Morocco	[4] 144	62	93	142	36	17
Madagascar	10	536	584	438	516	648
Mozambique	56	291	254	229	276	[6] 500
Northern Rhodesia	----	6	4	9	6	1
Southern Rhodesia	[8] 25	933	1,110	1,186	1,774	1,077
South-West Africa	86	726	830	592	590	564
Tanganyika	2	----	----	----	----	([5])
Uganda	22	78	2	3	55	77
Union of South Africa	[8] 246	930	654	413	531	203
Total	591	3,562	3,531	3,012	3,792	[6] 3,100
Oceania: Australia	46	25	126	98	140	166
World total (estimate)	2,800	7,400	6,300	7,800	9,300	6,300

[1] In addition to the countries listed, beryl has been produced in a number of countries for which no production data are available; except for U. S. S. R., the 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 Beryllium chapters.
[3] United States imports.
[4] Average for 1948–49.
[5] Data not available; estimates by author of the chapter included in total.
[6] Estimate.
[7] Less than 0.5 ton.
[8] Average for 1 year only, as 1949 was first year of commercial production.

South-West Africa.—Pegmatites of the Karibib-Omaruvu area and the area north of the Orange River have become important sources of beryl and lipidolite.[13]

[12] Metal Bulletin (London), No. 3944, Nov. 16, 1954, p. 25.
[13] Cameron, E. N., The Occurrence of Mineral Deposits in the Pegmatites of the Karibib-Omaruvu and Orange River Areas of South-West Africa: Econ. Geol., vol. 49, No. 1, January-February 1954, p. 117.

Bismuth

By Abbott Renick[1] and E. Virginia Wright[2]

WORLD production of bismuth in 1954, estimated at 3,800,000 pounds, was 10 percent lower than in 1953 but exceeded the 1945–49 average (3,000,000 pounds) by 27 percent. Mexico and Peru, the leading bismuth-producing countries, reported increases over 1953. Outside the Western Hemisphere, the Republic of Korea and Yugoslavia were the most important producers.

Bismuth refined in the United States in 1954 was 42 percent less than in 1953; imports of metallic bismuth remained virtually unchanged from the previous year. Exports of metal and alloys increased 9 percent, and total refiners', consumers', and dealers' stocks on December 31 were slightly higher than those reported on hand at the beginning of the year.

TABLE 1.—Salient statistics of bismuth, 1951–54, in pounds

	1951	1952	1953	1954
Consumers' and dealers' stocks at beginning of year	[1] 238,000	195,400	211,500	166,700
Consumption	[2] 1,737,000	1,775,000	1,568,000	1,439,000
Imports	514,000	708,300	641,400	628,800
Exports [3]	147,000	244,800	[4] 127,000	137,900
World production [5]	3,900,000	3,900,000	4,200,000	3,800,000
Price per pound, New York	$2.25	$2.25	$2.25	$2.25
Consumers' and dealers' stocks at end of year	195,400	211,500	166,700	252,800

[1] Stocks on hand Feb. 1. Data for January not available.
[2] Estimated annual figures. Based on data for 11 months compiled by National Production Authority, U. S. Department of Commerce.
[3] Gross weight.
[4] Revised figure.
[5] Exclusive of U. S. S. R.

Consumption of bismuth totaled 1,439,000 pounds and decreased for the second consecutive year. The fabricating alloys industry, the largest user, consumed 70 percent of the total; the balance was used in pharmaceuticals.

The New York quoted market price of metallic bismuth remained throughout the year at $2.25 per pound, in ton lots, unchanged since September 5, 1950.

DOMESTIC PRODUCTION

Virtually all of the bismuth produced in the United States is derived as a byproduct from smelting domestic and foreign lead ores and by

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

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 1954 output declined 42 percent from that of 1953.

Companies reporting output of refined bismuth metal in 1954 were American Smelting & Refining Co., 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.

CONSUMPTION AND USES

In 1954 domestic consumption of bismuth metal, totaling 1,439,000 pounds, was 8 percent less than in 1953. Consumption of bismuth in pharmaceuticals was 427,500 pounds, representing an increase of about 13,500 pounds, or 3 percent, from the previous year. Consumption of bismuth metal in fabricating alloys was 70 percent of the total.

TABLE 2.—Bismuth metal consumed in the United States, 1951–54, by uses

Use	1951 [1]		1952	
	Pounds	Percent of total	Pounds	Percent of total
Fusible alloys	204,000	12	261,700	15
Solder	109,300	6	145,900	8
Other alloys	560,100	32	865,800	49
Selenium rectifiers	55,000	3	25,500	1
Pharmaceuticals [2]	621,400	36	[3] 417,000	23
Other uses	187,200	11	[3] 59,100	4
Total	1,737,000	100	1,775,000	100

Use	1953		1954	
	Pounds	Percent of total	Pounds	Percent of total
Fusible alloys	191,200	12	192,300	13
Solder	221,000	14	139,600	10
Other alloys	613,800	39	415,000	29
Selenium rectifiers	47,500	3	42,600	3
Pharmaceuticals [2]	[3] 419,500	27	433,500	30
Other uses	[3] 75,000	5	216,000	15
Total	1,568,000	100	1,439,000	100

[1] Estimated annual figures. Based on data for 11 months compiled by National Production Authority, U. S. Department of Commerce.
[2] Includes industrial chemicals.
[3] Revised figure.

STOCKS

Consumers' and dealers' stocks of bismuth increased 52 percent during the year, but producers' stocks decreased. Figures are given in table 1.

PRICES

The New York price for refined bismuth metal remained unchanged at $2.25 per pound, in ton lots, throughout 1954, according to 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] Quotations in pounds sterling converted to dollars, based on an exchange rate of $2.80 to £1 sterling.
[2] Ore or concentrate.

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	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 1954 imports of refined metal totaled 628,800 pounds, virtually unchanged from the 641,400 pounds imported in 1953. Of the total imports, Peru supplied 64 percent, Yugoslavia 12 percent, Republic of Korea 11 percent, Mexico 8 percent, and Canada 5 percent.

Exports.—Exports of bismuth metal and alloys increased 9 percent above the 127,000 pounds exported in 1953. The United Kingdom received 46,400 pounds, West Germany 45,000 pounds, the Netherlands 33,800 pounds, and all other countries combined 12,700 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.

[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 3.—Bismuth metal and alloys imported (for consumption) into and exported from the United States, 1945–49 (average) and 1950–54

[U. S. Department of Commerce]

Year	Imports of refined metallic bismuth		Exports of metal and alloys [1]	
	Pounds	Value	Pounds	Value
1945–49 (average)	381,561	$512,108	210,469	$368,514
1950	781,670	1,287,098	199,253	387,458
1951	514,020	1,003,285	146,998	376,246
1952	708,254	1,451,729	244,797	635,260
1953	641,428	1,273,417	[2] 127,010	[2] 300,963
1954	628,833	1,235,321	137,856	185,841

[1] Gross weight.
[2] Revised figure.

TABLE 4.—Refined metallic bismuth imported for consumption in the United States, 1953–54

[U. S. Department of Commerce]

Country	1953		1954	
	Pounds	Value	Pounds	Value
North America:				
Canada	21,670	$38,271	34,723	$69,043
Mexico	26,604	45,710	49,976	82,679
Total	48,274	83,981	84,699	151,722
South America: Peru	437,779	920,357	400,278	826,912
Europe:				
Belgium-Luxembourg	11,641	23,327		
Netherlands	7,716	14,661	3,307	6,283
Yugoslavia	49,419	98,317	73,191	143,883
Total	68,776	136,305	76,498	150,166
Asia: Korea, Republic of	86,599	132,774	67,358	106,521
Grand total	641,428	1,273,417	628,833	1,235,321

TECHNOLOGY

New uses for bismuth have developed in the field of nuclear power. A study of solutions of uranium and thorium liquid metals and of dispersions of uranium-thorium compounds in liquid metals has led to the discovery of several fuel and breeder systems useful in reactor design. A solution of uranium in bismuth has been proposed for an externally cooled reactor and a dispersion of a uranium-tin compound (USn_3) in lead-bismuth-tin alloys for an internally cooled reactor. A thorium-bismuth compound (Th_3Bi_5) dispersed in bismuth and lead-bismuth has been suggested for a breeder blanket in both reactor designs.[4]

A survey of literature on extractive metallurgy and electrolytic refining of bismuth was made by the Bureau of Mines and published in 1954.[5]

[4] Teitel, R. J., Gurinsky, D. H., and Bryner, J. S., Liquid Metal Fuels: Nucleonics, vol. 12, No. 7, July 1954, pp. 14–15.
[5] Gruzensky, P. M., and Crawford, W. J., A Survey of the Literature on the Extractive Metallurgy and Electrolytic Refining of Bismuth: Bureau of Mines Inf. Circ. 7681, 1954, 22 pp.

The abstract of a technical paper on refining bismuth by distillation and chlorination stated: [6]

> The experiments described show that crude bismuth metal containing up to 5 percent lead, 0.14 percent silver, 0.015 percent copper, 0.02 percent iron, and small amounts of antimony, nickel, and tin may be refined to a bismuth content of 99.98 percent by distillation followed by chlorination. It also is shown that bismuth trichloride of high purity may be produced by passing chlorine over hot crude bismuth metal and allowing the resulting vapours to condense in a cooler part of the system.

The abstract of a technical paper describing the results of tests on the electrodeposition of bismuth follows: [7]

> Bismuth metal of high purity has been electrodeposited from molten mixtures of bismuth trioxide (10% and 25%) and the eutectic mixture of sodium and calcium chlorides. The rate of metal recovery (g./hr.) is good. Energy consumption, based solely on the electrolysis and not on the furnace requirements, is approximately 1 kw.-hr./lb of bismuth.

WORLD REVIEW

Australia.—Bismuth ores were smelted and refined by Bismuth Products Pty., Ltd., Sydney.

Bolivia.—In 1954 bismuth exports were 51 short tons contained in concentrates compared with 69 tons in 1953.

Canada.—The Consolidated Mining & Smelting Co. of Canada, Trail, B. C., continued during 1954 as Canada's largest bismuth producer. Several shipments of crude bismuth metal were made by the Molybdenite Corp. of Canada, Ltd., from its operations at La Corne, Quebec.

A Government report [8] stated:

> In ores at the La Corne mine both molybdenite and bismuth are of economic importance. Reserves at the end of 1954 were estimated to be 200,000 tons averaging 0.51 percent molybdenite (MoS_2) and 0.035 percent bismuth. Ore milled in 1954 was 105,924 tons from which 875,000 pounds of MoS_2 and 70,700 pounds of crude bismuth metal averaging 97.4 percent bismuth were produced. * * *
>
> Treatment of the La Corne ore involves bulk flotation to produce a concentrate averaging 80 percent MoS_2 and 10 percent bismuth. The bismuth is recovered by leaching with hydrochloric acid and then hydrolysing with water to form bismuth oxychloride, which is smelted in cast-iron crucibles to form crude bismuth metal. This is poured in 100-pound ingots.

Korea, Republic of.—In 1954 bismuth production at the Sang Dong mine was about 127 short tons compared with 265 tons (revised figure) in 1953.

Mexico.—Production of bismuth (metal content) in Mexico totaled 398 short tons, of which 109 tons was refined bismuth. The principal Mexican producers are American Smelting & Refining Co. and the Companía Metalurgia Penoles, S. A. (subsidiary of the American Metal Co.).

Peru.—Peru continued to be a substantial producer of bismuth. In 1954 Cerro de Pasco Corp. produced 346 short tons, of which 191

[6] Rogers, R. R., and Campbell, R. A., Refining Bismuth by Distillation and Chlorination: Canadian Inst. Min. and Met., Ann. General Meeting, Montreal, Canada, April 1954.
[7] Morris, Kelso B., Douglass, Dolores Z., and Vaughn, Clarence B., Electrodeposition of Bismuth: Jour. Electrochem. Soc., vol. 101, No. 7, July 1954, pp. 343–347.
[8] Canada Department of Mines and Technical Surveys, Bismuth in Canada, 1954 (Prelim.): Ottawa, 3 pp.

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TABLE 5.—World production of bismuth, by countries,[1] 1945–49 (average) and 1950–54, in pounds [2]

(Compiled by Pauline Roberts)

Country [1]	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Canada (metal) [3]	211,564	191,617	362,571	162,371	117,364	272,696
Mexico [3]	424,743	580,339	745,100	672,297	739,209	795,900
United States	(4)	(4)	(4)	(4)	(4)	(4)
South America:						
Argentina:						
Metal	[5] 28,300	(6)	(6)	[5] 1,100	(6)	(6)
In ore	[5] 27,800	(6)	(6)	[5] 1,100	(6)	(6)
Bolivia (in ore and bullion exported) [7]	77,174	53,887	150,788	35,119	138,731	101,467
Peru [3]	583,562	500,116	579,049	714,828	631,990	691,726
Europe:						
France (in ore)	75,000	172,000	198,000	190,000	159,000	(6)
Spain (metal)	39,295	25,009	33,466	27,044	56,006	[5] 50,700
Sweden	10,335	----------	----------	(6)	(6)	(6)
Yugoslavia (metal)	65,671	124,075	193,476	217,600	217,047	241,842
Asia:						
China (in ore)	[5] 8,300	(6)	(6)	(6)	(6)	(6)
Japan (metal)	50,871	72,860	92,615	96,068	110,159	[5] 128,000
Korea, Republic of	[8] 152,900	(6)	27,600	243,000	529,000	254,000
Africa:						
Belgian Congo (in ore)	798	1,473	496	1,036	----------	(6)
Mozambique	[9] 895	2,575	1,567	11,199	7,057	(6)
South-West Africa (in ore) [5]	1,100	15,900	200	----------	100	(6)
Uganda	5,062	6,385	6,385	6,200	1,100	400
Union of South Africa (in ore)	3,439	16,863	7,019	3,391	[5] 2,200	(6)
Oceania: Australia (in ore)	[10] 5,935	2,015	2,575	3,153	900	(6)
World total (estimate)	3,000,000	3,100,000	3,900,000	3,900,000	4,200,000	3,800,000

[1] Bismuth is believed to be produced also in Brazil, East Germany, Rumania, U. S. S. R., and United Kingdom. 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.
[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 1946–49.
[9] Average for 1 year only as 1949 was first year for commercial production.
[10] Partly estimated. Excludes content of some bismuth-tungsten concentrates.

tons was refined bismuth. According to the Engineering and Mining Journal,[9] Minas de Buenaventura, S. A., explored lower levels at its property in the Julani region, Province of Angaroes, Department of Huancavelica. Ore reserves were reported to assay about 25 ounces of silver per metric ton and 0.15 percent bismuth.

United Kingdom.—Demand for bismuth in the United Kingdom increased substantially in 1954, reflecting the improvement of business in many segments of the economy throughout the year. Quantitative data, however, are not available for publication.

[9] Engineering and Mining Journal, vol. 155, No. 6, June 1954, p. 159.

Boron

By Henry E. Stipp [1] and Annie L. Marks [2]

PRODUCTION of boron minerals and compounds in the United States during 1954 continued to come entirely from California, and output increased somewhat over 1953.

Research on production of elemental boron and boron compounds was prominent during the year, and new uses were explored.

TABLE 1.—Salient statistics of boron minerals and compounds in the United States, 1945–49 (average) and 1950–54

	1945–49 (average)	1950	1951	1952	1953	1954
Sold or used by producers: [1]						
Short tons:						
Gross weight	435, 416	647, 735	862, 797	583, 828	715, 228	778, 420
B_2O_3 content	130, 800	191, 000	241, 000	169, 100	213, 300	225, 888
Value [2]	$10, 342, 993	$15, 890, 000	$20, 030, 000	$14, 105, 000	$17, 668, 000	$26, 714, 440
Imports for consumption (refined):						
Pounds	21, 543	[3] 1, 224	1, 424	[4] 860	624	----------
Value	$1, 444	[3] $416	$497	[4] $306	$216	----------
Exports:						
Short tons	72, 589	142, 580	213, 445	103, 292	139, 317	205, 614
Value	$4, 058, 778	$8, 301, 081	$13, 322, 383	$6, 723, 925	$8, 971, 987	$12, 904, 410
Apparent consumption: Short tons [5]	362, 838	505, 167	649, 353	480, 536	575, 911	572, 806

[1] Borax, anhydrous sodium tetraborate, kernite, boric acid, and colemanite.
[2] Partly estimated.
[3] In addition, 21,286 pounds of crude valued at $200.
[4] In addition, 88 pounds of crude valued at $2.
[5] Quantity sold or used by producers plus imports minus exports.

DOMESTIC PRODUCTION

In 1954 borax was produced from bedded deposits and from natural brines in the United States. The entire output came from California.

The deposit of kernite (rasorite) and borax (tincal) in the Kramer district of California was the world's principal source of supply of boron compounds. The deposit consists of 2 beds of borate minerals approximately 200 to 250 feet thick interspersed with shale and covered by 100 to 400 feet of alluvial overburden. The ore was mined by shrinkage stoping and room-and-pillar methods.[3] Ore treated in the mill at Boron, Calif., was crushed, sized, and concentrated by magnetic separation. Some of the output was further

[1] Commodity-industry analyst.
[2] Statistical clerk.
[3] Pickard, M. H., Borates for the Glass Industry: Glass Industry, vol. 35, No. 2, February 1954, p. 73.

concentrated by calcining to produce anhydrous rasorite. Part of the ore was shipped to Wilmington, Calif., where borax, boric acid, potassium borate, ammonium borate, and sodium metaborate were produced.

The following firms reported production of boron compounds in 1954: American Potash & Chemical Corp. recovered boron compounds from the brine of Searles Lake at Trona, Calif.; 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, Calif.; and West End Chemical Co. recovered boron compounds from the brine of Searles Lake, Calif.

During the year 10 acres of Government land in Kern County, 4 miles northwest of Boron, Calif., was leased to a group of Los Angeles mining men. It was reported that they were planning to mine and process borax on this site.[4]

Boron alloys and related compositions were produced by the following firms:

Producer:	*Products*
American Electro Metal Corp., Yonkers, N. Y.	Miscellaneous metal borides; experimental.
F. W. Berk Co., Inc., Woodridge, N. J.	Boron.
Cooper Metallurgical Associates, Cleveland, Ohio.	Boron; borides of Zr, Ta, W, Ti, Cr, Th, Mo, Cb, Al; cobalt boron; aluminum boron; lithium boron; copper boron; aluminum-titanium boron; boron nitride.
Electro Metallurgical Division, Union Carbide & Carbon Corp., Niagara Falls, N. Y.	Ferroboron, manganese boron, nickel boron, cobalt boron, Silcaz, calcium boride, boron carbide.
Metal Hydrides, Inc., Beverly, Mass.	Borohydrides of sodium, lithium, beryllium, and other elements.
Molybdenum Corp. of America, Washington, Pa.	Ferroboron, manganese boron, cobalt boron, chromium boron, calcium boride.
Niagara Falls Smelting & Refining Division, Continental-United Industries, Inc., Buffalo, N. Y.	Manganese-aluminum boron, nickel aluminum boron.
Norton Co., Worcester, Mass.	Boron carbide, boron, ferroboron.
Ohio Ferro-Alloys Co., Philo, Ohio.	Borosil.
Titanium Alloy Mfg. Division, National Lead Co., Niagara Falls, N. Y.	Carbortam.
U. S. Atomic Energy Commission, Oak Ridge, Tenn.	Boron isotopes B-10 and B-11.
Vanadium Corp. of America, Bridgeville, Pa.	Grainal alloys.

CONSUMPTION AND USES

Boron compounds were consumed in a number of diverse fields. It was estimated that approximately 25 percent of the annual domestic production of B_2O_3 was used in the glass industry, while another 25 percent was consumed by the vitreous enamel and glaze manufacturers.[5]

[4] Mining World, vol. 16, No. 13, December 1954, p. 76.
[5] Pickard, M. H., Borates for the Glass Industry: Glass Industry, vol. 35, No. 2, February 1954, p. 76.

The application of boron compounds to soils deficient in boron increases resistance to certain plant diseases and improves yield.

Borax was used in soaps, cleansers, and synthetic detergents. Borax or boric acid was used in pharmaceuticals, starches, adhesives, chemicals, fireproofing, and smelting.

TABLE 2.—Consumption of alloying metals in the manufacture of steel in the United States, 1951–54 [1]

	Pounds of named alloying metal contained [2]			
	1951	1952	1953	1954
Boron	29,594	48,973	35,015	27,266
Chromium	305,289,694	278,085,534	322,134,071	235,545,168
Cobalt	2,581,689	2,633,413	2,546,384	1,406,042
Columbium and tantalum	453,722	340,871	300,592	370,055
Manganese	(3)	[4] 1,084,988,541	[4] 1,327,068,314	1,042,762,085
Molybdenum	19,069,143	16,530,769	22,066,723	17,798,668
Nickel	75,914,210	84,854,360	79,202,666	62,451,141
Titanium	5,202,645	4,909,339	4,877,225	3,577,631
Tungsten	3,783,382	2,650,147	3,380,867	2,014,306
Vanadium	3,310,898	3,050,586	3,227,900	1,702,354
Zirconium	1,783,443	1,449,282	1,816,392	1,059,001

[1] American Iron and Steel Institute, Annual Statistical Report: New York, N. Y., 1954, p. 19.
[2] Does not include alloying metal contained in scrap.
[3] Data not available.
[4] Revised figure.

TABLE 3.—Production of alloy-steel ingots (other than stainless-steel ingots) in the United States, net tons [1]

Grade	1953		1954	
	Without boron	With boron	Without boron	With boron
Carbon boron		21,269		22,974
Nickel	30,884		26,796	
Molybdenum	406,757	95,482	455,131	53,782
Manganese	331,230	29,967	194,709	23,222
Manganese-molybdenum	290,706	314	307,631	
Chromium	1,621,496	100,177	1,116,999	64,168
Chromium-vanadium	62,038		41,284	
Nickel-chromium	164,824	390	96,648	
Chromium-molybdenum	1,177,141	1,862	686,609	
Nickel-molybdenum	189,286	6,085	359,567	2,466
Nickel-chromium-molybdenum	1,415,479	202,615	851,406	57,018
Silicomanganese	105,096		69,171	
All other	[2] 653,384	6,955	413,389	3,546
Subtotal	[2] 6,448,321	465,116	4,619,340	227,176
High-strength steels	986,139	32,099	528,894	17,752
Silicon sheet steels	[2] 1,276,562		902,429	
Total all grades	8,711,022	497,215	6,050,663	244,928

[1] American Iron and Steel Institute, Annual Statistical Report: New York, N. Y., 1954, p. 53.
[2] Revised figure.

According to one report, three independent clinical research studies confirmed the safety of borated baby powder.[6]

Extremely small percentages of boron added to low carbon and alloy steels increase their hardenability and save alloying metal such as chromium, nickel, and molybdenum.

[6] Chemical and Engineering News, vol. 32, No. 19, May 10, 1954, p. 1878.

Boron trifluoride was reported as being used primarily in the resins and allied organics field, being an essential catalyst for the production of polybutene.[7]

Boron trichloride was used as a catalyst in producing silicone, as a source of boron for borocarbon resistors, and as an extinguishing agent for magnesium fires.

Increased use of elemental boron as a slow neutron absorber, in delayed-action fuses, as a deoxidizer of metals, and as a refractory material in high-temperature jet aircraft components was indicated during the year.

Borate esters were found to be useful 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.[8]

Coatings of boron, boron carbide, and boron nitride can be formed in place on silicon, zirconium, vanadium, or tungsten, producing surfaces that resist heat, corrosion, and wear.[9] Much experimentation has been conducted on the use of zirconium boride for jet and rocket nozzles.

Other promising applications of boron compounds are as a gasoline additive and in jet and rocket fuels.

PRICES

According to Oil, Paint and Drug Reporter, the following prices for boron compounds were quoted during 1954:

Borax, tech., anhydrous, bags, carlots, works, ton	$78.00
Ton lots, ex-warehouse, New York or Chicago, ton	125.75
Bulk, carlots, works, ton	70.00
Crystals, 99½ percent, bags, carlots, works, ton	67.25
Ton lots, ex-warehouse, New York or Chicago, ton	115.00
Granular decahydrate, 99½ percent, bags, carlots, works, ton	41.25
Ton lots, ex-warehouse, New York or Chicago, ton	89.00
Bulk, carlots, works, ton	35.75
Pentahydrate, 99½ percent, bags, carlots, works, ton	55.50
Ton lots, ex-warehouse, New York or Chicago, ton	108.25
Powder, 99½ percent, bags, carlots, works, ton	46.25
Ton lots, ex-warehouse, New York or Chicago, ton	94.00
Borax packed in kegs is $45.50 per ton higher than in paper bags; in barrels $24.50 higher. U. S. P. borax $15.00 per ton higher than technical.	
Acid, boric, tech., 99½ percent:	
Crystals, bags, carlots, works	124.25
Ton lots, ex-warehouse, New York or Chicago, ton	172.00
Granular, bags, carlots, works, ton	99.25
Ton lots, ex-warehouse, New York or Chicago, ton	147.00
Boric acid in kegs $45.50 per ton higher than in paper bags. U. S. P. boric acid $25.00 per ton higher.	

FOREIGN TRADE[10]

In 1954, 205,600 short tons of boron compounds valued at $12,904,400, were exported from the United States. Imports of

[7] Encyclopedia of Chemical Technology, vol. 6, 1951, p. 678.
[8] Chemical World, Boron's New Bid for Jobs: Vol. 75, Sept. 4, 1954, p. 62.
[9] South African Mining and Engineering Journal, Boron as a Coating Material: Vol. 65, pt. 1, No. 3209, Aug. 14, 1955, p. 927.
[10] 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.

boron carbide from Canada totaled 24,200 pounds valued at $49,800. A small quantity of boron products was imported from the United Kingdom.

TABLE 4.—Boric acid and borates (crude and refined) exported from the United States in 1954, by countries of destination

[U. S. Department of Commerce]

Country	Short tons	Value
North America:		
Canada	9, 987	$768, 768
Canal Zone	8	1, 400
Costa Rica	320	23, 138
Cuba	437	29, 921
Dominican Republic	28	2, 549
El Salvador	3	1, 140
Guatemala	5	1, 710
Haiti	1	810
Mexico	3, 236	294, 952
Nicaragua	10	3, 517
Panama	7	2, 480
Trinidad and Tobago	36	2, 542
Total	14, 078	1, 132, 927
South America:		
Argentina	48	21, 125
Brazil	7, 479	550, 082
Colombia	550	51, 882
Peru	344	31, 002
Uruguay	288	27, 632
Venezuela	343	27, 760
Total	9, 052	709, 483
Europe:		
Austria	2, 304	109, 911
Belgium-Luxembourg	4, 710	269, 816
Denmark	1, 531	74, 528
Finland	996	56, 807
France	21, 255	1, 178, 905
Germany, West	45, 146	2, 474, 578
Greece	154	7, 805
Ireland	831	54, 698
Italy	6, 844	348, 991
Netherlands	10, 762	696, 186
Norway	899	65, 287
Portugal	797	53, 764
Sweden	3, 418	212, 706
Switzerland	4, 176	282, 688
Europe—Continued		
United Kingdom	51, 675	$3, 330, 367
Yugoslavia	213	12, 946
Total	155, 711	9, 229, 983
Asia:		
Ceylon	60	6, 236
Hong Kong	3, 098	190, 671
India	3, 624	234, 385
Indonesia	72	5, 497
Iran	181	18, 036
Israel	150	11, 986
Japan	11, 185	717, 511
Korea, Republic of	123	9, 873
Lebanon	28	2, 274
Pakistan	38	1, 768
Palestine	55	4, 599
Philippines, Republic of	411	31, 439
Taiwan	602	37, 499
Other Asia	16	1, 510
Total	19, 643	1, 273, 284
Africa:		
Egypt	424	24, 188
Federation of Rhodesia and Nyasaland	295	22, 690
Union of South Africa	1, 321	123, 017
Total	2, 040	169, 895
Oceania:		
Australia	4, 111	313, 112
British Western Pacific Islands	7	2, 277
New Zealand	972	73, 449
Total	5, 090	388, 838
Grand total	205, 614	12, 904, 410

TECHNOLOGY

A report on refractory hard metals listed the physical and chemical properties of zirconium, chromium, and molybdenum borides.[11] The borides could be polished to a high luster, their electrical and thermal conductivities were similar to those of metals, and they had high melting points (up to 5,000° F.).

Experiments on sintered and hot-pressed specimens of the mixed carbides of titanium, silicon, and boron were conducted at Ohio State University. Tests were evaluated on the basis of apparent porosities, densities, and their oxidation resistances at 2,000° F.[12] At 3,700° F. and higher, titanium and boron carbides were found to react to form titanium diboride and another compound of approximate composition

[11] Everhard, J. L., New Refractory Hard Metals: Materials and Methods, vol. 40, August 1954, pp. 90–92.

[12] Accountius, O. E., Sisler, H. H., Shevlin, T. S., and Bole, G. A., Oxidation Resistances of Ternary Mixtures of the Carbides of Titanium, Silicon, and Boron: Jour. Am. Ceram. Soc., vol. 37, No. 4, April 1954, pp. 173–177.

TiB_{10}. Compounds of 50 to 70 percent titanium carbide, 20 to 40 percent silicon carbide, and 10 percent boron carbide gave objects with low porosities and superior oxidation resistances. Hot-pressed bodies were more resistant to oxidation than sintered forms. A hot-pressed compound of 73.5 percent titanium carbide, 17 percent silicon, and 9.5 percent boron was more resistant than other mixtures.

The use of boron nitride as a thermal and electrical insulation in furnaces for vacuum-induction melting was reported.[13] The crucible, which is rammed in the heating-coil assembly, is surrounded by the boron nitride.

A simple method of preparing potassium, rubidium, and cesium borohydrides from sodium borohydride was described.[14] To prepare potassium borohydride, a water solution of sodium borohydride was added to a water solution of potassium hydroxide. The resulting precipitate was washed and dried in a vacuum oven.

In preparing rubidium borohydride, sodium borohydride dissolved in a minimum amount of methanol was added to a concentrated solution of rubidium methoxide. The white precipitate that formed was filtered and dried in a stream of nitrogen and then in a vacuum oven.

Cesium borohydride was prepared by a similar procedure.

A somewhat similar procedure for preparing lithium, magnesium, and calcium borohydrides has been described.[15]

The United States Atomic Energy Commission applied for patent rights to a process for preparing elemental boron in high-density form.[16] In the process molten alkali metal is dispersed in gaseous boron halide. The dispersed alkali metal reacts with the boron halide to produce elemental boron.

Extensive research on the preparation of boron steels and their characteristics, properties, and performance was reported during the year. A number of graphs showing the hardenability bands for boron steels was published. The graphs denote the Rockwell hardness for given distances from the quenched end of specimens.[17]

A hypothesis for the boron hardenability mechanism [18] was formulated by critical study of boron steels and rate of decomposition of austenite. It was concluded that proeutectoid ferrite forms from austenite by a shear mechanism. In austenite, boron atoms in solid solution effectively retard this shear process.

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[13] Gray, R. V., Boron Nitride as a Furnace Insulation: Metal Progress, vol. 65, March 1954, p. 108.

[14] Bragdon, R. W., and Hickley, A. A., Potassium, Rubidium, and Cesium Borohydrides: Jour. Am. Chem. Soc., vol. 76, July 20, 1954, p. 3848.

[15] Kollonitsch, J., Fuchs, O., and Gabor, U., New and Known Complex Borohydrides and Some of Their Applications in Organic Syntheses: Nature, vol. 173, 1954, p. 125.

[16] Spevack, J. S., Process for Preparing Boron: Official Gazette, U. S. Patent Office, vol. 685, No. 1, Aug. 3, 1954, p. 172.

[17] Metal Progress Data Sheet, Hardenability Bands for Boron Steels: Vol. 65, No. 4, April 1954, p. 112-B.

[18] Spretnok, J. W., and Speiser, Rudolph, A Hypothesis for the Boron Hardenability Mechanism: Trans. Am. Soc. for Metals, vol. 46, 1954, p. 1089.

A report [19] describing the influence of boron on the hardenability of steel listed the following facts:

1. Boron does not appreciably influence the thermodynamic free-energy changes occurring during the transformation of austenite.
2. Boron does not influence the temperature range or rate of formation of martensite, lower bainite, carbide, or pearlite.
3. Boron influences only the rate of formation of ferrite or upper bainite that is nucleated at grain boundaries, by slowing the nucleation rate or decreasing the number of nuclei, not by altering the growth rate.
4. Increasing the austenitizing temperature from which a steel is quenched can decrease the hardening influence of boron.
5. Increasing the carbon content of a steel decreases the influence of boron.

The United Steel Companies of Great Britain listed the composition of a boron steel that is slated to replace some stainless steel and aluminum in aircraft production.[20] The paper reviewed the heat treatment, mechanical properties, fatigue resistance, creep and rupture properties, machinability, deep-pressing properties, welding properties, and applications of the steel. High ductility, fatigue resistance, and tensile strength in addition to superior machinability were claimed for the boron steel.

Data on standard samples and reference standards for boron steels and glass were published by the National Bureau of Standards.[21]

According to Shyne and Morgan, boron is removed from steel at austenitizing temperatures by oxidation at exposed surfaces combined with diffusion to the surfaces.[22] Owing to the loss of boron during austenitizing, the authors of the article proposed that Jominy hardness surveys be made on flats ground deeper than the standard 0.015 inch.

A metal for shielding purposes which absorbs thermal neutrons without producing hard gamma radiation has been studied by the United States Atomic Energy Commission.[23] The metal, called Boral, was produced by adding oxidized boron carbide to molten aluminum. The Boral was cast into ingots and rolled into $\frac{3}{16}$-inch sheets with cold rolls lubricated by kerosene.

The tensile strength of specimens containing 50 percent B_4C, by weight, which were exposed to radiation showed no serious damage. Thermal conductivity (B. t. u./hr.-ft.-° F.) at 200°, 450°, and 500° F., respectively, is $k=25$, 19.2, and 19.0. Density of the metal is equal to 2.5 gm./cc. Boral can be worked by shearing, punching, and sawing. Welding must be done with heliarc. Boral tubes can be hot-turned or pressed.

The influence of boric oxide on the melting, refining, and setting rates of 6 container glasses and 1 sheet glass was investigated.[24]

[19] Fisher, J. C., Jour. Metals, vol. 6, No. 10, October 1954, pp. 1146–1147.
[20] Canadian Metals, vol. 17, No. 5, May 5, 1954, pp. 52, 54.
[21] National Bureau of Standards, Standard Samples and Reference Standards Issued by the National Bureau of Standards: Nat. Bureau of Standards Circ. 552, Aug. 31, 1954, pp. 17, 18, 22.
[22] Shyne, J. C., and Morgan, E. R., Metal Progress, vol. 65, No. 6, June 1954, pp. 88–90.
[23] Kitzes, A. S., and Hullings, W. Q., (U. S. Atomic Energy Commission), Boral: A New Thermal Neutron Shield, Supplement I: AECD 3625, May 1954, pp. 25–40.
[24] Allison, R. S., and Turner, W. E. S., Further Investigations Upon the Influence of Boric Oxide on the Rate of Melting of the Batch, and on the Rate of Refining and of Setting of Commercial Glasses of the Soda-Lime-Silica Type: Jour. Soc. Glass Tech., vol. 38, No. 182, June 1954, pp. 297–364.

Substitution of B_2O_3 in the glasses ranged from 0 to 2.5 percent. Melting and refining rates were measured at 1,400°, 1,450° and 1,500°, with additional meltings at 1,425° and 1,475° in special cases. Viscosity was measured over the temperature ranges 525°–700° and 900°–1,400°. At all temperatures the rate of melting the glasses was significantly increased by progressive additions of B_2O_3, except in the tests on the sheet glass. The rate of refining in all tests increased progressively with additions of B_2O_3. Increase of B_2O_3 progressively lowered the viscosity of all glasses within the range 1,400° to 602°–625°, below which addition of B_2O_3 progressively increased the viscosity. The annealing temperatures were also raised by adding B_2O_3. From the viscosity data, it was shown that a given stage of shaping a glass article could be carried out at a somewhat lower temperature as addition of B_2O_3 was increased.

WORLD REVIEW

Turkey produced 14,331 metric tons of boron minerals or compounds during 1954 as compared with 6,386 of boracite in the previous year.

Production of boric acid in Italy dropped to 3,844 metric tons in 1954 compared with 4,208 in 1953.

West Germany reported production of 33,893 metric tons of boron compounds in 1954.

Bromine

By Henry E. Stipp[1] and Annie L. Marks[2]

PRODUCTION of bromine and bromine compounds in the United States during 1954 continued to increase as it had since 1949. A record high in sales of 220,450,000 pounds, valued at $41,313,000, was established. The increased sale of ethylene dibromide for use in gasoline antiknock mixtures was largely responsible for the greater output of bromine.

DOMESTIC PRODUCTION

In the United States bromine was recovered from sea water, well brines, and saline lake brines. The bulk of output in 1954 was from sea water, and much of it was produced as a coproduct of magnesium.

The 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. The Westvaco Chemical Division at South Charleston, W. Va., also treated well brines. American Potash & Chemical Corp. recovered bromine from the brine of Searles Lake, California.

TABLE 1.—Bromine and bromine in compounds sold by primary producers in the United States, 1945–49 (average) and 1950–54

Year	Pounds	Value	Year	Pounds	Value
1945–49 (average)	73,088,338	$13,857,429	1952	156,201,577	$30,639,292
1950	98,502,300	18,794,978	1953	164,143,348	35,372,386
1951	129,563,073	26,179,556	1954	187,399,110	41,312,669

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

TABLE 2.—Bromine and bromine compounds sold by primary producers in the United States, 1953–54

	Pounds		Value
	Gross weight	Bromine content [1]	
1953			
Elemental bromine	7, 834, 239	7, 834, 239	$1, 701, 496
Sodium bromide	973, 279	755, 751	277, 261
Potassium bromide	2, 792, 563	1, 875, 206	777, 929
Ammonium bromide	376, 003	306, 743	123, 040
Other, including ethylene dibromide	180, 653, 233	153, 371, 409	32, 492, 660
Total	192, 629, 317	164, 143, 348	35, 372, 386
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

1 Calculated as theoretical bromine content present in compound.
2 Included with "Other, including ethylene dibromide."

CONSUMPTION AND USES

The compound ethylene dibromide, an additive to tetraethyl lead for use as an antiknock mixture in gasoline, was the chief bromine product used. In this antiknock mixture ethylene dibromide acts as a scavenging agent, preventing depositions of lead on the cylinders, valves, and spark plugs of the motor. The increasing number of high-compression automobile engines was responsible for the consumption of better quality gasoline. Octane ratings of gasoline can be raised by using more tetraethyl lead and ethylene dibromide.

Many experiments were being conducted on substitute antiknock compounds to find a more efficient, nontoxic additive. Prospects for continued high consumption of ethylene dibromide may be strongly affected by development of substitutes and 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 to control nematodes. The use of methyl bromide as a fumigant of stored products and of seed-bed soil was increasing. It was reported that about 180,000 acres of seed beds and fields was treated with ethylene dibromide in 1954.[3]

Bromine is also used in disinfectants, anesthetics, leather and rubber products, permanent-wave kits, pharmaceuticals, flour and bread, and many organic syntheses.

PRICES

According to Oil, Paint and Drug Reporter the following prices were quoted for bromine and bromine compounds in 1954: Bromine, purified, cases, carlots, delivered east of the Rocky Mountains, was quoted at 27 cents a pound from January to December 20 and 31

3 U. S. Department of Agriculture, Commodity Stabilization Service, The Pesticide Situation for 1954–55: April 1955, p. 12.

cents thereafter; less than carlots, up to 1,000-pound lots, same basis, was quoted at 29 cents a pound from January to December 20 and 33 cents thereafter; drums, lead-lined, delivered east of the Rocky Mountains, was quoted at 34 cents per pound from January to December 20 and 30 cents a pound thereafter; potassium bromide, U. S. P., granular, barrels, kegs, was quoted at 34 cents a pound from

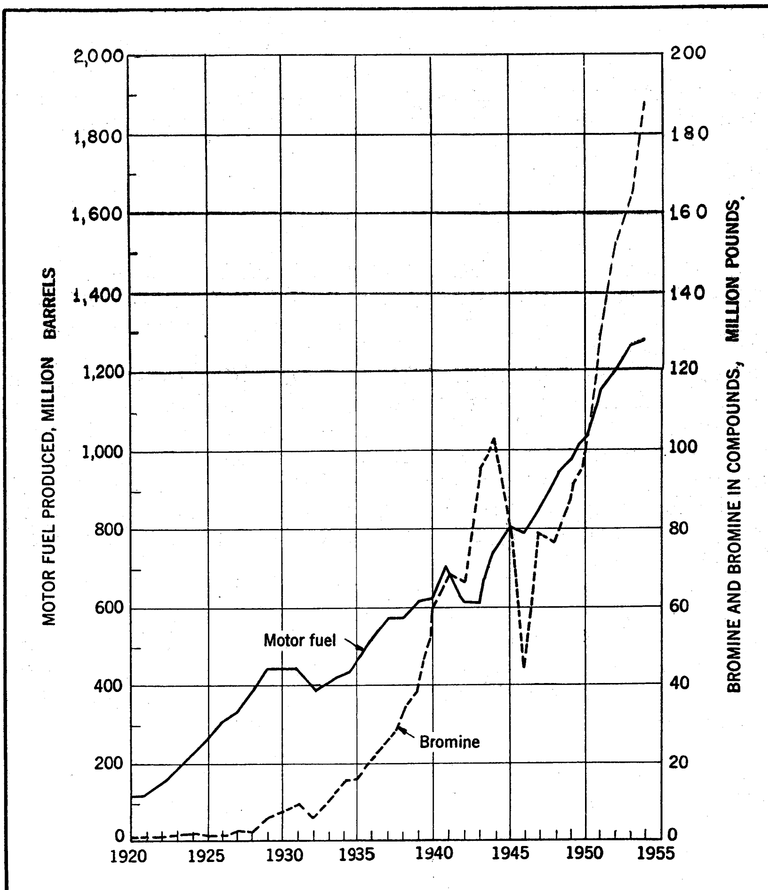

FIGURE 1.—Bromine and bromine in compounds sold or used and motor fuel produced, 1920–54.

January to December and 34–35 cents a pound for the remainder of the year; potassium bromate, barrels, 1,000 pounds or more, was quoted at 50-52 cents a pound; sodium bromide, U. S. P., barrels, kegs, works, was quoted at 34–35 cents a pound. There was no change in price for potassium bromate or sodium bromide during 1954.

FOREIGN TRADE [4]

Exports of bromine, bromides, and bromates (not separately classified) totaled 5,082,400 pounds valued at $2,308,431 in 1954. Brazil was the largest buyer, importing 2,825,400 pounds. Canada received 404,900 pounds, United Kingdom 390,400 pounds, Italy 287,400 pounds, Netherlands 260,400 pounds, Switzerland 192,700 pounds, Mexico 135,200 pounds, West Germany 129,400 pounds, and other countries the remainder, in smaller amounts.

Only small quantities of bromine and bromine compounds were imported into the United States during the year. Imports of 11 pounds of potassium bromide came from France, 77,162 pounds of ethylene dibromide from West Germany and Switzerland, and 487 pounds of bromine and bromine compounds from France, West Germany, Switzerland, and Australia.

TECHNOLOGY

A new bromine plant constructed on the northern coast of the Isle of Anglesy, Great Britain, involved application of approximately 170 tons of compounded rubber.[5] Concrete, steel, and other construction materials totaling 250,000 square feet in area were covered with rubber and ebonite to protect them from the corrosive action of chemicals used in recovering bromine from sea water.

According to an article, fuel additives such as tetraethyl lead and ethylene dibromide have not been used in concentrations that cause engine damage. However, there has been controversy over this point in the industry, and much work has been done to find more effective and harmless substitutes. Several compounds have reached the field-trial stage.[6]

A method was described for separating iodide, bromide, and chloride from each other. In the first step the iodide was converted to iodine in dilute-acid solution and removed by distillation. Bromide then was converted to bromine by a controlled concentration of nitric acid and then removed by distillation. Chlorine remained in the residual solution. A procedure for identifying individual halides was described.[7]

Patent rights were granted for a method of stabilizing an interpolymer of a isoolefinic hydrocarbon and a brominated polyolefinic hydrocarbon.[8]

A patent was granted for making a solid, nonflammable, cellular, resinous body composed for the most part of a solid solution of a brominated thermoplastic polymer.[9]

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[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] Chemical Age (London), New Ethylene Dibromide Plant: Vol. 70, No. 1818, May 15, 1954, pp. 1093–1094.

[6] Jeffrey, R. E., Griffith, L. W., Dunning, E., and Baldwin, B. S., Improve Fuel With Phosphorus Additives: Pet. Refiner, vol. 33, No. 8, August 1954, pp. 92–96.

[7] National Bureau of Standards, Separation of Iodide, Bromide, and Chloride From One Another and Their Subsequent Determination: Jour. Research, vol. 53, No. 1, July 1954, pp. 13–18.

[8] Crawford, R. A., and Morrissey, R. T., Stabilized Isoolefin Polyolefin Interpolymer Derivatives and Method of Producing Same: U. S. Patent 2,681,899, June 22, 1954.

[9] McCurdy, J. L., and Kin, L., Nonflammable Cellular Resinous Bodies and Method of Making Same U. S. Patent 2,676,927, Apr. 27, 1954.

WORLD REVIEW

France.—French production was reported as 1,216.3 metric tons in 1954.

Germany.—West Germany (Bonn) was reported to have produced 1,712 metric tons of bromine and bromine compounds.

Israel.—A plant at S'dom started potash production in 1953. It was reported that bromine is to be recovered from this operation in the near future; however, uncertain market conditions and political unrest could delay bromine production.

Jordan.—The Jordan Development Board was said to be considering a plan to set up a company to exploit the mineral resources of the Dead Sea.[10]

[10] Chemical Week, Expansion Jordan: Vol. 75, No. 11, Sept. 11, 1954, p. 29.

Cadmium

By Robert L. Mentch [1]

CADMIUM exceeded demand in the United States in 1954 for the third successive year. Features of the year were the high rate of production at domestic plants, reduced consumption, the continued accumulation of stocks, and a reversal of the import-export position. Total supply, consisting of output of metal and primary compounds at domestic plants and imports of metal, was 9,954,000 pounds or 12 percent below the alltime peak of 1953. Apparent consumption of primary cadmium declined from the historical peak of 9,570,000 pounds in 1953 to 7,499,000 pounds in 1954, the lowest since 1951 when restrictions on uses were in effect. Stocks advanced to a new high during the year; metal producers', compound manufacturers', and distributors' inventories of metallic cadmium totaled 5,329,000 pounds on December 31 compared with stocks of 3,872,000 pounds at the end of 1953. Metal producers' stocks increased nearly 1½ million pounds, accounting for the gain; at the annual rate of shipments (including internal plant consumption) in 1954 their inventories represented about 7 months' supplies.

One of the most significant developments of the year was a marked turnabout in the import-export position of cadmium metal. Imports of metal in 1954 totaled 402,300 pounds compared with 1,555,000 pounds in 1953, while exports were 999,000 pounds compared with 65,900 pounds in 1953. This change in the import-export pattern was attributed to a number of factors, including the large stocks on hand at domestic plants, increased consumption in Europe, and a lower selling price in the United States than in Europe for part of the year.

TABLE 1.—Salient statistics of the cadmium industry in the United States, 1945–49 (average) and 1950–54, in pounds of contained cadmium

	1945–49 (average)	1950	1951	1952	1953	1954
Production (primary)	7,873,047	9,190,394	8,311,337	8,567,159	9,767,197	9,551,710
Imports (metal)	46,689	630,109	90,065	1,478,770	1,555,140	402,299
Exports (metal)	413,564	352,927	606,233	[1] 300,918	[1] 65,866	[1] 998,959
Consumption, apparent	7,727,308	9,545,502	7,170,930	9,007,577	[2] 9,570,063	7,498,719

[1] Includes metal, dross, flue dust, residues, scrap, and alloys.
[2] Revised figure.

DOMESTIC PRODUCTION

The entire domestic supply of primary cadmium is recovered concurrently with the treatment of ores of other metals as a byproduct from the fumes and flue dusts of zinc blende roasting and sintering

[1] Commodity-industry analyst.

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machines and copper and lead smelting 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. A relatively small quantity of secondary metal is recovered from old bearings and other alloy scrap. A large part of the United States production of primary cadmium is obtained from foreign materials, notably from imported cadmium-bearing flue dust and zinc and lead ores and concentrates. In 1954, as in the two previous years, United States imports of zinc concentrates were considerably above the average for earlier years; consequently, in 1952–54 it was estimated that over 60 percent of the cadmium metal produced at domestic plants was of foreign origin. Virtually all of the foreign cadmium-bearing raw materials were obtained from countries in the Western Hemisphere. Mexico was the chief source, followed by Canada and Peru.

The output of primary metallic cadmium at domestic plants declined 3 percent in 1954, while the production of primary compounds (cadmium content) increased 60 percent. Recovery of cadmium in secondary metal and compounds produced from secondary materials nearly doubled during the year.

The efficiency of cadmium recovery operations has improved substantially over the past 14 years as a larger market for cadmium developed. The quantity of cadmium recovered from domestic and imported zinc concentrates has increased from about 5.2 pounds per ton of recoverable zinc in 1941 to approximately 9.7 pounds in 1954; the average recovery for 1950–54 was about 8.1 pounds. Table 3 shows the approximate recovery of cadmium per ton of recoverable zinc for the years 1941–54.

TABLE 2.—Cadmium produced and shipped in the United States, 1945–49 (average) and 1950–54, in pounds of contained cadmium

	1945–49 (average)	1950	1951	1952	1953	1954
Production:						
Primary:						
Metallic cadmium	7,549,368	8,849,690	8,114,238	8,387,824	9,682,197	9,415,710
Cadmium compounds [1]	323,679	340,704	197,099	179,335	85,000	136,000
Total primary production	7,873,047	9,190,394	8,311,337	8,567,159	9,767,197	9,551,710
Secondary (metal and compounds) [1,2]	207,580	427,052	167,957	80,000	70,000	138,000
Shipments by producers:						
Primary:						
Metallic cadmium	7,495,686	8,851,835	7,767,055	7,746,361	8,137,045	7,921,741
Cadmium compounds [1]	323,679	340,704	197,099	179,335	85,000	136,000
Total primary shipments	7,819,365	9,192,539	7,964,154	7,925,696	8,222,045	8,057,741
Secondary (metal and compounds) [1,2]	213,757	427,052	87,633	122,785	59,636	148,874
Value of primary shipments:						
Metallic cadmium	$10,410,609	$17,925,482	$19,397,411	$17,130,966	$15,229,861	$11,925,068
Cadmium compounds [3]	420,842	689,926	492,215	396,581	158,950	204,000
Total value	10,831,451	18,615,408	19,889,626	17,527,547	15,388,811	12,129,068

[1] Excludes compounds made from metal.
[2] Bureau of Mines not at liberty to publish figures separately for secondary cadmium compounds.
[3] Value of metal contained in compounds made directly from flue dust or other cadmium raw materials (except metal).

TABLE 3.—Recovery of cadmium per ton of recoverable zinc, 1941–54

	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
United States mine production of recoverable zinc (thousand short tons)	749	768	744	719	614	575	638	623	593	623	681	661	547	473
United States imports of recoverable zinc in zinc concentrates (thousand short tons) [1]	246	313	456	359	324	231	253	225	212	237	258	383	436	378
Total United States production of primary cadmium (thousand pounds)	7, 234	7, 371	8, 467	8, 779	8, 384	6, 471	8, 508	7, 776	8, 227	9, 191	8, 311	8, 567	9, 767	9, 552
Cadmium recovered from imported flue dust (thousand pounds) [2]	2, 089	1, 552	1, 479	1, 520	1, 974	1, 488	2, 120	1, 645	1, 611	1, 442	1, 446	1, 973	1, 678	1, 340
Cadmium recovered from domestic and foreign zinc concentrates (thousand pounds)	5, 145	5, 819	6, 988	7, 259	6, 410	4, 983	6, 388	6, 131	6, 616	7, 749	6, 865	6, 774	8, 089	8, 212
Cadmium recovered per ton recoverable zinc (pounds)	5. 2	5. 4	5. 8	6. 7	6. 8	6. 2	7. 2	7. 2	8. 2	9. 0	7. 3	6. 5	8. 2	9. 6

[1] Calculated as 85 percent of the zinc content.
[2] Calculated as 90 percent of the cadmium content.

A list of the plants producing cadmium metal in the United States in 1954 follows:

Primary metallic cadmium

Colorado: Denver—American Smelting & Refining Co.
Idaho:
  Bradley—Bunker Hill & Sullivan Mining & Concentrating Co.
  Silver King—Sullivan Mining Co.
Illinois:
  Depue—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—Anaconda Copper Mining Co.
Oklahoma:
  Bartlesville—National Zinc Co., Inc.
  Henryetta—Eagle-Pitcher Co. (Mining and Smelting Div.)
Pennsylvania:
  Donora—United States Steel Corp. (American Steel and Wire Div.)
  Josephtown—St. Joseph Lead Co.
Texas: Corpus Christi—American Smelting & Refining Co.

Secondary metallic cadmium

Arkansas: Jonesboro—Arkansas Metals Co.
Illinois: Chicago—United Smelting & Refining Corp.
New York: Whitestone, L. I.—Neo-Smelting & Refining, Inc.

A number of zinc- and lead-producing plants that do not produce refined cadmium have facilities for collecting cadmium fume, dust, sponge, or residues; these plants are listed below.

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.

Output of cadmium oxide (cadmium content) decreased 12 percent in 1954, and the cadmium content of sulfide pigments declined 15 percent. Data on the production of other cadmium compounds are not available because most compounds are produced at consumers' plants chiefly from metal.

TABLE 4.—Cadmium oxide and cadmium sulfide produced in the United States, 1945–49 (average) and 1950–54, in pounds

Year	Oxide		Sulfide [1]	
	Gross weight	Cd content	Gross weight	Cd content
1945–49 (average)	431,880	376,720	2,927,824	1,053,578
1950	579,538	505,336	4,383,943	1,570,522
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

[1] Includes cadmium lithopone and cadmium sulfoselenide.

CONSUMPTION AND USES

The apparent consumption of primary cadmium in all forms totaled 7,499,000 pounds in 1954, as computed by adding production and net imports of metal and adjusting for producers', distributors', and compound manufacturers' stock changes. This figure is a decrease of 22 percent from the quantity apparently consumed in 1953. Reduced apparent consumption in 1954 was reflected in the complete transition of the import-export position. In 1953 net imports of cadmium totaled 1,489,000 pounds, whereas in 1954 exports exceeded imports by 597,000 pounds. The inventory position of cadmium in the National Stockpile was favorable in 1954, and acquisitions were no longer highly urgent. In the preceding 6 years the Federal Government had purchased large quantities of the metal for this reserve.

The chief uses of cadmium are for electroplating, pigments, and low-melting-point alloys; these uses have accounted for about 90 to 95 percent of the total consumption of cadmium, electroplating being by far the largest use. For the period 1940–44, 71 percent of the United States cadmium consumption was for electroplating, 11 percent for bearing alloys, and the remainder for pigments, solders, miscellaneous alloys, and various chemicals. More recent information on end uses is not available, but the current pattern is believed to be much the same as in 1940–44, except that considerably more cadmium was used in pigments and low-melting-point alloys than for bearing alloys, which use has declined markedly since World War II.

Electroplating.—Cadmium is used largely as a protective coating for iron and steel and, to a much smaller extent, for high-copper alloys, and other metals and alloys. Although cadmium may be applied by spraying or hot dipping, it is most commonly electrodeposited.

Cadmium and zinc (unlike many other coatings, such as copper, tin, nickel, and chromium, which protect the basis metal only by physical enclosure) protect steel and copper-alloy base metals electrochemically. Thus, metals other than zinc, when substituted for cadmium, must be applied in appreciably thicker coatings to give equal protection. Cadmium is used as an electrodeposited coating in preference to zinc for the following reasons: (1) In thinner coatings it provides equal protection in some applications, principally where the plated article is subjected to extended alkali or salt-water exposure; (2) the rate of deposition for a given amperage of electric current is greater, thus reducing electric-power costs; (3) the electrical resistance of plated contacts is lower; (4) cadmium retains its metallic luster longer; (5) cadmiumplated parts are soldered more easily; (6) cadmium is superior in throwing power, or the property of depositing uniformly on intricately shaped objects; (7) it simplifies plating-process control and can be plated on cast and malleable iron and on high-carbon and carburized-steel surfaces; (8) it has higher cathode efficiency than zinc and hence reduces the tendency for hydrogen embrittlement more effectively; (9) its electrodeposits are highly ductile, so that parts to be formed or stamped may be plated before these operations. The chief disadvantage of cadmium plating as compared with zinc plating is its higher cost. Items commonly electroplated with cadmium include nails, screws, rivets, bolts, nuts, washers, fasteners, springs, electrical contacts, carburetor and magneto parts, television and radio parts, and miscellaneous parts for a wide variety of products, including aircraft, ordnance, and automobiles.

Data on the distribution of consumption are not available. It is believed, however, that in 1954 and the two preceding years, more zinc was substituted for cadmium in many plating applications than in previous years owing to the lower cost of zinc and its more reliable supply.

Cadmium-Base Bearing Alloys.—Cadmium-base bearing metals are used in internal-combustion engines for service under high pressures and temperatures and at high speeds. The bearing alloys are usually of 2 types—the cadmium-nickel type containing 98.65 cadmium and 1.35 percent nickel and the cadmium-silver containing 0.2 to 2.25 percent silver, 0.25 to 2 percent copper, and the balance cadmium. During World War II this was the second largest use for cadmium, exceeding 1 million pounds annually for several years. After the war, use of cadmium in bearing alloys decreased and in 1954 was relatively small.

Cadmium Solders and Other Cadmium Alloys.—Cadmium forms solders when combined with various proportions of such metals as copper, lead, tin, zinc, and silver. The most widely used have been the cadmium-silver solders. Solders of cadmium and base metal, containing little or no tin, were developed during World War II because of the scarcity of tin.

Cadmium metal is alloyed with lead, bismuth, and tin to make low-melting-point alloys for fire-detection apparatus, fusible elements in automatic sprinkler heads, fire-door release links, automatic shutoffs for gas and electric water-heating systems, safety plugs for compressed-gas cylinders, and temperature-controlled safety clutches.

Cadmium alloys quite easily with copper; master alloys containing up to 50 percent cadmium are added to copper and bronze. Low-cadmium copper (0.7 to 1 percent) is ductile and has found wide use in telegraphic, telephonic, and power-transmission wires, since it has high tensile strength, is a good conductor, and is resistant to wear. It is most useful as trolley wire where these properties are of prime importance. An alloy of copper-zirconium-cadmium, also used for power-transmission lines, is superior in strength and hardness to copper-cadmium alloys without severe loss of electrical conductivity.

Cadmium Compounds.—The most important cadmium compounds are the sulfide and the sulfoselenide; their chief use is as paint pigments, in colors ranging from yellow to dark maroon. These compounds extended with barium sulfate are known as cadmium lithopones. Cadmium pigments are useful on exposed surfaces such as on automobiles, where heat resistance is essential, since cadmium sulfide is not oxidized as easily as zinc sulfide. They also are useful in atmospheres containing hydrogen sulfide, which darkens paints containing lead owing to the formation of the black lead sulfide. The increased use of cadmium pigments in automotive finishes was one of the bright spots in the cadmium industry in 1954. Introduction of new cadmium enamels has permitted car stylists to select colors considered impermanent as recently as 3 years ago. Some of the more common uses of the cadmium pigments are in durable, nonbleeding automobile and machinery enamels and finishes, artificial leather, coated fabrics, plastics, rubber, soaps, glass, paper, printing inks, baking enamels, ceramic glazes, lithographic inks, and artists' oil and water colors.

The continued scarcity of selenium limited the output of cadmium sulfoselenide pigments in 1954; the supply of selenium has been extremely short since 1950.

Virtually all the cadmium oxide, hydrate, and chloride produced are used in electroplating solutions. Cadmium bromide, chloride, and iodide are used in photographic films, process engraving, and lithographing.

A table listing the more important cadmium compounds and their physical properties and uses can be found in the Cadmium chapter of the Minerals Yearbook, 1949 (pp. 187–188).

Nickel-Cadmium Batteries.—The nickel-cadmium battery received considerable attention during the year, but actual consumption of cadmium for this use was small. Models (suitable for automobiles) containing 2 to 3 pounds of cadmium have been manufactured in the United States, but so far consumer acceptance has been limited. Nickel-cadmium batteries are used at present chiefly for heavy-duty purposes, such as in buses, diesel locomotives, and other heavy machinery. More widespread use of the automobile-type battery appears to be hindered by its high cost, which is estimated at 4 to 5 times that of a comparable lead-acid battery.

Cadmium in Atomic Energy.—Relatively small quantities of cadmium have been used in the atomic energy program. Cadmium absorbs thermal neutrons readily and in this connection is employed to control the fissionable elements in reactors. It is also used for shielding purposes, usually with lead; the absorption of neutrons causes cadmium to emit gamma rays, which in turn are stopped by the lead. Details of cadmium's role in nuclear physics were given in the Cadmium chapters of Minerals Yearbooks, 1952 and 1953.

STOCKS

Total domestic stocks of cadmium metal and cadmium contained in compounds, excluding consumers' stocks (other than those of compound manufacturers) for which data are not available, increased 38 percent during 1954 to 5,329,000 pounds, an alltime high. Details are given in table 5.

TABLE 5.—Cadmium stocks at end of year, 1953–54, in pounds of contained cadmium [1]

	1953 [2]			1954		
	Metallic cadmium	Cadmium compounds	Total cadmium	Metallic cadmium	Cadmium compounds	Total cadmium
Metal producers (primary)	3,047,745		3,047,745	4,541,714		4,541,714
Compound manufacturers	76,724	416,511	493,235	85,480	442,319	527,799
Distributors [3]	256,468	74,762	331,230	203,677	55,351	259,028
Total stocks [4]	3,380,937	491,273	3,872,210	4,830,871	497,670	5,328,541

[1] Excludes cadmium in National Stockpile.
[2] Figures partly revised.
[3] Comprises principally 8 largest dealers and producers of plating salts.
[4] Excludes consumers' stocks (other than compound manufacturers), which were about 1 million pounds at the end of 1944 (latest date for which figures were compiled).

PRICES

The quoted price of cadmium sticks and bars, delivered, in 1- to 5-ton lots, was reduced from $2.00 a pound to $1.70 on February 1 and remained at this level for the balance of the year. Concurrently, the quoted price for special platers' shapes was lowered 40 cents a pound to $1.75 and on June 21 was further reduced to $1.70. In addition to the official price cuts, large quantities of cadmium were sold, both for the domestic and export markets, at prices considerably below the listed quotations.

In the London market the quotation for cadmium sticks and bars per pound ranged from 13s. 10d. (equivalent to $1.93 on the basis of $2.7975 per £) to 14s. 4d. ($2.00) at the beginning of the year to 11s. 6d. ($1.61) to 11s. 8d. ($1.63) at the year's close.

FOREIGN TRADE [2]

Total imports (for consumption) of metallic cadmium and cadmium contained in flue dust decreased 45 percent in weight and 59 percent in value in 1954. Exports of cadmium metal, alloys, dross, flue dust, residues, and scrap increased more than 15-fold in weight and nearly 24 times in value compared with 1953 figures.

Imports.—United States imports of metallic cadmium in 1954 declined 74 percent from the record total of 1953. Of the 402,300 pounds imported, Canada supplied 40 percent, Belgium-Luxembourg 23 percent, Australia 14 percent, Japan 11 percent, Peru 7 percent,

[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.

and Italy 5 percent. Imports of flue dust (cadmium content), preponderantly from Mexico, decreased 20 percent and were the lowest on record.

Exports.—United States exports of cadmium (metal, alloys, dross, flue dust, residues, and scrap) increased from 65,900 pounds in 1953 to 999,000 pounds in 1954, an alltime high. Of the quantity exported, the United Kingdom received 51 percent, West Germany 31 percent, and the Netherlands, Canada, Sweden, Belgium-Luxembourg, Brazil, Mexico, Switzerland, India, Yugoslavia, Italy, and the Philippines the remaining 18 percent.

TABLE 6.—Cadmium metal and flue dust imported for consumption in the United States, 1952–54, by countries

[U. S. Department of Commerce]

Country	1952		1953		1954	
	Pounds	Value	Pounds	Value	Pounds	Value
METALLIC CADMIUM						
North America: Canada	10,080	$13,104	508,946	$901,300	159,400	$248,529
South America: Peru			10,925	21,850	28,637	50,500
Europe:						
Belgium-Luxembourg	1,195,186	2,152,950	536,523	933,860	93,000	165,557
Germany, West	6,083	10,666	4,079	7,341		
Italy			66,142	120,800	22,047	28,617
Netherlands			3,000	5,700		
Norway			66,138	103,896		
United Kingdom					224	587
Total	1,201,269	2,163,616	675,882	1,171,597	115,271	194,761
Asia: Japan	267,421	449,806	211,175	337,867	44,094	65,224
Oceania:						
Australia			123,289	204,732	54,897	94,558
New Zealand			24,923	36,507		
Total			148,212	241,239	54,897	94,558
Total metallic cadmium	1,478,770	2,626,526	1,555,140	2,673,853	402,299	653,572
FLUE DUST (CD CONTENT)						
North America:						
Canada	2,506	6,645				
Mexico	1,984,831	2,429,495	1,863,538	1,586,895	1,482,565	1,077,992
Total	1,987,337	2,436,140	1,863,538	1,586,895	1,482,565	1,077,992
South America: Peru	4,212	10,742				
Total flue dust	1,991,549	2,446,882	1,863,538	1,586,895	1,482,565	1,077,992
Grand total	3,470,319	5,073,408	3,418,678	4,260,748	1,884,864	1,731,564

TABLE 7.—Cadmium exported from the United States, 1951–54, by kinds, in gross weight

[U. S. Department of Commerce]

Kind	1951		1952		1953		1954	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
Dross, flue dust, residues, and scrap	200,579	$10,029	300,918	$5,005,370	65,866	$60,256	998,959	$1,422,040
Metal	606,233	2,198,311						
Alloys	5,639	9,311						
Total		2,217,651		5,005,370		60,256		1,422,040

Tariff.—The import duty on cadmium metal remained at 3¾ cents per pound in 1954, the level 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 7½ cents per pound as established in the Canadian Trade Agreement of 1939. Cadmium contained in flue dust remained duty free in 1954.

TECHNOLOGY

A potential new use for cadmium has resulted from technological research. The United States Air Force announced [3] the development of a solar generator using cadmium sulfide for converting sunlight into electrical energy. Cadmium sulfide powder processed into crystal form permits a direct conversion of light into electric impulses. The Air Force said that a wafer-thin slab of the crystalline material, 4 by 15 feet, would supply enough current to take care of an average house.

According to the Air Research and Development Command, the crystal in the pilot model is about 1 inch square and supplies a charge of ¼ volt. Attached to opposite sides of the crystal are electrodes or terminals. One, made of silver, is the positive electrode, and the other, made of indium, is the negative. A wire running from the positive electrode to a motor or battery and back to the negative electrode forms the circuit. Light striking the crystal-electrode interface induces a direct potential carried out by means of the electrodes.

The potential of cadmium sulfide was detected by the Air Force while collecting data for a program of crystal study.

WORLD REVIEW

NORTH AMERICA

Canada.[4]—Output of cadmium in Canada in 1954 was 1,027,000 pounds, a slight decline from that in 1953. The Consolidated Mining & Smelting Co. of Canada, Ltd., by far the largest producer, and Hudson Bay Mining & Smelting Co., Ltd., produced refined cadmium from the treatment of zinc concentrates from company and custom ores. The metal is accumulated in cadmium-rich precipitates resulting from the purification of the zinc electrolyte used in the electrolytic process for making refined zinc. About 70 percent of the cadmium in the concentrates is recoverable. Consolidated's refinery at Trail, British Columbia, has a rated capacity of 1,400,000 pounds of cadmium a year and Hudson Bay plant 360,000 pounds.

Much of the Trail output came from zinc concentrates from Consolidated's Sullivan mine. Other important sources were the Bluebell and Tulsequah mines, both owned by Consolidated, and the Jersey mine of Canadian Exploration, Ltd. The Sullivan zinc concentrates averaged about 0.14 percent cadmium, but the cadmium content of some of the other concentrates ranged up to 0.82 percent. United Keno Hill Mines, Ltd., in the Mayo district, Yukon, was an important cadmium producer. In 1954 the company shipped zinc concentrates containing about 310,000 pounds of cadmium to the Trail smelter.

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[3] Press release, United States Air Force, Air Research and Development Command, June 1954.
[4] Neelands, R. E., Cadmium in Canada, 1954 (Prelim.): Canada Dept. Mines and Tech. Surveys.

TABLE 8.—World production of cadmium, by countries, 1945–49 (average) and 1950–54, in thousand pounds [1]

(Compiled by Berenice B. Mitchell and Jane Lancaster)

Country	1945–49 (average)	1950	1951	1952	1953	1954
Australia	549	659	517	641	665	515
Belgian Congo	46	65	54	45	71	139
Belgium [2]	213	805	990	1,210	1,040	1,100
Canada	756	848	1,327	949	1,118	1,027
France	90	158	187	195	283	313
Germany, West	[3] 5	26	154	141	227	618
Italy	101	165	441	293	401	448
Japan	48	199	259	367	459	501
Mexico [4]	1,884	1,519	1,969	1,618	2,103	[2] 1,488
Norway	99	174	221	163	197	178
Peru	6	3	----------	38	23	66
Poland [2]	302	530	530	530	530	530
South-West Africa [5]	560	1,344	1,434	1,112	1,194	1,620
Spain	5	10	9	12	16	[2] 12
U. S. S. R.[2]	120	150	180	200	200	220
United Kingdom	295	262	326	347	380	315
United States:						
Metallic cadmium	7,549	8,849	8,114	8,388	9,682	9,416
Cadmium compounds (Cd content)	324	341	197	179	85	136
Total (estimate)	10,500	13,250	13,510	13,700	15,380	15,540

[1] This table incorporates a number of revisions of data published in previous Cadmium chapters.
[2] Estimate.
[3] Average for 1946–49.
[4] Cadmium content of flue dust exported for treatment elsewhere; represents in part shipments from stocks on hand. To avoid duplication of figures, data are not included in the total.
[5] Cadmium content of concentrates exported for treatment elsewhere. To avoid duplication of figures, data are not included in the total.

Cadmium production of the Hudson Bay Mining & Smelting Co. came from its Flin Flon copper-zinc mine on the boundary between Manitoba and Saskatchewan and from several small mines nearby. Zinc concentrates from 12 mines in Quebec and other provinces in eastern Canada contained an average of 0.20 percent cadmium.

Consumption of cadmium in Canada during the year totaled 198,000 pounds compared with 239,000 pounds in 1953. The bulk of Canada's output was exported, principally to the United Kingdom and the United States.

EUROPE

Germany, West.—Production of cadmium in West Germany in 1954 totaled 309 short tons compared with 114 tons in 1953 and 71 tons in 1952.[5] Consumption of cadmium totaled 296 tons in 1953 and 104 tons in 1952.[6] Of the total in 1953, 94 tons went to the chemical industry, 46 tons was used in storage batteries, and 156 tons was used in anodes, alloys, and semifabricated products. The principal producers of cadmium in West Germany were Unterharzer Berg-und Hüttenwerke G. m. b. H. and Berzelius Metallhütten G. m. b. H.; the plants are at Harlingerode and Duisburg, respectively.

United Kingdom.—The British Bureau of Non-Ferrous Metal Statistics reported consumption of 819 short tons of cadmium in the United Kingdom in 1954 compared with 696 tons in 1953. The tonnages used for various purposes were: Plating anodes, 325; plating salts, 70; cadmium-copper alloys, 58; other alloys, 21; batteries, 89;

[5] Mining Journal (London), vol. 244, No. 6240, Mar. 25, 1955, p. 333.
[6] Das Statistische Bild Der Westdeutschen Metallwirtschaff in Jahre 1953, Metall, May & June 1954.

solder, 41; colors, 193; and miscellaneous uses, 22. Domestic production and imports totaled 158 and 818 tons, respectively, compared with 190 and 470 tons, respectively, in 1953. In 1954 imports were obtained from Canada (301 tons), United States (207 tons), Australia (205 tons), and Belgium (105 tons).

AFRICA

Federation of Rhodesia and Nyasaland.—The Rhodesia Broken Hill Development Co. in northern Rhodesia began work in 1953 on a new plant for the treatment of cadmium-bearing residues from the purification section of the company's zinc plant. Primary treatment of the accumulated residues was completed during 1954, and the resultant high-grade, but still impure, product was stockpiled pending completion of the cadmium refinery plant.[7]

World production of cadmium in recent years, insofar as data are available, is shown in table 8 (p. 10).

[7] Metal Bulletin (London), No. 3897, May 28, 1954, p. 21.

Calcium

By Joseph C. Arundale [1] and Annie L. Marks [2]

CALCIUM is one of the most abundant elements. In combination with other elements it is an integral part of many mineral commodities. Some of the more important calcium minerals or mineral products are limestone (calcium carbonate), lime (calcium oxide), fluorspar (calcium fluoride), and gypsum (calcium sulfate). These materials are discussed in the respective chapters in this volume. This chapter is concerned with calcium metal and with naturally occurring calcium minerals and compounds not discussed in other chapters of this volume.

DOMESTIC PRODUCTION

Calcium chloride (and calcium-magnesium chloride) was largely a coproduct of plants producing salt, bromine, magnesia, and soda ash. At one time considered a troublesome waste product, this material sold in large quantities in 1954. Shipments of natural and ammonia-soda byproduct solid and flake calcium chloride (77–80 percent $CaCl_2$) totaled 437,705 short tons valued at $10,814,000, and shipments of liquid calcium chloride (40–45 percent $CaCl_2$) were 155,877 short tons valued at $1,351,000.

Natural calcium chloride (and calcium-magnesium chloride) was produced at the following plants in 1954: California Rock Salt Co., Saltus, Calif.; 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-Alkali Division, Food Machinery and Chemical Corp., South Charleston, W. Va.

The three producers in California recovered calcium chloride from the brine of Bristol Lake. In Michigan, Ohio, and West Virginia, calcium chloride was recovered from brine with magnesia or salt as coproducts.

Nelco Metals, Inc., Canaan, Conn., produced calcium by thermal reduction of lime with aluminum in vacuum retorts. Calcium metal previously was produced by Electro Metallurgical Division, Union Carbide & Carbon Corp., Sault Ste. Marie, Mich. This firm produced the metal by electrolysis of calcium chloride but in recent years decided to discontinue this activity and now refines calcium metal imported from Canada. Ethyl Corp., for a short time in 1952–53, produced a finely divided crystalline calcium from byproduct sludges

[1] Assistant chief, Branch of Construction and Chemical Materials.
[2] Statistical clerk.

at its sodium-metal plant at Baton Rouge, La., but discontinued this because of an inadequate market.

The recent history of calcium-metal production, the problems of the industry, and the outlook were reviewed in an article.[3]

TABLE 1.—Calcium chloride and calcium-magnesium chloride from natural brines sold by producers in the United States, 1945–49 (average) and 1950–54

[In terms of 75 percent (Ca,Mg) Cl_2]

Year	Short tons	Value	Year	Short tons	Value
1945–49 (average)	263,426	$2,782,982	1951	328,042	$4,756,242
1950	299,821	3,801,508	1952–54	(1)	(1)

[1] Figure withheld to avoid disclosure of individual company operations.

CONSUMPTION AND USES

Calcium in its many forms has a multitude of uses. The principal uses of calcium metal have been in the metallurgical industries. Its affinity for oxygen, nitrogen, sulfur, and carbon makes calcium very useful in preparing both ferrous and nonferrous metals and alloys. Calcium metal and calcium hydride were used as reducing agents in preparing uranium, thorium, titanium, zirconium, and chromium. The metal is an alloying material for aluminum, copper, lead, magnesium, and bearing metals. It was used to remove bismuth from lead and to deoxidize iron castings. Calcium may be used to control grain size and inhibit carbide formation in certain steels, to dehydrate alcohol and other organic liquids, to separate argon and nitrogen, and to remove sulfur from petroleum fractions.

On the farm, on the roads, and in industry and military establishment calcium chloride is used in solution as a liquid ballast in rubber tires on tractors, motor graders, loaders, and other heavy equipment. Liquid ballast provides better traction and the calcium chloride lowers the freezing temperature of the solution. Calcium chloride is used to stabilize and control dust on secondary roads and the shoulders of some highways. In ice-making calcium chloride is used in refrigeration brine. Calcium chloride in concrete is said to accelerate the set, promote high early strength, increase ultimate strength, increase workability, and provide increased resistance to surface wear.

The periodic issues of Calcium Chloride Institute News published by the Calcium Chloride Institute, Washington, D. C., contained a digest of current developments in the field of calcium chloride usage. The use of calcium chloride in constructing bases for flexible pavements was discussed.[4] In one such project the use of calcium chloride to the full depth of stabilized aggregate base course was said to have eliminated the need for adding water on the job site and resulted in less segregation of material. Design density was obtained with less compactive effort, and savings were achieved in maintenance until the base was topped with a bituminous surface.

[3] Chemical Week, vol. 74, No. 16, Apr. 17, 1954, pp. 87–88, 90, 92.
[4] Calcium Chloride Institute News, vol. 4, No. 1, February 1954, pp. 3–5.

Although the material going into such base courses often is mixed on the road site, under certain conditions better control of the graded aggregate and calcium chloride is claimed for some plant mixed material.[5]

The major effects of calcium chloride in cement were discussed.[6] The use of calcium chloride solution in tires and for freezeproofing minerals during winter shipments was reviewed.[7]

PRICES

The price of calcium metal cast in slabs and small pieces was unchanged throughout the year at $2.05 per pound in ton lots, according to E&MJ Metal and Mineral Markets.

According to Oil, Paint and Drug Reporter, the following prices were quoted for calcium chloride throughout 1954: Calcium chloride, crystalline, purified, drums, jars, 27 cents per pound; flake, 77–80 percent, paper bags, carlots, works, freight equaled, $27 per ton; liquor, 40 percent, tank cars, works, freight allowed, $11.50 per ton (reduced to $11.35 in March); pellets, bags, carlots, works, $33 per ton; powder, bags, carlots, works, $37.65 per ton; solid, 73–75 percent, drums, carlots, freight equaled, $25.50 per ton; less than carlots, works, same basis, $34 to $71; U. S. P. granulated, drums, 40 cents per pound.

FOREIGN TRADE [8]

Imports of calcium metal, all from Canada, decreased but were exceeded only by the years 1952 and 1953. Shipments of calcium-silicon alloy from Italy were resumed after having been suspended for 3 years.

TABLE 2.—Calcium metal and calcium-silicon imported for consumption in the United States, 1945–49 (average) and 1950–54

[U. S. Department of Commerce]

Year	Calcium metal		Calcium-silicon	
	Pounds	Value	Pounds	Value
1945–49 (average)	4,349	$4,748	240,570	$31,005
1950	75,756	66,407	491,646	11,479
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

Small tonnages of calcium chloride were imported from Canada, United Kingdom, Belgium-Luxembourg, and West Germany. About three-fourths of the tonnage of exports went to Canada; Mexico, Cuba, and other Latin American countries received most of the remainder; minor tonnages went to the Philippines and southeast Asian countries.

[5] Calcium Chloride Institute News, vol. 4, No. 2, April 1954, pp. 3–5.
[6] Calcium Chloride Institute News, vol. 4, No. 2, April 1954, pp. 6–7.
[7] Work cited in footnote 6, pp. 8–12.
[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.—Calcium chloride imported for consumption in and exported from the United States, 1945–49 (average) and 1950–54

[U. S. Department of Commerce]

Year	Imports		Exports	
	Short tons	Value	Short tons	Value
1945–49 (average)	1,122	$14,356	12,290	$400,912
1950	1,881	54,170	15,624	403,230
1951	813	37,451	18,637	559,284
1952	1,333	45,888	19,193	594,904
1953	2,671	84,594	11,572	370,799
1954	1,547	51,249	10,987	374,332

TECHNOLOGY

A patent issued on a method of removing sulfate ions from brine involved adding enough calcium chloride to the brine to bring the molar ratio of calcium (Ca) to sulfate (SO_4) to more than 2.4 : 1. It was claimed that agitation of the solution would then cause $CaSO_4$ to precipitate.[9]

An improvement was claimed on a patented method of purifying calcium containing alkali metals other than lithium as impurities. A stainless steel cylindrical still is immersed in a salt bath to the level of an air-cooled condenser plate near the top of the still. The first stage of distillation takes place at 865°–900° C. Sodium boils off first and passes around the edge of the condenser plate into a space above. This is done in argon at about 20 mm. mercury pressure, which is higher than the vapor pressure of calcium in the bottom of the still at 865° C. When all sodium has been distilled away the still is evacuated, and calcium distills against its own vapor pressure and condenses on the bottom of the condenser plate. The invention consisted in inserting a perforated plate of stainless steel mounted above the calcium level, the perforations being about one-fourth inch in diameter. This was said to stabilize temperature conditions above and below it.[10]

The technical panel of the Calcium Chloride Institute met to exchange technical information on calcium chloride among technical representatives of the institute's members and authorities in industries using calcium chloride. The problems discussed and recommendations of the various technical committees were reviewed.[11]

WORLD REVIEW

Canada.—Dominion Magnesium, Ltd., Haley, Ontario, was the only commercial source of calcium metal in Canada. Much of the output of this unit was exported to the United States and United

[9] Hirsch, Alfred (assigned to Diamond Alkali Co.), Method of Purifying Brine: U. S. Patent 2,683,649, July 13, 1954.

[10] Barton, James (assigned to Imperial Chemical Industries, Ltd.), Distillation of Calcium, U. S. Patent 2,684,898, July 27, 1954.

[11] Calcium Chloride Institute News, vol. 4, No. 5, October 1954, p. 5.

Kingdom. Production began in 1945, and the method used was thermal reduction of lime with aluminum in a vacuum retort. The metal was supplied as coarse powder, granules, ingots and billets.

Japan.—It was reported that Japan Metallic Titanium Manufacturing Corp. of Tokyo was making titanium powder by direct reduction of titanium dioxide with metallic calcium. Production of this powder at the end of 1954 was at the rate of about 1.5 tons a month, and it was expected to increase to 10 tons a month.[12]

[12] Chemical Engineering, vol. 62, No. 2, February 1955, p. 136.

Cement

By D. O. Kennedy [1] and Betty M. Moore [2]

THE YEAR 1954 could well be called the year of decision in the cement industry. For several years increases in production capacity and increases in production had progressed uniformly. During the first half of 1954 production of portland cement lagged behind the 1953 figures despite apparently comparable demand, and concern was manifested throughout the construction industry. The proposed highway-construction legislation increased the tension, which was only partly relieved by announcements of expansion plans of cement companies. By the end of 1954, 16 cement companies had announced

TABLE 1.—Salient statistics of the cement industry in the United States, 1945–49 (average) and 1950–54 [1]

	1945–49 (average)	1950	1951
Production:			
Portland .... barrels	173, 712, 819	226, 025, 849	246, 022, 476
Masonry, natural, and pozzolan (slag-lime) .... do	2, 707, 002	4, 246, 299	3, 449, 463
Total .... do	176, 419, 821	230, 272, 148	249, 471, 939
Capacity used at portland-cement mills .... percent	69. 7	84. 3	87. 4
Shipments from mills:			
Total .... barrels	177, 469, 442	231, 975, 216	244, 628, 695
Value of shipments [2]	$353, 711, 299	$545, 950, 709	$623, 003, 439
Average value per barrel	$1. 99	$2. 35	$2. 55
Stocks at mills, Dec. 31 .... barrels	12, 817, 519	13, 308, 190	18, 223, 906
Imports .... do	80, 247	1, 409, 974	921, 953
Exports .... do	5, 778, 679	2, 418, 435	2, 932, 787
Apparent consumption [4] .... do	171, 771, 010	230, 966, 755	242, 617, 861
World production (estimated) .... do	[3] 503, 800, 000	[3] 781, 500, 000	[3] 876, 000, 000

	1952	1953	1954
Production:			
Portland .... barrels	249, 256, 154	264, 180, 522	272, 352, 557
Masonry, natural, and pozzolan (slag-lime) .... do	3, 401, 684	3, 488, 102	3, 504, 380
Total .... do	252, 657, 838	267, 668, 624	275, 856, 937
Capacity used at portland-cement mills .... percent	87. 8	90. 5	91. 4
Shipments from mills:			
Total .... barrels	254, 815, 893	264, 337, 896	278, 385, 350
Value of shipments [2]	$648, 264, 065	$707, 603, 575	$773, 076. 462
Average value per barrel	$2. 54	$2. 68	$2. 78
Stocks at mills, Dec. 31 .... barrels	16, 045, 980	[3] 19, 414, 334	16, 885, 921
Imports .... do	475, 986	386, 051	450, 248
Exports .... do	3, 174, 405	[3] 2, 550, 788	1, 844, 012
Apparent consumption [4] .... do	252, 117, 474	[3] 262, 173, 159	276. 991, 586
World production (estimated) .... do	[3] 941, 700, 000	[3] 1,042,400,000	1, 142, 900. 000

[1] Includes Puerto Rico and Hawaii, 1946; Puerto Rico only, 1947–54. There has been no production in Hawaii since 1946.
[2] Value received f. o. b. mill, excluding cost of containers.
[3] Revised figure.
[4] Shipments from domestic mills minus net exports.

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

expansion programs to be undertaken at 21 plants, and 3 companies announced plans to erect 5 new plants. As a service to the President's Advisory Committee on a National Highway Program, the Bureau of Mines conducted a special survey of the cement companies' expansion plans in October 1954. The results showed an estimated 16-percent increase in productive capacity in 1955–56 and a 40-percent estimated increase in 5 years to December 31, 1959. These figures contrasted drastically with the 1 to 3 percent per year expansion of the past 5 years and indicated an optimism within the cement industry not seen since 1921.

The rate of production of portland cement increased sufficiently during the second half of 1954 to set a new record figure of 272 million barrels [3] for the year. Shipments rose to 275 million barrels valued at $760 million. The portland-cement plants operated at 91.4-percent capacity in 1954 compared with 90.5 percent in 1953. At the end of 1954 the estimated annual capacity of all portland-cement-producing facilities in the United States and Puerto Rico was 298 million barrels, an increase of 2 percent over the capacity at the end of 1953.

The production of other hydraulic cements—natural, masonry (natural), and pozzolan—and production and shipments of prepared masonry cements increased in 1954.

The average net mill realization per barrel of portland cement increased from $2.67 in 1953 to $2.76 in 1954. The average net mill realization of the other hydraulic cements as a group increased 77 cents per barrel to $3.76, and prepared masonry cements were 14 cents per barrel higher at $3.41.

The increasing consumption of portland cement, as indicated in figure 1, followed the general trends established since 1945.

States in the regions shown in figure 1 are as follows: Northeastern—Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont; Southern—Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia; Middle—Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin; Rocky Mountain—Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming; and Pacific—California, Oregon, and Washington.

PORTLAND CEMENT

PRODUCTION AND SHIPMENTS

Portland cement constituted nearly 99 percent of the production of hydraulic cements produced in 1954 (exclusive of prepared masonry cements). One new plant was put into operation at Roberta, Ala., by the Southern Cement Co. in June 1954, raising the number of portland-cement-production plants to 157 in 37 States and Puerto Rico; 5 plants completed substantial expansions of their facilities.

Tables 2 and 3 show production, shipments, and stocks by districts for 1953 and 1954, and for the months of 1954, respectively. Data

[3] Barrel as used in this chapter, unless otherwise stated, refers to a 376-pound barrel.

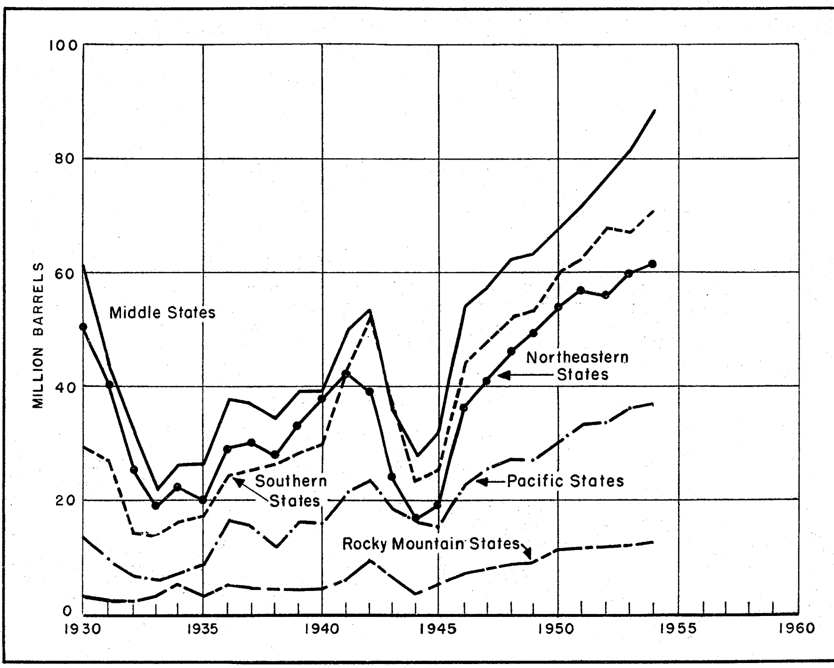

FIGURE 1.—Indicated consumption of portland cement in continental United States, 1930–54, by regions.

for the monthly table were compiled from monthly reports and were not adjusted to the final annual figures shown in table 2. The discrepancies are extremely small on a percentage basis.

Output in 1954 was greater in 15 districts and lower in 5 districts than in 1953. Changes ranged from a decrease of 5 percent in Western Pennsylvania-West Virginia district to an 11.9-percent increase in Texas. Thirteen districts, 1 more than in 1953, reported outputs over 10 million barrels.

TYPES OF CEMENT

The various types of cement produced for 1945–54 are shown in table 4. The 1954 figures for types I and II combined and type III were considerably higher than for previous years due to a difference in the reporting form used for the 1954 annual reports. Whereas air-entrained portland cement was formerly reported as a separate type of cement, it was reported in 1954 as a variety of each type. Thus the 255,673,000 barrels of types I and II shown for 1954 included 31,203,721 barrels (footnote 2) which formerly would have been shown under air-entrained cement. The actual increase in production of types I and II was about the same in 1954 compared with 1953 as in 1953 compared with 1952. The new reporting method showed that nearly two-thirds of the portland-pozzolan cement produced was air-entrained, whereas formerly no record of this appeared in the annual reports.

TABLE 2.—Finished portland cement produced, shipped, and in stock in the United States, 1953–54, by districts

District	Active plants		Production			Shipments from mills								Stocks at mills on Dec. 31		
			Barrels		Change from 1953 (percent)	1953			1954					Barrels		Change from 1953 (percent)
	1953	1954	1953	1954		Barrels	Value		Barrels	Value		Change from 1953 (percent) in—		1953	1954	
							Total	Average		Total	Average	Barrels	Average value			
Eastern Pennsylvania, Maryland	21	21	36,775,219	37,048,724	+0.7	36,304,071	$98,208,892	$2.71	37,336,814	$101,611,149	$2.72	+2.8	+0.4	2,242,344	1,954,254	−12.8
New York, Maine	11	11	17,022,581	16,458,513	−3.3	16,966,628	44,810,455	2.64	16,470,125	44,286,389	2.69	−2.9	+1.9	[1] 1,006,493	994,881	−1.2
Ohio	9	9	12,539,132	13,306,570	+6.1	12,532,437	32,957,308	2.63	13,076,921	35,929,163	2.75	+4.3	+4.6	[1] 755,237	984,886	+30.4
Western Pennsylvania, West Virginia	7	7	11,533,669	10,952,648	−5.0	11,234,723	29,404,837	2.62	11,269,630	30,223,272	2.68	+0.3	+2.3	[1] 1,172,169	855,187	−27.0
Michigan	7	7	15,532,853	16,671,383	+7.3	15,853,096	41,860,464	2.64	16,711,710	45,691,867	2.73	+5.4	+3.4	1,307,666	1,267,339	−3.1
Illinois	4	4	8,869,342	8,841,848	−0.3	8,651,385	21,961,761	2.54	9,109,076	23,147,871	2.54	+5.3		823,665	556,437	−32.4
Indiana, Kentucky, Wisconsin	6	6	16,162,378	16,423,738	+1.6	15,940,923	41,385,260	2.60	16,548,046	47,289,781	2.86	+3.8	+10.0	[1] 1,092,826	968,518	−11.4
Alabama	7	8	10,682,579	10,996,641	+2.9	10,427,542	25,701,421	2.46	11,121,599	28,582,683	2.57	+6.7	+4.5	806,678	681,720	−15.5
Tennessee	6	6	7,474,604	7,523,507	+0.7	7,276,964	18,283,366	2.51	7,569,279	19,734,262	2.61	+4.0	+4.0	585,930	540,158	−7.8
Virginia, Georgia, Florida, Louisiana, South Carolina, Mississippi	11	11	17,110,360	18,452,202	+7.8	16,951,199	46,114,623	2.72	18,552,091	51,283,337	2.76	+9.4	+1.5	882,054	782,165	−11.3
Iowa	5	5	9,341,422	9,658,123	+3.4	9,111,358	23,330,177	2.56	9,858,889	27,044,464	2.74	+8.2	+7.0	[1] 1,098,659	897,893	−18.3
Eastern Missouri, Minnesota, South Dakota	6	6	12,128,396	12,750,592	+5.1	11,551,967	30,949,811	2.68	13,043,450	36,201,230	2.78	+12.9	+3.7	[1] 1,484,095	1,191,237	−19.7
Kansas	6	6	8,766,206	8,803,007	+0.4	8,546,250	21,428,536	2.51	9,076,328	23,874,179	2.63	+6.2	+4.8	[1] 745,149	471,828	−36.7
Western Missouri, Nebraska, Oklahoma, Arkansas	6	6	9,351,805	10,331,058	+10.5	9,173,478	23,703,624	2.58	10,285,005	27,758,505	2.70	+12.1	+4.7	726,764	772,817	+6.3
Texas	13	13	19,253,677	21,541,325	+11.9	19,140,193	48,497,762	2.53	21,928,170	56,674,124	2.58	+14.6	+2.0	[1] 1,252,540	865,695	−30.9
Colorado, Arizona, Wyoming, Montana, Utah, Idaho	9	9	8,737,196	9,286,435	+6.3	8,534,313	26,577,933	3.11	9,436,381	29,704,078	3.15	+10.6	+1.3	775,605	625,659	−19.3
Northern California	5	5	15,125,072	14,389,330	−4.9	15,166,928	43,930,333	2.90	14,406,528	43,026,454	2.99	−5.0	+3.1	934,668	917,470	−1.8
Southern California	6	6	17,020,375	18,209,548	+7.0	16,835,389	46,942,408	2.79	18,355,462	55,224,791	3.01	+9.0	+7.9	[1] 791,525	645,611	−18.4
Oregon, Washington	9	9	7,098,042	7,107,301	+0.1	7,038,556	21,878,416	3.11	7,034,301	22,910,458	3.26	−0.1	+4.8	[1] 663,409	736,409	+11.0
Puerto Rico	2	2	3,655,614	3,600,064	−1.5	3,641,135	9,335,421	2.56	3,682,187	9,663,445	2.62	+1.1	+2.3	[1] 124,532	42,409	−65.9
Total	156	157	264,180,522	272,352,557	+3.1	260,878,535	697,262,808	2.67	274,871,992	759,861,502	2.76	+5.4	+3.4	[1] 19,272,008	16,752,573	−13.1
Pennsylvania	24	24	42,799,409	42,514,803	−0.7	42,093,765	114,002,846	2.71	43,068,234	117,912,299	2.74	+2.3	+1.1	[1] 3,096,231	2,542,800	−17.9
Missouri	5	5	10,281,230	11,201,697	+9.0	9,860,179	26,238,460	2.66	11,379,257	31,425,190	2.76	+15.4	+3.8	[1] 1,084,990	907,430	−16.4

[1] Revised figure.

TABLE 3.—Production, shipments from mills, and stocks at mills of finished portland cement in the United States in 1954, by months and districts, in thousand barrels

District	January	February	March	April	May	June	July	August	September	October	November	December
PRODUCTION												
Eastern Pennsylvania, Maryland	2,749	2,688	3,089	3,268	2,848	2,402	3,202	3,465	3,353	3,405	3,260	3,223
New York, Maine	1,149	1,034	1,229	1,437	1,000	706	1,600	1,800	1,710	1,874	1,526	1,376
Ohio	936	847	1,014	930	1,194	1,151	1,281	1,269	1,210	1,257	1,160	1,025
Western Pennsylvania, West Virginia	794	492	719	834	992	1,128	1,066	1,051	1,077	1,030	946	823
Michigan	809	540	792	1,372	1,656	1,717	1,818	1,772	1,841	1,615	1,594	1,144
Illinois	587	554	632	634	673	788	860	818	850	887	782	707
Indiana, Kentucky, Wisconsin	953	1,071	1,276	1,335	1,594	1,447	1,560	1,468	1,398	1,557	1,411	1,230
Alabama	743	703	832	770	872	1,027	1,058	976	1,034	1,031	937	985
Tennessee	344	527	543	528	630	645	731	721	695	743	688	612
Virginia, Georgia, Florida, Louisiana, South Carolina, Mississippi	1,368	1,387	1,528	1,560	1,537	1,409	1,577	1,565	1,695	1,661	1,557	1,503
Iowa	667	500	619	475	899	917	941	986	964	953	852	794
Eastern Missouri, Minnesota, South Dakota	683	672	923	861	1,186	1,184	1,242	1,255	1,278	1,285	1,074	1,053
Kansas	585	534	720	704	817	796	773	826	758	789	772	696
Western Missouri, Nebraska, Oklahoma, Arkansas	583	621	669	722	837	863	1,039	956	1,066	996	916	1,015
Texas	1,461	1,458	1,705	1,847	1,808	1,867	1,947	1,938	1,878	1,889	1,860	1,864
Colorado, Arizona, Wyoming, Montana, Utah, Idaho	430	540	527	779	900	986	889	929	903	964	798	645
Northern California	1,092	898	977	1,168	1,232	1,238	1,362	1,306	1,335	1,351	1,255	1,175
Southern California	1,232	1,226	1,539	1,434	1,554	1,538	1,518	1,545	1,540	1,713	1,567	1,567
Oregon, Washington	360	340	487	792	776	701	706	705	638	554	531	512
Puerto Rico	244	263	277	280	274	292	312	347	299	333	340	341
Total: 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
1953	18,856	17,325	20,215	21,802	23,399	22,698	24,134	24,289	23,795	24,738	22,529	20,243
SHIPMENTS												
Eastern Pennsylvania, Maryland	1,406	2,168	3,048	3,550	3,591	3,191	3,906	3,687	3,695	3,635	3,043	2,376
New York, Maine	451	589	1,049	1,457	1,217	1,069	2,117	2,144	2,032	2,058	1,438	839
Ohio	459	641	774	1,048	1,171	1,436	1,424	1,382	1,533	1,471	1,122	583
Western Pennsylvania, West Virginia	310	457	574	796	1,190	1,745	1,280	1,247	1,276	1,118	821	454
Michigan	438	495	667	1,197	1,786	1,984	1,935	2,143	2,046	1,799	1,481	741
Illinois	193	317	434	673	877	1,181	1,018	1,186	1,149	915	725	379
Indiana, Kentucky, Wisconsin	561	797	1,003	1,435	1,655	1,950	1,783	1,710	1,817	1,713	1,345	759
Alabama	718	745	839	818	853	1,207	1,073	1,017	1,058	1,082	891	801
Tennessee	339	510	536	645	624	833	732	794	696	765	557	423
Virginia, Georgia, Florida, Louisiana, South Carolina, Mississippi	1,169	1,376	1,522	1,658	1,532	1,705	1,544	1,728	1,724	1,621	1,558	1,335
Iowa	167	266	435	824	1,063	1,421	1,117	1,237	1,211	1,120	681	270
Eastern Missouri, Minnesota, South Dakota	362	626	760	1,077	1,212	1,657	1,446	1,503	1,566	1,299	929	584

TABLE 3.—Production, shipments from mills, and stock at mills of finished portland cement in the United States in 1954, by months and districts, in thousand barrels—Continued

District	January	February	March	April	May	June	July	August	September	October	November	December
SHIPMENTS—continued												
Kansas	329	595	625	894	787	981	801	915	959	865	810	488
Western Missouri, Nebraska, Oklahoma, Arkansas	320	578	633	863	800	1,120	961	1,113	1,203	1,026	1,014	625
Texas	1,206	1,722	1,882	1,857	1,822	2,036	1,937	1,987	2,019	1,777	1,863	1,803
Colorado, Arizona, Wyoming, Montana, Utah, Idaho	394	513	572	816	884	1,151	801	1,036	1,023	917	767	566
Northern California	793	818	963	1,210	1,342	1,351	1,321	1,437	1,537	1,401	1,208	1,025
Southern California	1,076	1,414	1,477	1,692	1,537	1,562	1,488	1,564	1,497	1,633	1,585	1,582
Oregon, Washington	172	336	671	786	701	757	711	696	673	606	536	382
Puerto Rico	280	239	287	293	267	295	307	361	318	313	392	332
Total: 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
1953	13,520	14,155	20,813	20,891	22,924	26,400	26,480	27,092	27,433	27,556	19,494	14,130
STOCKS (END OF MONTH)												
Eastern Pennsylvania, Maryland	3,587	4,108	4,148	3,866	3,123	2,362	1,680	1,458	1,116	886	1,103	1,950
New York, Maine	1,703	2,146	2,323	2,300	2,083	1,724	1,207	863	552	369	457	994
Ohio	1,233	1,438	1,678	1,559	1,582	1,297	1,154	1,041	718	504	542	985
Western Pennsylvania, West Virginia	1,657	1,692	1,838	1,877	1,679	1,061	847	651	452	364	490	858
Michigan	1,679	1,724	1,849	2,024	1,894	1,627	1,511	1,139	934	750	863	1,266
Illinois	1,218	1,455	1,652	1,613	1,408	1,020	867	499	200	172	228	556
Indiana, Kentucky, Wisconsin	1,479	1,754	2,026	1,925	1,865	1,389	1,176	992	577	427	498	969
Alabama	832	791	784	736	755	575	570	528	504	452	498	682
Tennessee	590	606	614	496	503	316	315	243	242	220	351	540
Virginia, Georgia, Florida, Louisiana, South Carolina, Mississippi	1,082	1,093	1,098	1,001	1,006	722	767	604	575	615	614	782
Iowa	1,598	1,833	2,017	1,668	1,504	1,009	839	588	340	173	344	867
Eastern Missouri, Minnesota, South Dakota	1,805	1,851	2,014	1,798	1,772	1,299	1,095	863	591	578	722	1,191
Kansas	1,000	939	1,035	845	874	690	668	579	379	303	265	472
Western Missouri, Nebraska, Oklahoma, Arkansas	990	1,033	1,069	928	965	708	786	630	493	463	365	756
Texas	1,508	1,244	1,068	1,058	1,045	875	885	836	695	807	804	866
Colorado, Arizona, Wyoming, Montana, Utah, Idaho	812	839	794	758	773	609	696	589	469	515	546	627
Northern California	1,233	1,313	1,327	1,286	1,176	1,063	1,104	973	771	720	768	918
Southern California	937	748	810	553	570	546	576	557	600	680	662	647
Oregon, Washington	838	842	658	664	738	688	683	691	635	583	578	707
Puerto Rico	88	113	103	90	97	94	98	84	66	86	34	42
Total: 1954	25,869	27,562	28,905	27,045	25,412	19,674	17,524	14,408	10,909	9,667	10,732	16,675
1953	21,294	24,464	23,865	24,773	25,247	21,542	19,204	16,445	12,859	10,049	13,083	[1] 19,243

[1] Revised figure.

TABLE 4.—Portland cement produced and shipped in the United States,[1] 1945–49 (average) and 1950–54, by types

Type and year	Active plants	Production (barrels)	Shipments		
			Barrels	Value	
				Total	Average
General use and moderate heat (types I and II):					
1945–49 (average)	150	147,825,957	148,798,086	$292,345,162	$1.96
1950	150	191,994,091	193,693,533	449,842,513	2.32
1951	155	207,702,941	203,279,206	510,975,002	2.51
1952	156	210,720,294	212,589,258	534,252,252	2.51
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
High-early-strength (type III):					
1945–49 (average)	93	5,942,536	5,990,258	13,762,622	2.30
1950	90	6,667,974	6,607,172	18,094,386	2.74
1951	96	7,455,107	7,294,686	21,494,894	2.95
1952	95	8,014,918	7,982,072	23,377,812	2.93
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
Low-heat (type IV):					
1945–49 (average)	4	119,287	117,651	237,476	2.02
1950	5	328,879	271,559	682,008	2.51
1951	6	900,624	790,819	2,647,460	3.35
1952	2	252,122	272,062	767,571	2.82
1953	2	192,889	171,717	507,290	2.95
1954	1	84,205	48,193	193,738	4.02
Sulfate-resisting (type V):					
1945–49 (average)	5	87,006	87,164	268,481	3.08
1950	4	4,070	49,152	141,888	2.89
1951	3	9,908	87,635	342,689	3.91
1952	4	99,229	78,276	240,129	3.07
1953	4	79,244	89,631	317,792	3.55
1954	7	142,171	119,711	433,400	3.62
Oil-well:					
1945–49 (average)	16	1,595,318	1,659,171	3,745,954	2.26
1950	17	1,829,651	1,830,167	4,735,423	2.59
1951	15	1,508,252	1,630,305	4,581,109	2.80
1952	18	1,841,470	1,787,786	5,099,335	2.85
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
White:					
1945–49 (average)	4	832,087	825,531	3,683,193	4.46
1950	5	1,175,490	1,187,202	5,637,101	4.75
1951	4	1,139,500	1,109,088	5,631,518	5.08
1952	4	1,081,122	1,094,276	5,900,986	5.39
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
Portland-pozzolan:					
1945–49 (average)	5	1,090,231	1,142,650	2,278,712	1.99
1950	5	1,369,764	1,321,223	3,232,282	2.45
1951	6	2,279,023	2,250,280	5,602,288	2.49
1952	6	1,861,991	1,856,656	4,646,078	2.50
1953	6	2,406,314	2,448,861	6,440,686	2.63
1954	8	[4] 2,412,536	2,251,005	6,100,311	2.71
Air-entrained:					
1945–49 (average)	69	15,475,816	15,383,254	29,944,248	1.95
1950	80	21,717,585	21,860,316	50,107,196	2.29
1951	79	24,201,376	23,885,423	59,247,898	2.48
1952	81	24,484,689	24,796,917	61,432,052	2.48
1953	95	32,130,866	31,474,609	82,593,723	2.62
1954	99	(5)	(6)	(6)	----------
Miscellaneous:[7]					
1945–49 (average)	19	744,582	755,844	1,894,639	2.51
1950	24	938,345	936,312	2,848,326	3.04
1951	23	825,745	825,830	2,647,625	3.21
1952	22	900,319	911,200	2,796,013	3.07
1953	21	891,706	882,764	2,891,162	3.28
1954	22	1,123,730	1,155,945	3,921,322	3.39

See footnotes at end of table.

TABLE 4.—Portland cement produced and shipped in the United States,[1] 1945–49 (average) and 1950–54, by types—Continued

Type and year	Active plants	Production (barrels)	Shipments		
			Barrels	Value	
				Total	Average
Grand total:					
1945–49 (average)	150	173,712,820	174,759,609	$348,160,487	$1.99
1950	150	226,025,849	227,756,636	535,321,123	2.35
1951	155	246,022,476	241,153,272	613,170,483	2.54
1952	156	249,256,154	251,368,503	638,512,228	2.54
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

[1] Including Puerto Rico and Hawaii, 1946; Puerto Rico only, 1947–54. There has been no production in Hawaii since 1946.
[2] Includes 31,203,721 barrels of air-entrained portland cement.
[3] Includes 2,650,930 barrels of air-entrained portland cement.
[4] Includes 1,667,368 barrels of air-entrained portland cement.
[5] See footnotes 2, 3, and 4.
[6] Data not available.
[7] Includes hydroplastic, plastic, and waterproofed cements.

Prepared Masonry Cements.—Prepared masonry cements are produced by intimately intergrinding portland-cement clinker or finished portland cement with limestone and an air-entraining plasticizer to a fineness greater than that of portland cement. The product has high plasticity and water-retention ability essential in mortars for brick or other masonry work. These specially compounded masonry cements are usually sold under proprietary names.

Production of prepared masonry cements was reported by 107 portland cement plants in 1954 and totaled 12,769,861 barrels. Shipments were 12,828,388 barrels valued at $43,706,775, an average mill value of $3.41 per barrel. These quantities are given in equivalent barrels of 376 pounds to maintain uniformity with other data in this chapter.

As the finished portland cement and clinker used in making these types of masonry cements were included in the portland-cement statistics of this chapter, to avoid duplication the above-prepared masonry-cement figures are not included in any of the statistical tables.

CAPACITY OF PLANTS

The estimated annual capacity of all portland-cement plants in 1954 was 2 percent greater than in 1953. The percentage of capacity utilized in 1954 was nearly 1 percent higher than in 1953 and nearly 4 percent greater than in 1952.

The addition of 1 new plant and expansions at 5 others increased the installed capacity over 6 million barrels. Capacity was higher in 15 districts and lower in 5. Increases of over 1 million barrels occurred in 3 districts—Michigan, Alabama, and Western Missouri-Nebraska-Oklahoma-Arkansas. Most portland-cement plants listed kiln departments as the factor limiting capacity, but a few reported that their capacity was limited by grinding facilities.

The percentage of capacity utilized was greater in 11 districts and lower in 9 districts compared with 1953. The changes ranged from an 8 percent decrease in Alabama to increases of 10 percent in Texas and 11 percent in Puerto Rico.

The capacity of plants utilizing the wet process for manufacturing portland cement continued to increase at a slightly greater rate than of those utilizing the dry process. The percentage of total capacity for wet-process plants increased from 56.5 to 56.8 percent in 1954.

TABLE 5.—Portland-cement-manufacturing capacity of the United States, 1953–54, by districts

District	Estimated (barrels)		Percent utilized	
	1953	1954	1953	1954
Eastern Pennsylvania, Maryland	39, 872, 977	40, 303, 225	92. 2	91. 9
New York, Maine	18, 426, 414	18, 762, 580	92. 4	87. 7
Ohio	13, 510, 125	13, 815, 725	92. 8	96. 3
Western Pennsylvania, West Virginia	12, 195, 300	12, 023, 795	94. 6	91. 1
Michigan	17, 988, 816	18, 990, 688	86. 3	87. 8
Illinois	9, 552, 230	9, 227, 510	92. 9	95. 8
Indiana, Kentucky, Wisconsin	17, 201, 097	18, 107, 000	94. 0	90. 7
Alabama	11, 586, 450	13, 053, 416	92. 2	84. 2
Tennessee	8, 174, 197	8, 132, 000	91. 4	92. 5
Virginia, Georgia, Florida, Louisiana, South Carolina, Mississippi	19, 324, 415	19, 753, 000	88. 5	93. 4
Iowa	10, 210, 298	10, 668, 000	91. 5	90. 5
Eastern Missouri, Minnesota, South Dakota	13, 181, 255	13, 750, 013	92. 0	92. 7
Kansas	9, 544, 609	9, 578, 000	91. 8	91. 9
Western Missouri, Nebraska, Oklahoma, Arkansas	9, 735, 987	10, 785, 987	96. 1	95. 8
Texas	22, 855, 000	22, 955, 000	84. 2	93. 8
Colorado, Arizona, Wyoming, Montana, Utah, Idaho	10, 665, 000	11, 065, 000	81. 9	83. 9
Northern California	15, 900, 000	15, 225, 000	95. 1	94. 5
Southern California	19, 320, 000	19, 620, 000	88. 1	92. 8
Oregon, Washington	8, 254, 300	8, 460, 000	86. 0	84. 0
Puerto Rico	4, 300, 000	3, 750, 000	85. 0	96. 0
Total	291, 798, 470	298, 025, 939	90. 5	91. 4

TABLE 6.—Percentage of capacity used in the finished portland-cement industry in the United States, 1953–54

Month	Monthly		12 months ended—		Month	Monthly		12 months ended—	
	1953	1954	1953	1954		1953	1594	1953	1954
January	79	74	89	93	July	100	102	93	90
February	80	78	89	93	August	101	103	93	90
March	84	83	90	92	September	102	106	93	91
April	94	93	90	92	October	103	104	93	91
May	97	96	91	92	November	97	98	93	91
June	98	97	92	92	December	84	89	93	92

TABLE 7.—Capacity of portland-cement plants in the United States,[1] Dec. 31, 1952–54, by processes

Process	Capacity, Dec. 31						Percent of capacity utilized			Percent of total finished cement produced		
	Thousands of barrels			Percent of total								
	1952	1953	1954	1952	1953	1954	1952	1953	1954	1952	1953	1954
Wet	159, 812	164, 726	169, 361	56. 3	56. 5	56. 8	88. 7	90. 9	92. 2	56. 9	56. 7	57. 3
Dry	124, 202	127, 072	128, 665	43. 7	43. 5	43. 2	86. 5	90. 1	90. 4	43. 1	43. 3	42. 7
Total	284, 014	291, 798	298, 026	100. 0	100. 0	100. 0	87. 8	90. 5	91. 4	100. 0	100. 0	100. 0

[1] Includes Puerto Rico.

A grouping of the cement plants according to their annual capacities is shown below. The number of plants of less than 1 million barrels annual capacities decreased from 21 in 1952 to 20 in 1953 and to 17 in 1954, reflecting the trend to larger sized plants. The number of plants over 3 million barrels' capacity decreased from 15 in 1952 to 12 in 1953 and 11 in 1954. These differences reflected corrections in company reports of capacity rather than any change in number or size of kilns.

Number of portland-cement plants in the United States (including Puerto Rico) in 1954, by size groups

Estimated annual capacity, Dec. 31, barrels:	*Number of plants*
Less than 1,000,000	17
1,000,000 to 2,000,000	85
2,000,000 to 3,000,000	44
3,000,000 to 10,000,000	11
Total	157

A special survey of future cement-producing capacity in continental United States was conducted by the Bureau of Mines in October 1954 as a service to the President's Advisory Committee on a National Highway Program. Producers were asked to estimate their capacity "assuming that the proposed $50 billion 10-year highway program is enacted by Congress in 1955, and assuming that new construction and maintenance and repair, other than highway construction resulting from the $50 billion highway program, will remain at about the current level . . ."

From this canvass the following national totals were compiled:

	Barrels per year
December 31, 1954	290,753,000
December 31, 1956	338,584,000
December 31, 1959	407,237,000

In the 1920's the cement companies had expanded from a total capacity of 142 million barrels to 271 million barrels and were caught by the depression of the 1930's. Production dropped to less than 25 percent of productive capacity, and since that time the cement industry has been very cautious about overexpansion. Since 1947 small increases of 1 to 3 percent a year in production capacity were made, and the sudden announcement of expansion plans of 16 percent in 2 years and 40 percent in 5 years were felt by many to be overly optimistic and not based entirely on facts.

CLINKER PRODUCTION

The intermediate product between the raw materials and the finished portland cement is clinker. The output of clinker in 1954 was 3 percent higher in 1954 than in 1953. The peak production was attained in the month of October 1954 as in the preceding year, and the greatest accumulation of stock was in March. At the end of the year stocks of clinker on hand were a little over 1 percent less than those reported at the end of 1953.

RAW MATERIALS

The principal raw materials for manufacturing portland cement in the United States have been limestone and clay or shale. In 1954, 70 percent of the output was made from the combination of materials. Argillaceous limestone (cement rock) or a mixture of cement rock and pure limestone was the source of 21 percent of the portland cement made in 1954. Eight plants in 1954 used oystershells in place of limestone.

Portland cement made from a mixture of limestone and blast-furnace slag is shown under the last heading in table 10. This mixture was used at cement plants in the Buffalo, Pittsburgh, Birmingham, Buffington, Seattle, and El Paso areas. The mixture differs from pozzolan cement in that it is subsequently burned, whereas pozzolan cement is not burned after mixing.

The tonnages of raw materials (exclusive of fuel and explosives) used in producing portland cement are shown in table 11.

FUEL AND POWER

The quantities of coal and fuel oil consumed in the portland-cement industry decreased in 1954 compared with 1953. Only natural gas was consumed in greater quantities than in 1953—an increase of 8 percent contrasted with a decrease of 3 percent for coal and fuel oil. Tables 12 and 13 show pertinent data on the fuel consumption and quantities of portland cement produced from each type of fuel.

Data on electric energy used at portland-cement plants are shown in table 14. During the past 2 years 62 percent of the electric energy used was purchased by the cement companies.

TRANSPORTATION

The trend in greater use of trucks to transport portland cement can be seen in table 15. From 1950 to 1954 the quantity shipped by truck has increased from 24 percent to 31. Similarly, the quantity shipped in bulk has increased from 55 percent in 1950 to 69 percent in 1954.

Shipments shown in table 15 represent the movement of cement as it leaves the manufacturer's possession; transportation between a producing plant and its distribution centers is not considered shipments.

CONSUMPTION

The quantities shown in table 16 are the total number of barrels of portland cement reported by domestic producers (including Puerto Rico) to have been shipped to destinations in the respective States and the District of Columbia. They represent shipments from plants within the State in question and from all other States. These data often are termed "apparent-consumption" or "indicated-consumption" figures.

At any time a variable but considerable quantity of cement is in transit, in warehouses at distributing points, and awaiting use at jobs. In some instances a substantial quantity of the cement shipped to a distributing point near a State line is subsequently used in a State

TABLE 8.—Production and stocks of portland-cement clinker at mills in the United States in 1954, by months and districts, in thousand barrels

District	January	February	March	April	May	June	July	August	September	October	November	December
PRODUCTION												
Eastern Pennsylvania, Maryland	3,049	2,869	3,228	3,231	2,753	2,326	3,144	3,331	3,279	3,390	3,275	3,356
New York, Maine	1,393	1,195	1,420	1,429	866	558	1,397	1,548	1,454	1,694	1,452	1,610
Ohio	1,014	979	1,121	967	1,170	1,148	1,209	1,169	1,135	1,191	1,143	1,168
Western Pennsylvania, West Virginia	901	756	815	689	903	869	895	932	922	920	906	852
Michigan	1,199	1,020	1,281	1,437	1,544	1,443	1,573	1,636	1,568	1,631	1,615	1,564
Illinois	734	654	720	697	661	734	767	792	785	775	767	754
Indiana, Kentucky, Wisconsin	1,303	1,135	1,278	1,338	1,466	1,388	1,442	1,417	1,419	1,469	1,431	1,439
Alabama	799	712	792	796	883	1,030	1,047	1,014	1,038	1,105	1,024	1,022
Tennessee	506	512	616	573	615	605	708	668	654	700	682	691
Virginia, Georgia, Florida, Louisiana, South Carolina, Mississippi	1,527	1,407	1,582	1,545	1,594	1,378	1,547	1,566	1,602	1,648	1,594	1,714
Iowa	742	722	816	487	785	877	878	916	858	888	866	817
Eastern Missouri, Minnesota, South Dakota	787	717	1,008	972	1,014	1,003	1,075	1,168	1,139	1,209	1,106	1,123
Kansas	724	580	700	649	789	758	747	788	755	779	762	794
Western Missouri, Nebraska, Oklahoma, Arkansas	737	711	827	709	698	725	970	948	971	950	914	1,006
Texas	1,416	1,339	1,742	1,818	1,796	1,805	1,984	1,931	1,903	1,876	1,894	1,814
Colorado, Arizona, Wyoming, Montana, Utah, Idaho	612	560	646	701	732	808	832	908	899	988	820	800
Northern California	1,176	1,047	1,231	1,189	1,207	1,160	1,292	1,235	1,257	1,278	1,152	1,162
Southern California	1,490	1,309	1,451	1,432	1,560	1,574	1,579	1,615	1,489	1,661	1,467	1,504
Oregon, Washington	438	422	480	658	741	705	669	709	695	560	477	517
Puerto Rico	226	235	269	271	215	231	322	323	310	319	318	322
Total: 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
1953	21,129	18,917	21,179	21,709	23,074	22,232	23,185	23,370	22,235	23,874	22,489	21,666
STOCKS (END OF MONTH)												
Eastern Pennsylvania, Maryland	658	774	879	823	715	628	540	386	283	232	216	335
New York, Maine	681	860	1,075	1,109	1,016	899	733	539	331	216	169	376
Ohio	256	377	481	494	464	443	357	246	173	98	70	187
Western Pennsylvania, West Virginia	379	651	783	677	623	396	277	226	135	112	137	222
Michigan	639	1,116	1,585	1,586	1,440	1,115	825	631	330	289	279	667
Illinois	183	283	365	423	405	344	246	215	150	37	23	70
Indiana, Kentucky, Wisconsin	535	599	583	572	440	374	256	193	199	111	128	283
Alabama	274	273	233	221	224	180	167	139	101	122	170	193
Tennessee	375	353	413	448	423	371	337	269	218	164	152	217
Virginia, Georgia, Florida, Louisiana, South Carolina, Mississippi	332	314	339	294	362	312	287	274	191	178	189	370
Iowa	218	435	631	638	521	467	404	336	239	177	198	221

Eastern Missouri, Minnesota, South Dakota	499	556	652	746	599	449	302	251	133	77	122	215
Kansas	210	251	222	164	143	107	75	43	43	36	28	124
Western Missouri, Nebraska, Oklahoma, Arkansas	370	450	596	585	449	310	249	250	146	96	94	104
Texas	439	303	351	299	256	164	230	199	217	181	187	126
Colorado, Arizona, Wyoming, Montana, Utah, Idaho	544	559	675	588	409	223	156	134	121	134	149	292
Northern California	375	530	790	823	806	736	676	615	549	486	390	387
Southern California	657	695	584	604	584	592	656	663	605	535	423	364
Oregon, Washington	499	584	577	451	422	431	403	414	473	480	425	437
Puerto Rico	146	128	133	136	91	44	68	57	83	88	85	84
Total: 1954	8, 269	10, 091	11, 947	11, 681	10, 392	8, 585	7, 244	6, 080	4, 720	3, 849	3, 634	5, 274
1953	7, 445	8, 899	9, 895	9, 715	9, 401	8, 832	7, 829	6, 652	5, 001	4, 109	4, 022	[1] 5, 349

[1] Revised figure.

TABLE 9.—Portland-cement clinker produced and in stock at mills in the United States,[1] 1953–54, by processes, in barrels [2]

Process	Plants		Production		Stocks on Dec. 31—	
	1953	1954	1953	1954	1953 [3]	1954 [4]
Wet	93	94	150, 225, 452	154, 717, 039	3, 369, 469	2, 862, 229
Dry	63	63	114, 833, 577	117, 212, 578	1, 979, 805	2, 412, 255
Total	156	157	265, 059, 029	271, 929, 617	5, 349, 274	5, 274, 484

[1] Including Puerto Rico.
[2] Compiled from monthly estimates of producers.
[3] Revised figures.
[4] Preliminary figures.

TABLE 10.—Production and percentage of total output of portland cement in the United States,[1] 1906–14, 1926, 1929, 1933, 1935, and 1941–54, 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
1906	23, 896, 951	51. 4	16, 532, 212	35. 6	3, 958, 201	8. 5	2, 076, 000	4. 5
1907	25, 859, 095	53. 0	17, 190, 697	35. 2	3, 606, 598	7. 4	2, 129, 000	4. 4
1908	20, 678, 693	40. 6	23, 047, 707	45. 0	2, 811, 212	5. 5	4, 535, 300	8. 9
1909	24, 274, 047	37. 3	32, 219, 365	49. 6	2, 711, 219	4. 2	5, 786, 800	8. 9
1910	26, 520, 911	34. 6	39, 720, 320	51. 9	3, 307, 220	4. 3	7, 001, 500	9. 2
1911	26, 812, 129	34. 1	40, 665, 332	51. 8	3, 314, 176	4. 2	7, 737, 000	9. 9
1912	24, 712, 780	30. 0	44, 607, 776	54. 1	2, 467, 368	3. 0	10, 650, 172	12. 9
1913	29, 333, 490	31. 8	47, 831, 863	51. 9	3, 734, 778	4. 1	11, 197, 000	12. 2
1914	24, 907, 047	28. 2	50, 168, 813	56. 9	4, 038, 310	4. 6	9, 116, 000	10. 3
1926	44, 090, 657	26. 8	101, 637, 866	61. 8	3, 324, 408	2. 0	15, 477, 239	9. 4
1929	51, 077, 034	29. 9	97, 623, 502	57. 2	4, 832, 700	2. 9	17, 112, 800	10. 0
1933	14, 135, 171	22. 3	43, 638, 023	68. 7	1, 402, 744	2. 2	4, 297, 251	6. 8
1935	23, 811, 687	31. 0	45, 073, 144	58. 8	1, 478, 569	1. 9	6, 378, 170	8. 3
1941	46, 534, 193	28. 4	102, 285, 699	62. 3	3, 142, 021	1. 9	12, 068, 646	7. 4
1942	49, 479, 304	27. 0	115, 948, 373	63. 4	3, 009, 562	1. 7	14, 343, 945	7. 9
1943	29, 915, 157	22. 4	92, 310, 018	69. 2	2, 300, 636	1. 7	8, 897, 977	6. 7
1944	17, 609, 055	19. 4	65, 478, 178	72. 0	2, 078, 530	2. 3	5, 739, 933	6. 3
1945	20, 383, 505	19. 8	73, 409, 831	71. 4	2, 035, 236	2. 0	6, 976, 312	6. 8
1946	39, 070, 643	23. 8	112, 142, 154	68. 3	2, 720, 500	1. 7	10, 130, 891	6. 2
1947	43, 428, 201	23. 3	129, 338, 247	69. 3	2, 408, 845	1. 3	11, 344, 054	6. 1
1948	47, 559, 783	23. 1	144, 855, 487	70. 5	2, 620, 060	1. 3	10, 412, 933	5. 1
1949	45, 655, 516	21. 8	150, 435, 948	71. 7	3, 310, 270	1. 6	10, 325, 683	4. 9
1950	47, 120, 142	20. 8	164, 811, 547	73. 0	2, 596, 962	1. 1	11, 497, 198	5. 1
1951	50, 328, 000	20. 4	169, 204, 269	68. 8	2, 653, 211	1. 1	23, 836, 996	9. 7
1952	48, 563, 411	19. 5	177, 900, 577	71. 4	4, 037, 749	1. 6	18, 754, 417	7. 5
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

[1] Includes Puerto Rico, 1941–54; Hawaii, 1945–46. There has been no production in Hawaii since 1946.
[2] Includes output of 2 plants using oystershells and clay in 1926; 3 plants in 1929, 1933, and 1935; 4 plants in 1941–45; 5 plants in 1946–49; 6 plants in 1950; 7 plants in 1951; and 8 plants in 1952–54 (includes 1 plant that used coquina shells).

TABLE 11.—Raw materials used in producing portland cement in the United States,[1] 1952–54

Raw material	1952	1953	1954
	Short tons	*Short tons*	*Short tons*
Cement rock	13, 404, 234	[2] 14, 624, 080	15, 148, 183
Limestone (including oystershells)	54, 229, 475	[2] 55, 575, 779	57, 466, 872
Marl	1, 065, 164	1, 291, 726	1, 298, 143
Clay and shale [3]	7, 939, 326	[2] 8, 596, 483	8, 596, 740
Blast-furnace slag	1, 017, 976	1, 408, 486	1, 297, 655
Gypsum	1, 855, 274	1, 956, 093	2, 009, 249
Sand and sandstone (including silica and quartz)	893, 682	888, 359	894, 757
Iron materials [4]	375, 852	410, 420	399, 283
Miscellaneous [5]	168, 901	176, 173	168, 826
Total	80, 949, 884	[2] 84, 927, 599	87, 279, 708
Average total weight required per barrel (376 pounds) of finished cement	*Pounds* 646	*Pounds* 643	*Pounds* 641

[1] Including Puerto Rico.
[2] Revised figure.
[3] Includes fuller's earth, diaspore, and kaolin for making white cement.
[4] Includes iron ore, pyrite cinders and ore, and mill scale.
[5] Includes fluorspar, flue dust, pumicite, pitch, red mud and rock, hydrated lime, tufa, calcium chloride, sludge, air-entraining compounds, and grinding aids.

TABLE 12.—Finished portland cement produced and fuel consumed by the portland-cement industry in the United States,[1] 1953–54, 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)
1953						
Wet	93	149,667,484	56.7	3,884,809	5,378,306	80,754,464
Dry	63	114,513,038	43.3	4,477,126	1,403,616	[3] 36,387,981
Total	156	264,180,522	100.0	[4] 8,361,935	6,781,922	[3] 117,142,445
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	[5] 41,516,268
Total	157	272,352,557	100.0	[6] 8,123,722	6,583,839	[5] 126,053,078

[1] Includes Puerto Rico.
[2] Figures compiled from monthly estimates of producers.
[3] Includes 71,112 M cubic feet of byproduct gas and 2,032,228 M cubic feet of coke-oven gas.
[4] Comprises 194,781 tons of anthracite and 8,167,154 tons of bituminous coal.
[5] Includes 48,685 M cubic feet of byproduct gas and 747,296 M cubic feet of coke-oven gas.
[6] Comprises 199,773 tons of anthracite and 7,923,949 tons of bituminous coal.

TABLE 13.—Portland cement produced in the United States,[1] 1953–54, 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)
1953						
Coal	72	[3] 121,394,784	46.0	6,768,087		
Oil	14	[3] 24,184,112	9.2		4,942,080	
Natural gas	17	[3] 27,175,944	10.3			38,255,085
Coal and oil	13	21,202,136	8.0	887,468	1,079,450	
Coal and natural gas	21	32,319,168	12.2	626,275		[4] 31,646,266
Oil and natural gas	11	26,744,952	10.1		594,809	32,668,501
Coal, oil, and natural gas	8	11,159,426	4.2	80,105	165,583	14,572,593
Total	156	264,180,522	100.0	[5] 8,361,935	6,781,922	117,142,445
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			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		[6] 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	[7] 8,123,722	6,583,839	126.053,078

[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: 1953—coal, 111.5 pounds; oil, 0.2044 barrel; natural gas, 1,408 cubic feet. 1954—coal, 110.4 pounds; oil, 0.2019 barrel; natural gas, 1,371 cubic feet.
[4] Includes 71,112 M cubic feet of byproduct gas and 2,032,228 M cubic feet of coke-oven gas.
[5] Comprises 194,781 tons of anthracite and 8,167,154 tons of bituminous coal.
[6] Includes 48,685 M cubic feet of byproduct gas and 747,296 M cubic feet of coke-oven gas.
[7] Comprises 199,773 tons of anthracite and 7,923,949 tons of bituminous coal.

other than that listed as its "destination." Some coastal and border States receive cement from foreign countries, and the quantities are not included here. Although shipments to destinations in a State do not equal its consumption during that period, shipments over a long period afford a fair index of consumption. Shipments were

428641—58——19

TABLE 14.—Electric energy used at portland-cement-producing plants in the United States,[1] 1953–54, by processes, in kilowatt-hours

Process	Electric energy used: Generated at portland-cement plants: Active plants	Generated at portland-cement plants: Kilowatt-hours	Purchased: Active plants	Purchased: Kilowatt-hours	Total: Kilowatt-hours	Total: Percent	Finished cement produced (barrels)	Average electric energy used per barrel of cement produced (kilowatt-hours)
1953								
Wet	29	739,405,805	87	2,466,097,364	3,205,503,169	54.8	149,667,484	21.4
Dry	35	1,462,850,110	54	1,185,740,136	2,648,590,246	45.2	114,513,038	23.1
Total	64	2,202,255,915	141	3,651,837,500	5,854,093,415	100.0	264,180,522	22.2
Percent of total electric energy used		37.6		62.4	100.0			
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			

[1] Includes Puerto Rico.

TABLE 15.—Shipments of portland cement from mills in the United States,[1] 1952–54, in bulk and in containers, by types of carriers

Type of carrier	In bulk: Barrels	In bulk: Percent	In containers: Bags: Paper (barrels)	Bags: Cloth (barrels)	Other containers[2] (barrels)	Total (barrels)	Total shipments: Barrels	Total shipments: Percent
1952								
Truck	[3]45,690,842	28.8	22,948,530	138,702		23,087,232	68,778,074	27.3
Railroad	109,566,554	69.1	68,891,460	446,361	8,218	69,346,039	178,912,593	71.2
Boat	3,248,587	2.1	392,025	36,340	884	429,249	3,677,836	1.5
Total	158,505,983	100.0	92,232,015	621,403	9,102	92,862,520	251,368,503	100.0
Percent of total	63.1		36.7	0.2	(4)	36.9	100.0	
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	

[1] Includes Puerto Rico.
[2] Includes steel drums and iron and wood barrels.
[3] Includes cement used at mills by producers as follows—1952, 1,212,495 barrels; 1953, 1,306,411 barrels; 1954, 2,955,556 barrels.
[4] Less than 0.05 percent.

TABLE 16.—Destination of shipments of finished portland cement from mills in the United States, 1952–54, by States

Destination	1952 (barrels)	1953 (barrels)	1954 Barrels	1954 Change from 1953 (percent)
Continental United States:				
Alabama	3,920,511	4,260,020	3,954,507	−7.2
Arizona	2,121,492	2,422,223	2,215,346	−8.5
Arkansas	1,941,519	1,772,135	1,897,348	+7.1
California	25,361,032	27,732,814	28,761,087	+3.7
Colorado	2,824,978	2,940,615	3,279,171	+11.5
Connecticut [1]	2,977,458	3,188,752	3,264,089	+2.4
Delaware [1]	906,245	891,978	910,193	+2.0
District of Columbia [1]	1,155,923	1,248,696	1,323,125	+6.0
Florida	6,680,385	7,487,563	8,313,451	+11.0
Georgia	4,116,620	4,643,993	4,447,570	−4.2
Idaho	1,110,295	985,580	1,220,895	+23.9
Illinois	13,324,065	13,515,338	15,017,658	+11.1
Indiana	6,222,861	6,430,278	6,756,519	+5.1
Iowa	4,976,010	5,025,264	5,907,952	+17.6
Kansas	5,852,155	5,791,950	6,596,942	+13.9
Kentucky	3,621,414	3,319,505	3,040,909	−8.4
Louisiana	5,868,630	5,759,267	6,291,696	+9.2
Maine	692,055	907,788	868,111	−4.4
Maryland	4,362,945	4,672,721	4,447,762	−4.8
Massachusetts [1]	4,346,378	4,351,196	4,158,916	−4.4
Michigan	11,310,322	12,716,532	13,085,398	+2.9
Minnesota	4,748,175	4,968,121	5,515,459	+11.0
Mississippi	1,704,719	1,696,176	1,750,784	+3.2
Missouri	6,319,588	6,797,881	7,570,836	+11.4
Montana	1,358,350	948,293	1,022,168	+7.8
Nebraska	2,626,741	3,384,652	3,741,686	+10.5
Nevada [1]	618,392	623,133	852,651	+36.8
New Hampshire [1]	456,691	548,692	830,141	+51.3
New Jersey [1]	8,084,668	8,574,407	9,206,660	+7.4
New Mexico [1]	1,645,426	1,876,499	2,062,937	+9.9
New York	16,898,736	19,101,250	20,367,852	+6.6
North Carolina [1]	3,885,629	3,746,417	3,855,839	+2.9
North Dakota [1]	1,071,422	1,120,297	1,161,684	+3.7
Ohio	13,095,380	14,292,284	16,033,134	+12.2
Oklahoma	4,651,344	4,158,026	4,365,606	+5.0
Oregon	2,927,040	2,445,679	2,089,482	−14.6
Pennsylvania	15,132,930	15,229,467	15,160,456	−0.5
Rhode Island [1]	923,860	859,500	689,556	−19.8
South Carolina	2,961,293	2,260,545	2,071,489	−8.4
South Dakota	1,108,810	1,188,758	1,115,853	−6.1
Tennessee	4,701,963	4,867,836	4,702,127	−3.4
Texas	17,257,467	16,153,989	19,198,914	+18.8
Utah	1,342,998	1,342,755	1,507,387	+12.3
Vermont [1]	316,066	296,159	241,995	−18.3
Virginia	4,649,768	4,705,831	4,495,388	−4.5
Washington	4,954,171	5,399,200	5,630,848	+4.3
West Virginia	1,804,409	1,922,820	2,306,293	+19.9
Wisconsin	5,667,282	6,138,721	5,912,086	−3.7
Wyoming	561,486	537,625	581,555	+8.2
Unspecified	8,840	14,250	27,684	+94.3
Total continental United States	245,176,937	255,263,471	269,827,165	+5.7
Outside continental United States [2]	6,191,566	5,615,064	5,044,827	−10.2
Total shipped from cement plants	251,368,503	260,878,535	274,871,992	+5.4

[1] Non-cement-producing State.
[2] Direct shipments by producers to foreign countries and to noncontiguous Territories (Alaska, Hawaii, Puerto Rico, etc.), including distribution from Puerto Rican mills.

higher into 32 States and the District of Columbia and lower into 16 States than in 1953.

Table 17 shows a monthly breakdown of apparent consumption in each State.

TABLE 17.—Destination of shipments of finished portland cement from mills in the United States in 1954, by months, in barrels

Destination	January	February	March	April	May	June	July	August	September	October	November	December
Alabama	267, 053	292, 643	332, 244	313, 743	322, 363	371, 842	295, 259	347, 645	374, 901	412, 804	340, 411	272, 492
Arizona	181, 426	201, 398	214, 391	230, 008	175, 945	185, 725	166, 695	159, 784	156, 334	176, 023	173, 729	193, 564
Arkansas	63, 308	116, 176	128, 607	135, 710	144, 049	218, 836	163, 847	212, 844	149, 678	138, 825	234, 941	186, 985
California	1, 631, 099	1, 980, 696	2, 125, 481	2, 521, 381	2, 593, 648	2, 597, 857	2, 480, 854	2, 596, 996	2, 589, 509	2, 718, 090	2, 426, 215	2, 265, 905
Colorado	141, 401	189, 546	203, 535	312, 460	331, 413	421, 996	208, 570	347, 748	336, 714	311, 483	267, 008	207, 121
Connecticut	106, 380	156, 221	267, 894	298, 122	294, 510	292, 734	370, 583	331, 651	295, 750	354, 627	291, 218	204, 291
Delaware	20, 565	46, 324	46, 442	59, 314	80, 964	107, 232	145, 813	116, 103	88, 784	92, 384	63, 472	42, 611
District of Columbia	59, 088	96, 508	95, 701	119, 793	120, 718	124, 773	132, 880	128, 674	116, 186	120, 050	119, 998	89, 587
Florida	649, 135	611, 827	673, 654	675, 941	613, 922	671, 336	638, 336	709, 111	727, 921	723, 618	810, 801	848, 688
Georgia	324, 513	358, 590	386, 681	383, 793	379, 346	445, 018	308, 832	370, 737	410, 679	423, 446	343, 717	305, 620
Idaho	26, 188	41, 506	67, 154	91, 774	107, 103	141, 349	161, 104	144, 205	190, 311	117, 383	87, 863	38, 722
Illinois	446, 571	651, 059	820, 683	1, 177, 594	1, 528, 699	1, 813, 913	1, 618, 312	1, 692, 174	1, 835, 153	1, 516, 935	1, 206, 798	665, 156
Indiana	221, 416	329, 961	404, 990	587, 519	651, 631	785, 923	751, 243	705, 756	760, 866	692, 181	534, 705	298, 063
Iowa	74, 363	128, 145	213, 134	440, 342	575, 409	813, 008	724, 839	765, 448	853, 029	715, 607	412, 355	147, 579
Kansas	209, 172	372, 109	406, 746	642, 843	574, 914	727, 595	566, 626	686, 364	752, 913	688, 351	611, 400	336, 935
Kentucky	104, 881	192, 476	240, 584	305, 373	275, 059	328, 171	297, 575	299, 538	301, 273	308, 118	234, 621	138, 193
Louisiana	352, 954	506, 487	502, 956	537, 095	504, 196	580, 697	481, 466	588, 397	664, 574	548, 596	572, 370	451, 809
Maine	20, 344	20, 191	34, 398	65, 049	92, 711	27, 690	108, 524	122, 999	124, 419	106, 627	92, 872	40, 910
Maryland	160, 227	300, 047	333, 177	426, 246	392, 102	447, 100	470, 431	394, 551	435, 929	449, 475	371, 628	266, 336
Massachusetts	145, 283	186, 906	355, 946	403, 632	372, 095	304, 096	458, 357	427, 610	384, 867	426, 633	421, 861	292, 599
Michigan	373, 326	402, 276	565, 887	1, 015, 205	1, 400, 992	1, 521, 203	1, 459, 566	1, 591, 786	1, 456, 628	1, 425, 043	1, 249, 253	615, 263
Minnesota	87, 306	135, 834	208, 505	413, 342	548, 586	832, 989	694, 537	774, 930	653, 973	639, 090	341, 933	169, 154
Mississippi	100, 100	116, 434	151, 693	156, 754	138, 213	185, 460	148, 211	162, 672	140, 435	142, 872	173, 360	115, 767
Missouri	252, 026	465, 058	517, 748	720, 879	727, 297	874, 738	735, 263	792, 738	794, 489	608, 521	645, 449	421, 832
Montana	20, 799	34, 210	57, 213	73, 748	96, 998	144, 373	117, 732	120, 494	118, 488	105, 480	83, 614	45, 763
Nebraska	57, 049	118, 489	186, 842	338, 479	333, 755	463, 814	444, 072	405, 424	490, 640	398, 638	326, 963	159, 681
Nevada	57, 346	60, 660	73, 058	95, 653	70, 052	80, 626	70, 552	73, 126	72, 044	68, 630	62, 220	57, 945
New Hampshire	16, 833	20, 645	37, 357	58, 463	66, 583	53, 059	105, 926	95, 373	99, 015	128, 791	114, 904	30, 269
New Jersey	379, 377	532, 388	808, 620	823, 434	903, 254	845, 167	900, 991	890, 954	870, 829	922, 493	732, 834	553, 926
New Mexico	98, 774	133, 086	143, 066	229, 170	186, 146	204, 775	164, 581	167, 851	177, 701	215, 187	223, 880	166, 641
New York	586, 162	850, 137	1, 357, 661	1, 639, 343	1, 862, 974	1, 924, 930	2, 486, 362	2, 546, 695	2, 323, 828	2, 199, 499	1, 468, 313	1, 044, 264
North Carolina	196, 966	296, 515	307, 009	429, 496	341, 738	411, 028	387, 474	378, 370	413, 393	336, 863	288, 406	222, 013
North Dakota	7, 843	20, 182	46, 077	71, 912	130, 240	200, 289	211, 011	163, 438	142, 820	113, 570	39, 052	15, 055
Ohio	517, 108	719, 526	848, 818	1, 190, 647	1, 397, 218	1, 680, 292	1, 816, 287	1, 848, 571	2, 152, 715	1, 822, 629	1, 335, 530	674, 109
Oklahoma	253, 531	398, 018	403, 104	419, 576	341, 739	459, 492	343, 315	355, 501	362, 675	319, 022	388, 306	319, 709
Oregon	70, 700	120, 849	170, 552	179, 448	189, 538	214, 695	218, 249	211, 970	218, 540	192, 870	161, 918	132, 028
Pennsylvania	476, 100	730, 753	960, 876	1, 324, 900	1, 418, 073	1, 611, 026	1, 745, 446	1, 622, 737	1, 643, 374	1, 574, 205	1, 179, 188	821, 387
Rhode Island	22, 288	36, 969	66, 102	77, 237	65, 817	53, 815	74, 737	55, 516	55, 600	66, 410	67, 567	43, 036
South Carolina	152, 259	172, 191	185, 389	199, 665	185, 277	180, 619	173, 811	163, 615	169, 043	167, 164	143, 017	101, 418
South Dakota	15, 849	37, 439	40, 046	84, 362	112, 333	159, 535	106, 633	133, 279	156, 860	154, 824	88, 305	26, 319
Tennessee	196, 165	309, 645	348, 654	433, 065	368, 129	467, 845	409, 388	475, 745	462, 175	478, 281	370, 843	264, 242
Texas	1, 039, 404	1, 493, 861	1, 646, 002	1, 597, 073	1, 562, 446	1, 805, 954	1, 737, 189	1, 808, 368	1, 790, 788	1, 540, 754	1, 557, 559	1, 600, 184
Utah	37, 938	54, 606	91, 760	143, 970	142, 112	176, 684	142, 344	176, 900	162, 427	155, 577	136, 873	86, 382
Vermont	3, 946	3, 795	12, 648	24, 660	26, 452	19, 718	33, 890	24, 977	31, 576	29, 216	20, 663	10, 832
Virginia	216, 390	317, 592	361, 504	413, 979	361, 626	459, 635	428, 235	444, 760	462, 414	417, 694	344, 970	245, 192

Washington	106, 031	232, 133	504, 795	593, 275	548, 731	555, 309	544, 133	583, 946	590, 445	536, 019	510, 864	378, 210
West Virginia	75, 501	101, 348	128, 353	199, 609	254, 079	310, 117	324, 182	292, 009	241, 481	181, 149	196, 799	74, 031
Wisconsin	121, 703	160, 963	244, 735	421, 932	600, 677	805, 124	635, 350	775, 673	704, 398	737, 875	390, 539	240, 938
Wyoming	21, 478	32, 414	26, 576	52, 233	55, 406	71, 313	52, 462	58, 377	70, 933	62, 227	51, 775	30, 220
Unspecified	1, 337	1, 074	792	3, 460	1, 904	1, 706	3, 761	885	1, 954	580	552	8, 275
Continental United States	10, 767, 002	14, 887, 906	18, 355, 840	23, 152, 701	24, 569, 182	28, 182, 221	27, 265, 836	28, 345, 015	28, 581, 471	26, 782, 429	22, 313, 432	15, 967, 251
Outside continental United States [1]	375, 998	314, 094	395, 160	436, 299	341, 818	449, 779	436, 164	541, 985	450, 529	351, 571	452, 568	379, 749
Total	11, 143, 000	15, 202, 000	18, 751, 000	23, 589, 000	24, 911, 000	28, 632, 000	27, 702, 000	28, 887, 000	29, 032, 000	27, 134, 000	22, 766, 000	16, 347, 000

[1] Shipments by producers to foreign countries and to noncontiguous Territories of the United States (Alaska, Hawaii, Puerto Rico, etc.), including distribution from Puerto Rican mills.

STOCKS

Shipments in 1954 were over 2 percent greater than production, and stocks of finished portland cement on hand at the end of the year were therefore considerably less (13 percent) than those on hand at the end of 1953. Only three districts reported stocks higher on December 31, 1954, than on December 31, 1953.

In the first 5 months of 1954 stocks of cement were higher than in the same months of 1953, but during the last 7 months stocks on hand were 4 to 18 percent less.

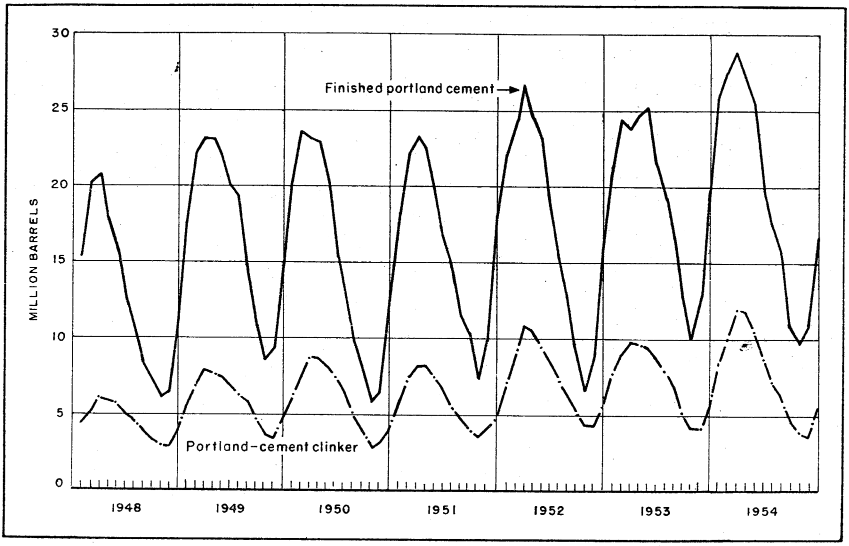

FIGURE 2.—End-of-month stocks of finished portland cement and portland-cement clinker, 1948–54

TABLE 18.—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, 1950–54

		Dec. 31 (barrels)	Range			
			Low		High	
			Month	Barrels	Month	Barrels
1950	Cement	13,118,867	October	5,945,000	February	23,583,000
	Clinker	3,924,801	do	2,852,000	March	8,821,000
1951	Cement	18,064,421	do	7,162,000	do	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	[2] 19,272,008	October	10,049,000	May	25,247,000
	Clinker	[2] 5,349,274	November	4,022,000	March	9,895,000
1954	Cement	16,752,573	October	9,667,000	do	28,905,000
	Clinker	5,274,484	November	3,634,000	do	11,947,000

[1] Includes Puerto Rico.
[2] Revised figure.

PRICES

The average net mill realization of all portland cement shipped in 1954 was $2.76 per barrel compared with $2.67 in 1953. The average value in the first two quarters of 1954 was $2.72 per barrel but increased to $2.80 per barrel for the last two quarters of 1954.

The composite wholesale price index of portland cement, f. o. b. destination, according to the Bureau of Labor Statistics index (1947–49 average=100) was 126.6 in 1954 compared with 122.2 in 1953.

Average mill value per barrel, in bulk, of portland cement in the United States,[1] 1945–49 (average) and 1950–54

1945–49 (average)	$1.99	1952	$2.54
1950	2.35	1953	2.67
1951	2.54	1954	2.76

[1] Includes Puerto Rico and Hawaii, 1946; Puerto Rico only, 1947–54.

NATURAL, MASONRY (NATURAL), AND POZZOLAN CEMENTS

Eight plants in the United States produced natural, masonry-natural, and pozzolan cements during 1954. Three of these produced a natural cement, two produced pozzolan cement, one a hydraulic-lime cement, and two produced only masonry cements. Two of the natural-cement plants and the two pozzolan plants also produced masonry cement. Output in 1954 was less than 1 percent higher than in 1953, shipments increased 2 percent, and stocks on hand at the end of the year were 6 percent less than in 1953. Producers in this group reported consumption of 31,280 short tons of coal and 343,741,000 cubic feet of gas (equivalent to approximately 3,000 short tons of coal).

The 8 production plants reported an estimated total annual capacity on December 31, 1954, of 3,702,000 equivalent barrels of 376 pounds. Raw materials used during 1954 in producing these cements were 348,254 short tons of cement rock, 153,757 short tons of slag, and 101,297 short tons of other materials, principally shale, lime, and limestone.

The quantities in table 19 are reported by producers in barrels of various weights, ranging from 250 pounds per barrel to 340 pounds per barrel, and have been converted to equivalent barrels of 376 pounds each to maintain uniformity with other data in this chapter.

TABLE 19.—Natural, masonry (natural), and pozzolan (slag-lime) cements produced, shipped, and in stock at mills in the United States, 1945–49 (average) and 1950–54

Year	Production		Shipments		Stocks on Dec. 31, (barrels)
	Active plants	Barrels	Barrels	Value	
1945–49 (average)	9	2,707,002	2,709,832	$5,550,813	159,854
1950	9	4,246,299	4,218,580	10,629,586	189,323
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	[1] 142,326
1954	8	3,504,380	3,513,358	13,214,960	133,348

[1] Revised figure.

FOREIGN TRADE [4]

Imports.—Imports of hydraulic cement totaled 450,000 barrels in 1954, an increase of 17 percent more than the quantity imported in 1953. Most of this cement came from three countries—Belgium-Luxembourg, Canada, and West Germany.

Imports of all hydraulic cement except white, nonstaining, and other special cements for 1952–54 are listed by countries of origin in table 21. Imports of white nonstaining cement in 1954 totaled 78,643 barrels. Imports of hydraulic cement clinker totaled 47 barrels, all from Canada.

Exports.—Exports of hydraulic cement in 1954 were 28 percent lower than in 1953 and represented less than 1 percent of the total shipments of domestically produced cement. About one-third of the exports went to Canada. Other countries receiving over 100,000 barrels were Cuba, Venezuela, Mexico, Haiti.

TABLE 20.—Hydraulic cement imported for consumption in the United States, 1945–49 (average) and 1950–54

[U. S. Department of Commerce]

Year	Barrels	Value	Year	Barrels	Value
1945–49 (average)	80, 247	$231, 998	1952	475, 986	$1, 397, 239
1950	1, 409, 974	3, 610, 056	1953	386, 051	1, 265, 821
1951	921, 953	3, 162, 960	1954	450, 248	[1] 1, 762, 708

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

TABLE 21.—Roman, portland, and other hydraulic cement imported for consumption in the United States, 1952–54, by countries [1]

[U. S. Department of Commerce]

Country	1952		1953		1954	
	Barrels	Value	Barrels	Value	Barrels	Value
North America:						
Canada	1, 731	$11, 246	11, 548	$51, 105	67, 588	$280, 989
Mexico					7, 250	17, 013
Total	1, 731	11, 246	11, 548	51, 105	74, 838	298, 002
Europe:						
Belgium-Luxembourg	194. 350	518, 617	187, 245	524, 552	194, 596	621, 069
Denmark	3, 963	18, 617	750	1, 559		
France			152	1, 281	51	1, 746
Germany, West	132, 710	328, 141	98, 678	275, 888	52, 053	185, 159
Sweden	33, 146	105, 375	17, 573	35, 854	22, 498	43, 063
United Kingdom	103, 289	379, 222	10, 578	61, 958	14, 103	88, 637
Yugoslavia	879	4, 371	10, 554	52, 411	12, 919	66, 767
Total	468, 337	1, 354, 343	325, 530	953, 503	296, 220	1, 006, 441
Asia: Japan	1	6				
Africa: French Morocco					500	3, 433
Grand total	470, 069	1, 365, 595	337, 078	1, 004, 608	371, 558	[2] 1, 307, 876

[1] Excludes "white, nonstaining, and other special cements."
[2] Due to changes in tabulating procedures by the U. S. Department of Commerce data known not to be strictly comparable to earlier years.

[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 22.—Hydraulic cement exported from the United States, 1945–49 (average) and 1950–54

[U. S. Department of Commerce]

Year	Barrels	Value	Percent of total shipments from mills
1945–49 (average)	5,778,679	$17,551,454	3.3
1950	2,418,435	7,274,564	1.0
1951	2,932,787	9,963,721	1.2
1952	3,174,405	11,148,535	1.2
1953	[1] 2,550,788	[1] 9,347,169	1.0
1954	1,844,012	6,621,970	1.0

[1] Revised figure.

TABLE 23.—Hydraulic cement exported from the United States, 1952–54, by countries of destination

[U. S. Department of Commerce]

Country	1952		1953		1954	
	Barrels	Value	Barrels	Value	Barrels	Value
North America:						
Bermuda	1,250	$5,021	7,425	$27,450	1,762	$5,956
Canada	1,407,735	5,163,635	1,207,296	4,519,410	639,046	2,493,150
Central America:						
British Honduras	2,049	9,418	3,900	13,692	2,312	8,707
Canal Zone	396	2,318	710	4,211	1,632	7,257
Costa Rica	8,893	35,451	9,577	36,046	40,000	96,649
El Salvador	8,716	37,918	2,508	19,655	1,416	10,561
Guatemala	1,888	14,459	1,326	8,878	660	6,621
Honduras	58,437	198,674	32,973	89,627	31,759	80,136
Nicaragua	6,692	26,359	8,064	30,808	4,637	18,829
Panama	1,388	10,091	1,452	10,204	692	4,817
Mexico	285,277	1,128,373	278,368	1,152,740	209,046	900,025
West Indies:						
British:						
Bahamas	15,147	68,306	12,252	54,790	13,895	57,872
Barbados	375	1,754	500	2,480	500	2,474
Jamaica	1,985	7,464	2,055	6,214	505	2,299
Leeward and Windward Islands	1,936	7,146	2,634	9,367	2,430	10,910
Trinidad and Tobago	1,232	9,989	4,133	20,133	3,474	16,164
Cuba	656,735	2,006,866	447,584	1,254,473	380,856	978,034
Dominican Republic	10,403	31,240	2,214	12,256	400	1,510
French West Indies	8,550	27,917	8,601	26,420	8,997	25,975
Haiti	118,848	269,695	73,628	193,655	131,585	367,016
Netherlands Antilles	99,647	280,014	76,710	195,650	55,692	166,870
Total	2,697,579	9,342,108	2,183,910	7,688,159	1,531,296	5,261,832
South America:						
Argentina	780	2,942	800	5,488		
Bolivia	704	4,103	2,916	13,723	2,916	12,980
Brazil	3,156	15,090	7,270	29,944	12,385	57,649
Chile	2,937	21,793	2,533	23,840	264	2,978
Colombia	17,473	107,285	11,663	76,875	15,385	98,650
Ecuador	3,000	13,260	4	104	8,250	28,875
Paraguay			382	2,815		
Peru	13,629	52,895	10,063	47,322	3,511	16,965
Surinam	6,325	18,355	32,638	78,995	5,937	12,655
Venezuela	375,880	1,285,239	[1] 239,264	[1] 1,043,017	213,918	873,266
Total	423,884	1,520,962	[1] 307,533	[1] 1,322,123	262,566	1,104,018
Europe:						
Belgium-Luxembourg	795	6,333	528	4,279	761	7,264
France	1,766	13,233	137	2,491	293	1,490
Italy	149	1,999	13	153	187	2,328
Norway	135	11,013	82	5,359	32	1,850
Spain	25	365	864	5,012	250	1,020
Turkey	4,238	21,870	45	152		
Other Europe	614	9,999	520	6,195	35	107
Total	7,722	64,812	2,189	23,641	1,558	14,059

See footnotes at end of table.

TABLE 23.—Hydraulic cement exported from the United States, 1952–54, by countries of destination—Continued

[U. S. Department of Commerce]

Country	1952		1953		1954	
	Barrels	Value	Barrels	Value	Barrels	Value
Asia:						
Bahrein	3,231	$12,998			425	$2,403
India	1,160	4,873	22	$400		
Indonesia	2,750	12,092	5,424	27,014	4,000	16,600
Iraq	9,781	45,659	11,327	53,195	250	1,220
Israel and Palestine	109	2,019	596	4,357	[2] 313	[2] 1,281
Japan	243	9,667	1,382	22,247	422	9,075
Korea			132	1,203	2,235	9,298
Kuwait	38	188	[1] 2,500	[1] 9,930	13,759	53,216
Malaya			197	934	2,250	10,748
Philippines	314	3,147	4,271	42,059	2,255	22,253
Saudi Arabia	22,095	104,087	[1] 18,631	[1] 92,695	8,485	47,240
Other Asia	175	957	1,248	9,879	232	2,636
Total	39,896	195,687	[1] 45,730	[1] 263,913	34,626	175,970
Africa:						
Ethiopia	1,250	5,455				
Federation of Rhodesia and Nyasaland			[3] 750	[3] 3,809		
Liberia	313	1,995	450	1,562	6,479	25,986
Nigeria			148	734	1,554	8,100
Tunisia	625	3,325	502	2,414		
Other Africa	276	1,125	672	5,860	963	6,190
Total	2,464	11,900	2,522	14,379	8,996	40,276
Oceania:						
Australia	280	2,991	375	1,574	1,682	10,966
New Zealand	2,530	9,845	8,113	29,814	3,025	11,677
Other Oceania	50	230	416	3,566	263	2,992
Total	2,860	13,066	8,904	34,954	4,970	25,635
Grand total	3,174,405	11,148,535	[1] 2,550,788	[1] 9,347,169	1,844,012	6,621,790

[1] Revised figure.
[2] Israel.
[3] Northern Rhodesia.

TECHNOLOGY

Technical improvements in kiln-operating efficiency were of major importance in the growth of the portland-cement industry. The industry grew progressively from 145 plants with a total capacity of 242 million barrels in 1945 to 150 plants with 268 million barrels capacity in 1950 and to 157 plants with 298 million barrels capacity in 1954. The number of kilns in operation decreased from 672 in 1945 to 671 in 1950 and 666 in 1954. From 1945 to 1954 nearly 100 kilns less than 200 feet long were converted to or replaced by longer kilns with greater capacity. Although the capacity of the industry increased 22 percent, the number of kilns decreased 1 percent. The number of kilns of various lengths in each producing district are shown in table 24 for 1945, 1950, and 1954.

Improvements in kiln efficiency from 2 million B. t. u. per barrel of cement to less than 0.9 million B. t. u. per barrel were reported at some installations and increases of 10 percent in production capacity without loss in fuel efficiency at others.[5]

[5] Lellep, O. G., Latest Practice in Burning Cement and Lime in Europe: AIME, Min. Eng., vol. 6, No. 7, July 1954, pp. 715–719.
Nordberg, B., Operates Cement Kilns for Best Efficiency Rather Than for Overcapacity: Rock Products, vol. 57, No. 9, September 1954, pp. 70–75, 90, 92.
Trauffer, W. E., Hercules Improvement Program: Pit and Quarry, vol. 47, No. 1, July 1954, pp. 76–79, 91.
Pit and Quarry, Expansion Program Can Do More Than Just Increase Production: Vol. 47, No. 2, August 1954, pp. 94–98.

TABLE 24.—Number of kilns used in the portland-cement industry in the United States 1945, 1950, and 1954

Producing district	Less than 100 ft. long			100 to 199 ft. long			200 to 299 ft. long		
	1945	1950	1954	1945	1950	1954	1945	1950	1954
Eastern Pennsylvania and Maryland	10	10	10	124	95	86	10	12	14
New York and Maine	------	------	------	27	22	21	9	10	9
Ohio	------	------	------	35	35	34	2	2	2
Western Pennsylvania and West Virginia	6	6	6	36	25	11	5	6	6
Michigan	------	------	------	28	30	35	3	3	3
Illinois	------	------	------	26	26	24	2	2	2
Indiana, Kentucky, and Wisconsin	------	------	------	51	52	39	3	3	3
Alabama	------	------	------	11	12	12	3	8	10
Tennessee	------	------	------	13	13	7	2	2	2
Virginia, Georgia, Florida, Louisiana, South Carolina, and Mississippi	8	8	8	11	11	11	5	6	10
Iowa	------	------	------	19	21	19	2	2	2
Eastern Missouri, Minnesota, and South Dakota	------	------	------	23	23	24	7	7	5
Kansas	------	------	------	20	21	15	4	5	6
Western Missouri, Nebraska, Oklahoma, and Arkansas	------	------	------	8	8	11	8	9	8
Texas	------	------	------	8	9	9	11	13	14
Colorado, Arizona, Wyoming, Montana, Utah, and Idaho	------	------	------	16	15	15	1	2	2
Northern California	------	------	------	22	13	13	6	6	6
Southern California	------	------	------	21	21	21	15	16	14
Oregon and Washington	------	------	------	13	10	10	6	7	7
Puerto Rico	------	------	------	1	1	1	------	------	------
Total	24	24	24	513	463	418	104	121	125

Producing district	300 to 399 ft. long			400 to 500 ft. long			Total		
	1945	1950	1954	1945	1950	1954	1945	1950	1954
Eastern Pennsylvania and Maryland	2	6	6	------	------	------	146	123	116
New York and Maine	2	3	6	------	------	------	38	35	36
Ohio	------	------	1	------	------	------	37	37	37
Western Pennsylvania and West Virginia	------	------	2	------	------	------	47	37	25
Michigan	1	------	------	2	2	3	34	35	41
Illinois	------	------	------	------	------	------	28	28	26
Indiana, Kentucky, and Wisconsin	------	------	2	------	------	------	54	55	44
Alabama	4	4	2	------	------	2	18	24	26
Tennessee	2	3	3	------	------	1	17	18	13
Virginia, Georgia, Florida, Louisiana, South Carolina, and Mississippi	1	3	8	------	1	4	25	29	41
Iowa	------	1	3	1	1	2	22	25	26
Eastern Missouri, Minnesota, and South Dakota	1	3	3	------	2	2	31	35	34
Kansas	1	1	1	------	------	------	25	27	22
Western Missouri, Nebraska, Oklahoma, and Arkansas	1	2	4	------	------	------	17	19	23
Texas	2	4	7	3	4	5	24	30	35
Colorado, Arizona, Wyoming, Montana, Utah, and Idaho	1	2	4	------	4	4	18	23	25
Northern California	------	1	2	4	4	5	32	24	26
Southern California	------	4	8	------	------	1	36	41	44
Oregon and Washington	------	1	1	------	1	1	19	19	19
Puerto Rico	3	6	6	------	------	------	4	7	7
Total	21	44	69	10	19	30	672	671	666

Theoretical discussions of heat control in rotary kilns indicate advantages for compound-flame dual burners in maintaining uniform heat distribution.[6]

The mechanical deformation of rotary kilns was studied, and methods were described for detecting this condition before irreparable damage took place.[7]

[6] Bauer, W. G., How to Control Heat for Calciners: Chem. Eng., vol. 61, No. 5, May 1954, pp. 193–200.
[7] Rosenblad, F. G., Detecting and Measuring Radial Deformations of Rotary Kilns: Rock Products, vol. 57, No. 8, August 1954, pp. 123–125 ,160, 162, 166, 168, 171–172.

The operation of German-designed suspension preheaters at an American plant was watched with interest. The capacity of the kilns was reportedly increased and a fuel efficiency of less than 0.7 million B. t. u. per barrel reached.[8]

An Argentine cement plant adapted the German Lepol system to preheating of the feed of wet-process kilns. Results were reported to have been excellent.[9]

Considerable attention was focused upon renovations at the Universal Atlas Cement Co. plant near Pittsburgh. In keeping with the smoke- and dust-abatement program in that city, the raw-mill department was rebuilt, resulting in removal of 14 stacks that had emitted considerable smoke and dust. Further changes were scheduled in the kilns and clinker-grinding department, and dust losses were expected to be reduced further when the changes were completed.[10]

Methods of returning recovered dust in cement plants to the kilns were discussed and a patent issued on one method.[11]

Increased production was claimed by the use of sodium tripolyphosphate to reduce the moisture content of slurries in wet-process cement.[12]

Articles were published in trade magazines describing in detail the cement-manufacturing plants of the Calaveras Cement Co. at San Andreas, Calif.,[13] the Dewey Portland Cement Co. at Davenport, Iowa,[14] the Dragon Cement Co., at Thomaston, Maine,[15] and the Permanente Cement Co. at Permanente, Calif.[16]

Mechanical improvements in cement plants included the use of magniflux to check working parts,[17] the trend toward single-stage, closed-circuit grinding of clinker in ball mills,[18] the use of lightweight trucks for hauling bulk cement,[19] the use of a special truck for hauling bulk cement from the plant and fuel oil to the plant,[20] the installation of the world's largest clamshell for handling raw material from a

[8] Engelhart, G. K., Suspension Preheating of Dry Pulverized Materials: AIME, Min. Eng., vol. 6, No. 4, April 1954, pp. 407–410.
Avery, W. M., First Published Report of American Experience With Suspension-Type Preheater: Pit and Quarry, vol. 47, No. 1, July 1954, pp. 88–90.
Nordberg, B., Cut Fuel Cost and Increase Output With Suspension Preheaters: Rock Products, vol. 57, No. 10, October 1954, pp. 68–72.

[9] Bolso, Jorge, First Lepol System Wet-Process Kiln in the World: Rock Products, vol. 57, No. 12, December 1954, pp. 68–71.

[10] Pit and Quarry, Universal Atlas Inaugurates "Smokeless," "Dustless" Facilities in Pittsburgh: Vol. 46, No. 8, February 1954, p. 64.
Nordberg, B., Universal Starts Up New Raw Mill: Rock Products, vol. 57, No. 2, February 1954, pp. 78–80.
Nordberg, B., A Three-Step Program to Rebuild an Old Cement Plant: Rock Products, vol. 57, No. 6, June 1954, pp. 74–77, 148, 150, 152, 154.
Trauffer, W. E., Universal Atlas Completes First of Three Stages of Plant Reconstruction: Pit and Quarry, vol. 47, No. 1, July 1954, pp. 80–85, 90.

[11] Krabbe, Iven, An Efficient Method of Returning Dust to Kilns: Rock Products, vol. 57, No. 6, June 1954, pp. 145–146.
Garoutte, J. M., and Hass, Peter (assigned to Permanente Cement Co.), Treatment of Recovered Cement Kiln Dust: U. S. Patent 2,687,290, Aug. 24, 1954.

[12] Rock Products, Dispersing Agent for Raw-Cement Slurries: Vol. 57, No. 1, January 1954, p. 142.

[13] Lenhart, W. B., Calaveras Increases Capacity Again: Rock Products, vol. 57, No. 3, March 1954, pp. 70–72.

[14] Gutschick, K. A., Dewey Further Expands Davenport Plant: Pit and Quarry, vol. 46, No. 7, January 1954, pp. 86–95.

[15] Persons, H. C., Dragon Doubles Plant Capacity: Rock Products, vol. 57, No. 4, April 1954, pp.102–105.

[16] Hull, W. Q., Hass, P., and Franklin, P., Modern Portland Cement Production: Ind. Eng. Chem. vol. 46, No. 5, May 1954, pp. 830–842.

[17] Pit and Quarry, Checking Equipment Parts Saves Time and Money at Dewey Cement Plant: Vol. 46, No. 8, February 1954, p. 67.

[18] Luebke, R. E., Clinker-Grinding in Ball Mills: Pit and Quarry, vol. 46, No. 10, April 1954, pp. 135–137, 148.

[19] Pit and Quarry, 25 Lightweight Units Added to Permanente's Hauling Fleet: Vol. 40, No. 12, June 1954, p. 60.

[20] Rock Products, Riverside Cement Co.: Vol. 57, No. 7, July 1954, p. 47.

stockpile,[21] and the installation of a mile-long conveyor belt to replace an aerial tramway for moving raw material to the crushing plant.[22]

Methods of procuring raw materials for cement include stripping up to 120 feet of overburden to uncover a 27-foot bed of limestone,[23] selective quarrying of various beds in a limestone deposit,[24] drilling in a quarry with heavy rotary drilling equipment,[25] dredging oystershells from San Francisco Bay,[26] and underground mining of limestone by the room-and-pillar method.[27]

Two articles in the series on theoretical chemistry of cement and concrete were published during 1954, one dealing with speculations on the water of hydration in concrete and the second summarizing recent theories of the hydration products of portland cement.[28]

Comparison of the compressive strength of test cylinders made from various portland cements produced during 1953, with compressive strength of testwork done 5 years earlier, indicated that the quality of cement had improved and that better cements were produced in 1953 than in 1948.[29]

Under the constant urge to improve the quality of portland cement the cement committees of the American Society for Testing Materials studied questions related to false setting of cement, the effect of mechanical mixing on the strength of cement, and further development of method for flame photometry.[30]

The release of a Tentative Specification for Portland-Pozzolan Cement by the American Society for Testing Materials was accompanied by discussions of the alkali-aggregate reaction of some cements.[31] The Bureau of Reclamation was given a $10,000 grant from the National Science Foundation Research to study the chemical and physical reactions involved in setting of cement in the presence of pozzolans.[32] The need for suitable tests to distinguish between good and poor pozzolan is emphasized by some specification that depended upon past performance records only.[33] The pozzolanic advantages of air-dried amorphous silica were discussed.[34]

Discussion continued of the proposed use of fuel oil in place of water for wet-process manufacture of cement.[35] In the proposed nonaqueous process, a liquid such as fuel oil No. 1 is used in place of water in the grinding circuit. The liquid may be removed by filtration and distillation before the ground material is fed into the kilns.

[21] Rock Products, World's Largest Clamshell: Vol. 57, No. 12, December 1954, p. 71.
[22] Pit and Quarry, Alpha Cement to Install One-Mile-Long Belt Conveyor: Vol. 47, No. 3, September 1954, p. 24.
[23] Peck, R. L., Marquette Strips Heavy Overburden at Oglesby: Pit and Quarry, vol. 47, No. 4, October 1954, pp. 96–98, 103–104.
[24] Gutschick, K. A., Selective Quarrying Leads Indiana Producer to Successful Working of 6-Ft. Bench: Pit and Quarry, vol. 47, No. 6, December 1954, pp. 91–93.
[25] California Mining Journal, Tells of Rotary Drilling by Calaveras Cement Co.: Vol. 24, No. 3, November 1954, p. 15.
[26] Rock Products, Dredging Oysters Shells: Vol. 57, No. 11, November 1954, pp. 58–59.
[27] Mining Congress Journal, Plans for Underground Mining: Vol. 40, No. 10, October 1954, p. 79.
[28] Rockwood, N. C., Prospective Chemistry of Cement and Concrete: Part 9, Rock Products, vol. 57, No. 1, January 1954, pp. 147–149; part 10, vol. 57, No. 8, August 1954, pp. 136, 140, 144–145, 149, and 152.
[29] Howard, E. L., Laboratory Tests Prove Cements Are Better: Rock Products, vol. 57, No. 3, May 1954, pp. 69 and 73.
[30] ASTM, Bulletin C–1 on Cement: No. 199, July 1954, pp. 31–32; No. 200, September 1954, p. 8.
[31] Rockwood, N. C., Highlights of ASTM Meeting: Rock Products, vol. 57, No. 9, September 1954, pp. 86–87, 106.
[32] Bureau of Reclamation, Reclamation Granted Funds for Research on Pozzolan Cement: Press Release, Nov. 15, 1954.
[33] Drury, F. W., Jr., Pozzolans in California: Mineral Inf. Service, Dept. of Natural Resources, State of California, vol. 7, No. 10, October 1954, 6 pp.
[34] Ferrari, F., Most Rational Cement: Jour. Am. Concrete Inst., vol. 25, No. 8, Aprll 1954, p. 691.
[35] Concrete, Progress in Nonaqueous Wet-Cement Making: Vol. 62, No. 5, May 1954, p. 9.

It was claimed that this method retains the advantages of the wet-process method yet conserves fuel because little or no water has to be evaporated from the feed in the kiln. Experiments in Europe were carried out with oil shale as both a fuel and an ingredient in the manufacture of portland cement.[36]

New types of cement introduced in 1954 included an all-purpose cement containing furfural-ketone resin for greater resistance to chemical action.[37] Patents were issued for a plastic cement containing a small amount of sodium matasilicate,[38] two types of retarded cements containing shellac [39] and carboxymethylcellulose,[40] respectively, and a hydraulic cement utilizing waste sulfite liquor solids and sulfonated aromatic hydrocarbons.[41]

WORLD REVIEW

Statistics on world production of cement in 1950–54 are shown in table 25. It should be noted that production figures are shown in equivalent United States barrels of 376 pounds.

NORTH AMERICA

Canada.—In 1954 the cement-manufacturing industry recorded the highest production in its history—20.9 million barrels valued at Can$59 million, a slight increase over 1953 production of 20.7 million barrels valued at Can$58.8 million. Imports of cement decreased from 2.3 million barrels in 1953 to 2.1 million in 1954. Imports from the United States dropped from 50 percent of all imports in 1953 to 26 percent in 1954, while imports from West Germany rose from 11 percent in 1953 to 33 percent in 1954.[42]

Plans for expansions of the cement industry in the Provinces of Manitoba, Alberta, Quebec, and British Columbia were announced. Descriptions of the plants of Canada's largest cement company [43] and the plant in Newfoundland were published.

Cuba.—Cement production increased from 2,386,000 barrels in 1953 to 2,468,000 barrels in 1954. The one cement plant in Cuba—at Mariel—exceeded its rated capacity (2.4 million barrels) in 1954, as it had in 1952. Construction of a new plant at Santiago continued. The rotary kilns for this new plant were obtained in Germany.

Dominican Republic.—Production of cement in 1954 increased to 938,000 barrels compared with 762,000 in 1953. A third kiln was placed in operation at the only plant in the Republic, giving an annual capacity of 2 million barrels. It was expected that the extra capacity would permit greater exports in the Caribbean area.[44]

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36 Kloiber, F., Portland Cement From Oil Shale: Rock Products, vol. 57, No. 7, July 1954, pp. 59, 104.
37 Commercial America, Cement Resists Chemicals: Vol. 50, No. 10, April 1954, p. 25.
38 Lorenz, John, Plastic Composition: U. S. Patent 2,695,869, Nov. 30, 1954.
39 Gobel, J., and Stuve, J. G. (assigned to Shell Development Co.), Method of Preparing Hydraulic Cement Having Retarded Setting Action: U. S. Patent 2,671,030, March 2, 1954.
40 Ludwig, N. C. (assigned to Universal Atlas Cement Co.), Retarded Cement: U. S. Patent 23,873, Sept. 21, 1954.
41 Scripture, E. W. (assigned to Masters Builders Co.), Hydraulic Cement Compositions: U. S. Patent 2,690,975, Oct. 5, 1954.
42 Simpson, R. A., Cement in Canada, 1954 (Preliminary): Canada Depart. of Mines and Technical Surveys, Ottawa, 3 pp.
43 Nordberg, Bror, Canada Cement Company's Growth Keeps Pace with Nation's Expansion: Rock Products, vol. 57, No. 8, August 1954, pp. 86–122, 157–158, 184, 186.
Leja, E. A., Newfoundland's New Cement Plant: Pit and Quarry, vol. 46, No. 9, March 1954, pp. 91–97
44 Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 1, January 1955, pp. 37–38.

Guatemala.—Construction activity was so great in 1954 that cement production continued at full capacity. Imports from Germany, Belgium, and Mexico did not prevent heavy withdrawals of domestic stocks of cement. Demands of the construction industry were increasing.[45]

TABLE 25.—World production of hydraulic cement, by countries, 1945–49 (average) and 1950–54, in thousand barrels [1]

(Compiled by Pearl J. Thompson)

Country	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Canada (sold or used by producers)	11,545	15,585	15,831	17,238	20,697	20,885
Cuba	1,595	1,853	2,240	2,463	2,386	2,468
Dominican Republic	[3] 223	410	610	803	762	938
Guatemala	182	246	334	352	393	375
Jamaica				440	592	580
Mexico	5,857	8,959	9,469	9,616	9,803	10,448
Nicaragua	88	100	117	111	141	141
Panama	[3] 281	299	440	545	469	451
Salvador					211	287
United States	176,420	230,272	249,472	252,658	267,669	275,857
Total	196,191	257,724	278,513	284,226	303,123	312,430
South America:						
Argentina	7,423	9,217	9,147	9,076	9,710	9,921
Bolivia	211	223	229	217	199	193
Brazil	5,752	8,127	8,537	9,493	11,902	14,107
Chile	3,084	3,008	4,093	4,796	4,468	4,544
Colombia	2,134	3,324	3,799	4,104	5,119	5,640
Ecuador	235	340	463	522	534	557
Paraguay				23	18	41
Peru	1,589	1,941	2,111	2,175	2,633	2,832
Uruguay	1,583	1,788	1,765	1,759	1,741	1,741
Venezuela	1,061	2,938	3,641	4,925	5,758	7,112
Total	23,072	30,906	33,785	37,090	42,082	46,688
Europe:						
Albania	(4)	[5] 88	[5] 94	[5] 100	[5] 117	[5] 235
Austria	2,920	7,558	8,648	8,150	8,173	9,510
Belgium	13,368	20,856	25,769	24,104	27,567	25,652
Bulgaria	1,929	3,536	3,723	3,952	4,151	[5] 4,691
Czechoslovakia	7,224	[6] 10,994	[6] 11,727	[6] 14,776	[5] 15,362	[5] 15,245
Denmark	3,471	5,119	5,775	7,106	7,388	6,737
Finland	2,627	4,356	4,861	4,562	5,494	6,092
France	25,611	42,263	47,639	50,688	53,063	54,939
Germany:						
East [5]	[7] 29,790	8,200	9,560	11,670	14,130	15,200
West		63,775	71,556	75,554	90,160	95,337
Greece	1,114	2,339	2,539	3,495	4,116	5,007
Hungary [5]	1,478	4,690	5,560	6,330	6,450	6,450
Ireland	1,888	2,603	2,498	2,697	2,721	3,471
Italy	15,860	29,340	32,705	39,003	44,104	51,081
Luxembourg	510	774	774	668	862	885
Netherlands	2,691	3,477	4,116	4,767	5,048	5,699
Norway	2,545	3,412	4,116	4,139	4,427	4,597
Poland	8,666	14,729	15,761	15,596	19,343	[5] 20,522
Portugal	1,777	3,360	3,764	4,263	4,509	4,603
Rumania	2,345	3,811	4,298	8,795	12,313	[5] 15,831
Saar	[8] 715	1,220	1,372	1,395	1,671	1,618
Spain	12,706	14,787	16,077	17,367	19,091	22,351
Sweden	8,689	11,422	11,932	12,407	13,790	13,902
Switzerland	4,814	6,321	7,710	8,115	9,276	10,618
U. S. S. R.[5]	28,850	61,600	72,700	82,700	94,000	108,500
United Kingdom	42,091	58,120	60,910	66,337	66,824	71,274
Yugoslavia	5,195	7,147	6,796	7,699	7,511	8,168
Total [5]	228,900	395,900	443,000	486,000	541,700	588,200

See footnotes at end of table.

[45] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 5, May 1955, pp. 35–36.

TABLE 25.—World production of hydraulic cement, by countries, 1945–49 (average) and 1950–54, in thousand barrels [1]—Continued

Country	1945–49 (average)	1950	1951	1952	1953	1954
Asia:						
Burma	----	----	----	217	240	358
Ceylon	----	----	369	358	375	493
China [5]	(4)	4,700	7,600	12,000	13,500	27,700
Hong Kong	223	393	416	399	375	586
India	[9] 10,947	15,549	19,067	21,072	22,515	26,021
Indochina	386	844	1,243	1,378	1,706	1,489
Indonesia	82	(4)	[5] 586	803	868	827
Iran [10]	276	381	381	410	381	(4)
Iraq	6	386	[11] 440	610	1,038	1,161
Israel	1,337	2,228	2,574	2,615	2,726	3,301
Japan	9,938	26,168	38,393	41,729	51,409	62,591
Jordan	----	----	----	----	----	369
Korea:						
North Korea	1,038	(4)	(4)	(4)	(4)	(4)
Republic of	59	70	41	211	258	317
Lebanon	1,055	1,542	1,777	1,671	1,788	1,964
Malaya	----	----	----	----	188	504
Pakistan	[3] 2,222	2,468	2,973	3,160	3,553	3,969
Philippines	633	1,712	1,812	1,818	1,706	1,818
Syria	281	399	375	885	1,313	1,460
Taiwan (Formosa)	1,050	1,947	2,281	2,615	3,049	3,143
Thailand (Siam)	410	973	1,829	1,448	1,689	2,228
Turkey	1,970	2,322	2,322	2,691	2,832	3,981
Total [5]	33,700	63,800	85,400	97,000	113,300	147,800
Africa:						
Algeria	709	1,900	2,627	2,844	2,896	3,700
Angola	----	----	----	----	170	(4)
Belgian Congo	639	1,020	1,202	1,407	1,536	2,117
Egypt	3,899	5,992	6,626	5,553	6,432	7,253
Ethiopia [5]	41	35	35	35	59	164
French Morocco	1,167	1,882	2,210	2,551	3,577	3,835
French West Africa	[12] 258	352	322	469	352	487
Madagascar	35	29	29	----	----	----
Mozambique	211	293	457	487	510	598
Rhodesia and Nyasaland, Federation of:						
Northern Rhodesia	----	----	59	334	369	487
Southern Rhodesia	422	844	932	1,120	1,519	(4)
Tunisia	692	991	1,096	1,220	1,331	1,583
Union of South Africa	7,218	10,830	11,457	11,850	12,448	12,676
Total	15,291	24,168	27,052	27,870	31,199	34,659
Oceania:						
Australia	5,207	7,493	7,247	7,956	9,370	11,222
New Zealand	1,395	1,501	956	1,542	1,642	1,911
Total	6,602	8,994	8,203	9,498	11,012	13,133
World total (estimate)	503,800	781,500	876,000	941,700	1,042,400	1,142,900

[1] This table incorporates a number of revisions of data published in previous Cement chapters.
[2] Average for 1947–49.
[3] Average for 1948–49.
[4] Data not available, estimate by senior author of chapter included in total.
[5] Estimate.
[6] Planned production.
[7] Includes Saar, 1945.
[8] Average for 1946–49.
[9] Pakistan included with India through 1947.
[10] Year ended Mar. 20 of year following that stated.
[11] Year ended Mar. 31 of year following that stated.
[12] 1 year only, as 1949 was first year of production.

Haiti.—The first cement plant in Haiti began operations in April 1954, using clinker from Belgium, pending completion of the kiln. Rated annual capacity of the plant will be 450,000 barrels.[46]

Honduras.—In 1954 a study was undertaken to determine the feasibility of establishing a cement plant.[47]

[46] Pit and Quarry, New Facilities Being Built by Haitian Cement Firm: Vol. 47, No. 1, July 1954, p. 64.
[47] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 4 ,April 1954, p. 31.

Jamaica.—Cement production decreased in 1954 to 580,000 barrels from 592,000 barrels in 1953; consumption increased nearly 12 percent but was still less than production.[48]

Mexico.—Expansion plans were announced for 6 of Mexico's 18 cement plants to meet the growing demand for cement.[49] Production in 1954 rose to 10.5 million barrels compared with 9.8 million barrels in 1953. In addition to plans for new plants at Orizaba and Torreon, announcement was made of a new plant at Tecoman in Colima. Lack of shipping facilities has curtailed exports of cement.[50] La Tolteca was the largest producer in Mexico.

Nicaragua.—Nicaragua's only cement plant produced virtually the same quantity of cement in 1954 as in 1953. The construction industry had grown steadily for 3 years and imports of cement increased from 36 percent of the production in 1953 to 70 percent in 1954. Expansion of the plant planned to go into operation in August was not completed at the end of the year.

Panama.—Production of cement in 1954 decreased for the second consecutive year. Highway construction plans failed to materialize, and the export market continued to decline. Exports of cement to other Central American countries decreased to 37 percent of 1953 exports because of the availability of European cement at lower prices in Central America.[51]

SOUTH AMERICA

Argentina.—Government restrictions on imports of cement were relaxed somewhat in 1954 to counteract the shortage developed by the end of 1953. Plans were announced for expansion of the domestic capacity.[52]

Bolivia.—A Government cement plant was under construction at Sucre. It was being financed by excise taxes on spirituous beverages and tobacco.[53]

Brazil.—The demand for cement[54] continued to increase at a faster rate than expansion of the cement industry. Domestic output equaled only two-thirds of requirements, in spite of expansions at 3 plants and the opening of 4 new plants. One of these new plants, Brazil's first white-cement plant, was described.[55]

Colombia.—A new company, organized in Colombia, planned to erect a cement plant near Monteria.[56]

Peru.—A serious cement shortage was created by rapid expansion of private and Government construction, and the one cement plant in Peru at Lima was unable to meet the demands. A new plant was under construction at Chilca,[57] 50 miles south of Lima, and plans were underway for a third plant at Pacasmayo, in northern Peru.[58]

Venezuela.—Credit extended to the Venezuela Cement Co. permitted the company to expand operations of its Pertigalete plant

[48] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 1, July 1955, p. 35.
[49] Pit and Quarry, Mexican Cement Producers Seek to Stimulate Demand, Make Expansion Plans: Vol. 47, No. 1, July 1954, p. 56.
[50] Rock Products, vol. 57, No. 11, November 1954, p. 58.
[51] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 3, March 1955 p. 29.
[52] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 3, March 1954, p. 43.
[53] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 4, April 1954, p. 30.
[54] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 4, April 1955, pp. 37-39.
[55] Barsoti, C. and Reichenbach, H. A., Brazil's First White-Cement Plant: Pit and Quarry, vol. 47, No. 1, July 1954, pp. 92-96, 118.
[56] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 4, October 1954, p. 48.
[57] Holmquist, H. O. E., Peru's Newest Cement Plant Generates Its Power: Rock Products, vol. 57, No. 11, November 1954, pp. 80-83.
[58] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 3, September 1954, pp. 48-49.

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fivefold from 1950 to 1953. Repayment of the loan to the Export-Import bank was made 5 years in advance of the date due.[59] Public works in the Federal District in 1954 resulted in a local cement shortage in December 1954, although production was reported to be sufficient for the country's overall requirements.[60]

EUROPE

The cement industry in Europe was analyzed by the Organization for European Economic Cooperation. Supply and demand factors, price trends and other pertinent subjects were discussed in a publication by this organization.[61]

Belgium.—A new company was incorporated as a subsidiary of Dieschbueg & Cigrang, Ltd., for importing Belgian and German cement into Canada.[62] The first International Congress of Manufactured Cement was held in Brussels in the summer of 1954. The goal of the congress was to coordinate research and exchange information on technical phases of cement making.[63]

Denmark.—The production of cement decreased slightly for the first time in 5 years. The decline in 1954 was reportedly due to deflationary measures taken by the Government in late 1954 which resulted in a cutback in construction and maintenance activities. Fuel for cement production has to be imported.[64] Two of the world's longest rotary kilns were reported to be in use in one of the Danish plants.[65]

France.—Rising demands for cement were met by increasing production from the 60 cement plants within the country—almost no cement was imported in 1954. The ceiling price of 5,339 francs per metric ton corresponded to a United States price of $2.60 per barrel. Increased production capacity was accomplished in France by increasing the average plant capacity rather than by a large increase in the number of plants. The number of plants with less than 600,000 barrels annual capacity decreased from 39 in 1938 to 14 in 1954, according to the annual report of the French National Association of Cement and Hydraulic Lime Producers.[66]

Iceland.—Shell sand in Faxa Bay has been investigated as a raw material for the cement plant under construction at Akranes.

Ireland, Northern.—A new cement plant was placed in operation at Magheramoine in Northern Ireland by the British Portland Cement Manufacturers, Ltd.[67]

Italy.—Production of portland cement increased from 44 million barrels in 1953 to 51 million barrels in 1954, but imports and exports were reduced nearly 50 percent in 1954 compared with 1953. The free market price of cement in Milan was 10,950 lire per metric ton, corresponding to $2.99 per barrel.[68] Further expansions were an-

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[59] Rock Products, Venezuela Cement Loan: Vol. 57, No. 4, April 1954, p. 80.
[60] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 5, May 1955, p. 37.
[61] Pit and Quarry, Report Presents Survey of European Cement Industry: Vol. 48, No. 6, December 1955, p. 47.
[62] Rock Products, vol. 57, No. 8, August 1954, p. 77.
[63] Pit and Quarry, International Cement Congress Recently Held in Belgium: Vol. 47, No. 4, October 1954, p. 35.
[64] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 1, July 1955, pp. 29–34.
[65] Chemical and Engineering News, Portland Cement: Vol. 32, No. 2, Jan. 11, 1954, p. 158.
[66] United States Embassy, Paris, France, State Department Dispatch 88, July 13, 1955, 5 pp.
[67] Rock Products, vol. 57, No. 6, August 1954, p. 78.
[68] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 4, October 1955, pp. 32–33.

nounced to meet the requirements of the large reconstruction and industrialization programs in southern Italy.

Netherlands.—The demand for cement exceeded production and was met by imports principally from two sources, Belgium and West Germany. Expansion plans announced in 1954 were so small that production was expected to continue to be less than 50 percent of the total consumption for some years.

Portugal.—Production of cement continued to rise owing to an expanded volume of public works and housing construction. The five producers expected to have a large market, even after completion of the dam-building program then in progress.[69]

United Kingdom.—Cement production continued to increase in 1954. Production would have been at least 50,000 tons higher but for the east coast floods, which damaged 4 Thames-side plants.[70] Cement capacity in the United Kingdom was expected to increase 1½ million tons over the 1953 figure by the end of 1955. The section of the British engineering industry that specialized in constructing cement plants and equipment competed successfully in the overseas erection of new plants against American, German, and Danish contractors.[71]

Expansion plans were announced for plants within the United Kingdom. Expansions completed at the Claydon plant of Mason's Cement Works were described.[72]

Yugoslavia.—Expansion of two cement plants was announced, and progress on the erection of a plant near Umag was reported.[73] The largest exports of cement were to Turkey.[74]

ASIA

Cyprus.—Construction of the island's first cement plant, at Limassol was nearly completed in 1954.[75]

Hong Kong.—Only 40.7 percent of the requirements for cement was met by domestic production; 59.3 percent was imported from Japan. Domestic production increased 56 percent in 1954 compared with 1953 and imports increased 20 percent.

India.—The production of cement in 1954 was more than double that of 1949. Two companies with 17 plants produced over 80 percent of the total output of the 25 cement plants in India. Approximately 45,000 men employed in the cement industry produced 26 million barrels of cement with an average price of $2.64 per barrel.[76] Expansion plans of the industry to over 30 million barrels per year were announced [77] and a description of the operations of the plant at Rajganpur was published.[78]

Indonesia.—A new cement plant at Gresik, East Java, financed by a loan from the Export-Import Bank, was planned to assist Indonesia's

[69] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 1, July 1955, p. 35.
[70] The Master Builder (London), vol. 72, No. 9, September 1954, p. 172.
[71] Engineering (London), The Boom in Cement: Vol. 177, No. 4612, June 18, 1954, p. 771.
[72] Engineering (London), Cement Works Enlarged: Vol. 178, No. 4620, Aug. 13, 1954, pp. 220–221.
[73] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 2, February 1955, pp. 45–46.
[74] State Department Dispatch, Yugoslav Mineral Industries: Annual Report, 1954.
[75] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 2, August 1955, p. 34.
[76] United States Embassy, Bombay, India, State Department Dispatch 693, June 9, 1955, 32 pp.
[77] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 6, June 1954, pp. 32–33.
[78] Grindrod, J., India Increasing Cement Capacity to Keep Up With Construction Needs: Rock Products, vol. 57, No. 11, November 1954, pp. 64–65.

cement situation. Imports during the first half of 1954 were 70 percent higher than those in the first half of 1953.[79]

Iraq.—To supply cement for dam construction, two new cement plants were planned. The savings realized by using domestic instead of imported cement are expected to pay for construction of the new plants.[80]

Israel.—Israel's third cement plant was placed in operation in 1954 by the Shimshon Cement Works at Hartuv, raising the annual production capacity of the country's plants to 4,675,000 barrels.[81]

Japan.—Japan maintained its position as the largest producer and exporter of cement in Asia. An overseas packaging plant was constructed on Okinawa to which cement will be shipped in bulk from a cement plant on Kyushu Island.[82] The addition of 10 kilns during 1954 helped to meet the demands arising from postwar reconstruction.[83]

Jordan.—The first cement plant in Jordan began operations at Amman in February 1954. Former annual requirements ranged from 26,000 to 290,000 barrels at average prices of $5. The capacity of the new plant is 350,000 barrels, and prices are expected to drop to about $3.50 per barrel.[84]

Lebanon.—Construction was begun on a second cement plant for Lebanon at Anfeh, with a yearly capacity of 350,000 barrels. The machinery for the plant was purchased in Germany. About 20 percent of the production of 1.7 million barrels from the only producing plant was exported. Plans for a third plant were dropped.[85]

Malaya Federation.—Consideration was given to doubling the size of the one cement plant in the Federation by an additional kiln and auxiliary equipment.[86]

Pakistan.—The semi-Government organization, Pakistan Industrial Development Corporation, promoted plans to enlarge the cement industry with Colombo Plan aid for one plant and Canadian-Colombo Plan aid for a second plant. Major components of a $5 million plant were shipped from Canada in 1954.[87]

Taiwan (Formosa).—It was reported that the cement plants were 1 of 4 groups of public enterprises to be transferred to private ownership.[88] Invitations were issued by a group of Chinese to private capital in America to invest in a proposed new cement plant.[89] Requirements for military and civilian uses continued to exceed production capacity.

Turkey.—Announcement was made of expansion plans at cement plants to increase annual production from 6 million barrels to 7.3 million barrels. Plans were reported to be under way for 14 new plants with a total capacity of nearly 9 million barrels. Extensive

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[79] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 1, January 1955, p. 42; Vol. 40, No. 3, March 1955 p. 27.
[80] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 5, May 1955, p. 36.
[81] Pit and Quarry, Israel's Third Cement Plant Stimulates Area Development: Vol. 47, No. 1, July 1954, p. 59.
[82] Pit and Quarry, Japanese Return to Okinawa With New Cement-Plant Unit: Vol. 47, No. 1, July 1954, p. 58.
[83] Rock Products, Japanese Cement Boom: Vol. 58, No. 7, July 1955, p. 33.
[84] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 4, April 1954, p. 31.
[85] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 4, April 1954, pp. 31–32; vol. 39, No. 3, September 1954, p. 48.
[86] Pit and Quarry, Overseas Cement Concerns Erecting, Enlarging Facilities: Vol. 47, No. 1, July 1954, p. 66.
[87] Rock Products, Pakistan Cement: Vol. 57, No. 2, February 1954, p. 67.
Pit and Quarry, Canadian Group to Build Cement Plant in Pakistan: Vol. 47, No. 1, July 1954, p. 56.
[88] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 1, July 1954, pp. 36–37.
[89] Foreign Commerce Weekly, Taiwan Cement Factory Planned: Vol. 52, No. 1, Nov. 22, 1954, p. 19.

road-building and construction projects increased cement requirements over threefold in 3 years.[90]

Yemen.—Plans for a cement plant to be constructed by an Italian company were abandoned.[91]

AFRICA

Angola.—Authorization was granted to the Companhia Geral de Cal E. Cimento to construct a 500,000-barrel cement plant in Luanda. Production in 1954 at the Labite plant, the only one in the country, was estimated at 247,000 barrels.[92]

Belgian Congo.—Production at the Ciments du Congo and at Katanga increased considerably and, supplemented by production from the new plant at Albertville, caused an increase of 38 percent in 1954 production for the country compared with 1953. Plans were announced for a new plant at Katanga. Requirements continued to exceed production and imports, 97 percent from Belgium, increased 30 percent from 1,267,000 barrels in 1953 to 1,653,000 barrels in 1954 at an average price of $4.41 per barrel. Increased production resulted in a decrease in the domestic average price per barrel from $5.86 in 1953 to $5.68 in 1954.[93]

Egypt.—The Ministry of Finance published Order 66 on June 21, 1954, specifying that imported cement should be in bags of 110 pounds each or barrels bearing the name of the producing country and weight.[94]

Ethiopia.—Production at the Dire Dawa plant increased to 164,000 barrels, a 180-percent increase compared with 1953 production.[95] Plans were anounced for erecting a second plant at Asmara.[96]

French Morocco.—Domestic production of cement increased 7 percent while imports decreased 31 percent from 768,000 barrels to 586,000 barrels.[97]

Kenya.—The British Standard Portland Cement Co., Ltd., began operations at the first cement plant in Kenya at Bamburi. A description of the 600,000-barrel plant was published.[98] The East African Portland Cement Co. announced plans to erect Kenya's second cement plant at Athi River, with a capacity of 600,000 barrels.[99]

Nigeria.—Plans were announced for the formation of a Nigerian company to erect and run a 600,000-barrel cement plant at Nkalagu to supply about one-third of the country's requirements.[1]

Rhodesia.—Expansion plans of the three operating companies in Northern and Southern Rhodesia were expected to increase production to meet cement requirements. The Portland Cement Co.

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[90] Chemical Age (London), Turkish Cement: Vol. 70, No. 1803, Jan. 30, 1954, p. 327.
[91] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 1, July 1955, p. 35.
[92] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 4, October 1954, p. 47.
United States Embassy, Luanda, Angola: State Department Dispatch 190, 5 pp.
[93] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 4, October 1955, pp. 29–32.
[94] Foreign Commerce Weekly, vol. 52, No. 6, Aug. 9, 1954, p. 14.
[95] United States Embassy, Addis Ababa, Ethiopia, State Department Dispatch 303, May 9, 1955, 5 pp.
[96] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 4, April 1955, p. 40.
[97] United States Embassy, Casablanca, French Morocco, State Department Dispatch 260, May 25, 1955, 13 pp.
[98] South African Mining and Engineering Journal, Cement Factory at Bamburi, Kenya: Vol. 65, Part 1 No. 3198, May 29, 1954, p. 493.
[99] South African Mining and Engineering Journal, vol. 65, Part 2, No. 3219, Oct. 23 ,1954, p. 273.
[1] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 4, October 1954, p. 49.

of Great Britain announced plans for a new 600,000-barrel cement plant at Salisbury, Southern Rhodesia.[2]

Uganda.—The cement plant at Tororo produced low-heat cement for use in constructing Jinja Dam at Owens Falls. The limestone used at the plant contained apatite, and a process had to be developed to reduce the amount of this objectionable constituent before the plant could be erected.[3]

OCEANIA

Australia.—Production of cement increased 20 percent in 1954 compared with 1953. The vertical-kiln plant at Traralgon was placed in operation and expansion of the plant at Geelong was announced.[4]

New Zealand.—Although production increased 16 percent in 1954, domestic output was able to supply only two-thirds of the country's requirement. Further expansion by the three cement manufacturers was announced.[5]

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[2] Rhodesian Mining Review, New Cement Factory: Vol. 19, No. 4, April 1954, p. 25.
Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 4, October 1954, pp. 51–52; vol. 41, No. 2, August 1955, pp. 34–35.

[3] South African Mining and Engineering Journal, New Cement Process: Vol. 64, Part 2, No. 3182, Feb. 6, 1954, p. 817.
Pit and Quarry, E. Africa's First Cement Plant Supplies Dam Construction: Vol. 46, No. 11, May 1954, p. 79.
American Ceramic Society, Ceramic Abstracts, vol. 38, No. 9, Sept. 1, 1955, p. 156.

[4] Chemical Engineering and Mining Review, vol. 46, No. 9, June 10, 1954, p. 364; vol. 46, No. 12, Sept 10, 1954, p. 499.

[5] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 4, April 1955, p. 41.

Chromium

By Charles Katlin [1] and Hilda V. Heidrich [2]

ALTHOUGH the general trend throughout the chromium industry was downward during 1954, domestic output of chromite increased because of Government purchasing to make the United States the sixth largest producer in the world. Domestic consumption, imports, and world production of chromite were considerably below the previous year, and domestic stocks rose appreciably as consumption failed to pace imports.

As part of the program to expand knowledge of our natural resources, the first chromite exploration loan was granted by Defense Minerals Exploration Administration. Alaska produced and shipped the first chromite in 10 years under stimulation of a Government loan and purchase contract. Montana production, stimulated in like manner, comprised about three-fourths of the national total.

All prices quoted for foreign chromites declined; Turkish and Pakistan prices fell most because of dwindling demand for the high-price ores. This decreased demand caused Turkey to lose its position as premier world chromite producer to Union of South Africa; both countries combined supplied 38 percent of the world total.

TABLE 1.—Salient statistics of chromite in the United States, 1945–49 (average) and 1950–54, in short tons

	1945–49 (average)	1950	1951	1952	1953	1954
Domestic production (shipments)	[1] 4,616	404	7,056	21,304	58,817	163,365
Imports for consumption	1,107,087	1,303,713	[2] 1,429,020	[2] 1,708,969	[2] 2,226,631	1,470,069
Total new supply	1,111,703	1,304,117	[2] 1,436,076	[2] 1,730,273	[2] 2,285,448	1,633,434
Exports	4,647	2,044	2,030	[2] 1,531	1,166	864
Consumption	784,808	980,369	1,212,480	1,185,460	1,335,755	913,973
Consumers' stocks Dec. 31	472,664	606,271	637,453	754,299	1,015,878	1,267,817
World production	1,800,000	[2] 2,600,000	3,100,000	[2] 3,700,000	4,200,000	3,600,000

[1] Average annual totals as widely divergent as 13,973 tons in 1945 and 433 in 1949.
[2] Revised figure.

GOVERNMENT REGULATIONS

Defense Minerals Exploration Administration.—Toward the close of 1954 the first chromite exploration loan was granted by DMEA, United States Department of the Interior, to an operator in Butte County, Calif. Six other applications were received during the year, but 4 were withdrawn and 2 were pending at year end. Domestic

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

chromite exploration projects were eligible for DMEA financing for up to 50 percent of the cost. Financial assistance for purposes other than exploration and of a nonspeculative nature could be obtained from the Small Business Administration, United States Department of Commerce. One such loan was applied for and approved by SBA in 1954 for work on a chrome property in northern California.

DOMESTIC PRODUCTION [3]

With the American Chrome Co. Mouat chrome mine, Stillwater County, Mont., in full production during 1954, the United States increased its output of chromite to more than twice the output in 1953 and became the sixth greatest producer of chromite in the world out of a total of 22 producing countries. Virtually the entire domestic output was purchased by the Government, either under individual contracts, as in the case of the shipments from Montana and Alaska, or under the stimulus of the Purchase Program for Domestic Chrome Ore and Concentrates at Grants Pass, Oreg. About three-fourths of the total United States production came from the Mouat mine in the Stillwater complex. The largest known reserve of chrome ore in the Western Hemisphere is in the Stillwater complex. During 1954 chromite was shipped from 194 mines—148 in California and 46 in Alaska, Montana, and Oregon combined.

Alaska produced and shipped chromite for the first time in 10 years during the fall of 1954. A substantial tonnage came from the Kenai Chrome Co. Star Four mine on Red Mountain, Kenai Peninsula, and a test shipment was made by the Seldovia Chrome Co., Inc., from Chrome Maverick mine in the Fish Creek area, Kenai Peninsula.

TABLE 2.—Chromite production (mine shipments) in the United States, 1950–54, by States, in short tons

State	1950	1951	1952	1953		1954	
				Shipments	Value	Shipments	Value
Alaska						2,953	$208,257
California	404	6,302	14,713	26,512	$2,078,461	30,661	2,285,250
Montana				26,089	869,958	123,096	4,132,475
Oregon		754	6,591	6,216	484,453	6,655	537,928
Total	404	7,056	21,304	58,817	3,432,872	163,365	7,163,910

Concentrate constituted 86.7 percent of the total 1954 chromite shipments, and the average grade of all shipments on a wet weight basis was 38 percent Cr_2O_3. All Alaska production was lump and averaged 45 percent Cr_2O_3. California shipped 63 percent of its output in concentrate form, and the average Cr_2O_3 content of all shipments was 42 percent. All Montana production was converted to concentrate averaging 39 percent Cr_2O_3. Oregon shipments of chromite averaged 47 percent Cr_2O_3, and 62 percent was composed of concentrate.

Coastal Oregon was again the scene of chrome activities when Mineral Sands Co. of Lansing, Mich., leased 4,028 acres near Coquille

[3] Production data for 1954 were collected jointly with the Bureau of the Census (U. S. Department of Commerce). Production totals will be compared with the Census totals when they are available and differences adjusted or explained.

and began to clear land for a concentrating plant and receive equipment in preparation for an open-pit mining operation. The company planned to use a roast and leach process developed by Battelle Memorial Institute to produce chrome concentrate meeting Government specifications from the black beach sands.

According to a published report by GSA, since the inception of the Chrome Purchase Program in August 1951, a total of 77,399 long dry tons of chromite had been delivered to the Grants Pass, Oreg., depot as of December 31, 1954. The Government purchase program is for 200,000 tons or the amount at the close of business on June 30, 1957, whichever occurs first. Regulations governing the program, as well as a table of prices offered by grade, appeared in the Chromium chapter, Minerals Yearbook 1951; subsequent amendments to the regulations appeared in the Chromium chapters, Minerals Yearbooks 1952 and 1953 (vol. I).

A private accumulation depot was established in Stockton, Calif., for reshipment of chromite in carlots to the Government Purchase Depot at Grants Pass, Oreg. By year end only 1 shipment had been made to Grants Pass, and that was not accepted, because it was under the 5-ton minimum limit.

TABLE 3.—Chromite shipped from mines in the United States, from before 1880 through 1954

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	Grand total	1,099,098
Total 1914–20	206,800	Total 1939–46	357,994		

[1] Annual totals published separately in Minerals Yearbooks, 1947–50.

CONSUMPTION AND USES

Although consumption of chromite for all purposes was at a depressed level during most of 1954, by the year end it had begun to rise. The total for the year was 32 percent below the 1953 high. Use of chromite for metallurgical purposes, such as the manufacture of ferrochromium, decreased 32 percent below the 1953 peak. Ore consumed in making refractories, such as bricks and cements, declined 37 percent compared with the 1953 high. Sodium bichromate, chromic acid, and other chromium chemicals consumed 12 percent less chromite than in 1953 in making 98,791 tons of chromium chemicals (sodium bichromate equivalent); this is an average of 1.35 tons of chrome ore per ton of sodium bichromate produced.

Of the total chromite consumed, the metallurgical industry used 55 percent, the refractory industry 30 percent, and the chemical industry 15 percent.

Of the chromite consumed by the metallurgical industry, 84 per-

TABLE 4.—Consumption of chromite and tenor of ore used by primary consumer groups in the United States, 1945–49 (average) and 1950–54, 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)
1945–49 (average)	375, 282	48. 1	277, 757	34. 1	131, 769	44. 8	784, 808	42. 4
1950	491, 685	47. 8	353, 642	34. 0	135, 042	44. 6	980, 369	42. 4
1951	573, 075	48. 1	440, 771	34. 7	198, 634	44. 3	1, 212, 480	42. 6
1952	676, 624	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

cent was metallurgical grade, 8 percent chemical grade, and 8 percent refractory grade.

The average reported chromic oxide content of all chromite consumed during 1954 in the United States declined to 42.4 percent from 42.7 percent in 1953. Chrome consumption centered in the six-State area comprised of Maryland, New Jersey, New York, Ohio, Pennsylvania, and West Virginia.

Reflecting the lowered industrial level during most of 1954, production of chromium ferroalloys and metal declined to 194,000 short tons compared with the 1953 high of 285,000 tons. Consumption dropped 27 percent to 206,000 tons with an average chromium content of 61 percent; ferrochromium comprised 73 percent of the total. Proportionately, the chrome-silicon alloys advanced somewhat in importance during 1954 compared with the previous 2 years. Other metallurgical products were exothermic ferrochromium and chrome-silicon, chromium metal, briquets, and other chromium alloys. The end uses of the alloys and metal, collectively and individually, are given in table 5.

TABLE 5.—Consumption of chromium alloys and chromium metal, 1952–54 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-temp. 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

[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.

Specifications.—Chromite, the only chromium-ore mineral, is composed of oxides of chromium, iron, aluminum, and magnesium within the formula (Mg, Fe) (Cr, Al, $Fe)_2O_4$. Chromite varies widely in composition, and its uses are related thereto. Theoretically pure chromite contains 68 percent Cr_2O_3 but ores in use may contain from

30 to almost 70 percent, depending on the extent and manner of substitution of the other oxides for the chromium and iron oxides.

In making ferrochromium alloys, chromite of all types is blended, although the major portion conforms to the traditional metallurgical standard: Hard lump ore with at least 48 percent chromic oxide, a 3:1 chromium-iron ratio, a maximum of 5 percent silica, and a combined magnesia and alumina content of about 25 percent. It is interesting to note that the percentage of chemical-grade chromite used for metallurgical purposes increased considerably during 1954, although still only a small portion (8 percent) of the total. Virtually all Cuban refractory chromite imported during 1954 went into the production of ferrochromium.

Indicative of the metallurgical trend to the use of lower grade chromites in the production of lower grade alloys was the conversion of high-iron, low-chromium concentrates produced during World War II from Oregon beach sands and stockpiled at Coquille, Oreg., to a low-grade, low-carbon ferrochromium by Pacific Northwest Alloys, Inc., under contract with GSA. The contract also called for the conversion of concentrates stockpiled by the Government at Nye, Mont., during the war.

Refractory bricks usually are made from hard lump chromite containing 31–33 percent chromic oxide, a combined chromic oxide and alumina content of over 60 percent, about 5 percent silica and 10 percent iron. Hard lump ore is preferred because grain size is important in obtaining proper qualities of density, and the brick manufacturers grind the ore to their particular specifications. Some refractory cements, mortars, ramming mixtures, and plastic mixes utilize friable ores, including chemical grade, containing up to 45 percent Cr_2O_3 with correspondingly lower alumina values and silica and iron percentages up to 11 and 19 percent, respectively; some hard lump ores containing up to 45 percent Cr_2O_3 are also used.

Chromium-chemicals manufacture in the United States utilizes only 1 grade of chromite—Transvaal chemical grade (commonly called Grade B Friable)—which contains 43–45 percent chromic oxide (average 44.5) and about 2.5–3.5 percent silica and is too high in iron content (Cr–Fe ratio about 1.6:1) for standard metallurgical use. Efficiency in extraction and use of materials decreases if ores containing less than 44 percent Cr_2O_3 are used, dropping sharply below 43 percent Cr_2O_3. To make chromium chemicals, chromite is finely ground (100–to 200–mesh) and roasted with soda ash (sodium carbonate) or a mixture of soda ash and some limestone or dolomite. The resulting calcine, which contains an impure sodium chromate, is then water-leached, and the leach liquor is acidified to obtain pure sodium chromate or sodium bichromate, from which all other chromium chemicals are derived. Chromite with low silica content (5 percent maximum) is desired to minimize soda-ash loss. The selection of Transvaal chemical-grade chromite for chemicals manufacture is based on its price—it is the cheapest available chrome ore—and the tremendous reserves, estimated in hundred million tons, which provide a steady source of relatively uniform material.

Federal specifications for the purchase of chromite for the National Strategic Stockpile are listed on table 6. Specifications under the Domestic Purchase Program call for minimums of 42 percent Cr_2O and a 2:1 chromium-iron ratio, and a maximum of 10 percent SiO_2.

TABLE 6.—Chromite purchase specifications for National Strategic Stockpile in 1954

[General Services Administration, Emergency Procurement Service]

Grade	Percent by weight, dry basis						
	Cr_2O_3, minimum	Fe, maximum	Cr-Fe ratio, minimum	$Al_2O_3+Cr_2O_3$ minimum	SiO_2, maximum	S, maximum	P, maximum
Metallurgical:[1]							
Low-grade[2]	42		1.5:1		10	0.10	0.04
High-grade	46		2.7:1		8	.08	.04
Refractory:[3]							
Masinloc	31	12		60	5.5		
Camaguey	30	12		58	7		
Moa Bay	34	12		60	5.5		
Chemical:[4] Friable ore	44				5		

[1] Specification P-11, June 13, 1951, covers chromite ore suitable for the manufacture of commercial ferrochromium and special chromium alloys. Lumpy ore shall be hard, dense, nonfriable material, of which not more than 25 percent shall pass a 1-inch Tyler Standard screen. Material of friable nature, regardless of an initially lumpy appearance, will be classified as fines. No size restrictions apply to fines or concentrates.

[2] Guaranteed analysis 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.

On October 19, 1954, National Stockpile Specification P-11a was established for the purchase of low-carbon ferrochromium; it called for a minimum of 65 percent chromium and percentage maximums of 0.10 carbon, 1.50 silicon, 0.04 phosphorus, and 0.10 sulfur, the material to be in lumps 8-mesh or larger. On the same date, National Stockpile Specification P-11b-R (superseding issue of December 30, 1950) was established for the purchase of high-carbon ferrochromium; it called for a minimum chromium content of 65 percent, carbon content of 4.0-6.0 percent, and percentage maximums of 1.50 silicon, 0.04 phosphorus, and 0.10 sulfur; the material to be in lumps 1 inch or larger.

Metallurgical Uses.—Chromium is one of the basic alloying elements because of its ability to impart resistance to corrosion, high temperature, impact, creep, friction, and wear. Most chromium finds applications in the metallurgical industry, in the making of various alloys, through the use of chrome refractories in steel furnaces, or the use of chromium chemicals in chromium-metal manufacture and the cleaning, protection, and treatment of metal surfaces.

Direct metallurgical applications of chromium include the conversion of chromite to various chromium ferroalloys and the use of these primary alloys as chromium additives in making stainless and high-speed steels, high-temperature alloys, and various other special purpose alloys. Some steels are made by the direct addition of chromite to the furnace. In producing the primary chromium alloys the chromite is always reduced in the electric furnace, and low-carbon ferrochromium is the chief product; high-carbon ferrochromium is the next most important product. Ferrochrome-silicon alloys, exothermic ferrochromium, and exothermic silicon-chrome are also produced for use in steelmaking. Chromium metal currently is made commercially from ferrochromium (electrolytic process) and chrome oxide green (aluminothermic process); a prime use for the metal is in high-temperature alloys for jet engines and gas turbines. Stainless steels are used wherever corrosive conditions or high temperature are to be encountered, such as in chemical-manufacturing and food-processing equipment, petroleum production and refining, and architectural trim and exterior wall facings on modern buildings. High-speed steels are used in metal-cutting tools and machinery. Electrical heating elements and resistors, welding electrode coatings, valves, grinding balls, and special thermocouples make use of the various properties of chromium. The element is also used in high-strength low-alloy steels for the manufacture of trains, trucks, automobiles, ships, farm machinery, construction and mining equipment, and wherever else high tensile and creep strength and hardness are required.

Refractory Uses.—The principal use of chrome refractories was in steel mills for lining basic open-hearth and electric arc furnaces. Chrome brick may be all chrome or chrome mixed with magnesia in all proportions. It may be used as one of the courses of the hearth in basic open-hearth furnaces, along the sides of the furnace, and wherever resistance to extreme heat, spalling, or abrasion is needed. In furnaces that have basic hearths and acid roofs, chrome brick is used at the juncture between the two because of its neutral qualities. Basic electric arc furnaces may be almost completely lined with chrome refractories. Chrome mortars are used for cementing bricks, for patching furnace linings, and wherever a smooth surface or special contouring is desired. Chrome mixes may be made that are slightly plastic at furnace temperatures and keep the melt from leaking through cracks in the furnace lining. Chrome refractories are also used in lining naval boilers, in nonferrous-metal smelting furances, and in the ceramics and paper industries.

Chemical Uses.—Chromium chemicals are used by the metallurgical industry in electroplating, surface treating, and cleaning metals and in making chromium metal by the aluminothermic process. Virtually all chromium chemicals are made from sodium bichromate, and in a discussion[4] of the end use of chromium chemicals it was reported that in 1954 an estimated 38 percent of the sodium bichromate was used to make the major chrome pigments, of which ½ went into paints, ¼ into printing ink, and ¼ into rubber, plastics, textiles, linoleum and other uses; metal treatment used an estimated 23 percent; and leather tanning consumed about 20 percent (about 90 percent of all shoe upper leather is chrome-tanned).

Among the major chromium pigments are the lead chromates (chrome yellow and orange are by far the most important chrome pigments) which impart brilliance and high covering power to paints and printing inks, chrome oxide green which resists chemicals, heat, water, and sunlight, and zinc chromate (zinc yellow) used in corrosion-inhibiting paints.

Chrome tanning is very much faster than vegetable tanning, doing in hours what would take days for vegetable tannings. Chromium metal made by the aluminothermic process utilizes chromic oxide as the

[4] Chemical Week, Chromates for Integration: July 24, 1954, pp. 69–71.

source of chromium. Chromium electroplating is effected by means of chromic oxide solutions and is utilized extensively in industry for adding qualities of resistance to friction, impact, heat and corrosion to machinery, tools and equipment; for these purposes, coatings 0.0001 to 0.02 inch thick are applied as compared with 0.00002-inch coatings used for decorative purposes. Pyrotechnics, matches, photographic supplies, medicinals such as cortisone, wood preservatives, and corrosion inhibiting muds for oil-well drilling are some additional end uses for chromium chemicals.

STOCKS

As a result of the continued excess of commercial imports over consumption, stocks of chromite in the hands of the consuming industry continued to climb during 1954. A 25 percent rise in total industrial stocks during the 12-month period brought inventories to a 16.6-month supply level at the end of 1954 compared with 9.1-month supply in 1953 (based on the respective annual consumption rates). Stocks held by metallurgical and chemical users rose 32 and 39 percent, respectively, while refractory stocks declined 1 percent.

TABLE 7.—Stocks of chromite at consumers' plants, December 31, 1950–54, in short tons

Grade	1950	1951	1952	1953	1954
Metallurgical	248, 872	305, 134	364, 013	607, 724	803, 889
Refractory	251, 663	247, 673	269, 933	259, 896	257, 451
Chemical	105, 736	84, 646	120, 353	148, 258	206, 477
Total	606, 271	637, 453	754, 299	1, 015, 878	1, 267, 817

In conformity with the lower operating rate of the chromium industry in 1954, producers' stocks of ferrochromium alloys and metal at the end of the year, though still high, had dropped 14 percent below the beginning of the year. Consumers' stocks decreased 23 percent.

PRICES

All prices for foreign chromites declined during 1954 according to E & MJ Metal and Mineral Markets. Prices of Turkish and Pakistan ore fell most and were nominal much of the year. In the final weeks of 1954 quoted prices for Turkish chromite experienced a slight rise, presumably because of contracts signed with the United States for sizable shipments.

Virtually all domestically produced chromite was purchased by the Federal Government at incentive prices; a base price of $115 per long dry ton was paid for metallurgical lump ore containing 48 percent Cr_2O_3 and having a 3:1 chromium-iron ratio. Off-grade Montana concentrates containing 38 percent Cr_2O_3 and having a low chromium-iron ratio were bought at $34.97 per short dry ton ($39.17 per long dry ton).

TABLE 8.—Price quotations for various grades of foreign chromite in 1954

[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	[2] 3:1	\$51-\$52	\$43-\$44
Rhodesian	48	[2] 3:1	44- 46	43- 44
Do	48	2.8:1	40- 42	40- 41
Do	48		32- 34	32- 33
South African (Transvaal)	48		33- 34	32- 33
Do	44		23- 24	22- 23
Turkish	48	[2] 3:1	53- 54	46- 47

[1] Quotations are on a dry basis, subject to penalties if guarantees are not met, f. o. b. cars, east coast ports.
[2] Lump ore.

Electrolytic chromium metal, commercial grade, 99 percent minimum, experienced a price reduction in September 1954 to \$1.16 per pound from the former minimum of \$3.00 per pound. The 97 percent grade aluminothermic chromium with 0.5 percent carbon was also reduced to \$1.16 per pound, and metal with 9–11 percent carbon was quoted at \$1.25 per pound, wholesale lots, f. o. b., New York. Ferrochromium prices quoted by E&MJ Metal and Mineral Markets remained the same as in 1953; high-carbon ferrochromium (65–69 percent Cr, 4–9 percent C) was 24.75 cents per pound of contained chromium, f. o. b. destination, continental United States; low-carbon ferrochromium was 34.5 cents per pound of contained chromium for the 0.06 percent carbon grade.

FOREIGN TRADE[5]

Imports.—Consequent to the decline in demand for consumption and Government stockpiling, imports of all grades of chromite dropped 34 percent during 1954 compared with the record total of 1953. Imports of metallurgical, refractory, and chemical grade chromite fell 46 percent, 16 percent, and 5 percent, respectively. Metallurgical ore comprised 51 percent of the total, refractory 36 percent, and chemical 13 percent.

The Republic of the Philippines was again the largest supplier of chromite to the United States in 1954, accounting for 33 percent of the total and 83 percent of the refractory imports. Other principal sources of chromite were Union of South Africa 22 percent, Turkey 21 percent, and Southern Rhodesia 18 percent. Turkey was the greatest source of metallurgical chromite, supplying 41 percent of the total; Southern Rhodesia was next with 33 percent. All chemical-grade chromite came from Union of South Africa. Imports of chromite came from 11 countries in 1954, in contrast with 13 during 1953. The average value at foreign ports of all United States chromite imports was \$23.20 a short ton compared with \$25.20 in 1953.

Overall chromite imports contained an average chromic oxide content of 41.4 percent in 1954; metallurgical chromite contained 46.4 percent, refractory 33.4 percent, and chemical 44.0 percent.

[5] 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.—Chromite imported for consumption in the United States, 1953–54, 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	
1953												
North America: Cuba				29,656	11,721	$822,057	57,630	19,644	$1,086,518	87,286	31,365	$1,908,575
Europe:												
Greece				375	164	12,920	1,003	401	27,300	1,378	565	40,220
Turkey				565,120	[1] 259,625	[1] 21,777,196				565,120	[1] 259,625	[1] 21,777,196
Yugoslavia				48,675	22,099	1,769,168				48,675	22,099	1,769,168
Total				614,170	[1] 281,888	[1] 23,559,284	1,003	401	27,300	615,173	282,289	23,586,584
Asia:												
Afghanistan				47	28	1,987				47	28	1,987
India				6,782	3,069	240,820	7,842	3,188	111,864	14,624	6,257	352,684
Iran				5,816	2,912	209,072				5,816	2,912	209,072
Pakistan				14,038	6,316	534,118				14,038	6,316	534,118
Philippines				84,935	38,938	2,408,876	544,523	177,566	7,256,195	629,458	216,504	9,665,071
Total				111,618	51,263	3,394,873	552,365	180,754	7,368,059	663,983	232,017	10,762,932
Africa:												
Sierra Leone [2]				15,008	6,425	490,424				15,008	6,425	490,424
Southern Rhodesia				[1] 326,116	[1] 152,861	[1] 10,010,225	2,530	1,045	41,699	[1] 328,646	[1] 153,906	[1] 10,051,924
Union of South Africa	204,968	91,087	$2,033,620	[1] 197,855	[1] 90,597	[1] 3,436,107	14,835	6,069	164,831	[1] 417,658	[1] 187,753	[1] 5,634,558
Total	204,968	91,087	2,033,620	[1] 538,979	[1] 249,883	[1] 13,936,756	17,365	7,114	206,530	761,312	348,084	16,176,906
Oceania: New Caledonia [3]				98,877	48,737	3,667,256				98,877	48,737	3,667,256
Grand total 1953	204,968	91,087	2,033,620	[1] 1,393,300	[1] 643,492	[1] 45,380,226	628,363	207,913	8,688,407	[1] 2,226,631	[1] 942,492	[1] 56,102,253
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				304,643	141,745	11,876,739				304,643	141,745	11,876,739
Total				304,643	141,745	11,876,739	55	23	1,300	304,698	141,768	11,878,039

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				9,553	4,412	363,965				9,553	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				57,392	26,459	1,684,949	451,476	145,827	6,043,738	508,868	172,286	7,728,687
Africa:												
Rhodesia, Federation of and Nyasaland [4]				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	194,853	85,817	2,113,183	108,660	48,066	1,670,910	17,874	7,441	200,562	321,387	141,324	3,984,655
Total	194,853	85,817	2,113,183	356,889	163,296	9,835,991	37,390	16,205	616,587	589,132	265,318	12,565,761
Oceania: New Caledonia [3]				29,792	15,568	1,110,820				29,792	15,568	1,110,820
Grand total 1954	194,853	85,817	2,113,183	748,716	347,068	24,508,499	526,500	175,850	7,490,622	1,470,069	608,735	34,112,304

[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."
[4] Effective July 1, 1954, Northern and Southern Rhodesia not separately classified.

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Imports of ferrochromium for consumption containing at least 3 percent carbon totaled 14,756 short tons with an average chromium content of 55 percent; Canada supplied 88 percent, Union of South Africa 11 percent, and Sweden and Norway the remainder. A total of 2,017 tons of ferrochrominum imported contained less than 3 percent carbon and had an average chromium content of 71 percent; France shipped 47 percent, Sweden 26 percent, Yugoslavia 23 percent, and Southern Rhodesia the remaining 4 percent. Chromium metal imports from United Kingdom were 97 tons, West Germany 35 tons, and France 11 tons; a total of 143 tons. Imports of sodium chromates and bichromates totaled 932 tons, all from the Union of South Africa.

Exports.—Chromite exports in 1954 were negligible as usual, the total being 864 short tons of material that originated abroad but was processed domestically; 711 tons was shipped to Canada, 138 tons to Chile, and 15 tons to Colombia. Reexports, all shipped to Canada, were only a small fraction of the previous year's, dropping to 427 tons.

Exports of all grades of ferrochromium totaled 2,105 tons, valued at $995,797; they were shipped to Canada (76 percent) and 10 other countries. Sodium chromate and bichromate exports totaling 4,981 tons, valued at $1,053,093, were shipped to Brazil (44 percent), Canada (26 percent), Mexico (14 percent), and 14 other countries. Chromic acid exports of 397 tons valued at $216,220 went to 10 countries, including Canada which received 68 percent of the total.

TABLE 10.—Chromite ore and concentrates exported from the United States, 1945–49 (average) and 1950–54

[U. S. Department of Commerce]

Year	Domestic [1]		Foreign [2]	
	Short tons	Value	Short tons	Value
1945–49 (average)	4,647	$138,457	10,296	$346,991
1950	2,044	63,409	2,543	100,382
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

[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.

Effective August 26, 1954, shipments of chrome ores and products were freed from normal export controls with the exception of low-carbon ferrochromium containing 0.03 percent maximum carbon which still required licensing to countries outside the Western Hemisphere if valued at over $100. Licensing regulations were still in force on all exports to Soviet bloc countries and the shipping transfer points of Hong Kong and Macao.

Tariff.—No import duty is imposed on chrome ores. In accordance with the Tariff Act of 1930 as superseded by various trade agreements, the following tariffs are imposed on imports of chromium products from nations signatory to these agreements.

Ferrochromium containing 3 percent carbon or over is subject to a tariff of ⅝ cent per pound of contained chromium. The tariff rate on ferrochromium containing less than 3 percent carbon, chromium metal, chromium carbide, ferrochrome silicon and chrome silicide, chromium nickel, and chromium vanadium is 12½ percent ad valorem. Alloys which number chromium and at least 1 of the following elements among their constituents are dutiable at 20 percent ad valorem: Calcium, zirconium, titanium, barium, boron, strontium, thorium, or vanadium. Chromic acid and chromic oxide and other chrome colors enter at 12½ percent ad valorem.

Imports from all countries are subject to the same tariff rate for chrome bricks and shapes (25 percent ad valorem), sodium chromate and bichromate (1¾ cents per pound) and potassium chromate and bichromate (2¼ cents per pound).

Imports from countries not participating in the aforementioned agreements (such as the Soviet Union) are subject to tariffs of 2½ cents per pound of contained chromium for high-carbon ferrochromium, 30 percent ad valorem for low-carbon ferrochromium and chromium metal, and 25 percent ad valorem for everything else.

TECHNOLOGY

First full-scale commercial production of electrolytic chromium metal was underway at the Marietta, Ohio, plant of Electro Metallurgical Division of Union Carbide & Carbon Corp. during 1954. Using procedures based on a Federal Bureau of Mines process, the company uses standard high-carbon ferrochromium as a source of chromium for its metal which has a minimum purity of 99 percent. A reported annual output of about 2,000 tons is anticipated.

Several papers [6] by American, Australian, and English researchers discussed the production and characteristics of high-purity chromium metal.

Methods and applications of chromizing (the surface impregnation of metals with chromium) were described.[7] Chromizing in effect creates a high-chrome alloy on the surface of a metal and is used where surface properties, such as resistance to corrosion and high temperature, are required, the cost being less than that of high chrome alloys. Chromizing is also used to make hollow, unwelded parts by chromizing a steel core and then removing the steel base by submersion in nitric acid, leaving the acid resistant chromized surface as a thin alloy shell.

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[6] Gilbert, H. L., and Johansen, H. A., High-Purity Chromium—Key to Better Alloys: Iron Age, vol. 173, No. 3. Jan. 21, 1954, pp. 93–96.

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Greenaway, H. T., The Electrodeposition and Refining of High-Grade Chromium: Jour. Inst. Metals (England), vol. 83, part 4, December 1954, pp. 121–125.

Henderson, F., Quaass, S. T., and Wain, H. L., The Fabrication of Chromium and Some Dilute Chromium-Base Alloys: Jour. Inst. Metals (England), vol. 83, part 4, December 1954, pp. 126–132.

Wain, H. L., Henderson, F., and Johnstone, S. T. M., A Study of the Room-Temperature Ductility of Chromium, With an Appendix on Analytical Methods Used for the Determination of Nitrogen and Oxygen in Chromium, by E. J. Lumley: Jour. Inst. Metals (England), vol. 83, part 4, December 1954, pp. 133–142.

Sully, A. H., Brandes, E. A., and Mitchell, K. W., The Effect of Temperature and Purity on the Ductility and Other Properties of Chromium: Jour. Inst. Metals, vol. 81, August 1953, pp. 585–598.

[7] Seelig, R. P., Chromizing Improves Surface Properties of Steels: Materials and Methods, vol. 37, No. 5, May 1953, pp. 106–109.

Materials and Methods, French Developments in Chromizing Metals: Vol. 40, No. 5, November 1954, pp. 160–162.

Metal Progress, Chromium Diffusion Into Steel: Vol. 65, No. 2, February 1954, p. 112.

In a discussion of chromium plating, the use of plastics to resist corrosion in chrome solution vats and ancillary equipment was cited as one of the greatest improvements in modern chromium plating. Another important innovation mentioned was the use of special waxes on chromium solution surfaces to prevent the formation of fumes and the resultant loss of chromic acid.[8]

The corrosion results reported for bonded chromium boride showed that it has excellent resistance to concentrated nitric, hydrochloric, sulfuric, and hydrofluoric acids; is unaffected by dilute nitric acid; is dissolved rapidly by fused sodium peroxide and nitrate carbonate mixtures. Chromium boride also has good high-temperature strength and hardness. It is used for rubbing seals and bearings in high-temperature service, and as hard-facing on a mild steel base in the chemical industry for its resistance to wear and corrosion. Suggested uses have been for turbine blades, valve inserts and seats, and jet engine discharge nozzles and exhaust tubes.[9]

Refractory bricks composed of 60 percent chromite and 40 percent magnesia made by the Bureau of Mines from offgrade domestic chromites were tested by industry in actual commercial use and found to be highly satisfactory. The Bureau-made bricks were used in the bulkhead of an open-hearth steel furnace for 103 heats before being replaced, in contrast to the normal life of similar commercial brick of 60 to 100 heats.

Operations at the Mouat mine in the Stillwater complex of Montana, the largest chrome mine in North America, were described in an article.[10] The mine is developed in the upper and middle of three mineralized zones about 300 feet apart. The lowest zone will be explored after completion of an adit to gain 1,700 feet in depth and provide a direct train haulageway to the concentrator. The mine is opened by 5 levels at 150-foot vertical intervals and various ore transfer raises. The main haulage level is 2,700 feet long, and all levels are 7 x 8 feet in cross section. Little timbering is required, as the ground holds up well. Mining methods using long-hole drilling and shrinkage stopping are described; stull-stoping methods are used on veins less than 5 feet wide. Ore loading is accomplished by chute, scraper, and mucking machine. Trains haul the 18-inch lump mine-run ore from loading points on the lowest level to 1,200-ton coarse-ore bins. At the primary crushing plant near the mine portal the ore is reduced to 3 inches and then sent via a 1¼-mile aerial tram to the secondary crushing plant at the Mouat camp where the concentrator is located. Two 500-ton treatment circuits are in the concentrator building with space available for 2 additional units. Ore containing 19–21 percent Cr_2O_3 is converted to a concentrate containing about 38 percent Cr_2O_3 with a chrome-iron ratio of about 1.5:1; the concentration ratio is 2.4:2.6. The chromite is ground in rod mills to about 20-mesh, hydraulically classified, tabled (72 tables on 6 floors), dewatered, and stockpiled near the mill. Water is obtained from the nearby Stillwater River. Overall mill recovery is about 80 percent.

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[8] Metal Industry (London), Modern Chromium Plating: Vol. 84, No. 11, Mar. 12, 1954, pp. 209–210.
[9] Materials and Methods, vol. 40, No. 2, August 1954, p. 92.
[10] Huttl, John B., How One Chrome Producer Aims at Self-Sufficiency: Eng. and Min. Jour., vol. 155, No. 6, June 1954, pp. 92–95, 101.

WORLD PRODUCTION

Reversing the situation prevailing the previous year, all major chromite producers and most minor producers decreased their output in 1954 except the United States, where virtually all chromite production was bought by the Government at high incentive prices. Union of South Africa was the largest producer of chromite in the world; Turkey was next, despite a drop of 38 percent compared with the 1953 high. Although total world output in 1954 declined to 3.6 million short tons from the 1953 high of 4.2 million tons, it was, nevertheless, almost twice as much as the annual average for the 5-year period 1945–49.

Australia.—Of 2,741 long tons of chromite produced in 1953, Western Australia supplied the major portion and Queensland the rest.[11] Production from the Coobina deposits, 200 miles southeast of Port Hedland, Western Australia, began in 1952 and accounted for the bulk of production in both 1952 and 1953. This ore contains 47 percent Cr_2O_3 with 2:1 Cr-Fe ratio. It has been reported that 250,000 tons of chromite containing 42–49 percent Cr_2O_3 could be mined easily at Coobina.[12] All domestic chromite was used for refractory purposes, other needs being supplied by imports chiefly from New Caledonia and Rhodesia.

The average apparent annual consumption during the period 1951–53 was 6,250 tons of chrome ore and 1,140 tons of ferrochromium. About 2,500 tons of chromite was used annually in making chemicals and the rest in steelmaking. Broken Hill Proprietary Co., Ltd., steel works consumed the major portion of the total; two-thirds of its consumption went into chromium production, and the rest was used for refractories. In 1952, 1,034 tons of ferrochromium was produced requiring some 2,000 tons of ore. Small steel and iron foundries consumed some ferrochromium, and there was appreciable consumption of refractory-grade chromite for refractory bricks and crucibles.

There was no competitive marketing of chrome ore in Australia; prices were by arrangement. The value of chrome ore produced in Western Australia in 1953 was £15 per ton; the point of valuation may have been at seaboard.

Income-tax exemptions on 20 percent of the profits earned on the mining of chromite, among other commodities, were granted in 1952 by the Commonwealth Government to encourage local production.

Cuba.—In an effort to prove additional reserves of 800,000 long tons of refractory chromite, the Federal Geological Survey began to explore the Camaguey area in July 1954 under agreement with GSA.

Greece.—Chromite deposits occur on the Chalkidiki Peninsula and in Kozani, Larissa, Volos, Domokos, and Thrace. Yearly production (chiefly of refractory ore) averaged 45,000 metric tons from 1935 to 1939. Large reserves of subgrade material suitable for concentration are reported.

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[11] Pearson, H. F., Chromium; The Australian Mineral Industry, 1953 Review: Bureau of Mineral Resources Geology and Geophysics, Melbourne, Australia, 1954, pp. 47–48.

[12] Haycroft, J. A., Chromium; The Australian Mineral Industry, 1952 Review: Bureau of Mineral Resources Geology and Geophysics, Melbourne, Australia. 1953, pp. 49–51.

TABLE 11.—World production of chromite, by countries,[1] 1945–49 (average) and 1950–54, in short tons [2]

[Compiled by Pearl J. Thompson]

Country [1]	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Canada	2,620					
Cuba	162,659	72,554	87,154	68,132	77,205	[3] 70,000
Guatemala	541	319	1,254	116	441	[3] 110
United States	4,616	404	7,056	21,304	58,817	163,365
Total	170,436	73,277	95,464	89,552	136,463	[3] 233,000
South America:						
Argentina	661					(4)
Brazil	[5] 726	3,557	2,663	2,920	[3] 4,000	[3] 3,000
Total	[5] 1,387	3,557	2,663	2,920	[3] 4,000	[3] 5,700
Europe:						
Albania	[3] 12,677	[3] 57,320	(4)	(4)	(4)	(4)
Greece	4,188	13,923	27,925	35,452	40,520	29,549
Portugal	608	50	36	119	5	
U. S. S. R.[3 6]	410,000	500,000	600,000	600,000	600,000	600,000
Yugoslavia	73,437	126,475	109,333	118,192	139,950	137,216
Total [3]	500,000	715,000	820,000	835,000	870,000	855,000
Asia:						
Afghanistan	[7] 1,102	606	83			
Cyprus (exports)	6,456	20,328	13,948	14,867	9,115	10,087
India	[8] 46,869	18,737	18,706	[9] 40,530	72,543	[3] 55,000
Iran			(4)	9,728	22,046	[3] 20,000
Japan	19,868	36,331	45,134	51,975	41,418	35,821
Pakistan	(8)	20,300	19,848	19,040	25,760	24,527
Philippines	180,264	276,141	368,801	599,121	614,086	442,230
Turkey	252,433	465,758	682,793	889,466	1,005,883	619,001
Total [6]	506,992	838,201	1,151,518	1,624,727	1,790,851	[3] 1,207,000
Africa:						
Egypt	144	40			231	584
Sierra Leone	12,706	8,287	18,139	26,312	27,277	[5] 16,667
Southern Rhodesia	213,211	321,351	330,987	355,679	463,028	442,506
Union of South Africa	331,039	547,103	600,763	639,366	798,567	706,939
Total	557,100	876,781	949,889	1,021,357	1,289,098	1,166,692
Oceania:						
Australia	330	998	1,545	1,565	3,070	[3] 2,000
New Caledonia	65,987	93,477	97,876	118,675	133,446	92,818
Total	66,317	94,475	99,421	120,240	136,516	94,818
World total (estimate)[1]	1,800,000	2,600,000	3,100,000	3,700,000	4,200,000	3,600,000

[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.
[3] Estimate.
[4] Data not available; estimates by senior author of chapter included in total.
[5] Exports.
[6] Output from U. S. S. R. in Asia included with U. S. S. R. in Europe.
[7] Average for 1 year only, as 1949 was the first year of commercial production.
[8] Pakistan included with India.
[9] Does not include 21,603 tons of low-grade ore accumulated from production from 1943 through 1948.

Union Minière, S. A., one of the major producers of chromite in Greece, suspended operations at the Domokos mine in Thessaly during September 1954 after an estimated 10,000 metric tons of stocks had accumulated.[13]

Hellenic Mines Corp.'s contract with DMPA (now administered by GSA) for developing chrome deposits at Kozani and expanding a concentrating plant was amended during 1954 to extend the first-stage

[13] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 2, February 1955, p. 6.

completion date from July 1954 to March 31, 1955, and set July 1, 1954, rather than January 1, as the date when repayment of the production loan was to begin. During 1954 extensive drilling was being done, a 2-kilometer aerial tramway was installed, dwellings for miners were built, and road construction and improvements were completed. Machinery and equipment to expand the concentrating-plant capacity from 60 to 120 tons was delivered in 1954, and the plant was to be assembled by March 1955. Stage 2 of the development program, to be initiated upon notification by GSA, called for expansion of the mill capacity to 400 tons daily, construction of a Diesel powerplant and laboratory, mine development, installation of an 8-kilometer aerial tramway, and further road construction and improvements.

India.—Effective September 27, 1954, the Government of India permitted unlimited export of chrome ore upon presentation of shipping bills. During the first half of the year exports of chrome ore were limited to a total of 15,000 tons.[14]

An article describing the physical, chemical, and mineralogical features and refractory characteristics of 26 Indian chrome ores of varying analyses obtained from various localities indicated that these ores are not of the standard refractory type used in the United States, having a much lower alumina content.[15]

The Indian Government extended the 31.5 percent ad valorem duty on chromium compounds and bichromates an additional 4 years from January 1955.[16]

A brief review of chromite in India, indicating sources, production, and estimated consumption of ore, was published during 1953.[17]

Italy.—New annual import quotas for ferrochromium alloys were announced by the Italian Official Gazette. . The quotas, subject to the 5 percent ad valorem important duty, are: 600 tons of ferrochromium containing 0.06 to 0.1 percent carbon and 1,900 tons of ferrochromium containing a maximum of 0.06 percent carbon.[18]

New Caledonia.—Société la Tiebaghi mined 89 percent of the total 1954 output and was the only producer during the last 2 months of the year. Because of decreased demand and almost complete exhaustion of the deposit, the Chagrin mine Société Caledonienne du Chrome, second largest in New Caledonia, closed in August after producing 6,516 short tons of chromite during the year.

Toward the end of 1954 the reported price of 48-percent chromite dropped to $32 per ton from the 1953 level of $39.[19]

Philippines.—Benguet Consolidated Mining Co. expanded its facilities for washing, handpicking, and heavy-medium separation at the Masinloc mine in Zambales, Luzon, largest known deposit of refractory-grade chromite in the world. Completion of the railroad connecting the mine with the pier was anticipated. A pilot plant was being built to wash and clean close to a quarter of a million tons of minus-one-quarter-inch chrome sands stockpiled at the mill. Despite geological exploration during 1954, including extensive dia-

[14] U. S. Dept. of Commerce, Foreign Commerce Weekly, vol. 52, No. 18, Nov. 1, 1954, p. 9.
[15] Banerjee, J. C., Indian Chrome Ore—Their Characteristics and Use as Refractories: Jour. Sci. Ind. Res. (India), vol. 12A, No. 5, May 1953, pp. 224-229.
[16] Chemical Age (London), vol. 71, No. 1832, Aug. 21, 1954, p. 368.
[17] Krishnan, M. S., Chromite Requirements Expected to Expand: Supplement to "Capital" (India). June 25, 1953, p. 43.
[18] Metal Bulletin (London), No. 3900, June 11, 1954, p. 30.
[19] American Consulate, Moumea, New Caledonia, State Dept. Dispatch 76, May 20, 1955, p. 3.

mond drilling, there was very little increase in known reserves at the mine.[20] The company contracted with the United States Government in 1954 for the shipment of 250,000 tons of chromite.

Faced with the possibility of a shutdown because of lack of demand, Acoje Chromite Mining Co. managed to procure a one-half-million-dollar loan from Philippine banks to enable it to continue operations at the Acoje mine in the Zambales Mountains of Luzon.

Other companies producing during 1954 were Luzon Stevedoring Co. from deposits in Masamis Oriental, Mindanao, the Mayon Chromite Mining Co. mining at Lagonoy, Camarines Sur, and Jose Robles Mine Operations, working the former Filipinas and Zambales properties in Zambales part of the year. Marsman & Co. discovered the Irahuan deposit 18 miles northwest of Puerto Princesa on Palawan Island late in 1953 and explored the area during 1954; it was reported that 50,000 tons of reserves was blocked out, averaging 59 percent Cr_2O_3 with a 3.45:1 Cr-Fe ratio.

Rhodesia and Nyasaland, Federation of.—Rhodesian Vanadium Corp. started operation of its new mill for concentration of eluvial and lode chrome ore deposits in Southern Rhodesia.[21] The German Otto Wolf group acquired an option on the Windsor Chrome Mines, on the Great Dyke near Que Que. These mines are current producers of high-grade, lump chrome ore containing over 50 percent Cr_2O_3 and with a Cr-Fe ratio of over 3.4:1.[22] The Windsor ores are used by Rhodesian Alloys, Ltd., in Gwelo, whose plant and ferrochromium process were described during the year.[23]

An article discussing chrome mining in Southern Rhodesia described deposits and methods of mining and gave general cost data, and miscellaneous information.[24]

Another article gave a rather complete description of African Chrome Mines workings at Mtoroshanga in the Umvukwes Hills about 60 miles from Salisbury, indicating the nature of chrome mining on Southern Rhodesia's Great Dyke.[25]

Mining and milling operations at the Selukwe Peak mine operated by Rhodesia Chrome Mines, Ltd., were also described, with special emphasis placed on the heavy-medium separation phase of the concentration process.[26]

Syria.—It was reported that chrome deposits had been discovered in Latakia governorate and that an official technical committee had been appointed in Damascus to supervise development.[27]

Turkey.—The lagging Turkish chrome-mining economy was bolstered during the second half of 1954 by rejuvenation of an old contract for 100,000 tons of chromite for the United States National Strategic Stockpile and the signing of a contract involving the barter of 100,000 tons of United States wheat for Turkish chromite. The duty on chrome-ore exports was reduced from 5 percent to 1 percent,

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[20] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 4, October 1954, pp. 7-8.
[21] American Metal Market, vol. 61, No. 7, Jan. 12, 1954, p. 1.
[22] Mining World, vol. 16, No. 13, December 1954, p. 56.
[23] Keeling, Denys, Rhodesian Alloys' Chrome Refining Plant Is Among Largest in the World: Rhodesian Min. Rev., vol. 19, No. 5, May 1954, pp. 27-30.
[24] Hodges, Parke A., Chrome Mining in Southern Rhodesia Shows Wide Variety of Operations: Min. Eng., vol. 6, No. 8, August 1954, pp. 791-797.
[25] Rhodesian Mining Review, Chrome Mining at Mtoroshanga in the Umvukwes: Vol. 19, No. 7, July 1954, pp. 27, 29, 30.
[26] Rhodesian Mining Review, Sink-Float Aids Recovery of Fines at Selukwe Peak Mine: Vol. 19, No. 4, April 1954, pp. 17, 18.
[27] Engineering and Mining Journal, vol. 155, No. 6, June 1954, p. 163.

effective November 1954 through the end of 1955. It was hoped that this would assist the miners to lower their prices to a competitive level on the world market.

A recent publication by an American mining engineer in Turkey lists the production and estimated reserves of chromite (among other minerals) by location and grade, and includes sketch maps locating deposits by province.[28] Turkish chrome-mining problems, costs, geology, location of current and potential mining areas, and general mining information were discussed during the year.[29]

TABLE 12.—Exports of chromite from Turkey, 1945–49 (average) and 1950–54, by countries of destination, in short tons [1] [2]

(Compiled by John E. McDaniel)

Country	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Canada	531	6,719	-	2,240	-	-
United States	126,533	266,144	392,694	468,463	516,577	224,037
Europe:						
Austria	12,791	32,224	39,101	43,771	38,455	31,281
Belgium	79	-	-	55	-	-
France	16,589	11,827	30,080	43,411	20,286	20,224
Germany, West	1,659	9,637	42,800	54,863	25,374	69,568
Greece	-	1,120	-	-	-	-
Hungary	698	64	110	-	-	-
Italy	3,584	4,081	6,768	7,744	2,470	5,897
Netherlands	-	-	304	8,299	4,700	7,883
Norway	8,101	14,220	8,569	15,826	23,830	8,063
Spain	411	-	1,224	-	1,764	661
Sweden	15,854	25,494	14,133	17,820	24,413	12,125
Switzerland	10	-	2,860	17,764	9,060	-
United Kingdom	4,424	18,250	17,592	9,689	14,807	12,419
Yugoslavia	-	-	-	-	-	882
Other countries	190	-	-	551	1,102	-
Total	191,454	389,780	556,235	690,496	682,838	393,040

[1] Compiled from Custom Returns of Turkey.
[2] This table incorporates a number of revisions of data published in the previous Chromite chapter.

U. S. S. R.—U. S. S. R. entered the non-Soviet world chrome market in both Europe and Asia during 1954. Both Belgium[30] and Japan[31] were reported to have signed trade agreements with the U. S. S. R. calling for deliveries of chrome ore from the Soviet Union, and France[32] was reported to be negotiating an agreement. The United States was also approached with regard to the barter of American butter and edible oils for Soviet chrome and manganese,[33] but no agreement was made.

[28] Ryan, C. W., A Guide to the Known Minerals of Turkey: Pub. by Güzelis Natbaasi, Ankara, Turkey, August 1954, 74 pp.
[29] Kromer, H. Ferid, Chrome-Ore Mining in Turkey, Geology, Methods, Costs, Law: Eng. and Min Jour., vol. 155, No. 4, April 1954.
[30] Metal Bulletin (London), No. 3866, Feb. 5, 1954, p. 20.
[31] Metal Bulletin (London), No. 3905, June 29, 1954, p. 25.
[32] Metal Bulletin (London), No. 3948, Nov. 30, 1954, p. 27.
[33] American Metal Market, vol. 61, No. 241, Dec. 18, 1954, pp. 1, 3.

Clays

By Brooke L. Gunsallus [1] and Eleanor V. Blankenbaker [2]

TOTAL CLAYS sold or used by producers in 1954 increased less than 1 percent in tonnage compared with 1953. Of the six major classifications of clay—china clay or kaolin, ball clay, fire clay, bentonite, fuller's earth, and miscellaneous clay—the output of ball clay, bentonite, and miscellaneous clay increased and all of the others decreased in 1954 from 1953.

TABLE 1.—Salient statistics of clays in the United States, 1953–54

	1953		1954	
	Short tons	Value	Short tons	Value
Domestic clays sold or used by producers:				
Kaolin or china clay	1,883,974	$27,092,181	1,873,000	$28,019,179
Ball clay	300,762	3,388,667	328,185	4,168,570
Fire clay, including stoneware clay	10,267,113	[1] 38,450,849	8,814,480	33,715,098
Bentonite	1,269,971	16,180,242	1,278,393	14,722,864
Fuller's earth	435,837	7,614,759	376,321	6,861,603
Miscellaneous clay	[1] 28,268,307	[1] 32,407,412	29,981,973	37,587,123
Total sold or used by producers	42,425,964	125,134,110	42,652,352	125,074,437
Imports:				
Kaolin or china clay	118,775	1,854,248	134,354	[2] 2,158,417
Common blue and Gross Almerode	[3] 25,822	[3] 296,803	[4] 25,557	[4] 272,214
Fuller's earth	222	2,573	(5)	(5)
Other clay	[3] 4,292	[3] 41,595	[6] 4,789	[6] 54,643
Total imports	149,111	2,195,219	164,700	2,485,274
Exports:				
Kaolin or china clay	43,590	795,043	49,199	946,027
Fire clay	90,897	919,928	77,913	815,059
Other clay (including fuller's earth)	167,901	5,315,867	200,602	6,581,849
Total exports	302,388	7,030,838	327,714	8,342,935

[1] Revised figure.
[2] Due to changes in tabulating procedures by the U. S. Department of Commerce, data known not to be comparable to earlier years.
[3] Common blue and Gross Almerode revised to include "Wrought or manufactured," formerly included with "Other clay."
[4] Common blue and ball clay, effective January 1, 1954. Gross Almerode not separately classified, included with "Other clay."
[5] Effective Jan. 1, 1954, not separately classified, included with "Other clay."
[6] Includes fuller's earth and Gross Almerode.

Ball-clay output increased 9 percent in tonnage and 23 percent in value; bentonite increased less than 1 percent in tonnage but decreased 9 percent in value; and miscellaneous clay sold or used by producers increased 6 percent in tonnage and 16 percent in value.

Kaolin output decreased 1 percent in tonnage but increased 3 percent in value; fuller's earth decreased 14 percent in tonnage and 10 percent in value; and fire clay decreased 14 percent in tonnage and 12 percent in value.

[1] Commodity-industry analyst.
[2] Literature research clerk.

The quantity of bentonite produced in 1954 was exceeded only in the banner year 1952. The tonnage increased less than 1 percent compared with 1953, whereas the value decreased 9 percent. The foundry and petroleum industries consumed 89 percent of the total tonnage in 1954 compared with 93 percent in 1953. Bentonite used for filtering and decolorizing oils increased 17 percent, whereas the tonnage used for foundry-sand bond decreased 15 percent and the tonnage used for rotary-drilling mud decreased 6 percent.

Fuller's earth sold or used by producers decreased 14 percent in tonnage in 1954 compared with 1953 and was the smallest production since 1949. In 1954 absorbent uses consumed 31 percent of the total, followed by mineral-oil refining, 23 percent; insecticides, 19 percent; rotary-drilling mud, 11 percent; and vegetable-oil refining, 5 percent.

Fire-clay tonnage sold or used by producers decreased 14 percent in 1954 compared with 1953, the smallest production since 1949.

Price quotations for most clay and clay products in 1954 as shown in most trade papers, remained steady.

Imports of kaolin for 1954 increased 13 percent from 1953 and were a little more than 7 percent of the total domestic consumption of kaolin.

Imports of ball clay (including common blue and Gross Almerode clays) in 1954 decreased 1 percent in tonnage and 8 percent in value.

Exports of kaolin or china clay in 1954 increased 13 percent over 1953; 81 percent was shipped to Canada. Exports of fire clay in 1954 decreased 14 percent in tonnage and 11 percent in value. Canada received 79 and Mexico 15 percent of the total exports.

CONSUMPTION AND USES

Heavy clay products (building brick, structural tile, sewer pipe, etc.) in 1954 consumed 3 percent more clay than in 1953 and comprised 55 percent of the total clay output compared with 54 percent in 1953, 53 percent in 1952, and 55 percent in 1951. Clays used in portland cement and other hydraulic cements in 1954 consumed 21 percent of the total clay output; refractories, 11 percent; rotary-drilling mud, 1 percent; paper filler and paper coating, 1 percent each; and filter and decolorizing oils and pottery, less than 1 percent each. In 1954 the tonnage of clay and shale used in producing lightweight aggregate almost entirely for use in concrete was compiled for the second time. This tonnage represented 4 percent of the total clay output compared with 3 percent in 1953. The remainder was consumed for a large number of miscellaneous purposes.

The total tonnage of clay consumed in 1954 increased less than 1 percent above 1953, and many branches of the clay industry showed decreases.

The increases for some of the more important branches were as follows: High-grade tile, 32 percent; portland and other hydraulic cements, 2 percent; heavy clay products, 3 percent; and paper filler, less than 1 percent. The clay used in the following branches of the industry showed decreases: Pottery, 11 percent; paper coating, 2 percent; rubber, 1 percent, refractories, 21 percent; and rotary-drilling mud, 21 percent.

TABLE 2.—Clay sold or used by producers in the United States in 1954, by kinds and uses, in short tons

Use	Kaolin	Ball clay	Fire clay and stoneware clay	Bentonite	Fuller's earth	Miscellaneous clay, including slip clay	Total
Pottery and stoneware:							
Whiteware, etc	111,827	209,995					321,822
Stoneware, including chemical stoneware	1,165	200	24,502				25,867
Art pottery and flower pots	4,496	8,623	9,985			52,197	75,301
Slip for glazing			218				218
Total	117,488	218,818	34,705			52,197	423,208
Tile, high-grade	30,373	43,536	143,288			86,607	303,804
Kiln furniture: Saggers, pins and stilts	3,896	10,815	12,823				27,534
Architectural terra cotta	1,050		22,581			10,025	33,656
Paper:							
Filler	438,143						438,143
Coating	550,611						550,611
Total	988,754						988,754
Rubber	247,431		8,781			224	256,436
Linoleum	34,193		7,330			4,000	45,523
Paints: Filler or extender	34,682			34		519	35,235
Portland and other hydraulic cements	33,216		1,361			8,764,852	8,799,429
Refractories:							
Firebrick and block	141,347	10,999	3,169,277			1,963	3,323,586
Bauxite, high-alumina brick			61,791				61,791
Fire-clay mortar	22,042	2,700	144,963			66	169,771
Clay crucibles	324		4,620				4,944
Glass refractories	19,705		60,705				80,410
Zinc retorts and condensers			19,650				19,650
Foundries and steelworks	2,452	400	623,480	294,732		12,674	933,738
Other refractories	743	11,370	90,636	657		8,478	111,884
Total	186,613	25,469	4,175,122	295,389		23,181	4,705,774
Heavy clay products: Building brick, paving brick, drain tile, sewer pipe, and kindred products	6,300	11,310	4,246,883			19,118,000	23,382,493
Miscellaneous:							
Rotary-drilling mud			227	548,300	42,435	44,062	635,024
Filtering and decolorizing oils (raw and activated earths)				155,602	[1] 102,605		258,207
Other filtering and clarifying				144,752	5,993		150,745
Artificial abrasives	160		1,545				1,705
Absorbent uses (oily floors, etc.)	1,994				116,504	9,483	127,981
Asbestos products	730						730
Chemicals	5,281		85,348	12,361		16,363	119,353
Enameling	972	3,292					4,264
Fertilizers	12,608				270	2,182	15,060
Filler (other than paper or paint)	13,248	10,700	400	4,705	17,029	2,017	48,099
Insecticides and fungicides	28,969		335	2,581	71,244	3,961	107,090
Plaster and plaster products	3,950			34			3,984
Concrete admixture, sealing dams, etc				12,460			12,460
Lightweight aggregates						1,548,550	1,548,550
Other uses	121,092	4,245	73,751	102,175	20,241	295,750	617,254
Total	189,004	18,237	161,606	982,970	376,321	1,922,368	3,650,506
Grand total:							
1954	1,873,000	328,185	8,814,480	1,278,393	376,321	29,981,973	42,652,352
1953	1,883,974	300,762	10,267,113	1,269,971	435,837	[2] 28,268,307	[2] 42,425,964

[1] Comprises the following: Mineral oils, 85,269 tons; vegetable oils, 17,336 tons.
[2] Revised figure.

CHINA CLAY OR KAOLIN

Although kaolin sold or used in 1954 decreased 1 percent in tonnage compared with 1953 it was the second largest output in the history of the industry, and the value exceed the previous high value of 1953 by 3 percent.

Nine States shipped kaolin in 1954, the same as in 1953. Georgia, the principal producing State, continued to hold its place in 1954, with 70 percent of the total United States output; South Carolina was second with 17 percent. Both Georgia and South Carolina in 1954 reported small decreases compared with 1953.

As has been the pattern for the previous several years, the paper, rubber, pottery, and refractories industries were the principal consumers. Paper consumed 53 percent of the total kaolin—23 percent for filling and 30 percent for coating. The rubber industry consumed 13 percent; refractories, 10 percent; and pottery, 6 percent. The remaining 18 percent was consumed for a wide variety of purposes, including cement, high-grade tile, fertilizers, chemicals, insecticides, paint filler or extender, and linoleum. Of the large consumers, paper and pottery showed small decreases and refractories and rubber small increases.

TABLE 3.—Kaolin sold or used by producers in the United States, 1953–54, by States

State	Sold by producers		Used by producers		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1953						
Alabama, Florida, and North Carolina	83,086	$1,506,788	27	$134	83,113	$1,506,922
California	(1)	(1)	(1)	(1)	29,296	410,428
Georgia	1,219,834	18,915,545	121,891	744,080	1,341,725	19,659,625
South Carolina	327,594	4,213,431			327,594	4,213,431
Other States [2]	128,566	1,701,193	2,976	11,010	102,246	1,301,775
Total	1,759,080	26,336,957	124,894	755,224	1,883,974	27,092,181
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

[1] Included with "Other States."
[2] Includes States indicated by footnote 1, and Arkansas (1954 only), Pennsylvania (1953–54), Utah (1953 only), and Virginia (1953 only).

No quotations were reported by E&MJ Metal and Mineral Markets on domestic kaolin in 1954. The last quotations, given in June 1951, were as follows: Georgia kaolin, for filler and ceramic grades, $8.50 to $9.50 per ton, depending upon grade for crushed material, and $13 to $17 for pulverized, in paper bags. North Carolina china clays, ceramic grades, in bulk, carlots, were quoted at $20.25 to $22.25 per ton. Florida kaolins were quoted by the same source at $18.75 per ton for purified and crushed; $24.75 for washed and air-floated clays; and $38.50 for air-floated enamel grade. Crude Pennsylvania kaolin was quoted at $5 to $7.50 per ton and "purified" kaolin at $21 to $24. These prices were the same as those quoted in December 1950 and are substantially the same as those for 1949.

The average value of domestic kaolin sold or used, as reported to the Bureau of Mines in 1954, was $14.96 per short ton compared with $14.38 in 1953, $13.78 in 1952, $13.57 in 1951, and $13.68 in 1950.

TABLE 4.—Georgia kaolin sold or used by producers, 1945–49 (average) and 1950–54, 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
1945–49 (average)	845,357	$10,902,265	$12.90	112,839	$609,865	$5.40	958,197	$11,512,130	$12.01
1950	1,087,174	16,533,582	15.21	133,481	806,946	6.05	1,220,655	17,340,528	14.21
1951	1,147,865	17,615,634	15.35	175,945	1,084,101	6.16	1,323,810	18,699,735	14.13
1952	1,145,063	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

[1] Data not available.

Prices for imported china clay in December 1954 were quoted by the Oil, Paint and Drug Reporter as follows: White lump, carlots, ex dock (Philadelphia, Pa., and Portland, Maine), $20 to $40 per long ton; powdered, ex dock, in bags, $50 per net ton; and powdered, l. c. l., ex warehouse, $60.

Imports of kaolin for 1954 increased 13 percent compared with 1953 and represented a little more than 7 percent of the total domestic consumption in 1954. Imports represented a little more than 6 percent in 1953 and a little less than 6 percent in 1952. Over 99 percent of the 1954 imports came from the United Kingdom and the remainder from Canada.

Exports of kaolin or china clay in 1954 increased 13 percent over 1953; 81 percent was shipped to Canada, 7 percent to Mexico, and 2 percent to West Germany. Small tonnages also were sent to Central and South America, Europe, and Japan.

BALL CLAY

Ball clay sold or used by producers in 1954 increased 9 percent in tonnage and 23 percent in value compared with 1953.

Beginning with 1943 Tennessee has been the largest producer. In 1954 Tennessee production was 59 percent of the United States total; Kentucky was second, with 29 percent; and Mississippi third, with 4 percent. Compared with 1953 ball-clay production in 1954 in Tennessee increased 17 percent, but in Kentucky production decreased 4 percent, and in Mississippi the decrease was 7 percent.

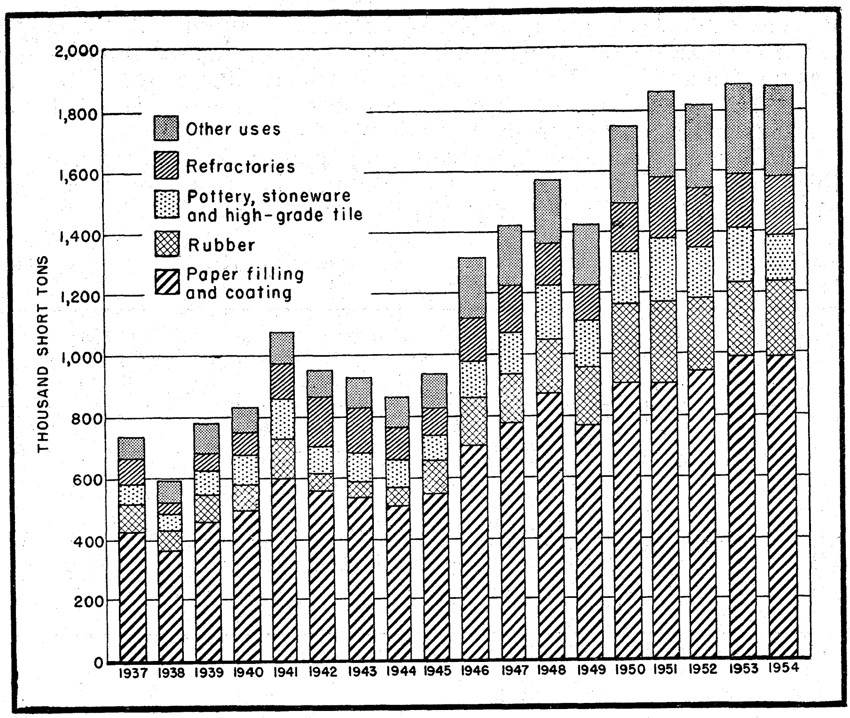

FIGURE 1.—Kaolin sold or used by domestic producers for specified uses, 1937–54.

The pottery industry consumed 67 percent of the ball-clay produced in 1954 compared with 73 percent in 1953 and 1952, and 78 percent in 1951. Ball clay used in making whiteware increased less than 1 percent. Other increases were: High-grade tile, 8 percent; refractories, 33 percent; and saggers, pins, and stilts, 120 percent. The following uses decreased: Fillers, 6 percent; art pottery, 8 percent; and stoneware, 58 percent.

Quotations on ball clay have not appeared in E&MJ Metal and Mineral Markets since 1949. In 1954 the average value per short ton for ball clay, as reported by producers, was $12.70, compared with $11.27 in 1953, $12.97 in 1952, $10.80 in 1951, and $12.27 in 1950. In 1954 the average value per short ton was: Tennessee ball clay, $12.84, compared with $12.52 in 1953, $12.98 in 1952, $9.18 in 1951; for Kentucky ball clay, $13.10, compared with $9.70 in 1953, $12.80 in 1952, and $12.69 in 1951.

Imports of common blue and ball clay and Gross Almerode clays in 1954 decreased 1 percent in tonnage and 8 percent in value compared with 1953. 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 1954, totaled 256 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, 1952–54, by States

State	Sold by producers		Used by producers		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1952						
Kentucky	107,211	$1,372,695			107,211	$1,372,695
Maryland, Mississippi, and New Jersey	34,010	455,989			34,010	455,989
Tennessee	163,862	2,127,274			163,862	2,127,274
Total	305,083	3,955,958			305,083	3,955,958
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

1 Maryland and Oregon combined to avoid disclosure of individual company operations.

FIRE CLAY

Fire clay sold or used in 1954 decreased 14 percent compared with 1953 and was the smallest since 1949. The decline was due to a slackening in the consumption of refractories in the steel and other industries that began in 1952 and continued through 1954. Consumption of fire clay in heavy clay products increased slightly. Of the principal fire-clay-producing States, only Pennsylvania reported an increased output compared with 1953.

The principal uses of fire clay in 1954 were for refractories manufacture, which consumed 47 percent of the national output, and heavy clay products, which consumed 48 percent. These 2 uses absorbed 95 percent of the 1954 tonnage compared with 96 percent in 1953, the same as in 1952, and 97 percent in 1951. In 1954 fire clay consumed for refractories decreased 22 percent and heavy clay products 6 percent compared with 1953. About 2 percent was consumed in manufacturing high-grade tile, a little less than 1 percent for chemicals, and the remainder in a wide variety of uses. For the first time in the history of the industry, as reported to the Bureau of Mines, heavy clay products consumed more tonnage than refractories, the former representing 48 percent and the latter 47 percent of the total output.

In 1954 Ohio ranked first in fire-clay output, followed by Pennsylvania, Missouri, California, Indiana, Texas, Arkansas, Illinois, West Virginia, Colorado, and Alabama. These 11 States supplied 92 percent of the total in 1954. The remainder was produced in 17 States. Of the 11 principal producing States, Pennsylvania was the only one that reported an increase. All the others registered decreases. Price quotations on fire clay do not appear in trade journals. However,

TABLE 6.—Fire clay, including stoneware clay, sold or used by producers in the United States, 1953–54, by States [1]

State	Sold by producers		Used by producers		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1953						
Alabama	149,510	$288,491	103,416	$438,948	252,926	$727,439
Arizona	----------	----------	540	1,485	540	1,485
Arkansas	(2)	(2)	(2)	(2)	331,252	1,524,865
California	161,975	431,071	290,765	1,175,029	452,740	1,606,100
Colorado	213,364	511,410	151,828	455,286	365,192	966,696
Illinois	215,132	[3] 1,144,577	103,375	221,526	318,507	[3] 1,366,103
Indiana	287,688	527,229	294,951	636,458	582,639	1,163,687
Kentucky	50,369	228,739	297,990	1,581,249	348,359	1,809,988
Maryland	8,149	26,393	[3] 145,790	[3] 389,838	[3] 153,939	[3] 416,231
Mississippi	(2)	(2)	(2)	(2)	43,850	74,209
Missouri	457,067	1,397,851	1,039,070	8,689,894	1,496,137	10,087,745
Montana	2,470	12,160	----------	----------	2,470	12,160
New Jersey	48,341	446,452	89,663	377,254	138,004	823,706
New Mexico	(2)	(2)	(2)	(2)	5,367	17,605
Ohio	802,219	2,203,621	2,005,824	3,976,014	2,808,043	6,179,635
Pennsylvania	247,837	941,928	[3] 1,422,616	[3] 6,879,193	[3] 1,670,453	[3] 7,821,121
South Carolina	(2)	(2)	(2)	(2)	15,208	44,075
Texas	594	2,548	355,617	913,027	356,211	915,575
Utah	11,262	26,444	24,308	69,020	35,570	95,464
Washington	6,209	10,471	67,479	113,691	73,688	124,162
West Virginia	(2)	(2)	(2)	(2)	677,005	2,213,376
Other States [4]	73,804	386,262	1,137,891	3,947,290	139,013	459,422
Total	2,735,990	8,585,647	7,531,123	29,865,202	10,267,113	38,450,849
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	674,817	206,025	814,697	381,392	1,489,514
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	79,071	371,980	140,103	831,835
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	(2)	(2)	(2)	(2)	78,187	129,902
West Virginia	(2)	(2)	(2)	(2)	290,256	1,171,495
Other States [4]	46,133	150,917	447,274	1,415,184	124,964	264,704
Total	2,723,506	8,193,186	6,090,974	25,521,912	8,814,480	33,715,098

[1] Includes stoneware clay as follows: 1953—67,628 tons, $175,574; 1954—34,705 tons, value not available.
[2] Included with "Other States."
[3] Revised figure.
[4] Includes States indicated by footnote 2, and Georgia (1953 only), Idaho, Iowa (1953 only), Kansas, Mississippi, Minnesota, Montana (1954 only), Nevada (1953 only), New York (1953 only), Oregon (1953 only), and Tennessee (1953 only).

the average value per short ton of fire clay sold by producers, as reported to the Bureau of Mines in 1954, was $3.01 compared with $2.90 in 1953, $3.46 in 1952, $3.22 in 1951, and $3.00 in 1950. The average value of all fire clay, including both sales and captive tonnage, was $3.82 in 1954, compared with $3.75 in 1953, $4.29 in 1952, $4.11 in 1951, and $3.04 in 1950. Quotations on fire brick manufactured from fire clay were reported in December 1954 in E&MJ Metal and

Mineral Markets (comparable 1953 prices in parentheses) as follows: Missouri, Kentucky, and Pennsylvania, superquality, $114 per thousand ($99.30); high-heat quality, $107 ($92.40); Ohio fire brick, intermediate grade, $107 ($92.40); second grade, $98 ($83.15) per thousand.

Imports of fire clay are not shown separately in foreign trade statistics. Exports of fire clay in 1954 decreased 14 percent in tonnage and 11 percent in value. Canada received 79 percent and Mexico 15 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 1954 was exceeded only in the record year 1952. The tonnage increased less than 1 percent compared with 1953, whereas the value decreased 9 percent.

The foundry and petroleum industries consumed 89 percent of the total tonnage in 1954, compared with 93 percent in 1953 and 94 percent each for 1952 and 1951. Rotary-drilling mud consumed 43 percent in 1954, compared with 46 percent in 1953, 50 percent in 1952, and 38 percent in 1951; filtering and decolorizing oils, 23 percent (20 percent in 1953, 21 percent in 1952, and 33 percent in 1951); and foundry-sand bond, 23 percent (27 percent in 1953 and 23 percent each for 1952 and 1951). The remaining 11 percent of the national output was used for a wide variety of purposes. Compared with 1953, the tonnage of bentonite used for filtering and decolorizing oils increased 17 percent, whereas the tonnage used for foundry-sand bond decreased 15 percent and the tonnage used for rotary-drilling mud decreased. Eleven States reported bentonite production in 1954, the same as in 1953.

The Wyoming-South Dakota district, in 1953, supplied 69 percent of the total bentonite production. In 1954 Wyoming furnished 58 percent of the total bentonite production, compared with 53 percent in 1953, 52 percent in 1952, and 38 percent in 1951. Mississippi accounted for 14 percent in 1954 (15 percent in 1953) and was included with "Other States" in previous years. Texas produced 8 percent in 1954, compared with 4 percent in 1953, 2 percent in 1952, and 3 percent in 1951; and Arizona 11 percent in 1954 (the same as in 1953) and was included with "Other States" in 1952. Trends in sales for principal uses are shown in figure 2.

The average value of bentonite per short ton, as reported by the producers to the Bureau of Mines in 1954 was $11.52 compared with $12.74 in 1953, $11.22 in 1952, $10.67 in 1951, and $8.79 in 1950. No price quotations on domestic bentonite were published in 1954.

Bentonite imported in 1954 comprised 141 short tons from Canada and 121 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.

TABLE 7.—Bentonite sold or used by producers in the United States, 1952–54, by States

State	1952		1953		1954	
	Short tons	Value	Short tons	Value	Short tons	Value
Arizona	(1)	(1)	134,850	$651,752	139,171	$728,326
California			(1)	(1)	3,348	90,004
Colorado			(1)	(1)	582	5,339
Mississippi	(1)	(1)	189,211	2,028,040	185,554	1,998,052
Montana	2,000	$24,000				
South Dakota	205,934	2,553,783	205,303	2,700,394	(1)	(1)
Texas	31,386	584,938	47,887	670,300	105,744	1,299,380
Utah	(1)	(1)	1,738	20,396	2,222	26,620
Wyoming	692,853	9,168,708	670,756	9,861,321	742,453	9,339,755
Other States [2]	385,806	2,459,519	20,226	248,039	99,319	1,235,388
Total	1,317,979	14,790,948	1,269,971	16,180,242	1,278,393	14,722,864

[1] Included with "Other States."
[2] Includes States indicated by footnote 1, and Alabama (1953 only), Louisiana (1952–54), Nevada (1952 only), North Dakota (1954 only), and Oklahoma (1952–54).

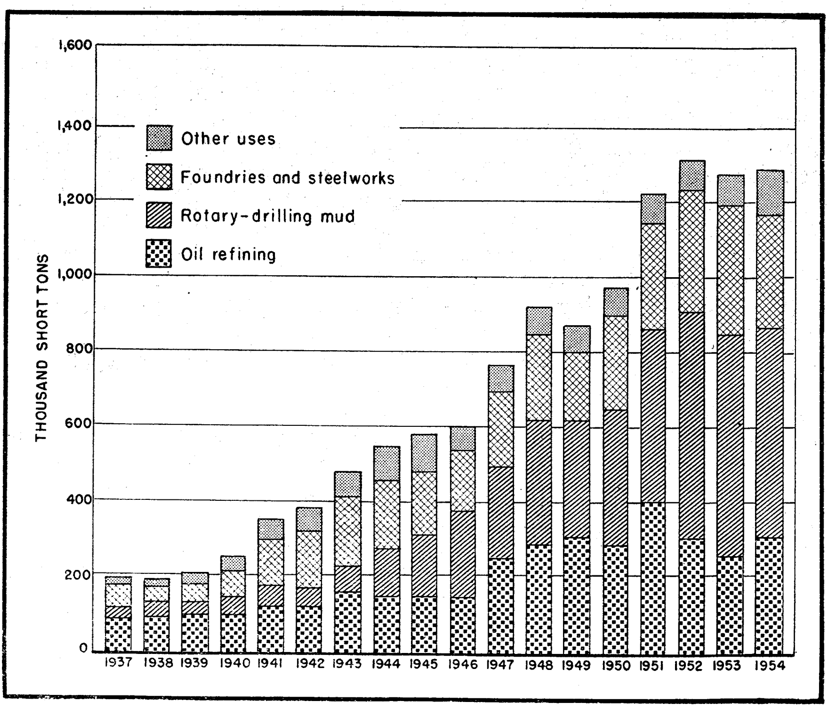

FIGURE 2.—Bentonite sold or used by domestic producers for specified uses, 1937–54.

FULLER'S EARTH

Fuller's earth sold or used in 1954 decreased 14 percent in tonnage compared with 1953.

Absorbent uses composed 31 percent of the national consumption in 1954, compared with 30 percent in 1953, 24 percent in 1952, 20 percent in 1951, and 21 percent in 1950. Mineral-oil refining was the second largest consumer in 1954, with 23 percent, compared with 29 percent in 1953, 32 percent in 1952, 36 percent in 1951, and 40 percent in 1950. This downward trend has resulted from changed methods of oil refining and marketing of a higher quality of fuller's earth.

In 1954 insecticides composed 19 percent of the national output, compared with 17 percent in 1953, 18 percent in 1952, 1951, and 1950; rotary-drilling mud 11 percent, compared with 12 percent in 1953, 15 percent in 1952, 16 percent in 1951, and 10 percent in 1950, and vegetable-oil refining 5 percent, 4 percent in 1953, 1952, and 1951, and 5 percent in 1950. The remainder was used in other filtering and clarifying, binders, and other unspecified uses.

The Florida-Georgia area, Tennessee, and Utah reported decreases and Mississippi an increase in 1954, compared with 1953. The Florida-Georgia area supplied 70 percent of the total tonnage produced in 1954, compared with 62 percent in 1953, 64 percent in 1952, and 62 percent in 1951. Production in Texas in 1954 cannot be disclosed without revealing individual company figures. In 1953 fuller's earth production in Texas represented 24 percent of the total United States production, 25 percent in 1952, and 29 percent in 1951.

The average value per short ton of fuller's earth reported as sold or used in the United States in 1954 was $18.23 compared with $17.47 in 1953, $16.26 in 1952, $16.81 in 1951, and $16.42 in 1950. Quotations on fuller's earth were last listed in E&MJ Metal and Mineral Markets in 1951.

Effective January 1, 1954, fuller's earth imports 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 12,000 short tons in 1954 compared with 18,000 in 1953, 26,000 in 1952, 35,000 in 1951, and 16,400 in 1950. Destinations reported included North, Central, and South America, Europe, and Asia.

TABLE 8.—Fuller's earth sold or used by producers in the United States, 1952–54, by States

State	1952		1953		1954	
	Short tons	Value	Short tons	Value	Short tons	Value
California and Nevada	(1)	(1)	10,286	$240,587	(1)	(1)
Florida and Georgia	270,261	$4,829,552	271,187	5,093,501	263,571	$5,244,591
Mississippi	(1)	(1)	12,472	523,044	13,920	512,256
Tennessee	25,974	358,752	30,961	427,933	27,532	449,480
Texas	105,565	1,030,005	106,437	1,277,670	(1)	(1)
Utah	(1)	(1)	4,494	52,024	2,801	35,400
Other States [2]	21,053	657,174			68,497	619,876
Total	422,853	6,875,483	435,837	7,614,759	376,321	6,861,603

[1] Included with "Other States."
[2] Includes States indicated by footnote 1, California (1952 and 1954 only), and Nevada (1952 only).

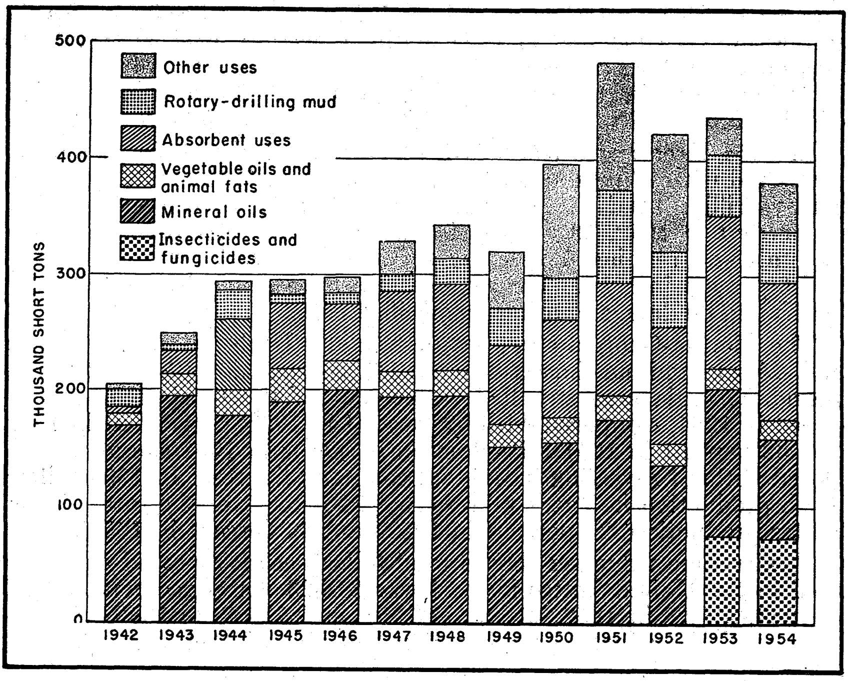

FIGURE 3.—Fuller's earth sold or used by producers for specified uses, 1942–54.

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.

Miscellaneous clay sold or used by producers increased 6 percent compared with 1953. As cement production reached an alltime high in 1954, clay used in cement production reached a corresponding alltime high. Miscellaneous clay consumed in the manufacture of heavy clay products increased 5 percent in 1954 compared with 1953. In 1954, 64 percent of the total miscellaneous clay was used in manufacturing heavy clay products and 29 percent in cement. The former percentage was 1 percent more than 1953, but the latter lost 1 percent (30 percent in 1953). 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 98 percent of the miscellaneous clay sold or used in 1954. The quantity of miscellaneous clay used in producing lightweight aggregate for concrete mixtures was shown for the second time in 1954 and composed 5 percent of the total compared with 4 percent in 1953. The average reported value of miscellaneous clay sold as crude or prepared clay in 1954 was $1.66, compared with $1.91 in 1953, $2.31 in 1952, and $2.05 in 1951.

TABLE 9.—Miscellaneous clay, including shale and slip clay sold or used by producers in the United States, 1953–54, by States

State	Sold by producers [1]		Used by producers [2]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1953						
Alabama			927,872	$922,341	927,872	$922,341
Arizona			62,011	62,011	62,011	62,011
Arkansas			197,874	209,549	197,874	209,549
California	158,665	$446,497	1,776,803	2,119,903	1,935,468	2,566,400
Colorado	47,281	81,905	364,158	374,035	411,439	455,940
Connecticut			438,200	448,260	438,200	448,260
Georgia	(3)	(3)	(3)	(3)	1,163,766	1,076,891
Idaho			20,643	10,932	20,643	10,932
Illinois	37,818	44,525	1,948,877	3,162,373	1,986,695	3,206,898
Indiana	98,394	184,324	973,079	1,166,216	1,071,473	1,350,540
Iowa	7,396	51,953	876,887	[4] 888,423	884,283	[4] 940,376
Kansas			606,583	621,357	606,583	621,357
Kentucky	(3)	(3)	(3)	(3)	262,368	333,727
Louisiana	(3)	(3)	(3)	(3)	614,427	901,612
Maine			29,661	27,476	29,661	27,476
Maryland	(3)	(3)	(3)	(3)	498,143	600,899
Massachusetts	(3)	(3)	(3)	(3)	152,117	[4] 195,837
Michigan	422,017	462,326	1,223,787	1,223,787	1,645,804	1,686,113
Minnesota	(3)	(3)	(3)	(3)	73,330	79,152
Mississippi			299,601	315,829	299,601	315,829
Missouri	104,591	582,888	630,868	511,463	735,459	1,094,351
Montana	350	500	34,174	25,652	34,524	26,152
Nebraska			175,856	186,893	175,856	186,893
New Hampshire			45,198	41,427	45,198	41,427
New Jersey	6,682	4,852	387,499	497,739	394,181	502,591
New Mexico	1,300	10,400	42,422	75,926	43,722	86,326
New York	90,257	144,641	869,609	1,149,390	959,866	1,294,031
North Carolina	100	120	1,419,139	1,647,726	1,419,239	1,647,846
North Dakota	(3)	(3)	(3)	(3)	23,084	47,862
Ohio	102,700	128,373	2,723,853	3,019,698	2,826,553	3,148,071
Oklahoma			571,269	576,466	571,269	576,466
Oregon			291,925	293,770	291,925	293,770
Pennsylvania	32,688	51,235	1,839,454	1,935,702	1,872,142	1,986,937
South Carolina			621,554	544,415	621,554	544,415
South Dakota	(3)	(3)	(3)	(3)	125,680	125,680
Tennessee	1,650	17,086	822,945	775,163	824,595	792,249
Texas			1,860,440	1,815,429	1,860,440	1,815,429
Utah	752	3,008	[4] 79,240	[4] 200,718	[4] 79,992	[4] 203,726
Virginia			949,266	881,571	949,266	881,571
Washington	(3)	(3)	(3)	(3)	185,733	187,979
West Virginia			291,833	275,562	291,833	275,562
Wisconsin	58,305	58,305	117,006	116,971	175,311	175,276
Wyoming			181,895	175,406	181,895	175,406
Undistributed [5]	334,000	599,726	3,061,880	[4] 3,235,169	297,232	285,256
Total	1,504,946	2,872,664	[4] 26,763,361	[4] 29,534,748	[4] 28,268,307	[4] 32,407,412
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	3,648,132	2,302,473	4,140,274
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)	843,540	1,070,540
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

See footnotes at end of table.

TABLE 9.—Miscellaneous clay, including shale and slip clay sold or used by producers in the United States, 1953–54, by States—Continued

State	Sold by producers [1]		Used by producers [2]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1954—Continued						
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	5,113,877	6,101,417	160,961	147,361
Total	2,503,316	4,163,872	28,066,969	34,011,563	29,981,973	37,587,123

[1] Purchases by portland-cement companies of common clay and shale: 1953—734,706 tons, estimated at $733,725; 1954—1,251,753 tons, estimated at $1,256,937.
[2] Includes the following: Common clay and shale used by portland-cement companies: 1953—7,805,275 tons, estimated at $7,659,662; 1954—7,220,861 tons, estimated at $6,974,452.
[3] Included with "Undistributed."
[4] Revised figure.
[5] Figures include Alaska (1954 only), Delaware (1953–54), District of Columbia (1953 only), Florida (1953 only), Hawaii (1953–54), Nevada (1953 only), Puerto Rico (1953–54), Vermont (1953–54), and States indicated by footnote 3.

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 ton.

Shales and the so-called common surface clays are included in the miscellaneous clay classification. Production was reported from all States except Rhode Island in 1954. Only Ohio and California reported tonnages exceeding 2 million short tons. States reporting over 1 million and less than 2 million tons sold or used by producers were, in decreasing order of output: Texas, Michigan, North Carolina, Illinois, Pennsylvania, Indiana, Georgia, New York, and Alabama. Of the States for which data are shown in table 9 for both 1953 and 1954, 28 reported increases and 15 decreases in output in 1954.

HEAVY CLAY PRODUCTS

In 1954 structural clay products increased 7 percent in value of shipments compared with 1953, according to data compiled by the United States Department of Commerce, renewing an upward trend noted in 1950 and 1951, which was broken in 1952. The quantity of clay consumed in producing structural clay products increased 5 percent in 1954. The largest percentage of increase in the value of shipments (9 percent) was in unglazed brick, the principal clay-construction product. The value of shipments of vitrified-clay sewer pipe and glazed and unglazed floor and wall tile each increased 6 percent compared with 1953. Hollow facing tile increased 3 percent.

TABLE 10.—Shipments of principal structural clay products in the United States, 1952–54 [1]

Product and unit quantity	1952		1953		1954	
	Quantity	Value (thousand dollars)	Quantity	Value (thousand dollars)	Quantity	Value (thousand dollars)
Unglazed brick (building) M stand. brick	5,642,239	154,881	5,771,211	162,752	6,119,395	177,539
Unglazed structural tile short tons	993,910	11,435	921,985	11,524	895,284	11,433
Vitrified clay sewer pipe do	1,548,109	59,161	1,562,986	61,117	1,636,503	64,591
Drain tile do	815,490	14,073	793,785	14,223	(2)	(2)
Hollow facing tile, glazed and unglazed M brick equiv	389,376	22,104	444,294	26,304	444,069	27,221
Glazed and unglazed floor and wall tile and accessories, including quarry tile M square feet	123,267	64,146	134,375	71,569	139,515	75,932

[1] Compiled from information furnished by the Bureau of the Census, U. S. Department of Commerce.
[2] Data not available.

Because the value of clay refractories shipments in 1954 was not available when this chapter was prepared, a table corresponding to table 11 of the Minerals Yearbook 1953, Production and shipments of refractories in the United States, by kinds, 1953–54, is omitted. The 1954 data will be given in the 1955 Minerals Yearbook.

TECHNOLOGY

The comprehensive research program begun in 1953 at the University of Toledo, Ohio, by the Expanded Shale Institute, Washington, D. C., made progress and was continued in 1954. This research project dealt with the correlation of structural properties of concrete using lightweight aggregate produced from expanded shale and clay. In 1954 an additional program to study the plastic flow of several concretes using expanded shale aggregates was initiated at Kansas State College, Manhattan, Kans. A study of the performance of expanded shale concrete after 34 years' exposure to sea water was completed, and the data were published. During 1954 this institute also surveyed bridges built in the United States and Canada, using expanded shale concrete for the floor and the bridge structure proper.[3]

The Expanded Clay and Shale Association was organized in January 1954 with 12 active members, using exclusively the sintering machine method of producing lightweight aggregate from clay or shale.[4]

A lightweight-aggregate plant designed to produce about 350 cubic yards daily from clay was built at Brooklyn, Ind.[5]

A plant with a daily capacity of 750 cubic yards of lightweight aggregates produced from clay began production at Memphis, Tenn., using a traveling-grate sintering machine.[6]

A plant producing about 600 cubic yards of lightweight aggregate from clay was placed in operation near Detroit, Mich. The sintering-machine method was used.[7]

[3] Expanded Shale Institute, letter to the Bureau of Mines, Feb. 16, 1955.
[4] Rock Products, vol. 57, No. 12, December 1954, p. 130.
[5] Brick and Clay Record, vol. 125, No. 5, November 1954, p. 32.
[6] Brick and Clay Record, vol. 124, No. 3, March 1954, p. 33.
[7] Brick and Clay Record, vol. 124, No. 2, February 1954, pp. 51–53.

A lightweight clay-aggregate block faced with a ceramic glaze was produced at Wichita, Kans. The ware was fired in a tunnel kiln at a maximum temperature of 1,200° F.[8]

Face brick, lightweight aggregate from sintered clay, and concrete block are produced in adjoining plants under the same management at Roanoke, Va., by the Roanoke Webster Co. This is a good example of a highly integrated operation.[9]

A new lightweight, all-ceramic building block that has many advantages over common cement block was developed by the Armour Research Foundation of Illinois Institute of Technology, Chicago, Ill. The block is composed of about 90 percent bloated clay bonded with plastic clay. After forming, the block is dried and fired in a kiln.[10]

New clay preparatory and production facilities, to cost about $1 million, was built by the Natco Corp. at its Canton, Ohio, plant. These plant improvements will increase potential production capacity 50 percent.[11]

Experiences in manufacturing Roman brick at Mineral Wells Clay Products, Mineral Wells, Tex., were outlined, covering machine room, drier operation, setting in kilns, firing, and cooling, and handling in the yard. Comparative costs installed in the wall of this type of brick with other types were explained.[12]

The Refractories Institute, Pittsburgh, Pa., published in 1954 a Product Directory of the Refractory Industry. This publication lists in convenient form the names and addresses of manufacturers of refractories in the United States, the location of plants, the product divisions, and the brand or trade names under which the products are sold.

Laboratory and commercial procedures developed for evaluating an electrically melted and cast basic refractory were described. Uses for this refractory were suggested.[13]

Glass-tank conditions, such as the presence of alkalies, operating pressures, temperatures, and gas velocities bearing on the choice of refractories, were discussed. Special refractories tailored to meet existing conditions were reported to lengthen furnace life and increase furnace output.[14]

Applications of cast monolithic refractories to liners, regenerators, reactors, cyclones, and stacks in fluid catalytic cracking refineries were described. A brief description of the fluid catalytic cracking process also was included to indicate how refractory mixes are selected to meet various conditions of service.[15]

Cast refractories and where to use them to the best advantage were discussed. This type of refractories was said to be most suitable in auxiliaries to large units and smaller furnace structures. Primary interest in cast refractories is due to their convenience and ease of

[8] Brick and Clay Record, vol. 125, No. 4, April 1954, pp. 62–63, 102.
[9] Brick and Clay Record, vol. 124, No. 5, May 1954, pp. 35–38, 71.
[10] Brick and Clay Record, vol. 124, No. 3, March 1954, pp. 39, 111.
[11] American Metal Market. vol. 61, No. 191, October 1954, p. 3.
[12] Brewer, R. C., Manufacture of Roman Brick: Bull. Am. Ceram. Soc., vol. 33, No. 4. April 1954, pp. 117–119.
[13] Hand, Thomas, and Baque, H. W., An Electrically Melted and Cast Magnesite-Chrome Refractory: Bull. Am. Ceram. Soc., vol. 33, No. 6, June 1954, pp. 176–179.
[14] Knauft, R. W., Use of Special Refractories in Superstructure and Feeder: Brick and Clay Record, vol. 125, No. 1, July 1954, pp. 71–73; No. 2, August 1954, pp. 69, 83.
[15] Paul, W. B., Jr., Monolithic Refractories in Fluid Catalytic Cracking Refinery Units: Bull. Am. Ceram. Soc., vol. 33, No. 4, April 1954, pp. 108–110.

installation. Other advantages include resistance to thermal shock, low permeability, and abrasion resistance.[16]

The ability of glass-tank regenerator checkers to withstand the treatment imposed upon them was discussed. Many types and classes of refractories are available which fulfill the requirements economically. Various checker sizes and constructions are used successfully.[17]

During the five years 1949–54 the Harbison-Walker Refractories Co. has been engaged in the greatest program of modernization and new construction in its history (1865–1954). This company and its subsidiaries operated 33 plants in 12 States and in Canada, producing all types of refractories.[18]

A silica-brick plant was being built at Leslie, Md., by the Harbison-Walker Refractories Co. The plant will cost about $3 million and will be the only one of its kind in Maryland. It was announced that the latest laboratory and pilot-plant developments will be put into commercial practice in constructing this plant.[19]

To keep pace with the rapid growth of the Nation's industrial economy, the General Refractories Co. completed 3 plants—1 each in California, Ohio, and Pennsylvania. In 1954 this company operated 25 plants in 10 States and raw-material deposits in 13 States. It also had producing subsidiaries in continental Europe.[20]

The North American Refractories Co. instituted a company-wide remodeling program of its plants in several States. Modernization at the Curwensville, Pa., plant was completed in 1954.[21]

The A. P. Green Fire Brick Co. purchased the Thermo Fire Brick Co. of Sulphur Springs, Tex., a producer of refractories for over 30 years.[22]

The purchase of the Niles Fire Brick Co. of Warren, Ohio, a 75-year-old concern, has been announced by the Mexico Fire Brick Co. of Mexico, Mo. This company then owned and operated plants in Missouri, Pennsylvania, Ohio, Maryland, and Canada.[23]

The H. K. Porter Co., Inc., of Pittsburgh, Pa., has acquired the six plants of the McLain Fire Brick Co. in Ohio and Pennsylvania. This company was said to be the largest producer of pouring-pit refractories in the United States.[24]

The proper selection of refractories to meet the demands of specific conditions was discussed.[25]

The National Clay Pipe Manufacturers, Inc., continued active research in 1954 that began in 1952 in developing longer clay-pipe sections and stronger pipe. Research also was conducted on new jointing techniques, including "tubular joints" that employ the hydraulic principle for use on pipe of 8-inch and larger diameters and development of new jointing techniques of clay-pipe house-connection

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[16] Hart, H. G., Castable Refractories: Iron Age, vol. 174, No. 27, December 1954, pp. 77–79.
[17] Ceramic Industry, vol. 63, No. 5, November 1954, pp. 53–55, 97.
[18] Garber, E. A., Interview on Refractories: Brick and Clay Record, vol. 125, No. 5, November 1954, pp. 75–78.
[19] Brick and Clay Record, vol. 124, No. 5, May 1954, p. 25.
[20] Greene, L. Y., Interview on Refractories: Brick and Clay Record, vol. 125, No. 6, December 1954, pp. 58–61.
[21] Brick and Clay Record, vol. 124, No. 5, May 1954, pp. 57–60.
[22] Brick and Clay Record, vol. 124, No. 4, April 1954, p. 29.
[23] Brick and Clay Record, vol. 126, No. 1, January 1955, p. 33.
[24] Ceramic Age, vol. 63, No. 3, March 1954, p. 9. Brick and Clay Record, vol. 124, No. 3, March 1954 p. 27.
[25] Fabianic, W. L., Use Right Refractories for Greater Efficiency: Brick and Clay Record, vol. 124, No. 5, May 1954, pp. 66–69, 73.

drains, including the use of new plastic polyesters and plastisols. All these joints use the mechanical compression principle and were claimed to be rootproof. In 1954 hydraulic research was continued to develop additional data on fluidflow characteristics.[26]

The Structural Clay Products Research Foundation, Chicago, Ill., in 1954 continued to concentrate on developing improved job-site techniques and more convenient unit sizes and shapes for the structural-clay-products industry. Research also continued for further reduction of in-the-wall costs of clay masonry.

The trend toward increased plant modernization and improved manufacturing methods in the structural-clay-products industry that was apparent in 1951 continued through 1954.[27]

The use of space heaters in plants producing ceramic products was explained.[28]

Kilgore Ceramics Corp. of Kilgore, Tex., approved an expansion program that may double the size of the 1954 manufacturing facilities.[29]

Lenox, Inc., built a new plant at Pomona, 14 miles from Atlantic City, N. J., said to have cost over $3 million. It was designed to operate on one level to take advantage of improved techniques in materials handling, efficient production flow, and modern procedures.[30]

A pottery plant was built in Athens, Tex., in 1954. A large part of the clay used came from local deposits.[31]

A plant to produce clay products in Anchorage, Alaska, was built and placed in operation in 1954. Structural clay products were produced from shale and refractories from fire clay.[32]

The modern plant of the Crane-Pacific Co., producer of sanitary ware at Colton, Calif., was further modernized to take advantage of new improvements in machinery and equipment in the designing and engineering of automatic equipment to meet specific conditions.[33]

The effects on clay of nonionic, anionic, and cationic surface-active agents on yield point, plasticity, drying and firing shrinkage, dry and fired density, and rate of drying were experimentally determined. These and other factors were correlated on the basis of a comprehensive theory of the plastic properties and drying behavior of clay-water masses.[34]

The dispersion of 1-percent kaolin suspensions in water was studied, utilizing ultrasonic vibrational energy. The effects of two accepted methods of dispersion were compared with the ultrasonic method.[35]

The evaluation of brittle refractory materials calls for special techniques that differ from those normally used for ductile materials.

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[26] National Clay Pipe Manufacturers, Inc., letter to Bureau of Mines, May 5, 1955.

[27] Brick and Clay Record, vol. 124, No. 1, January 1954, pp. 33, 41, 45; vol. 124, No. 2, February 1954, pp. 28, 39, 55, 59; vol. 124, No. 3, March 1954, pp. 42, 66; vol. 124, No. 4, April 1954, pp. 32, 33, 43–46, 48, 80–81, 111–112, 114; vol. 124, No. 5, May 1954, p. 31; vol. 124, No. 6, June 1954, pp. 36, 64–66, 81–84, 94–95; vol. 125, No. 1, July 1954, pp. 48–51, 63–64; vol. 125, No. 2, August 1954, pp. 33, 42–47, 50–52, 63–64, 77; vol. 125, No. 3, September 1954, pp. 61–63, 79–80; vol. 125, No. 4, October 1954, pp. 30–31, 33, 42–47, 50–53, 78–85, 90–91, 93; vol. 125, No. 5, November 1954, pp. 27, 44–49, 51, 64–65, 68–69, 85, 87; vol. 125, No. 6, December 1954, pp. 20, 22, 23, 52–53. Ceramic Age, vol. 63, No. 5, May 1954, p. 7.

[28] Coupe, G. H., Drying Ceramics With Space Heaters: Bull. Am. Ceram. Soc., vol. 33, No. 9, September 1954, p. 277.

[29] Ceramic Industry, vol. 63, No. 3, September 1954, p. 45.

[30] Ceramic Age, vol. 63, No. 6, June 1954, p. 11.

[31] Ceramic Industry, vol. 62, No. 3, March 1954, p. 48.

[32] Western Industry, vol. 19, No. 4, April 1954, p. 99.

[33] Ceramic Industry, vol. 63, No. 5, November 1954, pp. 76–78, 103–104.

[34] Kingery, W. D., and Francl, J., Fundamental Study of Clay: XIII, Drying Behavior, and Plastic Properties: Jour. Am. Ceram. Soc., vol. 37, No. 12, December 1954, pp. 596–602.

[35] Crowley, M. S., and Welch, A. P., Clay-Particle Dispersion of Ultrasons: Jour. Am. Ceram. Soc., vol. 37, No. 9, September 1954, pp. 433–439.

A convenient and accurate method was developed to determine the stress rupture and creep properties of brittle refractory materials at temperatures as high as 2,000° F.[36]

A detailed account was given of flame-spraying, which is a spectacular operation still in the research phase, in which powdered refractories can be momentarily liquefied and sprayed on metal surfaces, using a specially designed spray gun. A temperature of about 5,500° F. was said to be generated in the nozzle flame.[37]

Many phases of permeability were discussed. The permeability of kaolinite was found to decrease markedly as the polarity of the permeating fluid increased. Variation of permeability with void ratio was found to disagree with the Kozeny-Carman equation. However, the specific surface area of the clay, as calculated from this equation, was found to be a linear function of void ratio for all permeant fluids for a void ratio greater than unity.[38]

Increased interest was shown by structural-clay-product manufacturers in using low-cost additives, such as certain types of feldspar, nepheline syenite, and aplite. These materials are added after the clay has been screened. It was said that physical working properties of clays and shales are improved and the maturing temperature decreased by the addition of any one of these materials.[39]

A detailed description of the method used in producing vitrified-bond grinding wheels by firing a fusible mixture of ceramic bonding material with abrasive grains was given. Bond compositions generally contain one or more clays, for example, ball clay and kaolin; refractory material such as flint; and a flux such as feldspar.[40]

The importance of the climatological influence on architectural design has been recognized in every age, and the application of clay products in warm climates was discussed.[41]

Physical tests of many clays from several sections of the United States were made to evaluate their potential use in manufacturing structural clay products. The procedure and equipment were described.[42]

The application and operation of different types of crushing and grinding equipment to reduce clay to a fineness suitable for further treatment were discussed.[43]

Gladding, McBean & Co. awarded a contract for construction of a $750,000 clay-beneficiation plant at Ione, Calif. The plant will be operated in conjunction with the sand-separation plant of the Owens-Illinois Glass Co.[44]

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36 Gangler, J. J., High-Temperature Testing Techniques for Brittle Refractory Materials: Jour. Am. Ceram. Soc., vol. 37, No. 9, September 1954, pp. 439–444.
37 Steel, vol. 134, No. 17, April 1954, p. 106.
Science News Letter, vol. 65, No. 9, February 1954, p. 133.
38 Michaels, A. S., and Lin, C. S., Permeability of Kaolinite: Ind. Eng. Chem., vol. 46, No. 6, June 1954, pp. 1239–1246.
39 Brick and Clay Record, vol. 125, No. 5, November 1954, pp. 58, 85.
40 Levine S., Manufacture of Vitrified-Bond Grinding Wheels by Dry-Press Process: Ceram. Age, vol. 64, No. 5, November 1954, pp. 13–16; vol. 64, No. 6, December 1954, pp. 19–22.
41 Demarest, W. G., and Grimm, C. T. A Technical Study: Application of Clay Products in Warm Climates: Brick and Clay Record, vol. 125, No. 5, November 1954, pp. 39–43.
42 Garve, T. W., Clay Testing of Structural Clay Materials: Bull. Am. Ceram. Soc., vol. 33, No. 3, March 1954, pp. 75–78.
43 Hendryx, D. B., Control and Segregation in Dry Grinding: Brick and Clay Record, vol. 124, No. 1, January 1954, pp. 45, 46, 89, 107.
44 Mining World, vol. 16, No. 12, November 1954, p. 98.
Mining and Contracting Review, vol. 56, No. 9, September 1954, p.14.

The Battelle Memorial Institute purchased 397 acres of land near Columbus, Ohio, to be used in its expansion program. This institution has had an almost continuous expansion program since 1935.[45]

The Attapulgus Minerals & Chemical Corp., the largest producer of fuller's earth in the United States, and Edgar Bros. Co., one of the largest and oldest producers of kaolin, agreed on a merger, to be known as the American Minerals & Chemical Corp.[46]

The use of drilling fluids and their composition and application in the drilling-fluid system, one of the principal aspects of rotary drilling for oil and gas, was discussed. Bentonite is the main constituent tonnagewise of most drilling fluids (drilling mud).[47]

The processing of ball clay to obtain the characteristics desired in the finished slip for sanitary ware was discussed. Handling of the raw ball clays as received, variation of moisture, soluble salts, grain size, and storage effects were considered.[48]

Dragon Consolidated Mining Co., Utah, halloysite-clay producer, was said to have produced this mineral at the rate of 6,000 to 8,000 tons per month in 1954. For several years this company had had an agreement with Filtrol Corp., which received the output of the Dragon mine at its processing plant at Salt Lake City, Utah.[49]

A study of the Tuscaloosa kaolins of Georgia, which are used as fillers, coatings, refractories, and whiteware, was discussed. The geology, mineralogy, prospecting methods, and dry and wet processing were described. Specifications for the various uses and the relationship between production costs and selling price were discussed.[50]

The discovery of a large deposit of kaolin near Sandersville, Ga., prompted building of a new mill to process mine production from this deposit.[51]

WORLD REVIEW

A world table on clay production by countries is not available. The following published items pertain to clay deposits, production, and processing from several countries:

Algeria.—Production of fuller's earth [52] totaled 78,464 short tons in 1953, compared with 82,097 tons in 1952. The details of fuller's earth exports for 1952 and 1953 are shown in table 11.

Austria.—Production of bentonite (fuller's earth) totaled 3,851 short tons in 1954, compared with 1,892 tons in 1953. Imports for 1953 and 1954 are shown in table 12.

Exports of bentonite from Austria in 1953 totaled only 73 short tons, valued at S. 41,000. In 1954 exports totaled 649 tons valued at S. 372,000, of which 293 tons valued at S. 167,000 went to West Germany, 268 tons valued at S. 152,000 to Switzerland, and the remainder to other countries.[53]

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[45] Ceramic Age, vol. 63, No. 6, June 1954, p. 121.
[46] Ceramic Age, vol. 63, No. 3, March 1954, p. 9.
[47] Lacabanne, W. D., Rotary-Drilling Fluids in Exploration Drilling: Min. Eng., vol. 6, No. 12, December 1954, pp. 1174–1177.
[48] Ewing, R. F., Ball-Clay Control for Sanitary Slip: Bull. Am. Ceram. Soc., vol. 33, No. 6, June 1954, p. 180.
[49] Mining World, vol. 16, No. 11, October 1954, p. 86.
[50] Burgess, Blandford C., Tuscaloosa Kaolins of Georgia: Jour. Am. Ceram. Soc., vol. 37, No. 5, May 1, 1954, p. 98.
[51] Ceramic Industry, vol. 63, No. 5, November 1954, p. 47.
[52] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 6, June 1954, p. 42.
[53] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 3, September 1955, p. 39–40.

TABLE 11.—Exports of fuller's earth from Algeria, 1952–53, by countries of destinations, in short tons

Country of destination	1952	1953	Country of destination	1952	1953
France	37,605	38,233	Belgium-Luxembourg		198
French Union	4,936	1,688	Morocco		3,096
United Kingdom	1,146	584	French West Africa		22
Germany, West		66	Total	43,687	43,887

TABLE 12.—Imports of bentonite into Austria, 1953–54, by countries of origin, in short tons

Country of origin	1953		1954	
	Short tons	Value 1,000 S.[1]	Short tons	Value 1,000 S.[1]
Algeria			11	22
Czechoslovakia	126	224	182	335
Germany, West	464	878	478	960
Hungary	16	18	33	33
Italy	214	195	95	62
Total	820	1,315	799	1,412

[1] 26 schillings equals US$1.

Production of clay of unstated types totaled 82,915 short tons in 1954, compared with 72,521 tons in 1953. Kaolin production totaled 265,849 tons in 1954, compared with 216,992 tons in 1953. Imports and exports of kaolin for 1953 and 1954 are shown in tables 13 and 14, as compiled by the Statistik des Aussenhandel Osterreichs.

TABLE 13.—Imports of kaolin into Austria, 1953–54, by countries of origin

Country of origin	1953		1954	
	Short tons	Value 1,000 S.[1]	Short tons	Value 1,000 S.[1]
Czechoslovakia	1,104	1,211	904	856
Germany:				
East			66	38
West	29	23	269	254
Greece	24	19		
Italy			23	12
United Kingdom	40	35	50	40
United States	11	34	18	45
Yugoslavia			58	14
Other countries			5	17
Total	1,208	1,322	1,393	1,276

[1] 26 schillings equals US$1.

Canada.—The following information on clay, clay products, and foreign trade was abstracted from a report by the Canadian Department of Mines and Technical Surveys.[54] Detailed statistics from the report are given in table 15:

Clay products of all kinds made from both domestic and imported clays reached a value of $47,654,243 in 1954 compared with $44,649,679 in 1953. Structural clay products manufactured in Canada from both domestic and imported clays increased from $24,224,704 in 1953 to $26,407,203 during 1954 owing to continued

[54] Phillips, J. G., Clay and Clay Products in Canada, 1954 (Preliminary): Dept. of Mines and Tech. Surveys, Ottawa, Canada, 5 pp.

expansion of housing programs and to increased Government and industrial construction. Most of the increase occurred in the value of structural clay products made from domestic miscellaneous clays.

Imports of clay in 1954, about half of which was china clay or kaolin, were valued at $3,205,214 compared to $3,083,380 in 1953.

TABLE 14.—Exports of kaolin from Austria, 1953–54, by countries of destination

Country of destination	1953		1954	
	Short tons	Value 1,000 S.[1]	Short tons	Value 1,000 S.[1]
Germany, West	4,559	2,666	8,341	4,690
Italy	6,776	3,182	7,479	3,779
Netherlands			121	55
Poland	680	756	661	764
Switzerland	4,495	2,176	3,792	1,824
Yugoslavia	159	91	529	264
Other countries	23	18		
Total	16,692	8,889	20,923	11,376

[1] 26 schillings equals US$1.

TABLE 15.—Clay production, products, and trade, Canada, 1953–54

	1953	1954
Production from domestic clays:		
Clays, including bentonite	$517,382	$396,200
Clay products, from:		
Common clay	24,224,704	26,407,203
Stoneware clay	4,212,982	3,980,430
Fire clay	660,101	576,410
Other products	162,562	160,000
Total	29,777,731	31,520,243
Production from imported clays, from:		
Stoneware clay	886,370	
Fire clay	2,113,310	
China clay	11,872,268	
Total	14,871,948	[1] 16,134,000
Grand total	44,649,679	[1] 47,654,243
Imports:		
Clays:		
Fire clay	460,296	396,336
China clay	1,647,140	1,527,075
All other, including activated, filtering, and bleaching clays	1,975,944	1,281,803
Total	4,083,380	3,205,214
Clay products, from:		
United States	17,819,269	21,981,595
United Kingdom	13,339,754	13,539,058
Other countries	2,169,451	1,802,077
Total	33,328,474	37,322,730
Exports:		
Clays, to:		
United States	23,069	34,866
Other countries	2,025	
Total	25,094	34,866
Clay products, to:		
United States	1,099,244	1,297,328
Sweden	131,304	164,967
Brazil	107,066	128,341
Belgium	117,048	103,115
India	22,683	79,173
Finland	149,833	70,793
Union of South Africa	70,489	41,491
Other countries	223,695	302,960
Total	1,921,362	2,188,168

[1] Estimate.

The following information on bentonite was abstracted from a Canadian Government report: [55]

As in a number of prior years, Canadian production of bentonite was confined to Manitoba and Alberta in 1954. The greater part of the consumption continued to be imported from the United States. Imports in 1954 were valued at $835,433 compared with $443,510 in 1953. The consumption of bentonite in Canada, 1952–53, is shown in table 16.

In Manitoba, bentonite was mined near Morden by Pembina Mountain Clays from shallow beds with little overburden. The material was dried, crushed, and stored at Morden and later hauled by rail to the Winnipeg plant for grinding and activation. The company marketed both a natural ground bentonite that possessed good decolorizing properties and an activated bentonite that compared favorably with the best imported.

In Alberta, swelling (alkali) bentonite was produced in several localities in the Drumheller area, north of Calgary. The material, in raw lump form, was purchased by Alberta Mud Co. which prepared it for markets in Western Canada. It was sold for use as a component of weed killers, as an aid in diamond drilling, for sealing irrigation ditches, and as a foundry sand bond.

The price of Alberta bentonite ground to 90 percent minus 200-mesh was quoted at $40 per short ton f. o. b. Calgary, in 1954.

In British Columbia, beds of slightly swelling bentonite up to 15 feet in thickness occur in gently dipping Tertiary sediments near Quilchena and Princeton in the south-central part of the province, but no significant production had been recorded.

TABLE 16.—Consumption of bentonite in Canada, 1952–53

Consumption	1952	1953
	Short tons	Short tons
Oil-well drilling	[1] 16,000	19,578
Petroleum refining	6,658	7,090
Steel foundries	4,959	4,163
Miscellaneous chemicals	18	1,635
Miscellaneous nonmetallic mineral products	782	836
Soaps and washing compounds	726	739
Iron castings		463
Vegetable oil preparation	329	313
Pulp and paper	256	244
Cement products	86	78
Asbestos products		16
Polishes and dressings	32	8
Total	29,846	35,163

[1] Estimate.

In Saskatchewan, the Department of Natural Resources tested bentonites from St. Victor, Pelly, and Moosomin areas.

No deposits of bentonite have been found east of Manitoba. Bentonite is thought to be formed by the weathering or alteration of volcanic ash, and this is not known to occur east of Manitoba.

Articles in Canadian journals [56] reported that bentonite deposits in the area northwest of Edmonton, Alberta, were being investigated. The deposits are of the swelling variety. The bentonite was said to occur as a bed about 10 feet thick, with little or no overburden.

A firm in Toronto, Canada, completed a preliminary survey of a 30,000-acre bentonite-exploration permit about 15 miles south of Assiniboia, Saskatchewan. Some 150,000 short tons of bentonite had been previously proved in this area in a drilling program conducted

[55] Janes, T. H., Bentonite in Canada, 1954 (Preliminary): Dept. of Mines and Tech. Surveys, Ottawa, Canada, 3 pp.

[56] Canadian Mining and Metallurgical Bulletin (Montreal), vol. 47, No. 506, June 1954, p. 430. Northern Miner (Toronto), vol. 40, No. 4, Apr. 15, 1954, pp. 1, 7.

by the Saskatchewan Department of Mineral Resources. The bentonite is of a semiswelling type.[57]

Activities of two companies in the lightweight-aggregate industry were described in a Canadian journal.[58]

The Lightweight Building Products Co., Ltd., was organized in Regina, Saskatchewan, to produce lightweight aggregate by expanding glacial-like clays found in the vicinity of the city. Full-scale tests on the raw material showed that a strong uniform aggregate can be produced.

The plant of the Lightweight Aggregate of Canada, Ltd., at Calgary, Alberta, that was completed in 1954 will produce a coated lightweight aggregate from shale of the Pelly River formation. The mine operations will be at Preddis about 25 miles south of the processing plant. The shale will be transported by truck and will be sintered in a rotary kiln. It was estimated that this plant will have a daily capacity of about 275 cubic yards of aggregate.

Information on ball clay, kaolin, fire clay, and miscellaneous clay in 1953–54 is given in the following paragraphs abstracted from a Canadian Government report: [59]

Ball Clay.—The Saskatchewan Government continued to carry out an extensive program of exploration of its ball-clay resources, particularly in the southern part of the province, with the idea that markets could be expanded for such clays in eastern Canada and the United States. Eastern Canada requirements were imported.

Kaolin or China Clay.—No deposits of sufficient size and of uniform quality for commercial operations were known in Canada. Of the total value of the mineral imported by Canada in 1954, $973,532 came from the United States and $553,543 worth from the United Kingdom.

Fire Clay.—Firebrick and other refractory materials were manufactured at a plant about 50 miles from Vancouver from a semi-plastic fire clay, mined by the underground method, located in Sumas Mountain. It was said that part of this fire clay was exported to northwestern United States for use in making refractories.

A plant at Claybank, Saskatchewan, utilized the highly plastic refractory clays obtained by selective mining of the "Whitemud" beds in the southern part of the province.

The fire clay found at Musquodoboit, Nova Scotia, was said to be suitable for the production of stove linings and for certain foundry purposes, and the proposed opening up of the newly explored clay deposits near Shubenacadie, Nova Scotia, should make available a domestic source in eastern Canada of fire clay suitable possibly for intermediate or low duty refractories.

The rather extensive deposits of plastic fire clays that occur on the Mattagami, Missinaibi, and Abitibi Rivers in northern Ontario had not been developed commercially owing to their remoteness and the difficulty of obtaining a uniform product.

Fire clays imported from the United States entered Canada duty free if not processed further than by grinding, and producers of fire-clay refractories in Ontario and Quebec used imported fire clays.

Miscellaneous Clays and Shales.—Good miscellaneous clays or shales occur in all provinces at points not too distant from the thickly populated areas but the ones of good commercial quality are not plentiful. Surveys sponsored in a few years prior to 1954 by both Government and private industry disclosed some fairly promising new deposits.

The investigations into the possibilities of making lightweight aggregate from Canadian clays and shales was continued in 1954 in the Mines Branch and a number of new sources of raw materials were found suitable for this purpose. The demand for lightweight aggregate for uses in concrete was increasing.

[57] Canadian Mining and Metallurgical Bulletin (Montreal), vol. 47, No. 509, September 1954, pp. 628–629.
[58] Canadian Mining and Metallurgical Bulletin (Montreal), vol. 47, No. 509, September 1954, p. 629.
[59] Phillips, J. G., Clay and Clay Products in Canada, 1954 (Preliminary) Dept. of Mines and Tech. Survey, Ottawa, Canada, 1954, 5 pp.

Prices.—Average prices for the various kinds of clay are difficult to obtain because of the variability in quality. An estimate of the 1954 prices per ton, f. o. b. shipping point for three kinds of imported clay, was as follows: Fire clay, $4.50 to $6 per ton; kaolin or china clay, $9 to $30; and ball clay, $6 to $20.

Israel.—Production of kaolin totaled 5,512 short tons valued at US$55,000 in 1953.[60]

Italy.—Production of kaolin and bentonite totaled 112,659 short tons in 1954. The free-market value per ton Milan in 1954 was 48,000 lire (625 lire equal US$1). In 1953 output totaled 106,592 tons, and the free-market value per ton Milan in 1953 was 7,000 lire.

In 1954 production of bleaching and refractory clays totaled 125,404 tons. The free-market value per ton Milan in 1954 was 36,000 lire. In 1953 bleaching and refractory clays totaled 116,860 tons. The value was not reported. Imports and exports of bentonite and kaolin in 1953 and 1954 are shown in table 17.[61]

TABLE 17.—Italian trade in bentonite and kaolin, 1953–54, in short tons [1]

Country or origin or destination	Bentonite		Kaolin	
	1953	1954	1953	1954
Imports:				
Austria	----------	----------	6, 647	7, 492
Czechoslovakia	----------	----------	3, 957	3, 716
Eritrea	----------	----------	598	----------
France	----------	----------	742	----------
Germany, West	2, 689	3, 471	5, 955	6, 995
United Kingdom	----------	----------	38, 483	46, 284
United States	37	----------	864	1, 787
Other countries	----------	166	116	2, 776
Total imports	2, 726	3, 637	57, 362	69, 050
Value, 1,000 lire [2]	19, 351	27, 881	815, 059	939, 311
Exports:				
Austria	253	----------	----------	45
Belgium-Luxembourg	365	749	----------	----------
Finland	1, 146	----------	----------	----------
Germany, West	4, 410	4, 615	----------	----------
Sweden	776	1, 188	----------	----------
Switzerland	948	875	16	----------
United Kingdom	3, 214	3, 338	----------	----------
Other countries	1, 148	2, 328	7	37
Total exports	12, 260	13, 093	23	82
Value, 1,000 lire [2]	169, 638	165, 312	531	1, 492

[1] Source: Statistica Del Commercio Con L'Estero.
[2] 625 lire equals US$1.

Korea.—Production of kaolin (34 to 36 percent SK content) totaled 8,493 short tons valued at $164,000 in 1953.[62]

Union of South Africa.—It was reported that the first deposit of attapulgite (fuller's earth) found in Africa was discovered in the Northern Transvaal, near Narboomspruit and Zebedelia.[63]

[60] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 5, May 1954, p. 37.
[61] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 4, April 1955, p. 33.
[62] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 4, October 1954, p. 53.
[63] Mine and Quarry Engineering (London), vol. 20, No. 11, November 1954, p. 518.

Cobalt

By Hubert W. Davis,[1] and Charlotte R. Buck [2]

FOR THE FIFTH successive year world (exclusive of U. S. S. R.) production of cobalt increased to establish a new high of 14,200 short tons, a 12-percent gain over 1953, itself a record year. Belgian Congo, producing at a slightly higher rate than in 1953, furnished 66 percent of the total output. The new refinery of International Nickel Co. of Canada, Ltd., at Port Colborne, Ontario, was put into commercial operation in October 1954.

Production of cobalt metal in the United States reversed a 5-year uptrend and declined 0.5 percent from 1953; and imports, which established a new record in 1953, were 1.4 percent less. Belgian Congo and Belgium supplied 82 percent of the imports. Sales of cobalt metal to consumers were 34 percent smaller, but deliveries to the National Stockpile were 26 percent larger.

Cobalt oxide production in the United States in 1954 was 21 percent less than in 1953, imports were down 30 percent, and sales declined 10 percent. Belgium furnished 98 percent of the imports of oxide. Production of salts and driers was less than in 1953 by 7 and 28 percent, respectively, but output of hydrate gained 68 percent. Imports of sulfate and other compounds increased to 353,100 pounds (gross weight) in 1954, a 29-percent increase over 1953.

Despite adequate supplies, consumption of cobalt in the United States was 32 percent less than in 1953 and the smallest since 1949. The decrease resulted chiefly from a 2,546,000-pound (50-percent) decline in use of cobalt in high-temperature alloys. Less cobalt was consumed in permanent-magnet alloys, high-speed and low-cobalt alloy steels, alloy hard-facing rods, and cemented carbides. These losses were offset partly by larger consumption of cobalt in ground-coat frit for porcelain enamel and pigments.

Quoted prices of cobalt metal and oxide remained unchanged throughout 1954.

DOMESTIC PRODUCTION

Mine Production.—The United States is the largest consumer of cobalt in the world, yet only a small part of its requirements has been furnished by domestic ore. However, a record of nearly 2 million pounds of cobalt was produced by domestic mines in 1954. Moreover, when full production is attained at the refineries of Calera Mining Co. and National Lead Co., over 5 million pounds of cobalt will be required annually from domestic mines for capacity operation.

Production of cobalt ore or concentrates (cobalt content) in the

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

United States in 1954 was 59 percent greater than in 1953 and shipments were 25 percent larger.

Calera Mining Co., a wholly owned subsidiary of Howe Sound Co., was again the chief producer of cobalt concentrate in the United States. Its production, moreover, was more than double that in 1953; however, maximum production was not reached because of technical problems at the refinery. The company operates the Blackbird mine at Cobalt, Idaho, which is equipped to produce over 3 million pounds of cobalt annually. Ore carries about 0.7 percent cobalt, about twice as much copper, and a little nickel and gold. The concentrate produced averaged 17.75 percent cobalt in 1954. The concentrate was shipped to the company refinery at Garfield, Utah, where it is refined to metal. The company entered into a contract which provided that Chemical Construction Corp. would operate and manage the refinery for 2 years beginning February 15, 1954, and treat cobalt concentrate on a toll basis, returning the resulting metal to Calera for sale. During 1954 at the refinery 735,700 pounds of cobalt was recovered in metallic form; and 660,300 pounds of granules, meeting Government specifications, containing 631,400 pounds of cobalt and 25,700 pounds of nickel, was shipped. Of the cobalt recovered 104,300 pounds will require further treatment.

Calera Mining Co., Northfield Mines, and Montana Coal & Iron Co. continued to explore for cobalt at the Blackbird property, Stevenson property, and Black Pine mine, respectively, in Lemhi County, Idaho, with financial assistance provided by the Defense Minerals Exploration Administration under the Defense Production Act.

TABLE 1.—Cobalt ore or concentrate produced and shipped in the United States, 1945–49 (average) and 1950–54 [1]

Year	Produced		Shipped from mines	
	Gross weight (short tons)	Cobalt content (pounds)	Gross weight (short tons)	Cobalt content (pounds)
1945–49 (average)	20,612	694,489	20,772	743,931
1950	28,660	809,328	23,662	660,025
1951	28,485	902,629	26,564	755,631
1952	21,159	1,363,251	24,551	836,372
1953	22,524	1,258,924	24,026	1,775,489
1954	19,036	1,996,488	19,738	2,219,396

[1] Figures, by years, for 1933–49 are given in chapter on Cobalt in Minerals Yearbook, 1952, vol. I.

Bethlehem Steel Co. produced 13 percent less cobalt in 1954 than in 1953. The cobalt-bearing material (averaging 1.72 percent in 1954) was obtained as a flotation sulfide concentrate from the 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 1954 it recovered 72 short tons of residues containing 5,800 pounds of cobalt.

The St. Louis Smelting & Refining Division of National Lead Co. continued to produce a reject iron concentrate carrying cobalt, nickel, and copper at its property near Fredericktown, Mo. The cobalt content of the reject concentrate produced averaged 3 to 4 percent. The reject concentrate will be treated in the company refinery, which is scheduled to begin commercial production in 1955.

Refinery Production.—Despite the fact that the United States is a small producer of cobalt ore, it is an important producer of cobalt products, as is evident from table 2. Production of metal, which had increased for 5 consecutive years, declined 0.5 percent from 1953. The metal was produced from white alloy from Belgian Congo and concentrate from Idaho and Pennsylvania.

Production of oxide was 21 percent smaller than in 1953. The oxide was produced from white alloy from Belgian Congo, concentrate from Pennsylvania, and scrap. Production of hydrate was 68 percent larger than in 1953. The hydrate was produced chiefly from scrap, but some metal and concentrate were also used. Production of salts and driers was 7 and 28 percent, respectively, smaller than in 1953. 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 3 percent less than in 1953.

TABLE 2.—Cobalt products produced and shipped in the United States, 1948–52 (average) and 1953–54, in pounds

Product	Production		Shipments	
	Gross weight	Cobalt content	Gross weight	Cobalt content
1948–52 (average)				
Metal	1,895,535	1,863,252	1,985,426	1,951,871
Oxide	578,520	412,919	569,178	406,168
Hydrate	313,551	124,725	318,177	126,964
Salts:				
Acetate	144,154	33,760	149,167	34,919
Carbonate	147,918	67,506	151,956	69,454
Sulfate	601,309	126,929	608,450	127,870
Other	84,689	19,465	83,704	19,353
Driers	9,461,380	573,983	9,391,075	567,107
1953				
Metal	2,887,487	2,818,859	2,535,896	2,480,840
Oxide	579,457	415,974	575,209	413,600
Crude oxide	91,125	6,680	91,125	6,680
Hydrate [1]	259,169	108,692	241,771	101,013
Salts:				
Acetate	152,807	35,684	152,453	35,596
Carbonate	170,971	78,682	185,058	85,282
Sulfate	638,137	138,943	670,729	146,017
Other [1]	246,309	55,305	234,852	52,622
Driers	9,140,138	567,756	8,995,651	554,297
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

[1] Revised figures.

TABLE 3.—Cobalt consumed by refiners or processors in the United States, 1945–49 (average) and 1950–54, in pounds of contained cobalt

Cobalt material [1]	1945–49 (average)	1950	1951	1952	1953	1954
Alloy and ore	2,962,744	2,526,755	2,857,328	3,002,087	4,059,287	3,950,826
Metal	568,664	993,864	717,636	643,108	801,192	592,257
Hydrate	138,989	80,497	81,710	79,733	74,504	56,717
Carbonate	10,376	13,944	6,841	292	108	100
Purchased scrap Other	3,513	48,261	48,549	53,081	109,204 8,540	172,757 57,284

[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.

TABLE 4.—Refiners or processors of cobalt in the United States in 1954

Refiner or processor	Location of plant	Cobalt product [1] made	Cobalt raw material [1] used
Advance Solvents & Chemical Corp	Jersey City, N. J	E	A, D
African Metals Corp	Niagara Falls, N. Y	A, B, D	F
Allied Chemical & Dye Corp., General Chemical Div.	Marcus Hook, Pa	D	A
Baker Chemical Co., J. T	Phillipsburg, N. J	B, D	A
Calera Mining Co	Garfield, Utah	A	F
Ceramic Color & Chemical Manufacturing Co.	New Brighton, Pa	C, D	A
Chase Chemical Corp	Pittsburgh, Pa	E	C
Ferro Chemical Corp	Bedford, Ohio	C, D, E	A, C
Hall Chemical Co	Wickliffe, Ohio	B, C, D	G
Hanson-Van Winkle-Munning Co	Matawan, N. J	D	A
Harshaw Chemical Co	Cleveland, Ohio Gloucester City, N. J	D, E	A
Mallinckrodt Chemical Works	St. Louis, Mo	D	A, D
McGean Chemical Co	Cleveland, Ohio	D, E	A
Mooney Chemicals, Inc	do	E	A
National Lead Co	Fredericktown, Mo. [2]	A	F
Nuodex Products Co., Inc	Elizabeth, N. J	E	A, C
	Long Beach, Calif	E	A
Pyrites Company, The	Wilmington, Del	A, B, C, D	F
Shepherd Chemical Co	Cincinnati, Ohio	D, E	A, C, D, G
Standard Oil Co. of California	Richmond, Calif	E	A
Stresen-Reuter, Inc., Frederick A	Bensenville, Ill	E	A, C
	Chicago, Ill	C, E	A, C
Vitro Rare Metals Co	Canonsburg, Pa	B, C	G
Whitmoyer Laboratories, Inc	Myerstown, Pa	D	A, C
Witco Chemical Co	Chicago, Ill	C, E	A

[1] Abbreviations: A, metal; B, oxide; C, hydrate; D, salts; E, driers; F, ore, concentrate, or white alloy; G, scrap.
[2] Scheduled to begin commercial operation in 1955.

CONSUMPTION

Industrial consumers consumed 32 percent less cobalt in 1954 than in 1953, the smallest amount since 1949. For the fourth consecutive year the largest single use for cobalt was for cobalt-chromium-tungsten-molybdenum alloys, which represented 37 percent of the total quantity consumed in 1954 but utilized 48 percent less than in 1953. Consumption for this purpose was the smallest since 1950.

As in the past 3 years, production of magnet alloys was the second largest use of cobalt and consumed 29 percent of the total in 1954; however, consumption for this purpose was 10 percent less than in 1953 but the third largest of record.

Less cobalt was also used for high-speed and low-cobalt alloy steels, alloy hard-facing rods, and cemented carbides, but more was used in ground-coat frit for porcelain enamel and pigments. Cobalt salts and driers were utilized at a rate about 10 percent less than in 1953.

TABLE 5.—Cobalt consumed in the United States, 1946–49 (average) and 1950–54, by uses, in pounds of contained cobalt

Use	1946–49 (average)	1950	1951	1952	1953	1954
Metallic:						
High-speed steel	255,021	235,227	316,064	223,203	217,652	168,893
Other steel	146,277	252,885	79,885	115,761	162,185	112,323
Permanent-magnet alloys	}1,267,486	2,834,040	2,052,042	1,664,842	2,336,889	2,123,576
Soft-magnetic alloys		37,552	58,652	18,727	11,559	721
Cobalt-chromium-tungsten-molybdenum alloys:						
Cutting and wear-resisting materials	}975,571	}2,226,199	}4,899,591	}6,408,537	204,939	182,641
High-temperature high-strength materials					5,116,750	2,571,089
Alloy hard-facing rods and materials	81,174	260,371	575,268	505,367	591,909	432,342
Cemented carbides	75,213	136,935	297,751	610,750	359,125	166,708
Other metallic	103,266	208,574	276,222	132,917	233,428	113,522
Total metallic	2,904,008	6,191,783	8,555,475	9,680,104	9,234,436	5,871,815
Nonmetallic (exclusive of salts and driers):						
Ground-coat frit	514,469	683,358	448,983	309,167	374,158	403,953
Pigments	199,980	262,441	50,073	85,262	102,612	145,769
Other nonmetallic	60,518	43,826	60,462	42,960	84,293	75,686
Total nonmetallic	774,967	989,625	559,518	437,389	561,063	625,408
Salts and driers: Lacquers, varnishes, paints, inks, pigments, enamels, glazes, feed, electroplating, etc. (estimate)	816,250	1,102,000	818,000	701,000	953,000	853,000
Grand total	4,495,225	8,283,408	9,932,993	10,818,493	10,748,499	7,350,223

TABLE 6.—Cobalt consumed in the United States, 1946–49 (average) and 1950–54, by forms in which used, in pounds of contained cobalt

Form	1946–49 (average)	1950	1951	1952	1953	1954
Metal	2,943,429	6,087,048	7,534,864	8,328,552	7,727,210	5,119,853
Oxide	690,443	964,055	680,452	418,211	524,401	587,799
Cobalt-nickel compound	30,435	3,434	1,786			
Ore and alloy	2,700	436	3,438	2,736	2,451	301
Purchased scrap	11,968	126,435	894,453	1,367,994	1,541,437	789,270
Salts and driers	816,250	1,102,000	818,000	701,000	953,000	853,000
Total	4,495,225	8,283,408	9,932,993	10,818,493	10,748,499	7,350,223

PRICES

Prices of cobalt metal and cobalt oxide remained unchanged throughout 1954. Metal rondelles (97–99 percent, in 500-pound containers) and metal granules (in 2,152-pound containers) 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. These prices have been in effect since November 1, 1953.

FOREIGN TRADE[3]

Imports.—The 4-year uptrend in imports of cobalt into the United States was reversed in 1954, when 16,865,000 pounds (cobalt content) was imported, a decrease of 2 percent from 1953, the record year. However, imports in 1954 were the second largest. Belgian Congo continued to be the chief source; in 1954 it supplied 68 percent of the total imports. Belgium supplied 17 percent; however, 80 percent of the metal and oxide was produced from Belgian Congo alloy. The first imports of cobalt metal were received from Federation of Rhodesia and Nyasaland. Noteworthy also were the increases of 68, 56, and 55 percent, respectively, in imports of metal from Canada, West Germany, and Norway and the receipt of 330,000 pounds (gross weight) of cobalt sulfate and other compounds from West Germany.

TABLE 7.—Cobalt imported for consumption in the United States, 1945–49 (average) and 1950–54, by classes

[U. S. Department of Commerce]

Year	White alloy[1] (pounds)		Ore and concentrate[2]		
	Gross weight	Cobalt content	Pounds		Value
			Gross weight	Cobalt content	
1945–49 (average)	4,473,531	1,962,310	[3] 698,344	[3] 80,242	[3] $63,036
1950	3,979,088	1,792,348	164,188	18,838	16,003
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

Year	Metal		Oxide		Sulfate and other compounds	
	Pounds	Value	Pounds (gross weight)	Value	Pounds (gross weight)	Value
1945–49 (average)	3,954,412	$5,819,123	619,614	$726,652	567	$1,803
1950	[5] 6,706,875	[5] 11,210,872	[5] 904,650	[5] 1,009,431	4,649	5,927
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	[6] 13,009	[6] 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

[1] Reported by importer to Bureau of Mines. Figures for 1945–48 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 1949–54 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 9.
[4] Includes 146 pounds of zaffer, valued at $215.
[5] Adjusted by Bureau of Mines.
[6] Revised figure.

[3] Figures on United States 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.

TABLE 8.—Cobalt white alloy, ore, metal, and oxide imported for consumption in the United States, 1953–54, by countries, in pounds

[U. S. Department of Commerce]

Country	White alloy, ore and concentrates				Metal		Oxide (gross weight)	
	1953		1954					
	Gross weight	Cobalt content	Gross weight	Cobalt content	1953	1954	1953	1954
North America:								
Canada	445,063	51,323	27,130	3,349	[1] 727,373	1,219,628	9,500	-------
Mexico	---------	---------	---------	---------	---------	---------	1,554	-------
Total	445,063	51,323	27,130	3,349	727,373	1,219,628	11,054	-------
Europe:								
Belgium	---------	---------	---------	---------	[1] 3,615,146	2,515,225	590,800	422,300
France	---------	---------	---------	---------	---------	473	-------	-------
Germany, West	---------	---------	---------	---------	589,818	918,311	2,200	8,100
Norway	---------	---------	---------	---------	208,450	322,113	-------	-------
United Kingdom	---------	---------	---------	---------	135	---------	6,000	-------
Total	---------	---------	---------	---------	4,413,549	3,756,122	599,000	430,400
Africa:								
Belgian Congo	[2] 5,249,781	[2] 2,412,804	[2] 5,464,511	[2] 2,360,360	9,290,972	9,215,438	-------	-------
Rhodesia and Nyasaland, Federation of	---------	---------	---------	---------	---------	36,680	-------	-------
Total	5,249,781	2,412,804	5,464,511	2,360,360	9,290,972	9,252,118	-------	-------
Grand total	5,694,844	2,464,127	5,491,641	2,363,709	[2] 14,431,894	14,227,868	610,054	430,400

[1] Adjusted by Bureau of Mines.
[2] Reported by importer to Bureau of Mines.

During the 32 years 1923–54 imports of cobalt into the United States have totaled 137,621,000 pounds (cobalt content), of which 73 percent was imported in the 10 years 1945–54. During the 32 years receipts of metal comprised 62 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 (29 percent); virtually all was from Belgian Congo. Nearly 8 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 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 0.24 percent of the total imports.

TABLE 9.—Cobalt imported for consumption in the United States, 1945–49 (average) and 1950–54, in pounds [1]

Year	Gross weight					Total	
	White alloy	Ore and concentrate	Metal	Oxide	Sulfate and other compounds	Gross weight	Cobalt content (estimated)
1945–49 (average)	4,473,531	[2] 698,344	3,954,412	619,614	567	[2] 9,746,468	[2] 6,361,800
1950	3,979,088	164,188	6,706,875	904,650	4,649	11,759,450	9,095,000
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	[4] 13,009	[4] 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

[1] Figures, by years, for 1923–49 in chapter on Cobalt, Minerals Yearbook 1953, vol. I, p. 7.
[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.
[4] Revised figure.

Exports.—Exports of cobalt from the United States are usually small, but in 1953 and 1954 large quantities of cobalt scrap were shipped abroad. In 1954, 3,067,000 pounds of metal, alloys, and cobalt-bearing scrap valued at $1,173,000 was exported. 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. The duty on other salts and compounds continued at 30 percent ad valorem. Cobalt metal and ore enter the United States duty-free.

TECHNOLOGY

Operating difficulties at the new refinery of Rhokana Corp. at Nkana, Federation of Rhodesia and Nyasaland, were overcome in 1954, and production of 2.7 times more cathode metal than in 1953 was attained. Further work underway at the refinery was expected to put the various sections into better balance and to lead to increased metallurgical efficiency and a higher rate of production. A pneumatic calcine-handling plant was installed, work was started on erecting a roaster-gas scrubbing system, and a site was being prepared for a granulating plant.

National Lead Co. completed its refinery at Fredericktown, Mo., but made no commercial production. It performed tests and made development runs in an effort to resolve mechanical and material complications always present in a new plant and especially with a new process.

Concerning the cobalt refinery of Calera Mining Co. at Garfield, Utah, Howe Sound Co. reports as follows: [4]

> The plant was inoperative from February 15 to March 11 to allow a study of the condition of the mechanical and other equipment. The results obtained since that date have been below those expected. Two reduction autoclaves, essential to an expansion of production, were not received until December and were not placed in operation until February 3, 1955. An additional oxidation autoclave was received and put in place but * * * it is not anticipated that it will be in

[4] Howe Sound Co., Annual Report, 1954, pp. 5–6.

operation before April 1. The above mentioned equipment, together with a third reduction autoclave which is still on order, should make possible a material expansion in production. Some corrosion problems still remain unsolved.

Chibuluma Mines, Ltd., planned a cobalt-treatment plant near Ndola, Federation of Rhodesia and Nyasaland, to treat ore from the Chibuluma mine; treatment will take the form of a three-stage process.[5] The first stage will consist of the electric smelting of cobalt-rich concentrate to produce a matte containing cobalt and copper; the second will involve the production of cobalt oxide; and the third will produce cobalt metal.

Sherritt Gordon Mines, Ltd., developed an improved process for producing cobalt metal from the cobalt-nickel mixed sulfides produced at its nickel refinery. Engineering and operating data collected on all phases of pilot-plant operation were being applied to the design of a cobalt plant now under construction at Fort Saskatchewan, Alberta. Production was scheduled to begin during the second half of 1955.

Patents were issued for the separation of nickel from solutions containing cobalt and nickel[6] and for a cobalt-base alloy.[7]

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 sufficient 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.

NORTH AMERICA

Canada.—In Canada cobalt production is 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 as a residue from the Port Hope uranium refinery, at Port Radium, Northwest Territories. Recovery of cobalt from the nickel-copper ore of the Lynn Lake area, Manitoba, was scheduled for 1955.

According to the Dominion Bureau of Statistics, production of cobalt (content) was 2,182,000 pounds in 1954 compared with 1,603,000 pounds (revised figure) in 1953. These figures, however, do not include the cobalt recovered by Mond Nickel Co. at its Clydach (Wales) nickel refinery from nickel matte produced from the nickel-copper ores of the Sudbury district.

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[5] Mining Journal (London), Chibuluma to Erect Cobalt Treatment Plant: Vol. 243, No. 6207, Aug. 6, 1954, p. 168.

[6] Demerre, Marcel, Separation of Nickel From Solutions Containing Cobalt and Nickel: U. S. Patent 2,671,712, Mar. 9, 1954.

[7] Binder, W. O. (assigned to Union Carbide & Carbon Corp.), Cobalt-Base Alloys and Cast Articles: U. S. Patent 2,684,299, July 20, 1954.

TABLE 10.—World mine production of cobalt, by countries,[1] 1945–49 (average) and 1950–54, in short tons of contained cobalt

(Compiled by Berenice B. Mitchell)

Country [1]	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Canada [2]	292	292	476	711	801	1,091
Mexico (content of ore)			[3] 2	[3] 9		(4)
United States (shipments) (content of concentrate)	372	330	378	418	888	1,110
Total	664	622	856	1,138	1,689	2,201
South America: Chile	(4)					
Europe:						
Italy (content of ore)	2					
Sweden	2					
Total [1]	4					
Asia: Japan (content of concentrate)	5					
Africa:						
Belgian Congo (recoverable cobalt)	3,809	5,675	6,300	7,530	9,125	9,414
Morocco, French (content of concentrate)	205	463	750	1,100	661	811
Rhodesia and Nyasaland, Fed. of [5] (content of white alloy, cathode metal, and ferrocobalt): Northern Rhodesia	577	739	747	645	746	1,264
Total	4,591	6,877	7,797	9,275	10,532	11,489
Oceania: Australia (recoverable cobalt)	10	11	9	12	12	12
Grand total (estimate)[1]	5,600	7,900	9,300	10,900	12,700	14,200

[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 author of chapter has been included in the world total.
[3] Imports into United States.
[4] Less than 0.5 ton.
[5] Year ended June 30 of year stated.

Deloro Smelting & Refining Co., Ltd., at Deloro, Ontario, and Cobalt Chemicals, Ltd., at Cobalt, Ontario, each has a smelter for treating the arsenical cobalt-silver concentrates from the Cobalt-Gowganda area and the residue from Northwest Territories. The International Nickel Co. of Canada, Ltd., completed its cobalt refinery at Port Colborne, Ontario, and began commercial production of electrolytic cobalt metal in October from Sudbury nickel-copper ores. It continued to produce cobalt concentrate which was shipped to Clydach, Wales, for conversion to oxide and salts.

Falconbridge Nickel Mines, Ltd., produces electrolytic cobalt at its refinery at Kristiansand, Norway. The cobalt is recovered from the matte produced from Sudbury nickel-copper ores.

Occurrences of cobalt in Canada were described by Jones.[8] The author discussed consumption and uses, and presented statistics on Canadian foreign trade.

A program of geochemical prospecting in the summer of 1952 near Cobalt, Ontario, has been described.[9]

[8] Jones, R. J., Cobalt in Canada: Dept. of Mines and Technical Surveys, Mines Branch 847, Ottawa, 1954, 96 pp.
[9] Koehler, G. F., and Others, Geochemical Prospecting at Cobalt, Ontario: Econ. Geol., vol. 49, No. 4, June-July 1954, pp. 378–388.

EUROPE

Finland.—The cupriferous pyrite of the Outukumpu mine in eastern Finland contains about 0.2 percent cobalt, 3 percent copper, 25 percent iron, 27 percent sulfur, and 1.2 percent zinc. The sulfur contained in the pyrite concentrate produced is extracted by roasting in Finland. After the roasting process the remaining pyrite sinter, which contains 0.4 to 0.5 percent cobalt, is shipped to Duisburg, Germany, for recovery of the cobalt, copper, iron, and zinc.

Germany, West.—No cobalt ore was being mined in Germany in 1954, and its two active refineries depended on foreign sources for their raw materials. The refinery of Duisburger Kupferhütte at Duisburg, 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 11.—Production of cobalt in West Germany, 1948–53

Year	*Short tons*
1948	18
1949	121
1950	331
1951	491
1952	500
1953	642

AFRICA

Belgian Congo.—For many years Belgian Congo, where the Union Minière du Haut-Katanga is the sole producer, has been the world's premier source of cobalt. For 8 consecutive years output has established a new record; in 1954 it was 9,400 short tons, a 3-percent gain over 1953.

The Luiswishi, Star of Congo, and Ruashi mines near Elisabethville and the Musonoi and Kamoto mines near Kolwezi are the chief producers of cobalt. The Musonoi open-pit mine is the most important current operation. These copper-cobalt deposits worked contain large veins rich in cobalt, which are mined separately. Mixed copper-cobalt ores from the Musonoi and Kamoto mines are fed to the Kolwezi concentrator to produce concentrate containing 28 percent copper and 1 percent cobalt, which constitutes the normal feed for the Shituru plant. Cobalt-bearing ores also are periodically concentrated at the Kolwezi concentrator. These concentrates and the richer cobalt ores are treated at the Panda electric smelter in three single-phase 700 kv.-a. furnaces and two 3-phase furnaces (one of 2,000 kv.-a. and one of 3,000 kv.-a.). A third 3-phase furnace of 2,000 kv.-a. will replace 2 of the single-phase furnaces. The copper and cobalt contained in the ores and concentrates mix with other metals in the charge to form two alloys—a red alloy rich in copper and poor in cobalt and a white alloy rich in cobalt and iron but containing about 15 percent copper. The red alloy is treated further to produce white alloy. The white alloy, containing about 43 percent cobalt, is cast into ingots, which are shipped to Belgium and the United States for refining. The capacity of the Panda smelter is about 4,400 short tons of cobalt content a year.

Average grade ores and the copper-cobalt concentrates produced at Kolwezi are treated for cobalt recovery at the Jadotville-Shituru plant. The cobalt and copper in the copper concentrates enter into solution simultaneously in the copper leaching plant. Bleeding of the solution makes it possible to maintain the cobalt concentration in the copper circuit below a determined value. These bleedings are submitted to special treatment in the cobalt section to eliminate the copper by electrolysis. The cobalt ores are leached with sulfuric acid in the cobalt section of the plant. The solutions are specially treated by electrolysis and chemical methods to eliminate residual copper and other impurities. Cobalt is then deposited in metallic form (cathodes) by means of electrolysis. The cobalt cathodes are melted and refined to 99.5-percent purity and granulated in water. The Shituru cobalt plant has a capacity of about 4,900 short tons a year.

A flowsheet illustrating the treatment of oxidized ores by Union Minière du Haut-Katanga is shown as figure 1.

Federation of Rhodesia and Nyasaland.—Federation of Rhodesia and Nyasaland regained second place in the world as a producer of cobalt in 1954. The Rhokana Corp., which has been producing cobalt since 1933 from mines near Nkana, Northern Rhodesia, continued to be the sole producer. In the year ended June 30, 1954, production comprised 693 short tons of cathode metal, 86 tons of ferrocobalt containing 48.3 tons of cobalt, 24 tons of cobalt in electrolytic slimes and 0.5 ton in hydroxide, and 1,295 tons of alloy containing 498 tons of cobalt. Thus, total production of cobalt in various forms was 1,264 tons compared with 746 tons in 1953. Production of alloy from smelter slag was again curtailed to some extent owing to a power shortage. The overall recovery from concentrate to cathode metal improved from 33 percent in 1953 to 46 percent in 1954.

The grade of ore treated was 0.154 percent cobalt in1954 compared with 0.150 percent in 1953. Concentrates produced contained 1.48 percent cobalt in 1954 compared with 1.51 percent in 1953.

Chibuluma Mines, Ltd., in which Rhokana Corp. has an interest, was scheduled to begin production toward the end of 1955 and to reach an annual rate of about 500,000 pounds of cobalt. Ore reserves are reported at 7,300,000 short tons averaging 5.23 percent copper and 0.25 percent cobalt. The Chibuluma mine is a few miles to the west of Nkana.

French Morocco.—Production of cobalt concentrate in French Morocco was 8,113 short tons containing 811 tons of cobalt in 1954 compared with 6,635 tons containing 661 tons of cobalt in 1953. La Société Minière de Bou-Azzer et du Graara, Casablanca, was the sole producer. During 1954 a substantial quantity of French Morocco concentrate was refined to metal by Société Générale Métallurgique de Hoboken at Oolen, Belgium, for the United States Government. Most of the concentrates, however, were exported to France.

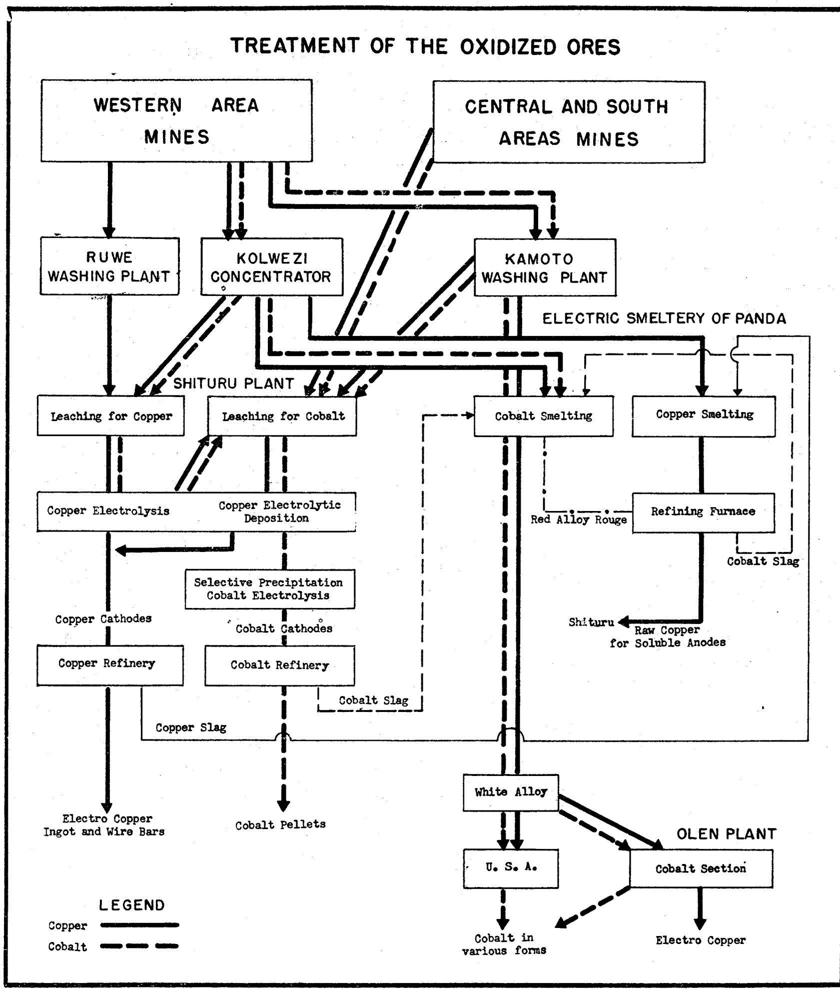

FIGURE 1.—Treatment of oxidized ores by Union Minière du Haut-Katanga, Belgian Congo.

Uganda.—An agreement between Frobisher, Ltd. (a subsidiary of Ventures, Ltd.), Colonial Development Corp., and Uganda Development Corp. will, it was reported,[10] provide the money necessary to bring the Kilembe mine in western Uganda into production in 1956 at an annual rate of 18 million pounds of copper and 900,000 pounds of cobalt. Cobalt concentrate will be processed to oxide at Kilembe and then shipped overseas, probably to Canada, for refining to metal. Another article reported Kilembe ore reserves were 17,781,000 tons averaging 1.88 percent copper and 0.18 percent cobalt.[11]

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[10] Mining World and Engineering Record (London), Copper-Cobalt in Uganda: Vol. 157, No. 4330, March 27, 1954, p. 171.
[11] Mining World, vol. 16, No. 10, September 1954, p. 91.

OCEANIA

Australia.—The only production of cobalt in Australia for many years has been obtained from zinc concentrate produced at Broken Hill, New South Wales, and Roseberry, Tasmania. The cobalt is recovered at Risdon, Tasmania, where it is converted into oxide.

Columbium and Tantalum

By Horace T. Reno [1]

DECLINING domestic consumption of columbium and increased world production of columbium and tantalum mineral concentrates marked 1954 as a year of change from acute scarcity to abundant supply of columbium and tantalum. Both metals, being of vital strategic importance, were subject to Government regulations, which restricted their use from the beginning of the Korean War until late in 1953. Increasing use of substitutes and further designing away from columbium, particularly in making stainless steel, resulted in a decrease of about 60 percent in the domestic consumption of columbium and tantalum mineral concentrates. Free-World production of columbium and tantalum minerals expanded at an accelerated rate as the stimulus furnished by the U. S. Government's purchasing program began to take full effect. More than 9 million pounds of concentrates were produced, about a million of which came from newly opened columbite-tantalite mineral deposits and a half million from pyrochlore mineral deposits.

Deposits of the pyrochlore-group minerals received marked attention in the search for and development of new sources of columbium. Production from the Norwegian koppite deposits, the first pyrochlore-type mineral deposit to be mined successfully on a large scale, was maintained, and a similar koppite operation was started in Germany. Almost all exploration was directed toward proving and finding new deposits of pyrochlore minerals. Enormous deposits were indicated in Nigeria, Uganda, Kenya, and Canada. Canadian deposits at Oka, Lake Nipissing, and Nemegos apparently contain many thousands of tons of columbium, which if exploited will greatly lessen United States dependence on seaborne imports.

TABLE 1.—Columbium-tantalum concentrates shipped from mines in the United States, 1945–49 (average) and 1950–54 [1]

Year	Pounds	Value
1945-49 (average)	3,001	$6,710
1950	1,000	2,150
1951	925	1,528
1952	5,385	16,723
1953	14,867	29,779
1954	32,829	57,262

[1] Includes columbite, tantalite, and microlite.

[1] Commodity-industry analyst.

DOMESTIC PRODUCTION

Mine Production.—Domestic production of combined columbium and tantalum mineral concentrates was by far the highest on record. South Dakota, the leading producer, produced 25,000 pounds, more than 5 times the quantity it produced in 1953. Colorado production almost doubled. North Carolina, a significant producer of columbium and tantalum concentrates in 1953, did not produce any in 1954. The Defense Mineral Exploration Administration's exploration aid program, premium prices paid by the Government for columbium and tantalum concentrates, and high production of other pegmatite minerals were the factors that contributed to increased domestic production.

Expected exploitation of columbium-tantalum-bearing placer deposits in Bear Valley, Idaho, did not develop, and pegmatite mines accounted for all domestic production of columbium and tantalum mineral concentrates in 1954. Twelve mines operating in the Black Hills pegmatites, South Dakota, produced columbium-tantalum concentrate principally as a byproduct of mining mica, feldspar, and beryl. Six pegmatite properties on both slopes of the Rocky Mountains in Colorado and three pegmatite properties in New Mexico produced columbium and tantalum. Columbium and tantalum production in other States came from 1 or 2 depostis, all pegmatites.

Refinery Production.—United States producers of primary columbium-tantalum materials from mineral concentrates were: Electro-Metallurgical Division, Union Carbide & Carbon Co., Niagara Falls, N. Y., producer of ferrocolumbium and ferrotantalum-columbium; Fansteel Metallurgical Corp., North Chicago, Ill., producer of tantalum and columbium metals and compounds; and Kennametal, Inc., Latrobe, Pa., producer of columbium and tantalum oxide and manufacturer of columbium-tantalum-bearing carbides. These companies supplied primary columbium-tantalum materials to processors and fabricators of end-use products.

CONSUMPTION AND USES

Columbium has been used principally in ferrocolumbium and ferrocolumbium-tantalum to stabilize stainless steel and in high-temperature alloys. Small quantities of columbium metal are employed as a "getter" in vacuum tubes. Tantalum is used principally in the form of pure metal in corrosion-resistant equipment, rectifiers, and capacitors. Tantalum carbide and to a lesser extent columbium with carbide are used in cutting tools.

Domestic consumption of columbium and tantalum mineral concentrates in terms of contained metal decreased about 60 percent compared with 1953. The decline can be attributed almost entirely to Government restrictions and consequent substitution for columbium and tantalum as a stabilizing agent in the manufacture of stainless steel. Order M-80 of the National Production Authority, which limited the percentage of columbium in stainless steel and prohibited use of columbium and tantalum if substitutes were available, was revoked November 1, 1953. The consumption pattern of columbium apparently was reversed during the time the order was in effect, and as a result the use of columbium in stainless steel continued to decline in 1954. The Department of Defense continued in 1954 to specify the quantity of columbium that could be used in airplane jet engines; consequently, consumption of columbium for making high-temperature alloys remained at about the same level as in 1953. Columbium carbide is used interchangeably with tantalum carbide in cutting tools; consumption of both elements for this purpose was about the same. The quantity of tantalum used in chemical and electronic equipment increased slightly over 1953.

Alloys containing columbium as the primary element have not been developed, but alloys containing columbium as a minor element were of vital importance in high-temperature applications in 1954. The presence of columbium apparently retards phase transformation.

Tantalum was available in sheet, foil, rod, wire, tubing, and special forms and shapes as well as in completely fabricated parts such as coils, condensers, heat exchangers, and bayonet heaters.[2] Its principal use was in corrosion-resistant equipment employed for all acids except hydrofluoric and, with certain limitations, strong sulfuric and phosphoric acids.

Tantalum seamless tubing used for steam coils in heating pickle-acid tanks was inspected after 10 years' service, and the wall thickness, originally 0.013 inch, was found to be 0.012 inch.[3]

"Tantung G," a new alloy of tantalum, tungsten, chromium, and cobalt made by Vascaloy-Ramet Corp., Waukegan, Ill., can reportedly be cast in the form of spring binding posts, used on portable wiring boards for making rapid communication connections, more economically than steel can be machined and hardened to make the parts and will have better corrosion resistance.[4]

PRICES

Government buying of columbium and tantalum mineral concentrates at an average price of about $3.40 per pound of contained combined pentoxide fixed the world price at essentially the same amount. Details of the Government purchase schedule were given in the 1952 Minerals Yearbook.

Ferrocolumbium per pound of contained columbium, 50–55 percent was quoted in E&MJ Metal and Mineral Markets at $6.40 January through March 11, at $9.50 March 12 through September 16, and $12 September 17 to the end of the year.

Ferrotantalum-columbium was quoted in American Metal Market per pound of contained columbium and tantalum, ton lots or more, f. o. b. purchaser's plant, at $4.75 January to September 14 and $6.25 September 14 to December 31.

Tantalum metal was quoted per kilogram, base price, at $137 for rod and $93 for sheet throughout 1954 in E&MJ Metal and Mineral Markets. Columbium metal powder was quoted in American Metal Market at $75 per pound.

[2] Gayle, T. M., Where To Use Tantalum: Materials & Methods, vol. 1, No. 1, January 1954, pp. 94–95.
[3] Iron Age, vol. 173, No. 10, Mar. 11, 1954, p. 71.
[4] E&MJ Metal and Mineral Markets, vol. 25, No. 3, Jan. 21, 1954, p. 7.

FOREIGN TRADE [5]

The United States imported approximately 82 percent of the reported Free-World production of columbium and tantalum mineral concentrates. Nigeria maintained its position of principal supplier of columbium concentrates, furnishing 67 percent of the total. Belgian Congo furnished approximately 15 percent, Norway 5 percent, and West Germany, a new producer in 1954, 4 percent. French Guiana and Madagascar exported columbium mineral concentrate to the United States for the first time. Belgian Congo furnished 43 percent of United States tantalum mineral concentrate imports, Brazil 26 percent, and Portugal 9 percent. West Germany and Madagascar were new suppliers. Imports of columbium mineral concentrates contained an average of 50.6 percent Cb_2O_5 and 17.1 percent Ta_2O_5. Imports of tantalum mineral concentrates contained an average of 41.5 percent Ta_2O_5 and 25.2 percent Cb_2O_5. Columbium-tantalum-bearing tin-smelter slag was imported from Canada, United Kingdom, Malaya, Belgian Congo, and Nigeria. Import figures cannot be revealed; however, the quantity of columbium and tantalum metal in the slag was slightly more than one-third that of the metal imported in columbium and tantalum mineral concentrates.

Material classified as tantalum ore and concentrates was not exported from the United States in 1954. Tantalum metal and alloys in crude form and scrap valued at $3,395 was exported to West Germany. Semifabricated tantalum forms valued at $89,781 were exported, in order of value, to Italy, Canada, France, West Germany, United Kingdom, Union of South Africa, Switzerland, Sweden, Kuwait, New Zealand, and Japan. Tantalum metal powder valued at $4,750 was exported to the United Kingdom. Columbium mineral concentrate valued at $850 was exported to Canada; 22 pounds of columbium metal alloys in crude form valued at $880 was exported to West Germany, and 64 pounds of columbium semifabricated forms valued at $13,320 was exported to the United Kingdom.

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[5] 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.—Columbium mineral concentrates imported for consumption in the United States, 1945–49 (average) and 1950–54, by countries, in pounds

[U. S. Department of Commerce]

Country	1945–49 (average)	1950	1951	1952	1953	1954
South America:						
Argentina						11,023
Bolivia	[1] 1,574			14,678	10,375	5,714
Brazil	4,642	10,981	6,377	5,017	[2] 34,391	124,460
British Guiana				800	2,324	
Total	6,216	10,981	6,377	20,495	47,090	141,197
Europe:						
Belgium-Luxembourg [3]	5,425					
Germany, West						267,957
Norway					[2] 40,367	342,886
Portugal		2,103			68,121	148,732
Spain					4,410	
Sweden					[2] 16,713	
United Kingdom [3]	240					
Total	5,665	2,103			129,611	759,575
Asia:						
Japan [3]		31,835				
Korea, Republic of					2,000	
Malaya				20,264	101,967	180,225
Total		31,835		20,264	103,967	180,225
Africa:						
Belgian Congo	63,027	400,868	177,273	354,732	580,232	976,832
Federation of Rhodesia and Nyasaland					[4] 20,460	11,788
Madagascar						11,060
Mozambique	4,649		17,082	21,205	57,894	31,183
Nigeria	2,524,651	1,280,930	1,336,041	1,450,787	3,167,344	4,575,648
Uganda [5]	6,676			4,622	19,891	4,446
Union of South Africa	364			6,030	34,472	76,714
Total	2,599,367	1,681,798	1,530,396	1,837,376	3,880,293	5,687,671
Oceania: Australia					25,119	35,408
Grand total: Pounds	2,611,248	1,726,717	1,536,773	1,878,135	[2] 4,186,080	6,804,076
Value	$826,719	$752,926	$1,362,393	$2,368,769	[2] $6,890,914	$14,191,142

[1] Classified by U. S. Department of Commerce as from Chile, some of which is believed to be the country of transshipment only.
[2] Revised figure.
[3] Presumably country of transshipment rather than original source.
[4] Southern Rhodesia.
[5] Classified by U. S Department of Commerce as British East Africa.

TABLE 3.—Tantalum mineral concentrates imported for consumption in the United States, 1945–49 (average) and 1950–54, by countries, in pounds

[U. S. Department of Commerce]

Country	1945–49 (average)	1950	1951	1952	1953	1954
South America:						
Argentina	215					
Brazil	62,123	13,378		49,813	[1] 46,146	255,533
French Guiana					10,987	24,809
Total	62,338	13,378		49,813	57,133	280,342
Europe:						
Belgium-Luxembourg [2]	640	85,683	20,876			
Germany, West						62,865
Netherlands [2]	5,900					
Portugal				35,428	154,323	86,279
Spain				741		
Sweden					4,242	19,251
Total	6,540	85,683	20,876	36,169	158,565	168,395
Asia:						
Japan [2]		10,691				
Malaya				2,087	3,639	1,479
Total		10,691		2,087	3,639	1,479
Africa:						
Belgian Congo	238,527	211,433	210,402	236,701	507,282	420,562
Federation of Rhodesia and Nyasaland	[3] 6,762			[3] 233	[3] 8,163	4,944
Madagascar						6,173
Mozambique						10,893
Nigeria	11,690	7,543	5,700	2,273		50,018
Uganda [4]	2,270				2,050	2,158
Union of South Africa	1,006				2,036	4,480
Total	260,255	218,976	216,102	239,207	519,531	499,228
Oceania: Australia	6,219		1,467	1,590	20,541	32,428
Grand total: Pounds	335,352	328,728	238,445	328,866	[1] 759,409	981,872
Value	$292,513	$244,205	$190,383	$398,849	[1] $1,229,534	$1,972,320

[1] Revised figure.
[2] Presumably country of transshipment rather than original source.
[3] Southern Rhodesia.
[4] Classified by U. S. Department of Commerce as British East Africa.

TABLE 4.—Columbium and tantalum mineral concentrates imported for consumption in the United States, 1954, by countries and grades

[U. S. Department of Commerce]

Country	Columbium					Tantalum				
	Concentrates (pounds)	Cb_2O_5		Ta_2O_5		Concentrates (pounds)	Ta_2O_5		Cb_2O_5	
		Pounds	Per cent	Pounds	Per cent		Pounds	Per cent	Pounds	Per cent
South America:										
Argentina	11,023	5,512	50.0	1,653	15.0	----	----	----	----	----
Bolivia	5,714	3,031	53.0	1,029	18.0	----	----	----	----	----
Brazil	124,460	62,022	49.8	27,775	22.3	255,533	124,934	48.9	54,049	21.2
French Guiana	----	----	----	----	----	24,809	11,962	48.2	4,884	19.7
Total	141,197	70,565	50.0	30,457	21.6	280,342	136,896	48.8	58,933	21.0
Europe:										
Germany, West	267,957	109,072	40.7	88,167	32.9	62,865	38,224	60.8	14,051	22.4
Norway	342,886	141,518	41.3	36,733	10.7	----	----	----	----	----
Portugal	148,732	55,680	37.4	42,802	28.8	86,279	33,495	38.8	27,816	32.2
Sweden	----	----	----	----	----	19,251	5,839	30.3	4,169	21.7
Total	759,575	306,270	40.3	167,702	22.1	168,395	77,558	46.1	46,036	27.3
Asia: Malaya	180,225	99,180	55.0	27,981	15.5	1,479	368	24.9	130	8.8
Africa:										
Belgian Congo	976,832	403,541	41.3	300,963	30.8	420,562	143,839	34.2	112,227	26.7
Federation of Rhodesia and Nyasaland	11,788	6,587	55.9	1,678	14.2	4,944	1,923	38.9	1,432	29.0
Madagascar	11,060	4,454	40.3	3,423	30.9	6,173	2,625	42.5	2,078	33.7
Mozambique	31,183	14,586	46.8	8,054	25.8	10,893	5,390	49.5	3,102	28.5
Nigeria	4,575,648	2,489,862	54.4	594,247	13.0	50,018	23,403	46.8	13,151	26.3
Uganda [1]	4,446	1,940	43.6	901	20.3	2,158	978	45.3	264	12.2
Union of South Africa	76,714	30,751	40.0	18,649	24.3	4,480	1,766	39.4	1,340	29.9
Total	5,687,671	2,951,721	51.9	927,915	16.3	499,228	179,924	36.0	133,594	26.8
Oceania: Australia	35,408	14,703	41.5	7,850	22.2	32,428	12,944	39.9	8,953	27.6
Grand total	6,804,076	3,442,439	50.6	1,161,905	17.1	981,872	407,690	41.5	247,646	25.2

[1] Classified by U. S. Department of Commerce as British East Africa.

TECHNOLOGY

The pyrochlore group of minerals (complex columbates of titanium, thorium, cerium metals, calcium, and other bases) were of particular interest in the worldwide search for new sources of columbium. Although deposits of these pyrochlore minerals have been known and recorded in literature for years, they did not become of economic interest until 1951, when the shortage of columbium and tantalum and high prices paid for their ores stimulated beneficiation research. The Norwegian Government developed a mineral-dressing procedure involving calcining and gravity and magnetic separation for concentrating koppite, a pyrochlore-type mineral, from the ores of the Sove fields near Ulefoss, Norway, and in 1954 produced about 30,000 pounds of high-grade concentrate monthly. A similar koppite deposit near Kaiserstuhl, Germany, was mined, and 260,000 pounds of concentrates were exported to the United States. African and Canadian pyrochlore mineral deposits were investigated, and mineral-dressing processes developed in the laboratory were tested on a pilot-plant scale. However, commercial production was not achieved.

Columbium and tantalum have different physical properties, but in many alloys and chemical compounds they produce similar effects.

For many applications they apparently can be used interchangeable. Investigation of the conductivities of columbium and tantalum pentafluorides over a range of temperatures revealed similar partial ionization. The specific conductivities at the melting points are 1.63 x 10^{-5} mho./cm. at 80° C. for CbF_5 and at 95.1° C. for TaF_5.[6] Columbium pentafluoride and tantalum tetrafluoride improve liquid-liquid extraction with liquid hydrofluoric acid in removing aromatic hydrocarbons from other hydrocarbons in either single contact or countercurrent petroleum refining.[7] The Electo Metallurgical Co. Research Laboratories found that columbium and tantalum can be used interchangeably or in combination to impart high-temperature strength to certain alloys.[8]

The solubility limit of oxygen in columbium was determined between 775° and 1,100° C. Solubility is a function of temperature and varies in the temperature range given above from 0.25 to 1.0 percent oxygen, respectively.[9] Temperatures and pressure dependence of the reaction of tantalum in oxygen were investigated from 500° to 1,000° C. at total oxygen pressures of 10 mm. Hg to 600 p. s. i.[10]

Columbium has desirable nuclear properties, a high melting point, and resistance to chemical attack, making it of more than cursory interest to the atomic energy program. The high cost of the pure metal, however, directs research toward investigation of its use as an alloy to enhance the properties of cheaper material. The columbium-vanadium alloy system was investigated as one possible combination for structural use in nuclear reactors. A complete series of solid solutions of the 2 elements is formed with a minimum of solidus at 1,810° C. near 35 weight-percent columbium.[11]

The Bureau of Mines continued to investigate (1) columbium-tantalum mineral beneficiating methods, (2) metallurgical processes for extracting columbium-tantalum compounds from low-grade materials, (3) separation of the compounds from each other, and (4) production of pure columbium and tantalum metals. A report describing progress made in 1953 on the mineral beneficiation and extractive metallurgical development of columbium in Arkansas was published.[12] During 1954 the investigation was continued, mineral-dressing techniques developed in the laboratory were tested in pilot plants, and a fractional-condensation-chlorination process being developed to recover columbium pentachloride and titanium tetrachloride separately was further refined and expanded. A process to recover columbium from Arkansas ores economically was not developed, but small quantities of relatively pure columbium pentoxide were produced. Beneficiation studies of columbium-tantalum-bearing minerals in alluvial black-sand deposits indicated that a satis-

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[6] Fairbrother, F., Frith, W. C., and Woolf, A. A., The Halides of Niobium (Columbium) and Tantalum. The Electrical Conductivities of Niobium and Tantalum Pentafluorides: Jour. Chem. Soc. (London), March 1954, pp. 1031–1038.

[7] Lien, A. P., and McCaulay, D. A., U. S. Patents 2,683,763 and 2,683,764, July 13, 1954.

[8] Electro Metallurgical Co., Columbium and Tantalum. Electromet Data Sheet: Iron Age, vol. 173, No. 9, Mar. 4, 1954, p. 17.

[9] Seybolt, A. U., Solid Solubility of Oxygen in Columbium: Jour. Metals, vol. 6, No. 6, June 1954, pp. 774–776.

[10] Peterson, R. C., Fasiell, W. M., Jr., and Wadsworth, M. E., High-Pressure Oxidation of Metals. Tantalum in Oxygen: Jour. Metals, vol. 6, No. 9, September 1954, pp. 1038–1044.

[11] Wilhelm, H. A., Carlson, O. N., and Dickinson, J. M., Columbium-Vanadium Alloy System: Jour. Metals, vol. 6, No. 8, August 1954, pp. 915–918.

[12] Nieberlein, V. A., Fine, M. M., Calhoun, W. A., and Parsons, E. W., Progress Report on Development of Columbium in Arkansas for 1953: Bureau of Mines Rept. of Investigations 5064, 1954, 23 pp.

factory separation can be made, using gravity, magnetic, and electrostatic methods.[13]

Columbium and tantalum compounds, better than 99 percent pure, were prepared in the Bureau of Mines laboratories at Albany, Oreg., by two methods: (1) Anhydrous columbium and tantalum chlorides were treated by a process involving partial hydrolysis of the chlorides and heat treatment with ammonium chloride, followed by selective chlorination (the process will yield either columbium or tantalum chlorides by careful regulation of the extent of hydrolyses);[14] (2) a feed mixture containing columbium and tantalum in any quantity and ratio was contacted with methyl isobutyl ketone in a perforated-plate pulse column in which the pH was controlled to extract either tantalum or columbium selectively.[15] Ductile tantalum was produced in the Bureau of Mines laboratories at Albany, Oreg., by magnesium reduction of the anhydrous chloride under an inert atmosphere of helium (Kroll process).[16] Tantalum sponge produced by this method was arc-melted and the button rolled to sheet.

A rapid chromatographic method for determining columbium in a hydrofluoric acid solution of an ore was described.[17]

WORLD REVIEW

World production of columbium and tantalum mineral concentrates in 1954 was by far the greatest in history, exceeding by 61 percent the quantity produced in 1953. Record production in Brazil, Belgian Congo, Malaya, Nigeria, and Norway accounted for most of the increase.

Heretofore, world production of columbium and tantalum mineral concentrates by countries has been classified as either columbite concentrates or tantalite concentrates according to information obtained from the country of origin. The production tables were misleading inasmuch as the classification was often erroneous because when columbium and tantalum are present in concentrates in approximately equal quantities it is not possible to determine which predominates without an analysis. This year inaccuracies in production data are recognized. In table 5 mineral-concentrates production is listed in the columbium or tantalum columns if the division between the two reported by the source country is believed to be accurate but is listed between the columbium and tantalum column if there is doubt regarding the classification.

Australia.—Northwest Tantalum N. L. was formed to mine tantalum, columbium, beryllium, and rare earths in Western Australia at Wodgina, Tubba, Strelley, and other places previously operated by

[13] 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.

[14] May, S. L., Henderson, A. W., and Johansen, H. A., Anhydrous Separation of Tantalum and Niobium: Ind. Eng. Chem., vol. 46, December 1954, pp. 2495–2499.

[15] Werning, J. R. Higbie, K. B., Grace, J. T., Speece, B. F., and Gilbert, H. L., Separation of Tantalum and Niobium by Liquid-Liquid Extraction: Ind. Eng. Chem., vol. 46, April 1954, pp. 644–652.

[16] Johansen, H. A., and May, S. L., Ductile Tantalum by Kroll Process: Ind. Eng. Chem., vol. 46, December 1954, pp. 2499–2500.

[17] Hunt, E. C., and Wells, R. A., Inorganic Chromatography on Cellulose. XV. A Rapid Chromatographic Method for the Determination of Niobium in Low-Grade Samples: Analyst (London), vol. 79, No. 939, June 1954, pp. 351–359.

Tantalite, Ltd.[18] Tin and Strategic Minerals, Ltd., tested ground for cassiterite and tantalite at Greenbushes, Australia, and obtained options to increase its holdings to 4,400 acres.[19] The Northern Mineral Syndicate moved most of the tungsten-mineral concentration plant of Northern Development & Mining Co., Pty., Ltd., from Cooke's Creek to its columbite-tantalite leases near the Turner River, about 12 miles from Wodgina, Australia.[20] Preliminary figures indicate that Australia's columbite-tantalite production exceeded 50 tons for the first time on record.[21]

Belgian Congo.—More than a million pounds of columbium-tantalum mineral concentrates were produced in Belgian Congo, principally by the Geomines Co.

British Guiana.—Columbian Corp., New York, disclosed it has been exploring and prospecting in the Mazaruni section of British Guiana for the past few years and is preparing to set up facilities to begin large-scale operations.[22] Heavy, high-grade deposits of columbite distributed over a wide area were discovered in the Upper Barama River in the northwest district, according to the Director of the British Guiana Geological Survey.[23]

British Somaliland.—A Government prospector of the Geological Survey Department gathered 150 pounds of columbite in 7 days in the Hinweina area, near Mandera.[24]

Canada.—The 100-ton concentrator of Boreal Rare Metals, Ltd., installed December 9, 1953, at its columbium-tantalum property on the north shore of Great Slave Lake, about 90 miles east of Yellowknife, Northwest Territories, Canada, was ready for capacity operation in February 1954.[25] In December the company announced that it was about to commence commercial production of tantalum and columbium high-purity oxide.[26] Beaucage Mines began sinking a 4-compartment shaft on its columbium prospect underlying Lake Nipissing, 12 miles west of North Bay, Ontario.[27] The Molybdenum Corp. of America started diamond drilling in Canada near the St. Lawrence River for uranium, thorium, columbium, and tantalum.[28]

Germany.—Germany began exporting columbium mineral concentrates to the United States in October from a koppite deposit at Kaiserstuhl.

Malaya.—Malayan columbite production more than doubled, increasing from 52 tons in 1953 to 111 tons in 1954. A number of Chinese tin-mining companies and individuals explored old columbite deposits around Pava Bakri in Johore, Malaya.[29]

Nigeria.—The Nigerian cassiterite-columbite deposits have been the principal world source of columbium for many years. In 1954 intensive research and investigation were undertaken to develop methods for concentrating minerals of the pyrochlore group to ensure future columbium reserves and continuation of Nigeria's position as principal

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[18] Mining World, vol. 16, No. 1, January 1954, p. 74.
[19] Chemical Engineering and Mining Review (Melbourne), vol. 46, No. 12, Sept. 10, 1954, p. 509.
[20] Industrial and Mining Standard (Melbourne), vol. 109, No. 2766, June 3, 1954, p. 21.
[21] American Metal Market, vol. 62, No. 51, Mar. 15, 1955 p. 11.
[22] Daily Metal Reporter, vol. 54, No. 129, July 8, 1954, pp. 1, 12.
[23] Metal Industry (London), vol. 85, No. 16, Oct. 15, 1954, p. 336.
[24] Delgado-Arias, D. E., State Department Dispatch 202, Aden (Arabia), Dec. 2, 1954.
[25] Western Miner and Oil Review (Vancouver), vol. 27, No. 2, February 1954, p. 92.
[26] Metal Bulletin (London), No. 3954, Dec. 21, 1954, p. 25.
[27] Engineering and Mining Journal, vol. 155, No. 12, pp. 144, 146.
[28] Mining World, vol. 16, No. 4, April 1954, p. 33.
[29] Metal Bulletin (London), No. 3942, Nov. 9, 1954, p. 28.

TABLE 5.—World production of columbium and tantalum concentrates by countries,[1] 1945–49 (average) and 1950–54, in pounds

(Compiled by Berenice B. Mitchell and Jane Lancaster)

<table>
<tr><th rowspan="2">Country [1]</th><th colspan="2">1945–49 (average)</th><th colspan="2">1950</th><th colspan="2">1951</th><th colspan="2">1952</th><th colspan="2">1953</th><th colspan="2">1954</th></tr>
<tr><th>Columbium</th><th>Tantalum</th><th>Columbium</th><th>Tantalum</th><th>Columbium</th><th>Tantalum</th><th>Columbium</th><th>Tantalum</th><th>Columbium</th><th>Tantalum</th><th>Columbium</th><th>Tantalum</th></tr>
<tr><td>Argentina</td><td colspan="2">416</td><td colspan="2">(2)</td><td colspan="2">(2)</td><td colspan="2">(2)</td><td colspan="2">(2)</td><td colspan="2">(2)</td></tr>
<tr><td>Australia</td><td>-----</td><td>3,759</td><td>-----</td><td>16,536</td><td>-----</td><td>5,125</td><td>-----</td><td>16,108</td><td>-----</td><td>18,124</td><td>-----</td><td>117,767</td></tr>
<tr><td>Belgian Congo [3]</td><td colspan="2">346,185</td><td colspan="2">297,675</td><td colspan="2">209,437</td><td colspan="2">231,042</td><td colspan="2">623,902</td><td colspan="2">[4] 1,102,300</td></tr>
<tr><td>Bolivia [5]</td><td>1,574</td><td>-----</td><td>-----</td><td>-----</td><td>1,043</td><td>-----</td><td>-----</td><td>-----</td><td>3,366</td><td>-----</td><td>[6] 5,714</td><td>-----</td></tr>
<tr><td>Brazil</td><td>[5] 11,974</td><td>[5] 67,252</td><td>[5] 26,709</td><td>[5] 18,700</td><td>[5] 11,000</td><td>[5] 8,818</td><td>[6] 5,017</td><td>[6] 49,813</td><td>[6] 34,391</td><td>[6] 46,146</td><td>[6] 130,866</td><td>[6] 267,517</td></tr>
<tr><td>British Guiana [6]</td><td>5,846</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>800</td><td>-----</td><td>2,324</td><td>-----</td><td>4,480</td><td>-----</td></tr>
<tr><td>French Equatorial Africa</td><td>-----</td><td>-----</td><td colspan="2">3,655</td><td>-----</td><td>-----</td><td colspan="2">3,527</td><td colspan="2">3,514</td><td colspan="2">6,261</td></tr>
<tr><td>French Guiana</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>13,228</td><td colspan="2">[6] 24,809</td></tr>
<tr><td>Germany, West</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>[6] 261,551</td><td>[6] 43,875</td></tr>
<tr><td>Madagascar</td><td>5</td><td>-----</td><td>-----</td><td>-----</td><td>8,598</td><td>-----</td><td>5,732</td><td>-----</td><td>8,377</td><td>-----</td><td>36,596</td><td>-----</td></tr>
<tr><td>Malaya</td><td colspan="2">[4] 600</td><td>17,920</td><td>-----</td><td colspan="2">56,000</td><td>105,280</td><td>-----</td><td>116,480</td><td>-----</td><td>248,640</td><td>-----</td></tr>
<tr><td>Mozambique</td><td>861</td><td>-----</td><td colspan="2">7,700</td><td colspan="2">[7] 11,257</td><td colspan="2">32,652</td><td colspan="2">[7] 58,133</td><td colspan="2">[6] 31,183</td></tr>
<tr><td>Nigeria</td><td>2,863,168</td><td>10,843</td><td>1,935,360</td><td>2,240</td><td>2,419,200</td><td>6,720</td><td>2,896,320</td><td>2,240</td><td>4,388,160</td><td>-----</td><td>6,527,360</td><td>22,400</td></tr>
<tr><td>Norway [6]</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>40,367</td><td>-----</td><td>342,886</td><td>-----</td></tr>
<tr><td>Portugal</td><td>-----</td><td>-----</td><td colspan="2">[5] 3,009</td><td colspan="2">[5] 4,526</td><td>-----</td><td>-----</td><td colspan="2">[5] 213,846</td><td>[6] 148,732</td><td>[6] 86,279</td></tr>
<tr><td>Southern Rhodesia</td><td>-----</td><td>17,180</td><td>-----</td><td>1,700</td><td>-----</td><td>-----</td><td>-----</td><td>10,360</td><td>-----</td><td>34,000</td><td>18,060</td><td>14,300</td></tr>
<tr><td>South-West Africa</td><td>-----</td><td>1,175</td><td>-----</td><td>12,570</td><td>-----</td><td>3,974</td><td>-----</td><td>4,400</td><td>-----</td><td>17,634</td><td>22,439</td><td>3,868</td></tr>
<tr><td>Spain [6]</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>741</td><td>4,410</td><td>-----</td><td>-----</td><td>-----</td></tr>
<tr><td>Sweden [6]</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>16,713</td><td>4,242</td><td>-----</td><td>-----</td></tr>
<tr><td>Uganda</td><td>5,747</td><td>727</td><td colspan="2">[5] 11,413</td><td colspan="2">[5] 42,560</td><td colspan="2">[5] 9,094</td><td colspan="2">23,542</td><td colspan="2">[8] 23,117</td></tr>
<tr><td>Union of South Africa</td><td>-----</td><td>955</td><td>-----</td><td>4,000</td><td>-----</td><td>6,000</td><td>-----</td><td>8,000</td><td>-----</td><td>38,000</td><td>-----</td><td>46,000</td></tr>
<tr><td>United States (mine shipments)</td><td colspan="2">3,001</td><td colspan="2">1,000</td><td colspan="2">925</td><td colspan="2">5,385</td><td colspan="2">14,867</td><td colspan="2">32,829</td></tr>
<tr><td>World total (estimate)</td><td colspan="2">3,400,000</td><td colspan="2">2,410,000</td><td colspan="2">2,850,000</td><td colspan="2">3,440,000</td><td colspan="2">5,780,000</td><td colspan="2">9,625,000</td></tr>
</table>

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 the production figure has been centered.

2 Data not available; estimate by author of chapter included in total.

3 In addition, tin-columbium-tantalum concentrates were produced as follows: 1947, 597,555 pounds, columbium-tantalum content unspecified; 1948, 1,148,050 pounds; 1949, 1,944,457 pounds; 1950, 2,431,674 pounds; 1951, 2,597,019 pounds; 1952, 2,813,070 pounds; 1953, 3,575,861 pounds; 1954, 3,941,825 pounds; columbium-tantalum content averaging about 10 percent.

4 Estimate.

5 Exports.

6 United States imports.

7 In addition to figure shown, 176 pounds of samarskite was produced in 1951 and 132 in 1953.

8 Tin-tantalum-columbium 5,846 pounds.

supplier. Principal tin, columbian-tantalum mines of Nigeria in approximate order of tin concentrate production were: Amalgamated Tin Group, Bisichi, Ex-Lands Nigeria, Gold & Base Metal Mines of Nigeria, Jantar Nigeria, Jos Tin, Kaduna Syndicate, Keffi Tin, London Tin, Naraguta Tin, Naraguta Extension, Naraguta Karama, Ribon Valley, Rukuba, Kaduna Prospectors, South Bukuru, Tin Fields of Nigeria, United Tin Areas, and Filani.[30] Columbite production from these mines has been erratic owing to variation in the concentration of the mineral in the alluvial deposits being mined. Tin & Associated Minerals, with a production of 188 tons of concentrates during the financial year ended March 31, 1954, is the newest company to become a Nigerian columbite producer.[31]

Norway.—Three columbium deposits, the Cappelen, Hydro, and Tufte deposits, have been found at Ulefoss, Norway. Only the Cappelen deposit has been exploited. Estimated ore reserves exceed 400,000 tons.[32] It has been reported that Norsk Bergverk, the operating company, is considering research to study the possibilities of ferrocolumbium production.[33]

South-West Africa.—Uis Tin Mining Co. installed a Dings magnetic separator for recovering columbite and tantalite from cassiterite concentrate obtained from ore mined at its Southwest Africa tin properties. Extraction was reported as satisfactory.[34]

[30] Sinclair, W. E., Columbite in Nigeria: Min. Jour. (London), vol. 242, No. 6201, pp. 769–770.
[31] Mining World, vol. 17, No. 1, January 1955, p. 69.
[32] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 1, Jan. 1, 1955, pp. 5–6.
[33] Mining World, vol. 16, No. 9, August 1954, p. 66.
[34] Mining World, vol. 16, No. 3, March 1954, p. 73.

Copper

By Helena M. Meyer[1] and Gertrude N. Greenspoon[2]

THE NATION'S copper industry in 1954 was marked by changing conditions of supply and demand. As the year began, consumption was declining, and supplies exceeded requirements. In January and February the principal producers moved to curtail production, and the quantities of copper received from abroad dropped. Early in the year the downtrend in consumption was reversed and before midyear producers resumed higher rates of operation; from time to time new large properties came into production. A period of inadequate supply developed in the latter half of the year, caused chiefly by serious labor strikes at some leading copper-producing properties. The Office of Defense Mobilization released Government copper to distressed users of the metal in the final quarter of the year in a move to relieve the temporary shortage.

Thus, domestic copper mine production did not increase in 1954, as was anticipated with the bringing into production of the new mines, but declined 10 percent to 835,500 tons. Smelter and refinery production from domestic primary materials dropped similarly, but refinery output from primary foreign materials rose 3 percent. Consumption of refined copper (1,255,000 tons) continued large for a peacetime year but was 16 percent below the high rate in 1953. Total imports declined 13 percent to 590,300 tons, whereas the exports of 216,000 tons of refined copper—the principal class—were almost double the 1953 rate. Producers' and consumers' inventories of blister and refined copper and of materials in process of fabrication decreased 16 percent in 1954. Quoted prices for domestic copper averaged 30 cents in 1954, an increase of 3 percent. Prices on the London Metal Exchange, on the other hand, moved upward sharply in the last months of the year and established a new alltime peak of £310 per long ton (equivalent to 38.75 cents a pound) in October; the average for 1954 was about £249 (31.125 cents a pound).

Four new large operations reached the production stage in 1954. The first three, all in Arizona, were open-pit mines. The Silver Bell mine, Pima County, of the American Smelting & Refining Co., started in April; the Bisbee East (Lavender pit) mine, Cochise County, of the Phelps Dodge Corp., started in July; and the Copper Cities, Gila County, owned by a subsidiary of the Miami Copper Co., started in August. The properties reached planned annual rates of 18,000, 38,000, and 22,500 tons, respectively, during the year. The fourth large mine to come into production was the White Pine, Ontonagon

[1] Assistant chief, Branch of Base Metals.
[2] Statistical assistant.

County, Mich., which started in October and was expected to produce 36,000 tons annually. This was an underground operation. The San Manuel underground mine, Pinal County, Ariz., owned by a subsidiary of the Magma Copper Co., Arizona, and largest of all, was not to reach the production stage before the end of 1955; an annual production rate of 70,000 tons was anticipated. The Kelley mine of the Anaconda Copper Mining Co., Butte, Mont., initially in production in 1952, was scheduled to attain an annual rate of 45,000 tons of copper in the first half of 1955. More than offsetting the gains in new productive capacity were the interruptions to output due to widespread labor strikes in August to October and to the voluntary curtailments by mining companies in the early months of the year, when it appeared that supplies would exceed demand. The voluntary cuts were attained chiefly by reducing the working hours per week rather than the number of miners employed. The chief work stoppages due to labor strikes began at the Arizona, Nevada, New Mexico, and Utah properties of the Kennecott Copper Corp. in mid-August and spread a week later to the Arizona mines of the Miami Copper Co. and Inspiration Consolidated Copper Co., the Miami smelter of the International Smelting & Refining Co., and the Butte and Great Falls, Mont., properties of the Anaconda Copper Mining Co. The Kennecott strikes were settled on September 1 and those at Miami, Inspiration, and International on September 16. The Garfield, Utah, smelter of the American Smelting & Refining Co., which smelts the output of the Utah mine of Kennecott, was closed by strike on September 13 and the Kennecott Garfield refinery September 14; both strikes were settled October 13. The strike at Anaconda's Montana plants was settled October 16.

To relieve the strike-induced shortage of copper, the Office of Defense Mobilization authorized release to distressed consumers of copper accumulated under the Defense Production Act and diversion of copper scheduled for delivery to the Government in October to December, inclusive. This action was taken after the strikes ended. The total quantity involved was originally expected to be about 50,000 tons of copper, but actually only about 40,000 tons was allocated. In response to a request of the Canadian Department of Defense Production in November, the ODM postponed scheduled delivery of 26,000 tons of Canadian copper to aid distressed Canadian consumers.

Consumption of refined copper was trending downward as 1954 began and totaled 97,000 tons in January. It rose to a monthly average of 107,000 tons in March to June, inclusive, and, following brass-mill vacations in July, again averaged 107,000 in August to October; 124,000 tons in December marked the peak for 1954, whereas 74,000 tons in July was the low point. Altogether consumption in 1954 was 16 percent less than in 1953.

The Chilean Government policy in 1953 of maintaining the price for copper at more than 6 cents a pound above the level for United States metal led to a large accumulation of unsold Chilean copper, partly in that country and partly in the United States. At the outset of 1954 the accumulation was stated in the press to be 180,000 tons. In August 1953 the Chilean Government had formally requested the United States Government to purchase the accumulated stocks for

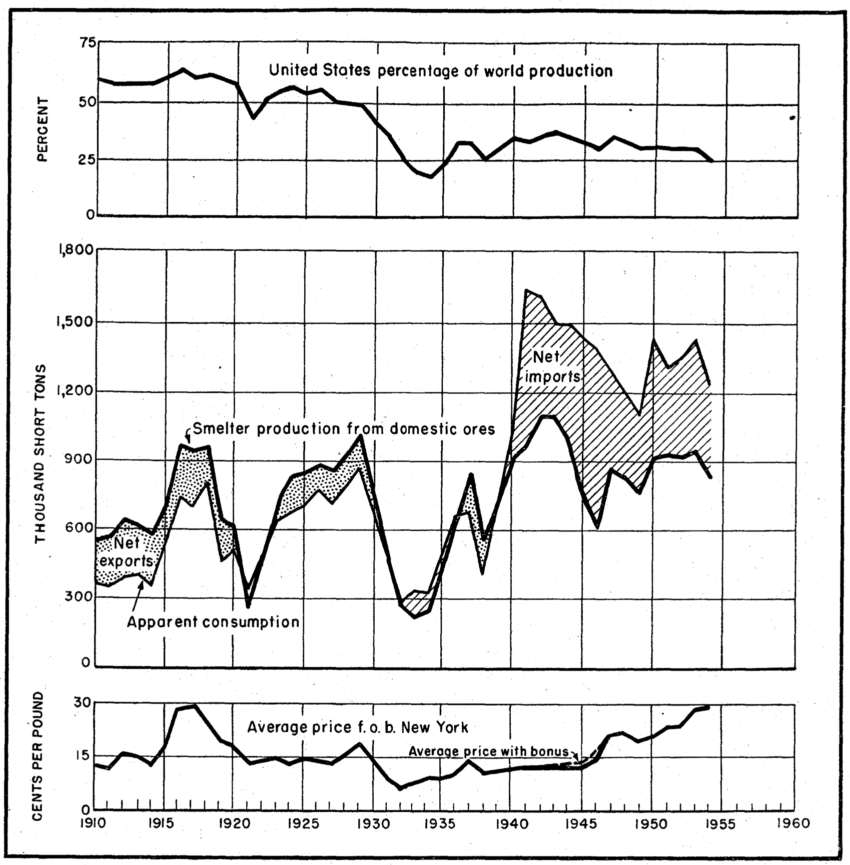

FIGURE 1.—Production, consumption, and price of copper in the United States, 1910–54.

the strategic stockpile. In March 1954 the two governments reached agreement for the purchase by the United States of 100,000 tons of copper "at market," and contracts were signed in May with the Anaconda Sales Co. for 64,000 tons and with Kennecott Sales Corp. for 36,000 tons of Chilean copper for delivery to the stockpile.

At the beginning of 1954 Chilean copper was selling in the United States at the price level for domestic copper, in contrast with the situation in 1953. In January prices for electrolytic copper delivered in the United States ranged from 29.5 to 30 cents a pound and beginning March 3 were 29.75 to 30 cents; after April 12 and through the end of the year a single price of 30 cents a pound prevailed. There was considerable fluctuation on the London Metal Exchange, but prices did not deviate greatly from those in the United States until September. Temporarily reduced world supplies, beginning in the third quarter, combined with threats of strikes at Rhodesian mines, led in October to increased prices on the London exchange to an alltime peak of £310 per long ton (equivalent to 38.75 cents a pound). The fact that the United Kingdom broker discontinued selling copper

TABLE 1.—Salient statistics of the copper industry in the United States, 1945–49 (average) and 1950–54, in short tons

	1945–49 (average)	1950	1951	1952	1953	1954
New (primary) copper produced—						
From domestic ores, as reported by—						
Mines	763,351	909,343	928,330	925,359	926,448	835,472
Copper ore produced [1]	77,666,359	94,585,792	95,494,214	99,947,492	101,064,945	93,654,258
Average yield of copper, percent	.91	.89	.90	.85	.85	.83
Smelters	769,132	911,352	930,774	927,365	943,391	834,381
Percent of world total	30	31	30	30	29	25
Refineries	763,683	920,748	951,559	923,192	932,232	841,717
From foreign ores, matte, etc., refinery reports	272,837	319,086	255,429	254,504	360,885	370,202
Total new refined, domestic and foreign	1,036,521	1,239,834	1,206,988	1,177,696	1,293,117	1,211,919
Secondary copper recovered from old scrap only	459,187	485,211	458,124	414,635	429,388	407,066
Imports (unmanufactured) [2]	544,724	690,389	489,135	618,880	[3] 676,104	590,323
Refined	272,030	317,363	238,972	346,960	[3] 274,111	215,146
Exports of metallic copper [4]	166,008	192,339	166,274	[5] 212,390	[3,5] 171,393	[5] 312,461
Refined (ingots and bars)	105,852	144,561	133,305	174,135	[3] 109,580	215,951
Stocks at end of year (producers)	331,200	258,000	217,000	211,000	272,000	214,000
Refined copper	82,800	26,000	35,000	26,000	49,000	25,000
Blister and materials in solution	248,400	232,000	182,000	185,000	223,000	189,000
Withdrawals (apparent) from total supply on domestic account:						
Total new copper	1,276,000	1,447,000	1,304,000	1,360,000	1,435,000	1,235,000
Total new and old copper (old scrap only)	1,735,000	1,932,000	1,762,000	1,775,000	1,864,000	1,642,000
Price average [6] ____ cents per pound	17.7	20.8	[7] 24.2	[7] 24.2	[7] 28.7	[7] 29.5
World smelter production, new copper	2,540,000	2,915,000	[3] 3,085,000	[3] 3,105,000	3,275,000	3,275,000

[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 manufacturers of copper," for which quantity figures are not recorded before 1953. (See table 31.)
[5] Due to changes in classifications 1952–54 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 Feb. 1, 1942, to June 30, 1947, inclusive.
[7] Exclusive of copper produced abroad and delivered in the United States.

on the exchange May 31, removing that market support, was a factor in the London situation. From September London prices fluctuated widely and remained well above those in the United States.

In June President Eisenhower signed a bill continuing for another year, from June 30, 1954, suspension of the excise tax (2 cents a pound) on copper and in August signed one extending suspension of duties on metal scrap, other than lead and zinc with certain exceptions, to June 30, 1955.

Of the 590,300 tons of copper imported in unmanufactured form in 1954, Chile supplied 45 percent, compared with 42 percent in all of 1953 and 59 percent in 1952. A little less than half of the tonnage from Chile in 1954 was refined copper and the remainder chiefly blister. Canada ranked next to Chile as a supplier in 1954, as in other recent years, but was the source of only about one-third as much total copper. All classes, except concentrate shared the drop in imports in 1954; imports of concentrate increased slightly and were supplied chiefly by Canada, Cuba, and the Philippines in both years.

Exports of refined copper, by far the largest copper export class, were almost twice as large in 1954 as in 1953. Of the 6 leading destinations in 1954 all except 1—Brazil—were in Europe.

Producers' stocks of refined copper at the end of 1954 was at or close to the lowest level of the 20th century and were only half of those at the beginning of the year. Smelter and refinery stocks of blister and materials in process of refining declined 15 percent in 1954, and fabricators' inventories of refined copper, of materials in process of fabrication, and of primary fabricated shapes, according to the U. S. Copper Association, fell 5 percent from 381,000 tons to 361,000.

World mine production of copper in 1954 was 3,100,000 short tons, or little changed from the 3,050,000 tons in 1953. The decrease in the United States was substantially counterbalanced by increases in Canada, Northern Rhodesia, Belgian Congo, and some smaller copper-producing countries. Chile's output remained virtually unchanged and fell below that in Northern Rhodesia for the second year in succession. Production in Chile, like that in the United States, would have advanced in 1954 except for labor strikes in August and September and for the voluntary workweek cutbacks in earlier months of the year. Northern Rhodesia and Belgian Congo established new high record productions for the fifth successive year.

Announcement by the Export-Import Bank in November that it was prepared in principle to extend the American Smelting & Refining Co. a credit of not to exceed $100 million to assist in the costs of financing the Toquepala copper project, southern Peru, promised to speed exploitation at this large mine. On January 6, 1955, A. S. & R. announced that it had completed preliminary negotiations with Cerro de Pasco Corp., Newmont Mining Corp., and Phelps Dodge Corp. to bring the property into operation.

A Foreign Operations Administration loan amounting to about $10 million made in June, was for the purpose of increasing the capacity of the Rhodesian railroads for transporting copper and other materials.

An FOA loan of $1,428,000 was granted to the French Government in July as an aid to the development of a copper deposit at Akjoujt, Mauritania.

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 in 1954. Contracts let to the end of 1953 were described in Minerals Yearbooks for earlier years. A maintenance-of-production contract was amended in 1954, and a company was granted tax-amortization assistance as shown in table 2.

Defense Minerals Exploration Administration contracts awarded in 1954 (amounting to 50 percent of costs in the case of copper) were as follows:

State and contractor:	*Location*	*Government participation*
Alaska: Alaska Copper Mines, Inc.	Talkeetna mining district.	$6,365
Idaho: Centrida Mines, Inc.	Lemhi County	31,570
Montana: Norman E. Boe & James Van Gorder.	Jefferson County	13,365
Washington: Chewelah Copper Co., Inc.	Stevens County	31,550

TABLE 2.—Contracts for expansion and maintenance of supply of copper under the Defense Production Act, as amended, in 1954

Type of contract, name of contractor, and location of project	Government contingent purchase commitments (pounds)	Effective date of contract	Date production starts	Approximate term of contract	Commitment purchase price (per pound)
Maintenance of production:					
Appalachian Sulphides, Inc.	[1] 4,000,000	Mar. 19, 1954	July 1, 1954	1½ years	$0.3106

Type of contract or assistance, name of contractor and location of project	Approximate amount involved	Effective date of contract
Tax amortization: [2]		
U. S. Metals Refining Co., Carteret, N. J.	$68,000	June 8, 1954

[1] Original contract provided for 12,000,000 pounds.
[2] Amortization—5 years at 75 percent of total amount involved.

DOMESTIC PRODUCTION

Copper production usually occurs in three stages—mining, smelting, and refining—upon each of which an annual production record may be based. These separate determinations of production are desirable because each of them has, for certain purposes, a particular advantage over the others. As they show different aspects of production the three sets of figures will never agree exactly, but taken together they afford complete data on the output of copper.

Geographic distribution of output is shown more precisely by statistics of mine production than by those of smelter and refinery production. Likewise, the character of the ores produced, their contents of copper and other valuable metals, and the treatment, other than smelting, they may have undergone can be learned accurately only from the mines themselves. On the other hand, mine statistics show only the estimated recoverable metal content of the ores.

The actual quantity of crude copper recovered from copper ores and from other ores having a low content of copper is shown by the smelter statistics. Lead and zinc ores, siliceous ores of the precious metals, and pyrite roasted in the manufacture of sulfuric acid often carry so little copper that the mines are not paid for it and do not report it, causing a difference between the figures of mine and of smelter production. The lag in time between the production and the smelting of an ore is another cause. For example, most of the ore mined in December of any year is not represented in the figures of smelter production for that year but enters into the figures of the year following. A third cause of difference between these two sets of figures is that the quantity of metal contained in ore, matte, and other material held in stock at smelters is rarely the same at the beginning and the end of a year.

The precise quantity of copper made available for consumption in a given period, as well as that of the precious metals recovered from crude copper, is shown only by refinery statistics, but these afford little detailed information on the distribution of output according to source.

Differences between smelter and refinery statistics are similar in origin to those existing between mine and smelter statistics, as some time must elapse after the copper is smelted before it is refined; and the quantity of copper in stocks of untreated or unfinished material at the beginning of the year differs from that at the end, not only at smelters but at the refineries as well.

Two or three months usually elapse between the time ore is mined and the time the copper derived from it becomes available for commercial use. Hence, the refinery statistics for the calendar year 1954 represent approximately the ore mined between October 1953 and October 1954. In periods when the course of production is little disturbed by pronounced fluctuations of activity the three sets of statistics on production from domestic ores should not differ greatly. Any decided rise or fall in production between October of one year and March of the year following, however, tends to accentuate the differences among the three sets of figures.

In order that smelter and refinery figures may coincide as nearly as possible smelter figures must include some refined copper that does not require smelting. The foregoing include the furnace-refined Lake copper and copper produced directly through the leaching of ores and subsequent precipitation by electrolysis.

TABLE 3.—Copper produced from domestic [1] ores, as reported by mines, smelters, and refineries, 1950–54, in short tons

Year	Mine	Smelter	Refinery
1950	909, 343	911, 352	920, 748
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

[1] Includes Alaska.

PRIMARY COPPER

Mine Production.—The figures for mine production are prepared from reports supplied voluntarily by all domestic mining companies that produce copper. These data are classified geographically, by metallurgical method, and by type of ore. Tables presenting the information in detail are to be found in the geographic area chapters appearing in volume III.

United States production was adversely affected by labor strikes in 1954, and output dropped 10 percent, despite the bringing into production during the year of four new, large operations.

Arizona continued to lead all other States by a wide margin in production in 1954, supplying 45 percent of the total for the United States, followed by Utah, with 25 percent. Arizona's output came from a number of important copper-producing districts and mines. In 1954 three new operations—all open pits—reached the production stage; the Silver Bell, Bisbee East (Lavender Pit), and the Porphyry Reserve (Copper Cities). Utah's output was predominantly from one mine—the Utah Copper mine—the largest copper producer in the United States. Production from Nevada, New Mexico, Montana, and Michigan, ranking next in importance as copper producers in

1954, made up 26 percent of the total. These 6 States produced 96 percent of the United States total in 1954. Nevada, which ranked fifth since 1943, rose to third place in 1954, following the first full year's operation of the Yerington mine; factors affecting the standings, however, were the aforementioned strikes that sharply curtailed Montana's and New Mexico's outputs. Too late to have an effect on Michigan's rank in 1954 was the starting of production in October at the White Pine mine, Ontonagon County. This mine was being operated by underground mining methods.

Classification of production by mining methods shows that approximately 79 percent of the recoverable copper and 83 percent of the copper ore came from open pits in 1954. 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 because of their fluxing qualities.

The first 5 mines in table 8 produced 60 percent of the United States total, the first 10 produced 80 percent, and the entire 25 furnished 97 percent.

Quantity and Estimated Recoverable Content of Copper-Bearing Ores.—Tables 9 to 12 list the quantity and estimated recoverable copper content of the ore produced by copper mines in the United States in 1954. Of the total copper produced from copper ores in the United States during 1954 (1953 data in parentheses), 92 percent (93) was obtained from ores concentrated before smelting, 5 percent (3) from direct-smelting ores, and 3 percent (4) from ore treated by straight leaching.

Close agreement between the output as reported by smelters and the recoverable quantity as reported by mines indicates that the estimated recoverable tenor is close to actual recovery. Classification of some of the complex western ores is difficult and more or less arbitrary. "Copper ores" include not only all those that contain 2.5 percent or more recoverable copper but also those that contain less than this percentage if they are valuable chiefly for copper, notably the "porphyry ores." Mines report considerable copper from ores mined primarily for other products. These include siliceous gold and silver ores, lead and zinc ores, and pyritic ores.

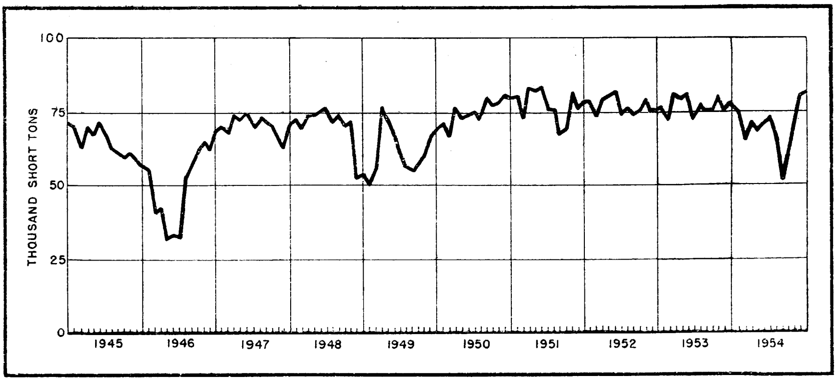

FIGURE 2.—Mine production of recoverable copper in the United States, 1945–54, by months, in short tons.

TABLE 4.—Copper ore and recoverable copper produced by open-pit and underground methods, 1939–54, percent of total

Year	Open pit		Underground		Year	Open pit		Underground	
	Ore	Copper	Ore	Copper		Ore	Copper	Ore	Copper
1939	59	41	41	59	1947	73	68	27	32
1940	61	44	39	56	1948	76	68	24	32
1941	63	47	37	53	1949	78	70	22	30
1942	66	51	34	49	1950	81	74	19	26
1943	69	54	31	46	1951	84	74	16	26
1944	68	57	32	43	1952	85	77	15	23
1945	68	61	32	39	1953	83	75	17	25
1946	66	58	34	42	1954	83	79	17	21

TABLE 5.—Mine production of recoverable copper in the United States in 1954, by months [1]

Month	Short tons	Month	Short tons
January	74,484	August	51,538
February	65,137	September	62,017
March	71,063	October	71,034
April	68,183	November	80,081
May	71,241	December	81,613
June	72,737		
July	66,344	Total	835,472

[1] Includes Alaska. Monthly figures adjusted to final annual mine production total.

TABLE 6.—Mine production of copper in the principal districts [1] of the United States, 1945–49 (average) and 1950–54, in terms of recoverable copper, in short tons

District or region	State	1945–49 (average)	1950	1951	1952	1953	1954
West Mountain (Bingham)	Utah	204,402	277,655	270,183	282,098	268,511	210,643
Copper Mountain (Morenci)	Arizona	126,868	154,689	143,921	124,882	123,789	114,362
Globe-Miami	do	85,380	84,688	90,225	93,079	86,478	63,222
Ajo	do	49,367	64,400	63,093	63,808	64,730	60,794
Summit Valley (Butte)	Montana	63,339	53,897	56,826	61,557	77,520	59,240
Central (including Santa Rita)	New Mexico	[2] 57,655	63,694	71,526	74,008	69,869	58,178
Robinson (Ely)	Nevada	44,900	52,087	56,198	57,148	60,557	43,972
Warren (Bisbee)	Arizona	12,655	13,345	27,271	27,440	29,344	41,884
Mineral Creek (Ray)	do	18,462	36,442	50,580	49,274	47,574	40,462
Pioneer (Superior)	do	15,373	22,636	17,662	17,716	25,093	26,521
Yerington	Nevada	62	12	(3)	----	(3)	(3)
Lake Superior	Michigan	24,706	25,608	24,979	21,699	24,097	23,593
Silver Bell	Arizona	26	22	1	71	85	(3)
Ducktown	Tennessee	6,790	6,851	7,069	7,620	7,829	9,087
Eureka (Bagdad)	Arizona	6,336	10,673	9,087	9,228	10,072	8,838
Orange County	Vermont	2,466	3,504	3,774	3,774	3,947	4,352
Pima (Sierritas, Papago, Twin Buttes).	Arizona	293	282	334	1,090	1,353	4,182
Chelan Lake	Washington	[4] 4,683	[5] 4,904	3,932	[6] 4,273	[6] 3,614	[7] 3,534
Lebanon (Cornwall mine)	Pennsylvania	3,868	4,142	5,297	3,485	3,027	3,270
Coeur d'Alene	Idaho	1,140	1,896	1,874	1,862	2,100	2,566
Redcliff (Battle Mountain)	Colorado	136	326	278	195	440	2,355
Lordsburg	New Mexico	1,551	2,061	1,521	1,475	1,988	2,210
San Juan Mountains	Colorado	1,524	2,582	2,712	3,157	2,376	2,076
Blackbird	Idaho	2	----	148	[8] 1,214	(3)	(3)
Cochise	Arizona	835	498	1,350	1,838	1,849	1,947
Southeastern Missouri	Missouri	2,611	2,982	2,422	2,576	2,374	1,925
Verde (Jerome)	Arizona	16,530	13,291	9,742	4,524	626	(3)

[1] Districts producing 1,000 short tons or more in any year of the period 1950–54.
[2] Includes average for Burro Mountain for 1945–46 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 Peshastin Creek and Wenatchee to avoid disclosing individual company operations.
[6] Includes Ferry to avoid disclosing individual company operations.
[7] Includes Ferry and King to avoid disclosing individual company operations.
[8] Includes Spring Mountain and Texas to avoid disclosing individual company operations.

TABLE 7.—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

State	Maximum production[1]		Production by years											Total production from earliest record to end of 1954
	Year	Quantity	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	
Western States and Alaska:														
Alaska	1916	59,927	2	5	2	12	16	4	6	1	------	------	4	685,909
Arizona	1951	415,870	358,303	287,203	289,223	366,218	375,121	359,010	403,301	415,870	395,719	393,525	377,927	14,264,783
California	1909	28,644	12,721	6,473	4,240	2,407	481	649	646	921	800	382	362	632,472
Colorado	1938	14,171	1,048	1,485	1,754	2,150	2,298	2,403	3,141	3,212	3,606	2,941	4,523	274,985
Idaho	1907	5,445	1,688	1,548	1,038	1,640	1,624	1,438	2,107	2,160	3,213	3,136	4,828	127,933
Montana	1916	176,464	118,190	88,506	58,481	57,900	58,252	56,611	54,478	57,406	61,948	77,617	59,349	7,061,914
Nevada	1942	83,663	61,232	52,595	48,616	49,603	45,242	38,058	52,569	56,474	57,537	61,850	70,217	2,214,218
New Mexico	1942	80,100	69,730	56,571	50,191	60,205	74,687	55,388	66,300	73,558	76,112	72,477	60,558	1,889,484
Oregon	1916	1,791	3	1	7	14	2	20	19	11	1	9	5	12,424
South Dakota	1918	32	1	------	------	------	------	------	------	------	------	------	------	106
Texas	1928	224	115	55	3	6	23	24	2	1	18	------	------	1,383
Utah	1943	323,989	282,575	226,376	114,284	266,533	227,007	197,245	278,630	271,086	282,894	269,496	211,835	6,905,167
Washington	1940	9,612	6,169	5,821	4,527	2,240	5,665	5,275	5,057	4,089	4,357	3,740	3,636	112,985
Wyoming	1900	2,102	------	------	1	------	------	------	------	------	------	1	1	16,328
Total	------	------	911,777	726,639	572,367	808,928	790,418	716,125	866,256	884,789	886,205	885,174	793,245	34,200,091
West Central States: Missouri	1949	3,670	3,302	3,399	1,857	1,760	2,370	3,670	2,982	2,422	2,576	2,374	1,925	[2] 39,757
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	42,421	30,401	21,663	24,184	27,777	19,506	25,608	24,979	21,699	24,097	23,593	5,010,933
New Hampshire	1908	[4] 94	------	------	------	------	------	------	------	------	------	------	------	(3)
North Carolina	1930	6,695	282	------	------	------	------	------	------	------	------	------	(5)	(3)
Pennsylvania	1942	6,410	4,942	3,565	2,839	3,613	5,347	3,974	4,142	5,297	3,485	3,027	3,270	(3)
South Carolina	(3)	(3)	------	------	------	------	------	------	------	------	------	------	------	(3)
Tennessee	1930	10,584	7,636	6,959	6,985	6,825	6,693	6,489	6,851	7,069	7,620	7,829	9,087	(3)
Vermont	1954	4,352	1,898	1,861	3,026	2,248	2,208	2,986	3,504	3,774	3,774	3,947	4,352	(3)
Virginia	1944	291	291	70	------	5	------	------	------	------	------	------	------	(3)
Wisconsin	1914	5	------	------	------	------	------	------	------	------	------	------	------	(2)
Total	------	------	57,470	42,856	34,513	36,875	42,025	32,955	40,105	41,119	36,578	38,900	40,302	[6] 5,697,493
Grand total	1943	1,090,818	972,549	772,894	608,737	847,563	834,813	752,750	909,343	928,330	925,359	926,448	835,472	[7] 39,937,341

[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 Hanpshire 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 8.—Twenty-five leading copper-producing mines in the United States in 1954, in order of output

Rank	Mine	District	State	Operator	Source of copper
1	Utah Copper	West Mountain (Bingham)	Utah	Kennecott Copper Corp	Copper ore.
2	Morenci	Copper Mountain (Morenci)	Arizona	Phelps Dodge Corp	Do.
3	New Cornelia	Ajo	do	do	Copper ore and tailings.
4	Butte Mines	Summit Valley (Butte)	Montana	Anaconda Copper Mining Co	Copper, lead-zinc ores.
5	Chino	Central	New Mexico	Kennecott Copper Corp	Copper ore and tailings.
6	Copper Queen-Lavender Pit	Warren (Bisbee)	Arizona	Phelps Dodge Corp	Copper ore.
7	Ray	Mineral Creek (Ray)	do	Kennecott Copper Corp	Do.
8	Inspiration	Globe-Miami	do	Inspiration Consolidated Copper Co	Do.
9	Magma	Pioneer (Superior)	do	Magma Copper Co	Do.
10	Yerington	Yerington	Nevada	Anaconda Copper Mining Co	Do.
11	Miami	Globe-Miami	Arizona	Miami Copper Co	Do.
12	Calumet & Hecla, Inc	Lake Superior	Michigan	Calumet & Hecla, Inc	Copper ore and tailings.
13	Ruth Pit	Robinson (Ely)	Nevada	Kennecott Copper Corp	Copper ore.
14	Silver Bell	Silver Bell	Arizona	American Smelting & Refining Co	Do.
15	Kimbley Pit	Robinson (Ely)	Nevada	Kennecott Copper Corp	Do.
16	Morris Brooks Pit	do	do	Consolidated Coppermines Corp	Do.
17	Burra Burra, Calloway, Mary, Eureka, Boyd.	Polk County	Tennessee	Tennessee Copper Co	Copper-zinc ore.
18	Bagdad	Eureka (Bagdad)	Arizona	Bagdad Copper Corp	Copper ore.
19	Porphyry Reserve	Globe-Miami	do	Copper Cities Mining Co	Do.
20	Elizabeth	Orange County	Vermont	Appalachian Sulphides, Inc	Do.
21	Ruth Pit Extension	Robinson (Ely)	Nevada	Consolidated Coppermines Corp	Do.
22	Holden	Chelan Lake	Washington	Howe Sound Co	Copper-zinc ore.
23	Cornwall	Lebanon County	Pennsylvania	Bethlehem Steel Co	Magnetite-pyrite-chalcopyrite ore.
24	Eagle	Redcliffe (Battle Mountain)	Colorado	The New Jersey Zinc Co	Silver and zinc ores.
25	Mineral Hill, Daisy	Pima	Arizona	Banner Mining Co	Copper ore.

TABLE 9.—Copper ore sold or treated in the United States in 1954, with copper, gold, and silver content in terms of recoverable metals [1]

State	Ore sold or treated (short tons)	Recoverable metal content				Value of gold and silver per ton of ore
		Copper		Gold (fine ounces)	Silver (fine ounces)	
		Pounds	Percent			
Alaska	26	8,300	15.96	3	36	$5.31
Arizona	43,072,894	714,154,795	.83	94,648	3,380,060	.15
California	8,510	396,000	2.33	491	7,610	2.83
Colorado	213	19,100	4.48	27	439	6.30
Idaho	162,145	4,247,500	1.31	1,438	11,254	.37
Michigan [2]	4,290,780	47,186,000	.55	-----	-----	-----
Montana	3,789,454	110,892,400	1.46	6,034	1,709,985	.46
Nevada	9,615,051	140,167,800	.73	34,201	111,244	.13
New Mexico	6,708,360	92,771,300	.69	3,176	103,792	.03
Oregon	44	7,800	8.86	8	61	7.61
Tennessee [3]	1,159,138	18,174,000	.78	218	60,759	.05
Utah	24,088,109	403,679,400	.84	361,660	2,639,162	.62
Vermont	309,845	8,704,000	1.40	185	48,572	.16
Washington [4]	449,664	7,233,400	.80	(5)	(5)	1.74
Wyoming	25	2,000	4.00	2	43	4.36
Total	93,654,258	1,547,643,795	.83	502,091	8,073,017	.27

[1] Excludes copper recovered from precipitates as follows: Arizona, 36,000,815 pounds; California, 71,200 pounds; Montana, 3,548,300 pounds; Nevada, 103,400 pounds; New Mexico, 28,307,100 pounds; Utah, 15,906,900 pounds.
[2] Includes tailings.
[3] Copper-zinc ore.
[4] Includes ore classed as copper-zinc ore and copper, gold, and silver recovered therefrom.
[5] Bureau of Mines not at liberty to publish.

TABLE 10.—Copper ore concentrated in the United States in 1954, with content in terms of recoverable copper

State	Ore concentrated (short tons)	Recoverable copper content	
		Pounds	Percent
Arizona	[1] 39,268,884	[2] 595,260,885	0.76
California	7,823	318,500	2.04
Idaho	161,370	4,128,600	1.28
Michigan [3]	4,290,780	47,186,000	.55
Montana	3,736,319	109,080,400	1.46
Nevada	[4] 9,548,371	[4] 137,466,900	.72
New Mexico	[5] 6,608,623	[6] 91,150,200	.69
Tennessee [7]	1,159,138	18,174,000	.78
Utah	24,079,400	403,012,500	.84
Vermont	309,845	8,704,000	1.40
Washington [8]	449,644	7,231,500	.80
Total	89,620,197	1,421,713,485	.79

[1] In addition 3,127,298 tons were treated by straight leaching.
[2] In addition 53,812,100 pounds of copper were 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 10,400 tons were treated by heap leaching.
[6] In addition 118,800 pounds of copper were recovered by heap leaching.
[7] Copper-zinc ore.
[8] Mostly copper-zinc ore.

Smelter Production.—The recovery of copper by smelters in the United States from ores of domestic origin totaled 834,000 tons in 1954—a 12-percent decrease from the 943,000 tons in 1953. The output of United States smelters from domestic ores constituted 51

TABLE 11.—Copper ore shipped to smelters in the United States in 1954, 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	26	8,300	15.96	8,400
Arizona	676,712	65,081,810	4.81	[1] 755,854,000
California	687	77,500	5.64	724,000
Colorado	213	19,100	4.48	9,046,000
Idaho	775	118,900	7.67	9,656,000
Michigan				47,186,000
Missouri				3,850,000
Montana	53,135	1,812,000	1.70	[1] 118,698,000
Nevada	66,680	2,700,900	2.02	[1] 140,434,000
New Mexico	89,337	1,502,300	.84	[1] 121,116,000
Oregon	44	7,800	8.86	10,000
Pennsylvania				[2] 6,540,000
Tennessee				18,174,000
Utah	8,709	666,900	3.83	[1] 423,670,000
Vermont				8,704,000
Washington	20	1,900	4.75	7,272,000
Wyoming	25	2,000	4.00	2,000
Total	896,363	71,999,410	4.02	1,670,944,400

[1] Considerable copper was recovered from precipitates.
[2] From magnetite-pyrite-chalcopyrite ore.

TABLE 12.—Copper ores [1] produced in the United States, 1945–49 (average) and 1950–54, 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
1945–49 (average)	842,560	3.53	73,575,898	0.89	77,666,359	0.91	0.0055	0.099	$0.27
1950	624,261	3.37	90,206,169	.88	94,585,792	.89	.0062	.089	.30
1951	776,558	3.63	91,021,243	.87	95,494,214	.90	.0059	.088	.29
1952	904,486	3.27	95,307,233	.82	99,947,492	.85	.0057	.082	.27
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

[1] Includes old tailings, smelted or retreated, etc., for 1945–52.
[2] Includes some ore classed as copper-zinc ore.
[3] Includes copper ore leached.

percent of the world production during 1925–29 but dropped sharply in the succeeding years until 1934, when it was only 17 percent. From 1936–41 it fluctuated between 25 and 33 percent; in 1942–44 it was slightly above 35 percent; and in 1945–54 it ranged from 25–34 percent; in 1954 alone it was 25 percent.

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. As regards Michigan, furnace-refined copper is included. Metallic and cement copper recovered by leaching is included in smelter production.

TABLE 13.—Copper produced (smelter output from domestic ores) in the United States, 1845–1954

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
1846	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			

[1] Exclusive of bonus payments of the Office of Metals Reserve under Premium Price Plan, which covered the period Feb. 1, 1942 to June 30, 1947, inclusive.

Refinery Production.—The refinery output of primary copper in the United States in 1954 was made by 13 plants; 9 of these employed the electrolytic method only, 2 the furnace process on Lake Superior copper, and 1 the furnace process on western ores; 1 used both the electrolytic and furnace methods.

Five large electrolytic refineries were on the Atlantic seaboard, 2 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. In 1942 fire-refined copper was produced for the first time at the Hurley, N. Mex., plant of the Kennecott Copper Corp.; a substantial part of the plant output went as blister to electrolytic refineries in 1954. The El Paso plant of the Phelps Dodge Refining Corp. produced fire-refined copper in addition to the electrolytic grade.

The leaching plant of the Inspiration Consolidated Copper Co. at Inspiration, Ariz., although not strictly speaking a refinery, is so listed here; it produced electrolytic copper direct from leaching solutions. At one time all this copper was shipped as cathodes to other refineries, where it was melted and cast into merchant shapes. In 1946, however, over one-third went directly to consuming plants.

In 1947 and 1948 the practice was continued on a considerably reduced scale, virtually ceased in 1949, but was resumed in 1950–53. In 1954 almost all of this copper was shipped to other refineries as cathodes.

These 13 plants constitute what commonly are termed "primary refineries."

In addition to the primary refineries, many plants throughout the country operated on scrap exclusively, producing metallic copper and a variety of alloys. The output of these secondary plants is not included in the statements of refined copper production in tables 14 and 15 but is included in table 17 on secondary-copper production.

TABLE 14.—Primary and secondary copper produced by primary refineries in the United States, 1945–49 (average) and 1950–54, in short tons

	1945–49 (average)	1950	1951	1952	1953	1954
Primary:						
From domestic ores, etc.:[1]						
Electrolytic	660,584	821,803	835,419	819,539	826,086	777,507
Lake	23,936	29,555	25,309	21,681	23,671	22,510
Casting	79,163	69,390	90,831	81,972	82,475	41,700
Total	763,683	920,748	951,559	923,192	932,232	841,717
From foreign ores, etc.:[1]						
Electrolytic	265,891	319,086	255,429	254,504	353,727	353,667
Casting and best select	6,947				7,158	16,535
Total refinery production of new copper	1,036,521	1,239,834	1,206,988	1,177,696	1,293,117	1,211,919
Secondary:						
Electrolytic[2]	170,134	173,063	127,347	113,827	166,802	156,764
Casting	15,683	16,683	7,676	8,549	22,783	23,179
Total secondary	185,817	189,746	135,023	122,376	189,585	179,943
Grand total	1,222,338	1,429,580	1,342,011	1,300,072	1,482,702	1,391,862

[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 15.—Copper cast in forms at primary refineries in the United States, 1952–54

Form	1952		1953		1954	
	Thousands of short tons	Percent	Thousands of short tons	Percent	Thousands of short tons	Percent
Wire bars	767	59	829	56	789	57
Cathodes	138	11	190	13	185	13
Billets	137	10	172	11	168	12
Cakes	108	8	130	9	135	10
Ingots and ingot bars	139	11	150	10	104	7
Other forms	11	1	12	1	11	1
Total	1,300	100	1,483	100	1,392	100

Copper Sulfate.—Production and shipments of copper sulfate in 1954 continued the downtrend that began in 1952. Production was the lowest since 1940, and shipments were the smallest since at least 1943; data before 1943 are not available. Of the total shipments of 66,500 tons (72,200 in 1953) producers' reports indicated that 17,600 tons (19,900) were for agricultural, 19,300 (18,000) for industrial, and

29,600 (34,300) for other purposes, chiefly for export. Stocks at the end of the year were 22 percent less than those held a year earlier, and were the lowest since 1950.

TABLE 16.—Production, shipments and stocks of copper sulfate, 1945–49 (average) and 1950–54, in short tons

Year	Production		Shipments (gross weight)	Stocks at end of year[1] (gross weight)
	Gross weight	Copper content		
1945–49 (average)	103,620	25,912	100,720	10,160
1950	87,300	21,814	91,300	2,200
1951	106,944	26,736	104,260	4,888
1952	94,536	23,634	92,472	6,884
1953	72,944	18,236	72,188	7,072
1954	65,308	16,327	66,488	5,540

[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 new and from old scrap. "New scrap" is defined as refuse produced during the manufacture of copper articles and includes defective finished or semifinished articles that must be reworked. Typical examples of new scrap are defective castings, clippings, punchings, turnings, borings, skimmings, drosses, and slag. "Old scrap" consists of metal articles that have been discarded 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 17 summarizes the production of secondary copper during 1945–54. Refined copper produced from scrap at primary refineries

TABLE 17.—Secondary copper produced in the United States, 1945–49 (average) and 1950–54, in short tons

	1945–49 (average)	1950	1951	1952	1953	1954
Copper recovered as unalloyed copper	217,395	260,704	186,462	173,904	242,855	212,241
Copper recovered in alloys [1]	674,152	716,535	745,820	729,293	715,609	627,666
Total secondary copper	891,547	977,239	932,282	903,197	958,464	839,907
From new scrap	432,360	492,028	474,158	488,562	529,076	432,841
From old scrap	459,187	485,211	458,124	414,635	429,388	407,066
Percentage equivalent of domestic mine output	117	107	100	98	103	101

[1] Includes copper in chemicals, as follows: 1945–49 (average), 17,830; 1950, 17,413; 1951, 22,905; 1952, 15,388; 1953, 21,550; 1954, 18,055.

is included in the "unalloyed" class. Detailed information appears in the Secondary Metals—Nonferrous chapter of this volume.

CONSUMPTION

Apparent consumption of primary copper, which includes deliveries to the stockpile when there are any, was 14 percent lower than 1953 and the lowest since 1949. When 1954 began consumption was declining and adequate supplies were available for all needs. In the early months, however, production was curtailed by voluntary company action and later by labor strikes; meanwhile, consumption had risen but could not be filled by the restricted supplies. The reduced consumption in 1954, therefore, was not a true guide to consumers' needs during the year.

Actual consumption of refined copper was also the lowest since 1949. Distribution of consumption by principal consuming groups followed the pattern of recent years, with wire mills taking 53 percent (50 in 1953) of the total consumed and brass mills 43 percent (46 in 1953). Unlike table 18, in which all but new copper is eliminated so far as possible, table 19 does not distinguish between new and old copper but covers all copper in refined form.

Some copper precipitates were used directly in manufacturing paint and other items. The figures may not be shown separately and are not covered by table 19, which relates to refined copper only.

TABLE 18.—New refined copper withdrawn from total year's supply on domestic account, 1950–54, in short tons

	1950	1951	1952	1953	1954
Production from domestic and foreign ores, etc.	1,239,834	1,206,988	1,177,696	1,293,117	1,211,919
Imports [1]	317,363	238,972	346,960	[2] 274,111	215,146
Stock at beginning of year [1]	61,000	26,000	35,000	26,000	49,000
Total available supply	1,618,197	1,471,960	1,559,656	[2] 1,593,228	1,476,065
Copper exported [1]	144,561	133,305	174,135	[2] 109,580	215,951
Stock at end of year [1]	26,000	35,000	26,000	49,000	25,000
Total	170,561	168,305	200,135	[2] 158,580	240,951
Apparent withdrawals on domestic account [3]	1,447,000	1,304,000	1,360,000	1,435,000	1,235,000

[1] May include some copper refined from scrap.
[2] Revised figure.
[3] Includes copper delivered by industry to the National Stockpile.

Figures on apparent consumption of primary copper are available for a long period, whereas compilations on actual consumption of refined copper were begun in 1945. In estimating apparent consumption it has been assumed that copper used in primary fabrication of copper is consumed. Although the table aims to show primary consumption only, it should be noted that exports and stocks, as well as the import component of "total supply," 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.

TABLE 19.—Refined copper consumed in 1952–54, by classes of consumers, in short tons

Class of consumer	Cathodes	Wire bars	Ingots and ingot bars	Cakes and slabs	Billets	Other	Total
1952:							
Wire mills	11	727,257	11,977	209		33	739,487
Brass mills	134,613	57,456	163,190	185,138	134,223	453	675,073
Chemical plants			279			3,440	3,719
Secondary smelters	8,819	8	13,203	326		562	22,918
Foundries and miscellaneous	5,947	130	23,953	161	624	7,720	38,535
Total	149,390	784,851	212,602	185,834	134,847	12,208	1,479,732
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

STOCKS

Producers' stocks of refined and unrefined copper declined 21 percent in 1954. These stocks rose in January and February, when adequate supplies of copper were available, and dropped thereafter to the lowest level of the year in October, following the serious labor strikes that began in August and ended in October. Refined stocks were 49 percent less than in 1953 and the lowest since 1906. Inventories of unrefined copper dropped 15 percent and, except for 1951 and 1952, were low in relation to earlier recent years. Of the total stocks at the end of 1954, only 12 percent was in the form of refined copper, the remainder being in smelter shapes at smelters and in transit to refineries and in smelter shapes and materials in process of refining at refineries. Table 20 gives domestic stocks of copper as reported by primary smelting and refining plants. Blister and anode copper in transit from smelters to refineries is included with stocks of blister copper.

TABLE 20.—Stocks of copper at primary smelting, and refining plants in the United States at end of year, 1949–54, 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]
1949	61,000	261,000	1952	26,000	185,000
1950	26,000	232,000	1953	49,000	223,000
1951	35,000	182,000	1954	25,000	189,000

[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 360,526 tons at the end of 1954 (a 5-percent decrease from those on hand at the beginning of the year). Working stocks (see table 21) were 304,619 tons (2 percent less than those at the end of 1953). After allowance for unfilled sales of metal, the deficiencies in stocks in relation to unfilled orders dropped 52,129 tons to 22,549 tons at the end of 1954. Not since 1940 had stocks come so close to equaling unfilled orders.

Figures compiled by the Copper Institute show that domestic stocks of refined copper decreased from 89,200 tons at the end of 1953 to 47,100 at the end of 1954. Inventory data of the Bureau of Mines and the Copper Institute always differ owing to somewhat different bases. Before 1947 a primary reason was that the Copper Institute coverage was limited to duty-free copper. 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 21.—Stocks of copper in fabricators' hands at end of year, 1950–54, in short tons

[United States Copper Association]

	Stocks of refined copper [1] (1)	Unfilled purchases of refined copper from producers (2)	Working stocks (3)	Unfilled sales to customers (4)	Excess stocks over orders booked [2] (5)
1950	290, 241	92, 372	288, 392	313, 052	−218, 831
1951	280, 402	32, 147	295, 385	303, 050	−285, 886
1952	331, 499	32, 652	292, 157	275, 608	−203, 614
1953	380, 881	25, 022	309, 664	170, 917	−74, 678
1954	360, 526	58, 125	304, 619	136, 581	−22, 549

[1] Includes in-process metal and primary fabricated shapes. Also includes small quantities of refined copper held at refineries for fabricators' account.
[2] Columns (1) plus (2) minus (3) and minus (4) equals column (5).

PRICES

Reports to the Bureau of Mines from copper-selling agencies indicated that 987,000 tons of domestic, refined copper from primary and secondary materials was delivered to purchasers in 1954 at an average price of 29.5 cents a pound. These figures are to be compared with 1,039,000 and 945,000 tons in 1953 and 1952, respectively, and 28.7 and 24.2 cents a pound but may not be compared with data for earlier years, which included deliveries of foreign copper to United States buyers. The average price of foreign copper delivered in the

United States was 29.4 cents in 1954 and 34.1 and 33.6 cents in 1953 and 1952.

Prices for electrolytic copper delivered in the United States were quoted at a range of 29.5–30 cents a pound at the beginning of the year. On March 3 the price increased to 29.75–30 cents and moved to a flat 30 cents on April 12, where it remained through the end of the year.

In January the Phelps Dodge Corp. and Phelps Dodge Refining Corp. began to sell copper on a uniform delivered price basis throughout the United States, and this method became representative of the industry. The Kennecott Copper Corp. began disposing of its copper on a delivered basis in August 1950.

TABLE 22.—Average weighted prices of copper deliveries, f. o. b. refinery, 1935–54 [1]

Year	Cents per pound	Year	Cents per pound
1935	8.3	1945	[2] 11.8
1936	9.2	1946	[2] 14.4
1937	12.1	1947	[2] 20.9
1938	9.8	1948	21.7
1939	10.4	1949	19.7
1940	11.3	1950	20.8
1941	[2] 11.8	1951	[3] 24.2
1942	[2] 11.8	1952	[3] 24.2
1943	[2] 11.8	1953	[3] 28.7
1944	[2] 11.8	1954	[3] 29.5

[1] Covers copper produced in the United States and delivered here and abroad and copper produced abroad and delivered in the United States; excludes copper both produced and delivered abroad whether or not handled by United States selling agencies.

[2] Excludes deliveries of foreign copper to Metals Reserve Company and bonus payments, applicable from February 1942 to June 30, 1947.

[3] Excludes deliveries of foreign copper to domestic consumers; average price of such deliveries was 26.2 cents per pound in 1951, 33.6 in 1952, 34.1 in 1953, and 29.4 in 1954. In 1951–54 includes a substantial quantity of copper sold on a delivered consumers' plant basis.

At the beginning of 1954 Chilean copper was selling in the United States at the price level for domestic copper, in contrast with the situation in 1953 when the Chilean Government policy of maintaining the price for copper at more than 6 cents above the United States price led to large accumulations of unsold Chilean copper in Chile and in the United States. The Chilean Government in August 1953 requested the United States Government to purchase the accumulated stocks for the Strategic Stockpile. In March 1954 the two Governments reached agreement for the purchase by the United States of 100,000 tons of copper "at market," and contracts were signed in May with the Anaconda Sales Co. for 64,000 tons and with Kennecott Sales Corp. for 36,000 tons of Chilean copper for delivery to the stockpile.

London Price.—Prices for copper on the London Metal Exchange fluctuated widely during the year but were not greatly out of line with those in the United States until September. At that time the

TABLE 23.—Average monthly quoted prices of electrolytic copper for domestic and export shipments, f. o. b. refineries, in the United States, 1953–54, in cents per pound

Month	1953			1954		
	Domestic f. o. b. refinery [1]	Domestic f. o. b. refinery [2]	Export f. o. b. refinery [2]	Domestic f. o. b. refinery [1]	Domestic f. o. b. refinery [2]	Export f. o. b. refinery [2]
January	24.37	24.200	34.780	29.62	29.671	28.767
February	25.25	24.968	34.783	29.62	29.669	29.000
March	30.36	29.289	34.451	29.74	29.686	29.168
April	30.55	29.902	32.863	29.83	29.700	29.520
May	29.72	29.683	29.710	29.87	29.700	29.658
June	29.75	29.688	29.699	29.87	29.700	29.603
July	29.72	29.687	29.482	29.87	29.700	29.570
August	29.24	29.611	29.254	29.87	29.700	29.492
September	29.37	29.623	28.688	29.87	29.700	30.066
October	29.48	29.598	28.522	29.87	29.700	31.529
November	29.62	29.651	28.848	29.87	29.700	31.259
December	29.62	29.673	29.061	29.87	29.700	31.036
Average for year	28.92	28.798	30.845	29.82	29.694	29.889

[1] American Metal Market.
[2] E&MJ Metal and Mineral Markets.

TABLE 24.—Average yearly quoted prices of electrolytic copper for domestic and export shipments, f. o. b. refineries, in the United States, 1945–54, in cents per pound

	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
Domestic f. o. b. refinery [1]	11.87	13.92	21.15	22.20	19.36	21.46	24.37	24.37	28.92	29.82
Domestic f. o. b. refinery [2]	11.775	13.820	20.958	22.038	19.202	21.235	24.200	24.200	28.798	29.694
Export f. o. b. refinery [2]	11.700	14.791	21.624	22.348	19.421	21.549	26.258	31.746	30.845	29.889

[1] American Metal Market.
[2] E&MJ Metal and Mineral Markets.

price rose to £285–£287 per long ton (equivalent to 35.6 cents a pound) and equaled the alltime record price established by the British Ministry of Materials in July 1952, when copper sales were controlled by the Government. Temporarily reduced world supplies of copper in the third quarter of 1954, threats of strikes at Rhodesian mines, and the London dock strike led to increases in prices on the London exchange to an alltime peak in October of £310 per long ton (equivalent to 38.75 cents a pound). The fact that the United Kingdom broker discontinued selling copper on the exchange May 31, removing that market support, was a factor in the London situation. From September London prices fluctuated widely and remained well above those in the United States.

London Metal Exchange monthly average prices per long ton and in cents per pound are shown in table 25.

TABLE 25.—United Kingdom monthly average prices in 1954 [1]

Month	Cash				Three months				Settlement			
	Per long ton			Cents per pound[2]	Per long ton			Cents per pound[2]	Per long ton			Cents per pound[2]
	£	s.	d.		£	s.	d.		£	s.	d.	
January	225	3	3	28.25	214	15	0	26.95	225	12	6	28.31
February	230	19	0	29.00	215	12	10.5	27.07	231	7	6	29.05
March	236	2	4.6	29.66	225	12	2	28.34	236	11	6.2	29.72
April	242	8	1.5	30.49	232	10	4.5	29.25	242	15	0	30.53
May	242	1	3.7	30.45	237	15	10	29.92	242	6	2.2	30.48
June	238	17	8.8	30.05	237	3	4.7	29.83	239	0	11.4	30.07
July	238	5	4	29.97	236	7	9.4	29.73	238	8	4.9	29.98
August	236	10	4.2	29.70	234	19	7	29.50	236	13	6.8	29.72
September	256	7	6	32.05	245	0	6.1	30.63	256	17	3.2	32.11
October	280	15	2.8	35.06	264	0	5.7	32.96	282	2	10.2	35.23
November	275	7	11.4	34.35	263	13	6.2	32.89	276	1	4.3	34.44
December	280	3	3.5	34.86	267	2	10	33.24	280	12	11.4	34.92
Average	248	17	11.0	31.20	239	17	7.4	30.07	249	6	11.6	31.26

[1] Metal Bulletin (London).
[2] Averages per long ton converted to cents per pound by using average monthly rates of Exchange recorded by Federal Reserve Board.

FOREIGN TRADE [3]

Copper entries into the United States in unmanufactured form declined 13 percent in 1954, largely because of reduced receipts from all major sources except the Philippines, Belgian Congo, and the Union of South Africa. The Philippines sent more copper in the form of concentrate to the United States in 1954 and the other two more unrefined metal.

Much of the foreign copper that came into the United States was for smelting and refining and exportation or for one or both of these treatments, primary or more advanced later fabrication, and exportation. Much of the copper exported could not be measured quantitatively, being in such items as electric motors, automobiles, and equipment of various types.

The excess capacities of domestic smelting and refining facilities for years were used to treat foreign materials, largely for reexport as refined copper, in fabricated shapes and in end products. United States smelters and refineries continued in 1954 to treat foreign crude materials, both purchased and toll copper.

Exports of refined copper—the principal export class by a substantial margin—virtually doubled in 1954 and were the largest since 1940. Copper exports remained under licensing control, but no quantitative quotas were established. Exports of copper scrap more than doubled in 1954 after nearly quadrupling in 1953.

TARIFF

Suspension of the 2-cent excise tax on copper was extended from June 30, 1954, to June 30, 1955, by a bill signed by President Eisenhower on June 30, and another bill signed August 27 extended suspension of duties on metal scrap, other than lead and zinc with certain exceptions, to June 30, 1955.

[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.

IMPORTS

Imports of copper in all unmanufactured forms dropped 13 percent from 1953, which, except for 1950, were the largest since the alltime record in 1945. Decreases were recorded in all classes of copper, except concentrate, which was virtually unchanged. Refined imports were 22 percent less than in 1953 and composed 36 percent of the total receipts. The percentage of total receipts represented by refined imports in 1954 was the smallest since 1947, which it equaled.

TABLE 26.—Copper (unmanufactured) imported into the United States, 1945–49 (average) and 1950–54, 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
1945–49 (average)	8,688	70,357	6,320	182,416	272,030	4,914	544,725
1950	2,600	104,168	3,233	224,222	317,363	38,803	690,389
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							
North America:							
Canada	102	[2] 31,353	1,768	3,494	67,487	3,223	[2] 107,427
Cuba	123	17,634				449	18,206
Mexico	357	8,646	4,310	44,982	7,513	10	65,818
Other North America	(3)	23	3			603	629
Total	582	57,656	6,081	48,476	75,000	4,285	192,080
South America:							
Bolivia	792	3,163	17				3,972
Chile	3,234	[2] 12,527		117,520	[2] 147,294	499	[2] 281,074
Peru	746	8,752	865		16,157	3	26,523
Other South America	233					95	328
Total	5,005	24,442	882	117,520	163,451	597	311,897
Europe:							
Belgium-Luxembourg					5,540	75	5,615
France						2,160	2,160
Germany, West					3,570		3,570
Malta, Gozo, and Cyprus		3,680					3,680
Norway					4,368	59	4,427
Sweden				550	1,603	64	2,217
Turkey				11,894			11,894
United Kingdom			56	326	1,396	416	2,194
Yugoslavia					7,775		7,775
Other Europe					117	58	175
Total		3,680	56	12,770	24,369	2,832	43,707
Asia:							
Philippines	(4)	[2,4] 13,538					[2] 13,538
Other Asia					71	39	110
Total	(4)	13,538			71	39	13,648
Africa:							
Belgian Congo					5,799		5,799
Northern Rhodesia				85,264	2,778		88,042
Southern Rhodesia		212					212
Union of South Africa	1,404	6,008		166	[2] 100		[2] 7,678
Total	1,404	6,220		85,430	8,677		101,731
Oceania: Australia	6	1,038		9,414	2,543	40	13,041
Grand total	6,997	[2] 106,574	7,019	273,610	[2] 274,111	7,793	[2] 676,104

See footnotes at end of table.

TABLE 26.—Copper (unmanufactured) imported into the United States, 1945–49 (average) and 1950–54, in short tons, in terms of copper content [1]—Continued

	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
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	125,596		266,993
Peru	507	8,056	884		13,003		22,450
Other South America	3	4					7
Total	2,039	22,979	896	128,850	138,599		293,363
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)	19,405			32	21	19,458
Africa:							
Belgian Congo				8,045	7,494		15,539
Federation of Rhodesia and Nyasaland [5]		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	10,696			12,106
Grand total	5,343	107,438	5,795	251,918	215,146	4,683	590,323

[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."
[5] Beginning July 1, 1954, Northern and Southern Rhodesia not separately classified, undoubtedly all except the copper in concentrate came from Northern Rhodesia.

TABLE 27.—Copper (unmanufactured) imported into the United States, 1945–49 (average) and 1950–54 [1]

[U. S. Department of Commerce]

Year	Short tons of contained copper	Year	Short tons of contained copper
1945–49 (average)	544,724	1952	618,880
1950	690,389	1953	[2] 676,104
1951	489,135	1954	590,323

[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 28.—Copper (unmanufactured) imported into the United States, 1945–49 (average) and 1950–54, by country, in short tons, in terms of copper content [1]

[U. S. Department of Commerce]

Country	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Canada (including Newfoundland and Labrador)	57,337	82,365	54,554	81,932	[2] 107,427	89,911
Cuba	13,774	22,891	22,302	19,934	18,206	18,282
Mexico	65,900	62,748	47,878	50,997	65,818	51,229
Other North America	357	524	744	408	629	406
Total	137,368	168,528	125,478	153,271	192,080	159,828
South America:						
Bolivia	5,533	5,220	4,449	3,097	3,972	3,913
Chile	297,762	292,215	268,359	362,303	[2] 281,074	266,993
Peru	27,196	28,502	10,054	11,317	26,523	22,450
Other South America	1,987	878	129	213	328	7
Total	332,478	326,815	282,991	376,930	311,897	293,363
Europe:						
Belgium-Luxembourg	72	[2] 474	----------	646	5,615	718
France	32	3,801	1,587	1,806	2,160	1,587
Germany	----------	44	----------	[3] 8,932	[3] 3,570	[3] 81
Malta, Gozo, and Cyprus	1,915	6,530	5,556	5,441	3,680	----------
Netherlands	205	352	47	41	175	----------
Norway	7	4,098		1	4,427	5,664
Sweden	----------	57	----------	----------	2,217	----------
Turkey	4,784	3,266	----------	3,779	11,894	2,664
United Kingdom	1,261	940	6	37	2,194	25
Yugoslavia	5,468	10,998	6,223	14,833	7,775	3,886
Other Europe	294	367	262	79	----------	17
Total	14,038	30,927	13,681	35,595	43,707	14,642
Asia:						
Japan	879	54,400	1,908	223	----------	1
Philippines	2,481	10,129	12,608	14,787	[2] 13,538	19,425
Other Asia	297	968	140	4	110	32
Total	3,657	65,497	14,656	15,014	13,648	19,458
Africa:						
Belgian Congo	18,819	103	----------	(4)	5,799	15,539
Northern Rhodesia	26,382	84,291	43,717	28,225	88,042	[6] 61,905
Southern Rhodesia	[5] 3,260	[5] 3,009	98	167	212	
Union of South Africa	7,414	9,859	7,353	8,588	[2] 7,678	13,482
Other Africa	457	45	17	----------	----------	----------
Total	56,332	97,307	51,185	36,980	101,731	90,926
Oceania:						
Australia	851	1,307	1,143	684	13,041	12,106
Other Oceania	----------	8	1	406	----------	----------
Total	851	1,315	1,144	1,090	13,041	12,106
Grand total	544,724	690,389	489,135	618,880	[2] 676,104	590,323

[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, Northern and Southern Rhodesia not separately classified.

As usual, Chile was the chief source of copper from abroad, supplying 45 percent of the total, but 5 percent less than in 1953. Canada, Northern Rhodesia, Mexico, and Peru were next in importance and comprised 15, 10, 9 and 4 percent, respectively. The large shippers of refined copper to the United States—Chile, Canada, and Peru—all supplied smaller quantities in 1954 than in 1953. Chile, on the other hand, sent more unrefined metal, but Northern Rhodesia and Mexico—

TABLE 29.—Copper imported for consumption in the United States, 1945–49 (average) and 1950–54, by classes

(Quantity in terms of copper content)

[U. S. Department of Commerce]

Year	Ore		Concentrate [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	
1945–49 (average)	4,383	$1,482,273	54,282	$18,403,053	6,983	$1,400,778	170,043	$53,885,998	271,520	$86,797,603	4,887	$1,680,341	$163,650,046
1950	547	127,597	87,614	32,958,680	868	338,670	120,239	41,483,624	322,368	130,375,262	34,242	11,109,722	216,393,555
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	96,563	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	[3] 274,111	182,190,014	7,827	4,017,577	425,538,413
1954	6,182	3,398,562	114,692	62,793,004	5,408	3,088,549	252,827	148,286,231	215,178	127,137,993	4,752	[4] 2,080,720	[4] 346,785,059

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

next in importance as suppliers—shipped smaller quantities. Receipt of copper in concentrate from the Philippines undoubtedly established a new high record.

TABLE 30.—Old brass and clippings from brass or Netherland metal [1] imported for consumption in the United States, 1945–49 (average) and 1950–54

[U. S. Department of Commerce]

Year	Short tons		Value	Year	Short tons		Value
	Gross weight	Copper content			Gross weight	Copper content	
1945–49 (average)	45,537	31,872	$14,611,492	1952	10,321	7,627	$3,765,416
1950	37,537	27,585	7,952,578	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

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

EXPORTS

Most of the copper exported from the United States is in advanced forms of manufacture, in which the copper content is not calculable, and in the form of refined copper. Exports of refined copper almost doubled those in 1953 and were the largest since 1940. Most of the increase was due to substantially larger shipments to European countries and to Brazil and Australia.

Exports of old and scrap more than doubled the alltime high of 1953 and went mainly to West Germany and Japan.

TABLE 31.—Copper exported from the United States, 1945–49 (average) and 1950–54, [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]
1945–49 (average)	569	105,852	6,131	2,512	4,165	3,160	9,147	35,041	(3)
1950	616	144,561	10,073	9,445	1,988	581	7,009	18,682	(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	[1] 109,580	321	34,568	1,622	367	9,313	15,622	294
1954									
North America:									
Canada	3	824	148	289	369	122	803	1,578	131
Cuba		2			78	3	145	735	
Mexico	246	70	1		41	45	128	570	35
Other North America		5			91	17	247	1,214	(4)
Total	249	901	149	289	579	187	1,323	4,097	166

See footnotes at end of table.

TABLE 31.—Copper exported from the United States, 1945–49 (average) and 1950–54, [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
1954—Continued									
South America:									
Argentina		4,736			15		2	204	
Brazil		28,613	125	339	29	5	286	458	(4)
Chile					4	1	34	175	81
Colombia		68	1		76	4	117	986	
Peru			4		70		12	350	1
Uruguay		38			3	37		9	
Venezuela		4	2		89	4	255	1,441	
Other South America		3			35	(4)	14	137	
Total		33,462	132	339	321	51	720	3,760	82
Europe:									
Austria		1,501		188					
Belgium-Luxembourg	33	742		116	17		64	104	1
Denmark		464						16	
France		39,239		44	(4)	1	2	217	
Germany, West	984	30,236		35,076	(4)		1	44	
Greece		223			2		56	20	
Italy	736	18,081		1,599	6	6	875	112	
Netherlands	13	24,343		139			17	27	
Norway		3,628			25		77	205	
Spain	223		55	202	1			35	
Sweden		5,941			2		1	9	
Switzerland		10,587		856	2			1	
Turkey			(4)		55	1	38	121	
United Kingdom	121	25,347		4,716		6	(4)	23	
Other Europe		5		143	5		300	144	
Total	2,110	160,337	55	43,079	115	14	1,431	1,078	1
Asia:									
India		6,237		3,791	13	5		17	
Israel					12	3	2	67	
Japan	10	6,841		28,278	26		466	62	
Philippines		5	4		53	15	213	1,916	1
Taiwan		7			3	2	39	1,047	
Other Asia		100	4		45	19	36	1,974	
Total	10	13,190	8	32,069	152	44	756	5,083	1
Africa:									
Federation of Rhodesia and Nyasaland [5]		167					196	3	
Union of South Africa					16		2	60	
Other Africa		174			15	3	119	236	
Total		341			31	3	317	299	
Oceania:									
Australia		7,720			1	1	(4)	21	
Other Oceania					(4)		1	5	
Total		7,720			1	1	1	26	
Grand total	2,369	215,951	344	75,776	1,199	300	4,548	14,343	250

[1] Changes in Minerals Yearbook, 1953, should read as follows: Refined in bars, ingots, and other forms, Canada 833 short tons.
[2] Owing to changes in classifications data for 1952–54 not strictly comparable to earlier years.
[3] Weight not recorded.
[4] Less than 1 ton.
[5] Beginning July 1, 1954, Northern and Southern Rhodesia not separately classified.

TABLE 32.—Copper exported from the United States, 1945–49 (average) and 1950–54

[U. S. Department of Commerce]

Year	Ore, concentrate, composition metal, and unrefined copper (copper content)		Refined copper and semimanufactures		Other copper manufactures [1]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1945–49 (average)	569	$232,228	166,008	$79,345,681	(2)	$1,791,770	166,577	$81,369,679
1950	616	222,592	192,339	86,711,592	(2)	1,502,917	192,955	88,437,101
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	[3] 171,393	[3] 116,212,961	294	352,124	[3] 172,182	[3] 116,855,490
1954	2,369	1,309,158	312,461	197,070,091	250	307,848	315,080	198,687,097

[1] Owing to changes in classifications 1952–54 data not strictly comparable to earlier years.
[2] Weight not recorded.
[3] Revised figure.

TABLE 33.—Unfabricated copper-base alloy [1] ingots, bars, rods, shapes, plates, and sheets exported from the United States, 1945–49 (average) and 1950–54

[U. S. Department of Commerce]

Year	Short tons	Value	Year	Short tons	Value
1945–49 (average)	13,229	$6,189,956	1952 [2]	5,514	$5,424,662
1950	2,334	1,694,488	1953 [2]	[3] 4,453	[3] 3,568,657
1951	3,820	2,951,881	1954 [2]	3,492	2,924,161

[1] Includes brass and bronze.
[2] Owing to changes in classifications data not strictly comparable to earlier years.
[3] Revised figure.

TABLE 34.—Copper-base alloys (including brass and bronze) exported from the United States, 1953–54, by classes

[U. S. Department of Commerce]

Class	1953		1954	
	Short tons	Value	Short tons	Value
Ingots	[1] 2,553	[1] $1,503,108	2,601	$1,762,433
Scrap	[1] 33,680	[1] 13,066,179	93,972	38,468,745
Bars, rods, and shapes	1,259	1,231,791	455	518,882
Plates, sheets, and strips	641	833,758	436	642,846
Pipes and tubes	2,858	2,706,919	865	1,215,410
Pipe fittings	727	1,719,955	983	2,222,044
Plumbers' brass goods	2,657	6,454,039	2,920	6,979,584
Welding rods and wire	634	1,334,035	760	1,444,106
Castings and forgings	607	912,032	435	708,889
Powders	66	88,499	68	71,166
Hardware	(2)	2,661,343	(2)	2,485,595
Semifabricated forms, not elsewhere classified	17	31,106	16	42,834
Other copper-base-alloy manufactures	(2)	420,893	(2)	523,062
Total	(2)	32,963,657	(2)	57,085,596

[1] Revised figure.
[2] Weight not recorded

TABLE 35.—Copper sulfate (blue vitriol) exported from the United States, 1945–49 (average) and 1950–54

[U. S. Department of Commerce]

Year	Short tons	Value	Year	Short tons	Value
1945-49 (average)	36,837	$4,486,284	1952	43,421	$8,482,870
1950	30,149	4,151,265	1953	32,659	6,250,121
1951	43,129	8,753,641	1954	29,762	5,780,801

TECHNOLOGY

Various types of copper deposits occurring in widely separated areas were described in several publications. The occurrence, operation, production, and possible future development of the primary copper industry of the New England and New York area were the subject of an article.[4] Another publication[5] described the White Pine copper deposit in Ontonagon County, Mich. Here the copper, largely in the mineral chalcocite, is found in the lowermost beds of the Nonesuch shale over many square miles. The relation of this deposit to the famous native copper deposits of Michigan was shown. The possible origin of the native copper deposits of the Lake region as well as others was given in the technical press.[6] A paper[7] describing the geology and mineral deposits of an area in the Mount Hayes quadrangle on the upper Maclaren River, Alaska, became available. This area, known as the Kathleen-Margaret prospect, has veins which assay 3.5 to 12.5 percent copper.

The use of geophysical methods[8] has been successful in the discovery of a commercial ore deposit in Pima County, Ariz., although the surface evidence of the deposit was hidden. Subsequent drilling and extensive underground development proved the existence of the deposit. Selection of the area to be explored, its location and description, the geophysical work, development program, and results obtained were all covered in the publication.

Improvements in methods and equipment to increase mining efficiency were described during the year. At Calumet and Hecla[9] total footage was increased about 30 percent by switching to airleg equipment and tungsten carbide detachable bits. Powder costs were reduced 20 percent by using smaller holes. At Copper Mountain mine[10] the heavy drifter type of drill mounted on columns has been replaced by lightweight, jackleg machines using light integral tungsten carbide-tipped steel for all development work. Also, drilling to induce caving in stopes was done by percussion-type instead of diamond drills. Technical details of a blast to remove the ore left in the wall of

[4] Allen, S. A., and Cornwall, H. R., Copper in New England and New York: New England-New York Interagency Committee, October 1954, 15 pp.

[5] White, Walter S., and Wright, James C., The White Pine Copper Deposit, Ontonagon County, Mich.: Econ. Geol., vol. 49, No. 7, November 1954, pp. 675–716.

[6] Cornwall, H. R., and White, W. S., Native Copper Deposits: Econ. Geol., vol. 49, No. 7, November 1954, p. 808.

[7] Chapman, Robert M., and Saunders, Robert H., The Kathleen-Margaret (K-M) Copper Prospect on the Upper Maclaren River, Alaska: Geol. Survey Circ. 332, 1954, 5 pp.

[8] Thurmond, Robert E., Heinrichs, Walter E., Jr., and Spaulding, E. D., Geophysical Discovery and Development of the Pima Mine, Pima County, Ariz.: Min. Eng., February 1954, pp. 197–202.

[9] Campbell, Colin A., and Van Evera, Robert W., Recent Drilling Trends at Calumet and Hecla: Min. Cong. Jour., vol. 40, No. 5, May 1954, pp. 26–28, 79.

[10] Postle, L. T., Recent Developments at Copper Mountain Mine: Min. Cong. Jour., vol. 40, No. 4 April 1954, pp. 62–64.

the Cananea Colorado open pit were described in a publication.[11] Best fragmentation depends upon slabbing stresses, size and length of holes, rock type, fracture pattern, and type of powder. It was learned at Vermont Copper [12] that drift-level drawpoints from a single-line main track gave increased extraction, cheaper and faster stope preparation, and dewatered stope muck. Basic requirements were proper fragmentation, scheduled maintenance program, and a satisfactory ventilating system.

Methods [13] and equipment used to handle wet ore at the Irwin shaft of the Roan Antelope Copper mines were described. Costs of the installation were included. Of special interest was a publication [14] describing the development of the San Manuel mine in Arizona. Block-caving methods were to be used to produce a scheduled 35,000 tons daily output. Another large copper project in Arizona, the Silver Bell,[15] reached production stage in April. Its scheduled production rate was 18,000 tons of copper annually. The design, construction, and operation of Anaconda's Yerington, Nev., copper-producing facility appeared [16] in a technical magazine. Over 5 million pounds of copper was to be leached and precipitated each month, with an overall recovery of 90 percent. Chrysocolla was the chief copper mineral in the find, which averaged 0.9 percent copper. The problems and factors involved in moving a mill to a new ore site were itemized.[17]

A similar and equally interesting article [18] described the revision of the Magna and Arthur concentrators without interrupting operations.

The role of microorganisms in the leaching of sulfides was receiving widespread interest. Laboratory experiments [19] showed that the release of iron, copper, and sulfuric acid in the leaching water was due to the biological oxidation of the sulfide minerals.

Addition of 0.02 to 0.03 percent phosphorus [20] to commercial anode copper improved the plating characteristics. Deposits were exceptionally smooth and any desired thickness could be obtained. Corrosion of the anode was uniform and nearly 100 percent of the copper from the anodes was deposited on the cathodes. Other advantages were that the plating solution remained clean for long periods of time, anode scrap loss was extremely low, and the anodes were particularly suited for electrotyping and electroforming.

Results of studies of copper smelting and refining were published during the year. One of these investigations [21] studied the effects of

[11] Ruff, Arthur, W., How Cananea Gets Good Fragmentation in Large Blasts: Eng. and Min. Jour., vol. 155, No. 1, January 1954, pp. 92–94, 166.

[12] Miller, Clinton L., Vermont Copper Uses Mucking Machines for Stope Drawing: Min. Eng., vol. 6, No. 11, November 1954, pp. 1072–1076.

[13] Sinclair, J. H., Handling Ore and Waste at Irwin Shaft, Roan Antelope Copper Mines: Bull. Inst. Min. and Met. (London), No. 573, August 1954, pp. 505–516.

[14] Pillar, C. L., Progress on Three Big Shafts Reveals Up-to-Date Sinking Practice: Min. Eng., vol. 6, No. 7, July 1954, pp. 686–695.

Ashby, H. I., Drifting Opens Huge Ore Body for Block Caving: Min. Eng., vol. 6, No. 7, July 1954, pp. 696–697.

[15] Huttl, John B., Silver Bell: AS&R's New Arizona Copper Project Starts Production: Eng. and Min. Jour., vol. 155, No. 7, July 1954, pp. 72–79.

[16] Ramsey, R. N., Anaconda's Nevada Project—New Approach to Copper Mining: Eng. and Min. Jour., vol. 155, No. 8, August 1955, pp. 74–93.

[17] Coil, B. R., How a 15-Mile Move Made New Pit Project Possible: Eng. and Min. Jour., vol. 155, No. 6, June 1, 1954, pp. 78–80.

[18] Huttl, John B., How Utah Copper Remodeled Two 50,000-Ton Mills Without Shutting Down: Eng. and Min. Jour., vol. 155, No. 10, October 1954, pp. 72–76.

[19] Bryner, Loren C., Beck, Jay V., Davis, Delmar B., and Wilson, Dean G., Microorganisms in Leaching Sulfide Minerals: Ind. and Eng. Chem., vol. 46, No. 12, December 1954, pp. 2587–2592.

[20] Nevers, R. P., Hungerford, R. L., and Palmer, E. W., Phosphorized Anodes Produce Smoother, Heavier Copper Plate: Iron Age, vol. 174, No. 7, Aug. 12, 1954, pp. 114–116.

[21] Yazawa, A., and Kameda, M., Fundamental Studies on Copper Smelting. I—Partial Liquidation Diagram for FeS-FeO-S.O₂ System: Tech. Rep. Tokoku Univ. (Sendai, Japan), 18 (1), 1953, pp. 40–58.

Cu_2S, CuO, and Al_2O_3 on matte-slag equilibria at 1,200° C. The systems were studied by thermal analysis and microscopy. Methods and equipment used in principal copper smelters and refineries in the United States were described in a booklet [22] prepared by a Technical Assistance Mission of European Experts, which visited the United States between October 14 and November 22, 1951. Continuous melting of electrolytic cathode copper in three-phase direct arc furnaces at International Nickel Co. of Canada [23] were reviewed. Also noted were a few basic changes and improvements in operations. The casting of slabs weighing between 1,900 to 3,000 pounds at the rate of 60,000 pounds an hour at Raritan Copper Works was described.[24] The slabs were parallel-sided and measure 65 to 76 inche long, 5 inches thick, and 15½ to 24¾ inches wide.

Several papers dealing with impurities in copper appeared. One [25] of these compared the vapor pressures and disassociation pressures of copper and its oxides. It was concluded that the oxidation behavior of copper could be explained by reference to the surface activities of Cu and O. In another study,[26] high-purity copper was prepared by electrolytic refining of copper and pressing and sintering the electrolytic copper powder. Effects of pressing and sintering conditions, soluble and insoluble addition elements, on the electrical conductivity were determined. Other studies [27] showed that substances such as methyl alcohol, which gives off reducing gases at the pressing temperatures, protected the powder from oxidation. Pressings made in this way were much harder than cast and cold-worked copper, and remained hard up to 300°–350° C. Of special interest to those refining secondary copper containing substantial amounts of lead was a study [28] to determine the relationship between Cu_2O-PbO slag in equilibrium with Cu-Pb alloys of various compositions.

A valuable contribution [29] was made in the form of stress data for copper tubes subjected to internal pressure. The data could be used for tubes in applications at ordinary temperatures where the safety factor used with tensile strength may be unduly conservative.

In the welding of copper and copper alloys where high-quality joints were required, the advantages of nitrogen-shielding over argon-shielding were determined.[30] Substitution of nitrogen for argon, it

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[22] Organization for European Economic Cooperation, Copper Smelting and Refining in the U. S. A.: Vol. 1, October 1954, 55 pp.

[23] Bischoff, Joseph C., Furnace Operation and Casting Improved at Copper Cliff: Jour. Metals, vol. 6, No. 11, November 1954, pp. 1194–1196.

[24] Pearce, C. D., Copper Slabs Weighing 3,000 Lb. Successfully Cast at Raritan Works: Jour. Metals, vol. 6, No. 5, May 1954, pp. 512–514.

[25] Endmann-Jesnitzer, F., and Gunther, F., [Effect of Oxygen on the Surface Behavior of Copper]: Ztschr. Metallkunde, June 1954, 45 (6) pp. 407–412.

[26] Kayser, O., Pawlek, F., and Reichel, K., [Effect of Impurities on the Conductivity of High-Purity Copper (From Powder)]: Metall., vol. 8 (13/14), July 1954, pp. 532-537.

[27] Palme, R., [Hot Pressings from Copper Powder]: Metall., vol. 8, No. 9/10, May 1954, pp. 369-371.

[28] Gebhardt, E., and Obrowski, W., [The Structure of the Copper-Lead-Oxygen System]: Ztschr. Metallkunde, June 1954, 45 (6), pp. 332–339, 341.

[29] Luskey, R. S. D., and McKeown, J., Stress-Rupture Lime Properties of Copper Tube Materials: British Nonferrous Metals Research Association, Repr. from The Engineer, June 4, 1954, 8 pp.

[30] Davis, E., Terry, C. A., and Wintertan, K., Nitrogen-Arc Welding of Copper: British Weld. Jour., vol. 1, February 1954, pp. 53–64, 87–90; abs. in Metal Progress, vol. 66, No. 4, October 1954, pp. 256, 258, 260, 262.

was said, may result in an overall saving in welding costs of 30 to 60 percent.

A compilation[31] of the composition and proper application of copper and various copper alloys was published. The paper also included the effects of acids, alkali, salt solutions, gases, organic compounds, and steam on copper.

Equipment and procedures used in the annealing of copper and brass alloys were described in a publication.[32]

Bureau of Mines Reports.—The following Bureau of Mines reports of investigations published in 1954 and early 1955 relate to copper in whole or in part:

5114. Holliday, R. W., Investigation of Chippewa Copper-Nickel Prospect Near Rockmont, Douglas County, Wis., 11 pp.

5127. Rowland, J. A., Armantrout, C. E., and Walsh, D. P., Casting and Fabrication of High-Damping Manganese-Copper Alloys, 20 pp.

Geological Survey Reports.—The following bulletins of the Geological Survey, published in 1954 and early 1955, also relate to copper:

995–C. Cater, F. W., Jr., and Wells, F. G., 1953 [1954], Geology and Mineral Resources of the Gasquet Quadrangle, California-Oregon, pp. 79–133.

989–E. Moffit, F. W., Geology of the Prince William Sound Region, Alaska, 1954, pp. 225–310.

1000–C. Huff, L. C., A Paleozoic Geochemical Anomaly Near Jerome, Ariz., 1955, pp. 105–118.

WORLD REVIEW

World mine output of copper was slightly higher in 1954 than in 1953 and established a new alltime peak rate. The 91,000-ton drop in United States production was more than counterbalanced by increases of 49,000 tons in Canada, 18,000 tons in the Union of Soviet Socialist Republics, 7,000 tons in Belgian Congo, and 28,000 tons in Northern Rhodesia. Chile's production remained unchanged and was below the Northern Rhodesian rate for the second successive year. In 1954 both Belgian Congo and Northern Rhodesia established new production highs for the fifth successive year. Production in Chile and in the United States would have risen above 1953, except for labor strikes in August and September and the voluntary workweek cutbacks in earlier months of the year.

An outstanding world event in 1954 was the announcement by the Export-Import Bank in November that it was prepared in principle to extend a credit of not to exceed $100 million to assist in costs of financing the Toquepala copper project in Southern Peru. This action promised to speed exploitation of that large mine. Further discussion appears under *Peru*.

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[31] Chemical Engineering, Copper and Alloys: Vol. 61, No. 11, November 1954, pp. 186–187.

[32] Copeland, A. H., Jr., The Annealing of Copper and Brass Alloys: Ind. Heat., vol. 21, No. 3, March 1954, pp. 444–446, 448, 450–452, 454, 456, 605–606, 620, 624, 626.

TABLE 36.—World mine production of copper, by countries, 1945–49 (average) and 1950–54, in short tons [1]

(Compiled by Augusta W. Jann)

Country	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Canada	234,072	264,209	269,971	258,038	253,252	302,732
Cuba	16,969	22,500	21,700	19,700	17,800	17,500
Mexico	66,700	68,011	74,242	64,444	66,302	60,413
United States	763,351	909,343	928,330	925,359	926,448	835,472
Total	1,081,092	1,264,063	1,294,243	1,267,541	1,263,802	1,216,117
South America:						
Bolivia (exports)	6,648	5,185	5,342	5,184	4,920	4,034
Chile	457,227	400,071	419,630	450,440	400,287	400,861
Ecuador	1,616	580	2	------	------	------
Peru	27,563	33,124	35,576	33,563	39,023	41,848
Total	493,054	438,960	460,550	489,187	444,230	446,743
Europe:						
Austria	657	1,802	2,026	2,913	3,279	3,381
Finland	17,871	17,196	20,283	24,250	21,000	23,150
France	452	660	770	660	[2] 550	[2] 550
Germany:						
East [2]	} 14,776	{ 11,000	13,200	12,100	17,600	22,000
West		1,520	1,840	2,593	2,262	2,460
Hungary	[2] 454	[2] 440	(3)	(3)	(3)	(3)
Italy	197	54	213	144	235	689
Norway	13,701	17,219	15,436	15,027	14,362	15,432
Spain [4] [5]	8,622	6,802	8,333	9,895	9,406	7,951
Sweden	16,433	17,747	15,925	17,500	14,924	14,565
U. S. S. R. [2] [6] [7]	184,000	240,000	280,000	325,000	334,000	352,000
Yugoslavia [7]	30,387	44,181	35,286	36,177	34,381	33,394
Total [2] [6]	287,550	358,600	393,800	446,800	452,500	476,100
Asia:						
China [7]	1,065	[2] 4,400	[2] 6,600	[2] 6,600	[2] 8,800	[2] 8,800
Cyprus (exports)	11,558	25,685	25,145	29,564	23,937	30,059
India	6,697	7,700	8,144	7,183	5,500	8,300
Japan	27,728	43,463	47,135	59,031	64,907	71,866
Korea, Republic of	497	30	7	550	1,540	550
Philippines	3,298	11,446	14,013	14,596	14,016	15,817
Taiwan (Formosa)	482	[2] 1,100	[2] 1,100	[2] 1,100	287	550
Turkey [7]	11,519	12,897	14,436	25,717	25,901	27,042
Total [2] [6] [8]	63,000	107,000	117,000	144,000	145,000	163,000
Africa:						
Algeria	17	89	132	57	110	220
Angola	304	1,410	1,200	1,100	1,200	1,900
Belgian Congo [7]	165,744	193,918	211,598	226,799	236,057	243,424
French Morocco	227	20	31	891	1,202	838
Rhodesia and Nyasaland, Federation of:						
Northern Rhodesia	236,716	327,923	352,048	363,190	410,808	438,708
Southern Rhodesia	151	129	105	120	211	298
South-West Africa	4,627	12,082	13,619	15,457	13,357	15,668
Tanganyka [9]	------	41	151	23	(10)	------
Union of South Africa	31,325	37,459	37,182	38,704	39,843	46,638
Total	439,111	573,071	616,066	646,341	702,788	747,694
Australia	18,196	16,693	18,600	22,498	40,875	45,760
World total (estimate)	2,380,000	2,760,000	2,900,000	3,020,000	3,050,000	3,100,000

[1] This table incorporates a number of revisions of data published in previous Copper chapters.
[2] Estimate.
[3] Data not available; estimate by authors of chapter included in continental and world totals.
[4] According to Yearbook of 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 estimate for Burma.
[9] Copper content of exports and local sales.
[10] Less than 0.5 ton.

TABLE 37.—World smelter production of copper, by countries, 1945–49 (average) and 1950–54, in short tons [1]

(Compiled by Pearl J. Thompson)

Country	1945-49 (average)	1950	1951	1952	1953	1954
North America:						
Canada	206,284	238,203	245,465	196,319	236,965	253,364
Mexico	169,838	53,437	65,302	56,402	57,633	48,527
United States [2]	849,401	1,008,529	1,036,637	1,024,427	1,047,810	945,899
Total	1,225,523	1,300,169	1,347,404	1,277,148	1,342,408	1,247,790
South America:						
Chile	441,967	380,802	396,944	422,498	371,745	372,818
Ecuador [3]	1,311	----------	----------	----------	----------	----------
Peru	21,046	25,603	26,804	22,640	25,802	27,907
Total	464,324	406,405	423,748	445,138	397,547	400,725
Europe:						
Austria	1,724	5,918	7,110	7,097	10,278	10,357
Finland	20,860	14,961	19,677	20,191	21,814	23,452
France [4]	137	(5)	(5)	(5)	(5)	(5)
Germany:						
East [6]	76,127	18,200	20,000	22,000	27,500	28,000
West [7]		223,218	225,749	206,746	233,328	258,271
Italy	157	20	204	193	313	860
Norway	7,804	9,959	9,542	11,033	13,342	14,205
Spain	6,571	5,451	5,506	5,070	6,590	6,376
Sweden	17,310	18,417	16,540	14,840	19,215	19,354
U. S. S. R. [6 8]	184,000	240,000	280,000	325,000	334,000	352,000
Yugoslavia	30,387	44,181	35,286	36,177	34,381	33,394
Total [6 8 9]	345,000	581,000	620,000	649,000	701,000	746,500
Asia:						
China [7]	1,065	[6] 4,400	[6] 6,600	[6] 6,600	[6] 8,800	[6] 8,800
India	6,831	7,408	7,933	6,808	5,510	8,020
Japan	32,742	40,979	48,334	54,353	70,080	75,914
Korea:						
Korea, Republic of	506	19	245	37	22	226
North Korea	[6 10] 2,756	(5)	(5)	(5)	(5)	(5)
Taiwan (Formosa)	653	397	556	798	655	1,012
Turkey	11,519	12,897	14,436	25,717	25,901	27,042
Total [6 8]	56,000	68,000	80,000	95,000	112,000	123,000
Africa:						
Angola	[11] 882	1,516	1,275	1,145	1,304	1,989
Belgian Congo	165,744	193,918	211,598	226,799	236,057	243,424
Rhodesia and Nyasaland, Federation of: Northern Rhodesia	233,513	308,632	346,239	349,837	406,087	424,045
Spanish Morocco	----------	293	140	83	63	----------
Union of South Africa	30,451	36,753	36,290	37,702	38,575	45,152
Total	430,590	541,112	595,542	615,566	682,086	714,610
Oceania: Australia	[12] 18,790	17,270	17,070	22,409	38,258	42,613
World total (estimate)	2,540,000	2,915,000	3,085,000	3,105,000	3,275,000	3,275,000

[1] This table incorporates a number of revisions of data published in previous Copper chapters.
[2] Smelter output from domestic and foreign ores, exclusive of scrap. Production from domestic ores only, exclusive of scrap, was as follows: 1945–49 (average), 769,132; 1950, 911,352; 1951, 930,774; 1952, 927,365; 1953, 943,391; and 1954, 834,381.
[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 a large output of refined copper which is believed to be produced principally from crude copper from Belgian Congo and is not given here, as that would duplicate output reported under the latter country.
[10] Average for 1946–47.
[11] Average for 1 year only, as 1949 was the first year of commercial production.
[12] Refined-copper production; smelter output not available.

NORTH AMERICA

Canada.—The mine output in 1954—303,000 short tons of copper—was the largest since 308,100 tons was produced in 1942. Labor strikes in effect January 1 at a number of properties in Quebec continued until mid-February. The output of refined copper, all from plants of The International Nickel Co. of Canada, Ltd., at Copper Cliff, Ontario, and of the Canadian Copper Refineries, Ltd., Montreal East, Quebec, was 252,600 tons compared with 237,000 in 1953. Consumption of refined copper was 102,000 tons in 1954 and 108,500 in 1953.

TABLE 38.—Copper produced (mine output) in Canada, 1945–49 (average) and 1950–54, by Provinces, in short tons [1]

Province	1945–49 (average)	1950	1951	1952	1953	1954
British Columbia	18,217	21,088	21,932	20,786	24,148	25,088
Manitoba	18,210	20,817	15,839	9,374	9,411	12,274
Newfoundland	4,500	3,221	2,899	2,959	2,814	3,481
Northwest Territories	----------	----------	1	3	----------	----------
Nova Scotia	----------	----------	----------	383	788	991
Ontario	111,360	117,210	128,809	125,343	130,583	140,776
Quebec	49,087	72,891	68,866	68,846	54,920	83,930
Saskatchewan	32,698	28,982	31,625	30,344	30,588	36,192
Total	234,072	264,209	269,971	258,038	253,252	302,732

[1] Dominion Bureau of Statistics, Department of Trade and Commerce, Government of Canada.

Nearly half of Canada's copper production in 1954 was from *Ontario*, where it came almost entirely from the nickel-copper ores of the Sudbury district. The International Nickel Co. of Canada, Ltd., was by far the leading copper-producing company in all Canada, despite the fact that it produced more nickel than copper. The company delivered 126,600 tons of refined copper in 1954 compared with 117,200 in 1953, Canada's customers receiving about 45 percent in both years. The bulk of the sales was in the form of vertically cast shapes. Most of the remainder went to the United Kingdom, with smaller quantities to the Continent and to the United States. A new record of 14,456,000 tons was established for ore production, nearly 800,000 tons more than the previous record in 1953. Ore reserves, nonetheless, were increased slightly to the highest total on record, or to 261,619,000 tons, containing 7,875,000 tons of nickel-copper.

The annual company report to stockholders stated that, at its Copper Cliff smelter, the recently developed oxygen flash-smelting process for treating all of the copper concentrate completed its first full year of satisfactory routine operation and reduced copper smelting costs. The daily smelting capacity of the furnace is approximately 1,000 tons of dry solid charge.

High-record production was also established at mines of the Falconbridge Nickel Mines, Ltd., the other important producer of copper in Ontario, also a more important producer of nickel than of copper. The company hoisted 1,409,000 tons of ore. Most of it came from the Falconbridge and McKim mines, which produced all year; the Mount Nickel, Hardy, and East mines in that order, came into production in 1954 and were expected to furnish one-third of 1955's output. Still under development were the Long Jack, Boundary, and Fecunis mines. The company delivered 11,200 tons of copper to customers in 1954 and 8,000 in 1953. Developed and indicated reserves totaled 35,516,000 tons at the end of 1954, an increase of 945,000 tons after extraction of the 1954 tonnage. The year-end reserves averaged 1.59 percent nickel and 0.82 percent copper. Smelted copper was, as usual, refined in Norway.

Geco Mines, Ltd., near Manitouwadge Lake, 40 miles northeast of Heron Bay, Lake Superior, did exploratory drilling on a 1953 discovery that indicated over 14 million tons, averaging 1.72 percent copper and 3.55 percent zinc, in 3 deposits. Preparations were reported underway for production at a daily milling rate of 3,300 tons. Exploration on several other properties in the Manitouwadge area disclosed some promising occurrences of copper and zinc. Copper deposits, apparently of considerable extent, were also discovered near Tashota and on Timagami Lake.[33]

Milnet Mines, Ltd., about 18 miles north of Falconbridge, and Nickel Offsets, Ltd., and Nickel Rim Mines, Ltd. (formerly East Rim Nickel Mines), both in the Sudbury area, shipped copper-nickel concentrate to the Falconbridge smelter. Near Matachewan, New Ryan Lake Mines, Ltd., continued to produce copper concentrate, which was shipped to the Noranda smelter, Noranda, Quebec.[34]

Noranda Mines, Ltd., maintained by a small margin its position as leading producer of copper in *Quebec*, second most important copper-producing Province in Canada. The Horne mine, on strike from August 22, 1953, reopened February 13, 1954. From the mine was delivered to the smelter and concentrator 446,000 tons of direct-smelting ore averaging 2 percent copper and 710,000 tons of concentrating ore averaging 1.97 percent copper. The smelter treated 1,137,000 tons of charge, from which 88,400 tons of anodes was produced, of which estimated recovery from the Horne mine was 21,900 tons of copper.

The copper was recovered at the electrolytic copper refinery of Noranda's subsidiary, Canadian Copper Refiners, Ltd., Montreal East. Some 336,000 tons of new ore in extension of known ore bodies was found during stoping operations, only partly replacing the 1,156,000 tons of ore mined. Indicated ore reserves above the 2,975-foot level, as of January 1, 1955, were as follows:

	Short tons	Copper, percent	Gold, ounce per ton
Sulfide ore:			
Over 4 percent copper	3,221,000	7.20	0.163
Under 4 percent copper	9,866,000	.69	.195
Total sulfide ore	13,087,000	2.29	.187
Siliceous fluxing ore	948,000	.09	.122
Total ore	14,035,000		

The foregoing does not include tonnages containing little or no copper in the Chadbourne ore body and the No. 5 zone of the Horne mine,

[33] Canada Department of Mines and Technical Surveys, Copper in Canada, 1954 (Prelim.): Ottawa, Canada, 10 pp.
[34] Work cited in footnote 33.

as well as 1,500,000 tons of ore averaging 0.7 percent copper in the No. 5 zone.

At the Quemont Mining Corp., Ltd., mine, which adjoins the Horne mine, 719,000 tons of ore averaging 1.69 percent copper and 2.70 percent zinc was concentrated. Copper concentrates produced contained 11,400 tons of copper which was smelted at Noranda. The strike, which began October 2, 1953, continued to February 16, 1954.

Ore reserves dropped during the year to 9,030,000 tons, averaging 1.44 percent copper and 2.68 percent zinc, with gold and silver values.

The mill of the Waite Amulet Mines, Ltd., subsidiary of Noranda, treated 430,400 tons of ore from the East Waite No. 3 shaft, Amulet Dufault, and "A"-11 winze. From the ore 20,800 tons of copper were produced. Ore reserves on December 31 were as follows:

	Short tons	Copper, percent	Zinc, percent
Waite Amulet:			
East Waite	628,000	4.53	3.87
"A"-11 ore below Amulet Dufault	107,000	4.20	.52
Amulet Dufault:			
Lower "A" ore body	493,000	7.11	4.21
Ore below 1,000-foot level	120,000	4.0	3.9
Total ore	1,348,000		

The company mill was being enlarged to treat 2,000 tons a day. Waite Amulet's daily output of 1,400 tons was expected to be reduced to 1,000 tons by July 1955, and new production of 1,000 tons from the West Macdonald Mines, Ltd., was to be handled. The strike that began October 21, 1953, terminated February 15, 1954.

Hydroelectric power, which had been expected to be available to Gaspè Copper Mines, Ltd., by October 1954, was delayed; then the mill was expected to get into production by March 1955, using steam-generated power, augmented by diesel-driven generators. Later the hydroelectric power was expected to be ready in June 1955 and the smelter not to be in operation until after that. Underground work preparing the Needle Mountain ore bodies for production continued to confirm the original estimate of tonnage and grade calculated from diamond-drilling results, that is, 67 million tons, averaging 1.3 percent copper.

Canadian Copper Refiners, Ltd. (another subsidiary of Noranda and 1 of the 2 copper refineries in Canada), produced 127,000 tons of refined copper in 1954 compared with 110,000 tons in 1953. The tankhouse was being extended, and the annual capacity of the plant was to be 190,000 tons of refined copper.

The Normetal Mining Corp., Ltd., milled 328,500 tons of ore averaging 2.33 percent copper and 6.46 percent zinc in 1954. The concentrate produced contained 7,000 tons of copper and 16,600 tons of zinc. The copper concentrated was shipped to Noranda and the zinc to the United States. The strike that began October 17, 1953, terminated February 17, 1954. Ore reserves above the 4,165-foot level as of December 31, 1954, before any allowance for dilution, were estimated at 2,188,100 tons, averaging 2.56 percent copper and 8.33 percent zinc. It was reported that ore was being drifted in on the 5,165-foot level, with indications that character, grade, and width were comparable with those on the 4,165-foot level.

East Sullivan Mines, Ltd., milled 916,100 tons of ore and produced concentrate containing about 13,000 tons of copper.

Opemiska Copper Mines (Quebec), Ltd., and Quebec Copper Corp., Ltd., produced concentrate containing 7,000 and 3,500 tons, respectively, of copper. There were a few other properties that produced small quantities of copper in the Province.

The construction of a 1,750-ton concentrator by the Campbell Chibougamau Mines, Ltd., was nearly completed and was expected to be in production in May 1955. Reserves, including those on an adjoining property leased from Merrill Island Mining Corp., Ltd., were estimated to exceed 2 million tons, averaging 2.9 percent copper.[35] Other properties were also being explored.

Saskatchewan and *Manitoba* together produced 16 percent of Canada's total copper output in 1954.

The Hudson Bay Mining & Smelting Co., Ltd., mined and hoisted, from underground operations at the Flin Flon mine, 1,524,000 tons of ore averaging 3.10 percent copper and 5.0 percent zinc. Production began at the company Schist Lake mine, 3½ miles southeast of Flin Flon, on August 1, and 54,670 tons of ore was mined and treated. The Hudson Bay mill produced 304,900 tons of copper concentrate and 127,900 tons of zinc concentrate. The company smelter treated 436,800 tons of Hudson Bay concentrate, residues and ores and 16,300 tons of custom concentrate. Blister shipped to a refinery contained 45,200 tons of copper.

The company continued development work at the North Star, Birch Lake, and Coronation mines; the first-named was expected to begin production in January 1955. One subsidiary company continued development work at the Don Jon mine, which adjoins the North Star mine, and another discontinued production at the Cyprus mine because the property was worked out. The foregoing properties are all within 12 air miles of Flin Flon.

The construction phase of the Lynn Lake project of Sherritt Gordon Mines, Ltd., was completed in 1954. The first shipment of concentrate was made on January 6, and thereafter shipments were on a regular basis. The tonnage increased until May when capacity was about reached. Mill feed before May was from the "A" mine; thereafter production from the "El" mine greatly improved the grade and quantity of feed. For the year, 557,600 tons of ore was milled and produced nickel and copper concentrates containing 1,100 and 3,200 tons, respectively, of copper. No exploratory work was done underground during the year and reserves were reduced by the tonnage mined or to 13,482,000 tons, averaging 1.193 percent nickel and 0.610 percent copper.

The Granby Consolidated Mining, Smelting & Power Co., Ltd., mined and milled 1,871,900 tons of ore averaging 0.82 percent copper, from the Copper Mountain mine, *British Columbia*, and produced concentrates containing 12,300 tons of copper. The concentrates were shipped to the smelter at Tacoma, Wash. Ore reserves were depleted to about 1 year's supply but the company was considering

[35] Work cited in footnote 33.

treatment of about 1 million tons of waste dump material containing 0.5 percent copper. The Britannia Mining & Smelting Co., Ltd., treated 916,400 tons of ore at its property on Howe Sound and produced about 30,000 tons of concentrate containing 8,700 tons of copper and 358 tons of copper contained in precipitates. The Granduc mine, 25 miles northwest of Stewart, being developed by Granby and the Newmont Mining Corp., was reported to have estimated reserves of 9,500,000 tons averaging 1.5 percent copper. The Canam mine, 28 miles east of Hope, was being explored by The American Metal Co., Ltd., and a large tonnage of ore containing 1.5 percent copper was indicated. Exploration was continued at the Cowichan mine, 30 miles west of Duncan, Vancouver Island, and the Yreka mine in the northwest part of the island.[36]

An important discovery of lead-zinc-copper-silver ore was made on the Little River, near Newcastle, *New Brunswick*, as a result of airborne geophysical surveys followed by ground geophysics, geochemistry, and diamond drilling. The Heath Steele Mines, Ltd., owned 75 percent by The American Metal Co., Ltd., and 25 percent by the International Nickel Co. of Canada, Ltd., was formed to continue development of the property. The former company announced that 4 million tons of ore had been disclosed by early November. Further work was planned and a target date of late 1957 set for bringing the property into production.

In central *Newfoundland* the Buchans Mining Co., Ltd., milled 340,000 tons of zinc-lead-copper ore, from which concentrate containing 3,000 tons of copper was produced and shipped from the port of Botwood. Over 2 million tons of ore averaging 2.2 percent copper was outlined in the old Tilt Cove mine, a former producer on Notre Dame Bay, by the Bathurst Mining Corp., Ltd., and Maritimes Mining Corp., Ltd., and there was other activity in the area.[37]

Elsewhere in Canada production of 1,000 tons of copper in concentrate came from the Stirling zinc-lead-copper Mindamar Metals Corp., Ltd., Cape Breton Island, *Nova Scotia;* North Rankin Nickel Mines, Ltd., carried out exploration which outlined 460,000 tons averaging 3.3 percent nickel and 0.81 percent copper at its property near Rankin Lake, *Northwest Territories;* and Hudson Bay Exploration & Development Co., Ltd., continued development at its Wellgreen mine in the Kluane Lake district, *Yukon Territory*, where ore reserves were increased to 500,000 tons, averaging 1.34 percent copper, 2.14 percent nickel, and 0.074 percent cobalt. Laboratory testwork was continued by Hudson Bay on the metallurgy of the copper-nickel ore.[38]

Exports of ingots, bars, and billets from Canada in 1954, compared with 1953, were as follows, by countries of destination, in short tons:

Destination:	*1953*	*1954*
United States	74, 655	60, 814
United Kingdom	51, 384	77, 867
France	2, 940	7, 728
Brazil	2, 345	5, 751
Other	670	3, 970
Total	131, 994	156, 130

[36] Work cited in footnote 33.
[37] Work cited in footnote 33.
[38] Work cited in footnote 33.

Exports of copper in ore, matte, regulus, etc., totaled 47,411 (51,158 in 1953) tons, of which the United States was the destination of 34,073 (35,716) tons, Norway 10,547 (9,063), West Germany 1,716 (2,926), Japan none (2,332), and the United Kingdom 1,075 (1,121) tons. In addition, 9,758 (6,855) tons of rods, strips, sheets, and tubing was shipped, of which 1,144 (3,050) tons went to the United States and 4,953 (2,313) to Switzerland.

Imports of refined copper were 1 ton in 1954 compared with 5,515 tons in 1953.

Mexico.—A 9-percent decline in mine output in 1954 to 60,400 tons was caused by closing of the Boleo mine, Baja California. The mine, closed because of depletion of the ore body, was being reopened on a miners' cooperative basis with the assistance of the Mexican Government. During the year a low-grade copper ore body was discovered near Concepcion de Oro, Zacatecas, and development during the following year was expected. Electrolytic copper sales by the Cobre de Mexico, S. A., the only producer of electrolytic copper in the country, were 27,100 tons in 1954, consisting of 8,000 tons of wire bars, 18,000 tons of cathodes, and 1,100 tons of billets. The company also sold 1,700 tons of copper sulfate and less than 100 tons of copper anode scrap.[39]

A report gave the following data on the history of the Boleo mine: [40]

Production.—The deposits, discovered about 1868, were acquired in 1885 by the Compagnie du Boleo, organized in Paris. Between 1890 and 1948 over 550,000 metric tons of copper were produced, the gross value of which exceeded $150,000,000. According to Billingsley and Locke the following North American copper districts belong with Boleo according to their scheme of classification (districts showing values for past production, plus reserves, of between $50,000,000 and $250,000,000): Brittania and Rossland, British Columbia; Superior and Ray, Arizona; Nacozari, Sonora. Boleo was one of the major copper deposits of the world. It is now mined out. * * *

SOUTH AMERICA

Chile.—Mine output of 400,900 tons of copper in 1954 was virtually unchanged from the low 1953 rate; production thus was lower than that in Northern Rhodesia for the second successive year, and Chile again ranked third among the copper-producing countries of the world. In the first half of the year production was reduced because of the large stocks that accumulated in 1953 when Chile's price was arbitrarily held at 6 cents a pound above the United States price. Press reports indicated that such stocks aggregated 180,000 tons at the beginning of 1954. Then in August and September 1954 labor strikes reduced production, as they did in the United States. In August 1953 the Chilean Government had formally requested the United States Government to purchase stocks accumulated at that time for its Strategic Stockpile. In March 1954 the 2 Governments reached agreement for the purchase by the United States of 100,000 tons of copper "at market," and contracts were signed in May with the Anaconda Sales Co. for 64,000 tons and with Kennecott Sales Corp. for 36,000 tons of Chilean copper, for delivery to the stockpile.

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[39] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 5, May 1955, pp. 13–14.
[40] Wisser, Edw., Geology and Ore Deposits of Baja California: Econ. Geol., vol. 49, No. 1, January–February 1954, pp. 44–74.

The annual report to stockholders of the Kennecott Copper Corp. stated:

The inflation in Chile is continuing and is the major factor affecting the company's operations. Its seriousness is indicated by the fact that in 1954 the cost of living (at Santiago as reported by the International Monetary Fund) advanced 71 percent. This is in addition to increases in 1953 and 1952 of 56 and 22 percent, respectively.

A new law purporting to give better treatment, in regard to taxes and other matters, to American copper companies operating in Chile was approved by the Chamber of Deputies in November and forwarded to the Senate for action. The annual report of the Anaconda Copper Mining Co., published in early 1955, said of the law:

Many of the problems affecting the large producers of copper in Chile, including the subsidiaries of your Company, will be measurably reduced by new legislation sponsored by the Administration, which has been passed by the Chilean Congress. This legislation will restore control of sales of copper to the large copper companies, permit them to retain the full sales price instead of the fixed price heretofore received by them, eliminate the discriminatory exchange rate, and impose a tax rate with provision for gradual reduction as production of copper is increased.

At the Braden mine of the Kennecott Copper Corp. 6,286,000 tons of ore was mined and milled and 108,100 tons of copper produced, compared with 8,198,000 and 140,300 tons, respectively, in 1953. After prolonged labor contract negotiations a strike was called August 18, and operations were interrupted for 1 month.

At the Chuquicamata mine of Chile Exploration Co., subsidiary of Anaconda Copper Mining Co., 205,300 tons of copper was produced, an increase of 19 percent over 1953. An "illegal" strike closed the mine for 6 days in September. The placing in operation of the primary and secondary crushing units during April marked the completion of the new sulfide plant.

The Andes mine of the Andes Copper Mining Co., another Anaconda subsidiary, produced 42,300 tons of copper in 1954, or 6 percent less than in 1953. Operations at this mine were suspended from August 30 to September 23, 1954, owing to an "illegal" strike.

TABLE 39.—Principal types of copper exported from Chile, in 1954, by countries, in short tons

	Refined		Standard (blister)	Total
	Electrolytic	Fire-refined		
United States	33,607	71,026	105,683	210,316
United Kingdom	53,107	15,850	5,096	74,053
Italy	11,234	56	10,299	21,589
Germany	4,646	276	15,093	20,015
Netherlands	17,075	112		17,187
Spain			7,984	7,984
Belgium	2,533			2,533
Sweden	1,875			1,875
Bolivia	1,512			1,512
Switzerland		1,367		1,367
Argentina		1,102		1,102
Norway	923			923
Japan	785			785
Other	392	169		561
	127,689	89,958	144,155	361,802

Empresa Nacional de Fundiciones, a Government agency that operates the national smelter at Paipote, produced 16,700 tons of blister in 1954 compared with 13,100 tons in 1953.

Chilean exports of the chief types of copper, by countries, are shown in table 39.

Shipments of ore and concentrate totaled 27,700 tons in 1954 (36,500 in 1953), of which 12,400 (20,300) went to the United States, 10,500 (13,100) to Germany, 1,800 (0) to Belgium, 1,500 (3,100) to Japan, and 1,500 (0) to other countries.

Peru.—The upward trend of production in Peru continued in 1954, and 41,800 tons of copper was produced; this was the largest output since 1940, when 48,500 tons was produced. Considerable headway was made in 1954 toward development of a new large deposit in Peru. The 1954 annual report to stockholders of the American Smelting & Refining Co. made the following comments in the foregoing connection:

> Since the last annual report, substantial progress has been made in connection with the Toquepala project in southern Peru. The Export-Import Bank of Washington announced in November 1954, that pursuant to the policy of intensifying its activities in the financing of economic development in this hemisphere, it had approved in principle the extension of a credit to Southern Peru Copper Corporation of not to exceed $100,000,000, plus capitalized interest during the construction and start-up period, for the purpose of developing and equipping the Toquepala property. This credit is subject to the requirement that private interests invest in the project not less than $95,000,000, inclusive of sums previously expended. This investment must be in a form satisfactory to the Bank and subordinate to the Bank's loan.
>
> On November 10, 1954, Southern Peru Copper Corporation entered into an agreement with the Government of Peru relating to the project, including provisions assuring stable income tax rates, waiver of import duties, freedom of exportation of copper and freedom of exchange.
>
> Recently, your Company completed preliminary arrangements with Cerro de Pasco Corporation, Newmont Mining Corporation and Phelps Dodge Corporation under which the Toquepala and Quellaveco properties of your Company's wholly-owned subsidiary, Northern Peru Mining and Smelting Company, and the Cuajone property of Cerro de Pasco and Newmont, also located in southern Peru, will be transferred to Southern Peru Copper Corporation. Under the arrangements, your Company will own 57¾% of the capital stock of Southern Peru Copper Corporation, Cerro de Pasco will own 16%, Newmont will own 10¼% and Phelps Dodge will own 16%. While engineering studies are still continuing, your Company's share of the new money requirements for the project on the basis of present estimates will be about $40,000,000. At the end of 1954, your Company's investment in the Toquepala and Quellaveco properties was approximately $10,000,000.
>
> Drilling of the Toquepala property was completed in 1952, and an ore reserve in excess of 400,000,000 tons has been proven, with an average assay slightly greater than 1% copper.
>
> The project includes preparation of the deposit for open pit mining, the construction of a concentrating mill, townsite, and other facilities near the mine, the construction of a standard gauge railroad of approximately 110 miles to the mine from the sea coast at Ilo, the construction of a smelter, powerplant and townsite on the sea coast near Ilo and the construction of port works, warehouses, and other facilities at Ilo. About five years will be required for construction.
>
> The Cuajone and Quellaveco properties also contain large porphyry-type copper deposits. Both have been drilled and their location is such that many of the major facilities for Toquepala can eventually serve these properties.

The three deposits owned by Southern Peru were estimated to contain over 1 billion tons of ore, averaging about 1 percent copper.

Total copper exports were 41,300 tons (35,100 in 1953), of which 24,100 (26,700) went to the United States, 7,900 (11) to the United

Kingdom, and 3,400 (800) to Argentina. Of the total, 27,400 tons was refined bars, and 10,500 tons was in concentrates.

EUROPE

Finland.—Mine production of copper in Finland in 1954 is shown in table 40. The Government-owned company [41]—Outokumpu Oy—produced all of the straight copper ore and 97 percent of the copper in concentrate. The nickel-copper mine at Nivala was abandoned in 1954 because of depletion of ore reserves. Whereas mining of zinc-copper ore was discontinued at the Orijarvi mine, the oldest in Finland (1757), sorting of old slag piles for residual mineral values was to continue on a limited scale and search for new ore reserves was to be undertaken.

A new shaft, hoisting tower, and concentration mill were being completed at the Outokumpu mine, where ore reserves were said to be 16 to 18 million tons, or enough at the present rate of mining for 25 years, compared with a total production to date of about 11 to 12 million tons.

The Harjavalta smelter produced 30,566 tons of copper anodes and 395 tons of copper crystals. The Pori Metal Works produced 23,551 tons of copper cathodes and 131 tons of copper sulfate.

Copper available for domestic consumption totaled 17,820 short tons, 41 percent more than the 12,653 tons in 1953.

Crude-copper exports were 1,475 tons, 1,115 of which went to Poland, 332 to the Soviet Union, and 28 to Sweden. In addition, 116 tons of waste and scrap, 2,910 tons of copper bars and wire, 293 tons of plates and sheets, 3,537 tons of copper manufactures (chiefly bare copper cable), and 2,755 tons of insulated copper cable were exported.

Imports were 771 tons of electrodes, 1,706 tons of crude copper, and 893 tons of semimanufactured and 636 tons of manufactured products.

TABLE 40.—Mine production of copper in Finland in 1954

	Copper ore, short tons	Copper, percent	Copper concentrate, short tons	Copper, percent
Outokumpu Oy:				
Outokumpu	627,798	3.22	94,232	19.47
Ylojarvi	152,242	.91	6,346	19.94
Aijala	134,546	1.55	10,508	16.90
Orijarvi	[1] 49,846	.61	1,003	21.87
Nivala	[2] 36,861	.41	(2)	3.81
Vihanti	[3] 30,602	.85	337	16.04
Vuoksenniska Oy: Haveri	131,175	.38	3,003	17.81
Total	1,163,070	-----------	115,429	-----------

[1] Zinc-copper ore.
[2] Nickel-copper ore from which 3,326 tons of nickel-copper concentrate was produced.
[3] Zinc-copper-lead ore.

France.—Consumption of copper in 1954 was estimated at 183,000 tons, which was distributed as follows:

Class:	*Percent of total*
Electrical construction and industrial equipment	24
Production and distribution of electrical power	11

[41] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 4, April 1955, pp. 12–13.

Class—Continued	Percent of total
Automotive industry	10
Various mechanical industries	8
National defense and offshore orders	8
Nationalized railways	4
Semifinished products for export	15
Other	20
	100

There was no production of copper ore in France in 1954. Copper production consisted of the electrolytic refining of scrap from domestic supply and of anodes and blister from Belgium. Processing was by the Compagnie Générale d'Electrolyse du Palais at its plant at Le Palais. Electrolytic copper production was 20,000 tons in 1954, compared with 18,400 in 1953, 18,500 in 1952, 18,200 in 1951 and 17,400 in 1950.[42]

The French nonferrous-metal industry was described in 1953.[43]

United Kingdom.—The United Kingdom regularly ranks as the second largest copper-consuming country in the world. Consumption of 502,200 tons of primary and secondary refined copper in 1954 exceeded the 1953 rate by 39 percent. On March 10 it was announced that there would be no further sales by the Government broker after May 31, and sales were discontinued as of that date. World supplies of copper temporarily failed to cover requirements in the second half of 1954; and this factor, combined with the removal of the steadying influence of the Government broker, caused widely fluctuating prices on the London Metal Exchange (see the section on Prices). The British Ministry of Materials was dissolved August 16, and its remaining functions were transferred to the Board of Trade. The latter almost immediately lifted the ban on export of copper wire and certain other products to Soviet Bloc countries. Trade reports indicated that a substantial volume of business developed.

According to the British Bureau of Nonferrous Metals Statistics imports of copper into the United Kingdom in 1953 and 1954 were as follows:

TABLE 41.—Copper imported into the United Kingdom, 1953–54, in short tons

Country	1953			1954		
	Blister	Electrolytic	Fire refined	Blister	Electrolytic	Fire refined
Belgian Congo		2,716			9,183	
Belgium		17,339			16,222	
Canada		53,526			72,241	
Chile				7,131	21,491	12,117
Germany, West		22,882			12,876	
Northern Rhodesia	121,037	125,663		140,039	124,914	
Peru		11			3,044	
Union of South Africa			5,694			2,134
United States		22,734	1,949		16,785	4,733
Others	635	2,381	13	1,430	3,610	692
Total	121,672	247,252	7,656	148,600	280,366	19,676

[42] Erickson, E. B., Nonferrous Minerals and Metals—France—1954: State Dept. Dispatch 68, Paris, France, July 11, 1955, pp. 6–8.
[43] Metal Bulletin (London), Special French Nonferrous Issue: September 1953, 26 pp.

Exports and reexports of refined copper were 29,046 tons (23,979 in 1953), of which 9,931 (8,848) went to Germany, 6,411 (4,240) to Italy, and 4,803 (502) to France. In 1954 the 17,517 (19,564) tons of blister and "rough" copper exported and reexported went mainly to Belgium and Germany for refining on toll and return to the United Kingdom.

Yugoslavia.—Blister-copper production was 33,400 tons in 1954 or 5 percent less than the average for 1951–53, and the electrolytic copper output (from blister) was 29,700 tons, or 28 percent higher than the average for that 3-year period. The new rolling mill at Sevojno, western Serbia, mentioned in Minerals Yearbook, 1953, was put into operation at the end of 1954 and the cable mill at Svetozarevo, Central Serbia, went into partial operation also in 1954; the other sections of the latter plant were to start operating in 1955. A report [44] indicated that until the Majdanpek mine was opened Yugoslavia would be able to fabricate 10,000 tons of imported refined copper. It stated that the Bor electrolytic refinery could process 10,000 tons of imported blister and that the chemical industry was able to process an additional several thousand tons of raw copper into copper sulfate and other products.

ASIA

Japan.—With a mine output of 71,900 tons in 1954 copper operations were the highest since 95,700 tons was produced in 1944. Copper mining in Japan dates back 1,200 years. An article [45] discussed the industry.

The maximum monthly capacity of copper and brass mills was reported [46] to be 14,700 tons of copper or brass sheet, strip, pipes, rods, and wire, and 400 tons of bronze and nickel-silver sheet, strip, rods, and wire.

Philippines.—Copper exports normally approximate production but exceeded it in 1954 owing to temporary paralysis of loading operations at the Lepanto pier in late 1953. Of the 18,400 tons of copper in concentrate exported in 1954, Lepanto Consolidated Mining Co. supplied over 99 percent. Lepanto milled 408,900 tons of ore, averaging 4 percent copper, and produced 67,500 tons of concentrate, averaging 23.1 percent copper. Copper production was 15,700 tons. Ore reserves at the end of the year were 2,789,000 tons, averaging 4.03 percent copper.

Ore reserves at the Toledo mine, Cebu Island, were 37,600,000 tons, averaging 1.02 percent copper. The Atlas Consolidated Mining & Development Corp. proposed to operate a 4,000-ton mill at the mine, beginning in early 1955. Mining was to be by open-pit methods.

Copper in the Philippines was described in a recent publication.[47]

AFRICA

Belgian Congo.—A new record high copper production was established in Belgian Congo in 1954 for the fifth successive year; the

[44] Commercial Information, Federal Chamber of Foreign Trade (Belgrade), New Copper-Processing Capacities: Vol. 8, No. 4, April 1955, pp. 17–20.

[45] United Nations Department of Economic Affairs, Development of Mineral Resources in Asia and the Far East: VI. Copper, Lead, Zinc, and Tin Ore Deposits and Mining Industry in Japan: Apr. 22, 1953, pp. 330–344.

[46] Haraldson, Wesley C. (commercial attaché), Maximum Capacity of Copper and Brass Mills in Japan State Dept. Dispatch 1605, Tokyo, Japan, May 28, 1954, 1 p.

[47] United Nations Department of Economic Affairs, Development of Mineral Resources in Asia and the Far East; XI. Copper in the Philippines: Apr. 20, 1953, pp. 348–59.

output was 3 percent above 1953 and 47 percent above the average annual rate in 1945–49. As usual, the Union Minière du Haut Katanga was the only producer. The company stated in its annual report to stockholders:

> * * * The 1954 financial year has been excellent from all points of view: volume of production with subsequent financial results, commencement of our activities in the fields of nuclear energy and germanium production, increase of our hydroelectric capacity, development of ore reserves, elaboration of technical processes, design of new installations or extensions of existing installations. These last activities are necessary to maintain the level of production already attained and will furthermore permit new increases in production. * * *

The average price of copper sold during the year was equivalent to 30.5 cents a pound, compared with 31.5 cents in 1953. Copper ore produced was 8,199,000 tons in 1954. Copper concentrate recovered totaled 931,300 tons, containing 251,500 tons of copper, an average of 27.01 percent. The output of copper, in short tons, was distributed as follows:

	1953	*1954*
Lubumbashi smelter (blister)	111,831	118,300
Jadotville-Shituru (electrolytic plant)	118,796	123,177
Jadotville-Panda (electric copper-cobalt alloy furnaces)	902	712
Copper recoverable contained in zinc concentrates exported	4,493	4,498
Total	236,022	246,687

Copper exported from Belgian Congo in 1953 and 1954 is shown in table 42.

TABLE 42.—Copper exported from Belgian Congo in 1953–54, by countries, in short tons[1]

Country	1953	1954	Country	1953	1954
Belgium	138,187	121,992	Other countries	2,072	3,221
Beira Depot	16,636	45,402			
France	36,295	35,909	Total	229,896	249,966
United States	7,140	16,011			
Italy	10,533	10,450	Shipments by type:		
United Kingdom	4,480	5,600	UMPC blister	115,874	123,245
Union of South Africa	3,907	3,421	Wire bars (99%)	103,666	112,059
Algeria	3,197	3,386	Ingot bars	10,356	13,417
Lobito Depot	1,733	2,152	Black copper		1,245
Sweden	3,059	1,433			
India	2,657	989	Total	229,896	249,966

[1] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 3, September 1955, p. 10.

Northern Rhodesia.—Copper mine production in 1954—438,700 short tons—established a new high record rate for the fifth successive year, exceeding the previous peak in 1953 by 7 percent. All of the records have been made despite continued coal-supply problems and problems in connection with labor, most latterly that of granting adequate recognition to native workers without causing discontent on the part of the European segment. A report [48] stated that the Federal Government's decision to proceed with the Kariba hydroelectric power scheme in preference to Kafue offered hope that by 1961 the Copperbelt would be assured of adequate power supplies freed from recurring coal shortages. Blister and electrolytic sales totaled 229,600 and 194,500 short tons, respectively.

[48] Mining Journal (London), The Rhodesias: Ann. Rev. No., 1954 ed., May 1955, p. 145.

The situation in Northern Rhodesia at the end of 1954, as to history, production, problems and outlook, was described by Prain.[49]

A total of 5,309,500 short tons of ore, averaging 2.18 percent copper, was mined and milled by Roan Antelope Copper Mines, Ltd., in the fiscal year ended June 30, 1954. Company concentrate yielded 99,300 tons of blister compared with 97,800 in 1953. The 1954 total included 334 tons of blister copper produced at the Mufulira smelter. Roan Antelope's smelter, on the other hand, treated 4,000 tons of Mufulira concentrate and 19,100 tons of Nchanga concentrate and produced 1,900 and 7,300 tons, respectively, of blister copper. Ore reserves at the end of June 1954 were 91 million tons, averaging 3.20 percent copper. The increase of 6 million tons, more than covering production for the year, was due to inclusion of additional ore in the Roan Extension, mainly in the folded area below the 820-foot level. In March 1954 Roan Antelope announced that it would construct an electrolytic copper refinery at Ndola to be operated by a subsidiary company to be organized, i. e., the Ndola Copper Refinery, Ltd. It was to have an initial capacity of over 60,000 tons of electrolytic copper commencing in 1958 and a possible eventual capacity to about twice as much.

At the Mufulira mine of Mufulira Copper Mines, Ltd., 3,606,000 tons of ore, averaging 3.24 percent copper, was milled. A total of 98,500 tons of copper was produced compared with 85,200 tons in the 1952–53 fiscal year. The electrolytic refinery, placed in operation in November 1952, produced 36,400 tons of electrolytic cathode copper, or capacity for the plant, and the company had 15,800 tons of copper electrolytically refined abroad. Doubling of the capacity of the refinery was in progress. At the end of June 1954 ore reserves at the mine were estimated at 132 million tons having an average grade of 3.48 percent copper. During the fiscal year the company divested itself of its holdings in Chibuluma Mines, Ltd., and two new companies were set up to take over the Baluba and Chambishi mines, leaving Mufulira as a producing company only.

On June 30, 1953, reserves for Chambishi were reported as 25 million tons and those for Baluba as 70 million tons.

Chibuluma, a relatively small but high-grade copper-cobalt property, was expected to be brought into production in the latter half of 1955. Production was to be at an estimated 18,000 tons of copper and 250 tons of cobalt annually. Estimated ore reserves were 7,300,000 tons, averaging 5.23 percent copper.

Bancroft Mines, Ltd., was expected to get into production at an annual rate of 48,000 tons in early 1957. Concentrates were scheduled to go to the Nkana smelter of Rhokana Corp., Ltd., at Nkana. At the end of June 1954 reserves were estimated at 90 million tons of 3.64 percent copper ore.

A total of 4,144,000 tons of ore was hoisted in the Nkana north and south and the Mindola ore bodies by the Rhokana Corp., Ltd., in the fiscal year ended June 30, 1954. The concentrator treated 4,138,500 tons averaging 2.59 percent copper and yielded 273,700 tons of concentrate averaging 36.11 percent copper and 1.48 percent cobalt. Copper production was 30,100 tons of blister and 59,300 tons of elec-

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[49] Prain, R. L., The Copperbelt of Northern Rhodesia, The Henry Morely Lecture: South African Min. and Eng. Jour., vol. 65, pt. 2, No. 3234, Feb. 5, 1955, pp. 989, 991, 993, 995, 997.

trolytic copper. The smelter produced 181,000 tons of copper, of which 30,100 was blister and 63,000 was anode copper for Nkana, 28,500 was blister and 59,400 anode copper for Nchanga, and 22 tons was blister for Broken Hill. Ore reserves at the end of June 1954 were as follows:

	Short tons (million)	*Copper (percent)*
Nkana north ore body	24	2. 97
Nkana south ore body	20	2. 82
Mindola ore body	52	3. 45
Total	96	3. 20

In the fiscal year ended March 31, 1954, 2,382,000 tons of ore, averaging 6.33 percent copper, was milled by Nchanga Consolidated Copper Mines, Ltd. The company's completed expansion program on the high-grade Nchanga West ore body resulted in an increase in output. Production of blister, anode and cathode copper was 123,000 tons in the 1953–54 fiscal year. Ore reserves on March 31, 1954, were as follows:

	Short tons (million)	*Copper (percent)*
Nchanga West	37	7. 06
Nchanga River Lode	2	4. 21
Chingola	2	7. 00
Nchanga	90	3. 48
Total	131	4. 56

The Rhodesia Copper Refineries, Ltd., produced 143,000 tons of electrolytic copper in the fiscal year ended June 30, 1954, compared with 125,000 tons in the 1952–53 fiscal year.

Exports of copper from the Federation of Rhodesia and Nyasaland in 1954, virtually all if not all from Northern Rhodesia, are shown in table 43.

TABLE 43.—Copper exported from Federation of Rhodesia and Nyasaland in 1954, in short tons [1]

Destination	Blister	Electrolytic			Copper slimes
		Bar and ingot	Cathodes	Wire bars	
Argentina				1, 100	
Australia		1, 665		7, 281	
Belgium	2, 073		559	952	
Canada	560				
Denmark				336	
France		1, 624		5, 178	
Germany, West	15, 363			448	
India	829			169	
Italy			840	13, 710	
Netherlands	4, 699		1, 600	2, 185	
Sweden				22, 145	
Switzerland	168	28	616	1, 006	
Union of South Africa	536			11, 385	
United Kingdom	143, 941	168	48, 226	77, 559	(2)
United States	62, 165		1, 232		
Other countries				14	
Total	230, 334	3, 485	53, 073	143, 468	(2)

[1] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 3, September 1955, p. 13.
[2] Less than 1 ton.

Southern Rhodesia.—Mine production of copper was only 300 tons in 1954, but expansion was in early prospect. The Messina (Transvaal) Development Co., Ltd., did not get the Umkondo mine into production in 1954 but expected to accomplish this in early 1955. Production was to be at an annual rate of 2,200 tons in the form of copper concentrates to be smelted at Messina's plant in the Union of South Africa. Messina owns 79 percent of the capital stock of Rhodesia Copper Ventures and intends through this company to bring a larger, low-grade copper property in the Sinoia district into production in the future.

Uganda.—Construction work was proceeding at the Kilembe mine on the eastern slopes of the Ruwenzori Mountains, and production was expected in 1956. According to the annual report to stockholders of Ventures, Ltd., the mine has proved reserves of 11,321,000 tons, averaging 2.12 percent copper and 0.18 percent cobalt. Future development was expected to outline a much larger tonnage of similar grade. The mine was being prepared for production at a rate of 1,335 tons a day. A concentrating mill was being erected and a railway built to connect the property to Jinja on Lake Victoria where the concentrates were to be reduced in an electric smelter.

Union of South Africa.—The Union of South Africa was one of several that reached new production peaks in 1954. The output (46,600 tons) was as follows: 16,000 tons of fire-refined copper, 29,100 tons of blister, 169 tons in concentrates, and 1,300 tons in matte. The breakdown of the 39,800 tons in 1953 was 14,000, 24,600, 42, and 1,200 tons, respectively. The blister copper was produced by the O'okiep Copper Co., Ltd., Cape Province; the fire-refined by Messina Transvaal Development Corp., Transvaal; and the Rustenburg Platinum Mines produced copper in a concentrate and in matte, as a byproduct of platinum production.

Of the 45,450 tons (36,000 in 1953) of blister and fire-refined copper exported in 1954, 23,700 (21,100) went to Italy, 9,000 (6) to Belgium, 5,000 (0) to the United States, 2,900 (0) to Spain, 2,800 (13,700) to the United Kingdom, and 1,500 (1,000) to Germany.

Diatomite

By Oliver S. North[1] and Annie L. Marks[2]

OUTPUT OF DIATOMITE in the United States in 1954 was only slightly lower than in 1953, the record year, and was considerably higher than the 1951–53 average of 302,816 short tons annually.

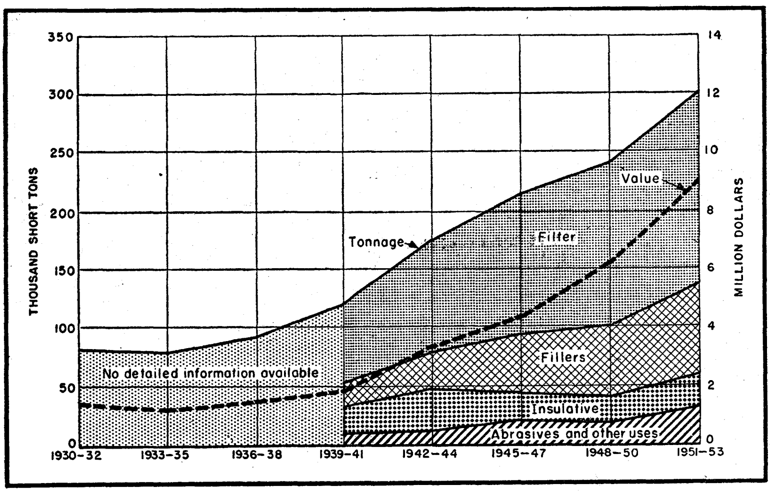

FIGURE 1.—Production, value, and use of diatomite in the United States, 1930–53.

DOMESTIC PRODUCTION

Diatomite (known also as diatomaceous earth or kieselguhr) is a siliceous material consisting of the skeletal remains of aquatic organisms known as diatoms. Large deposits of this material, the purest varieties of which are chalklike in appearance, are found in many States. However, large deposits of high purity and desirable physical characteristics that are well located with respect to transportation, markets, etc., are relatively scarce.

In 1954, as in previous years, California was by far the leading diatomite-producing State, followed in order by Nevada, Oregon, Washington, Arizona, and New Mexico. Arizona was listed among diatomite-producing States for the first time.

The average annual output of diatomite in the United States increased from 81,000 short tons valued at $1,206,000 in the 3-year period 1933–35 to 302,800 short tons valued at $9,074,000 in 1951–53.

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

The latter average was exceeded in 1954. The Bureau of Mines publishes only 3-year averages for this commodity.

The production and value of diatomite in the United States since 1930, as reported to the Bureau of Mines, are shown in table 1.

TABLE 1.—Production of diatomite in the United States, for 3-year periods, 1930–53

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

Diatomite Mine and Plant Developments.—A commercial history of diatomite deposits near Walteria, Calif., in the Palos Verdes Hills 25 miles south of Los Angeles, was published.[3] These deposits have been mined and processed by the Dicalite Co. and its successor, Dicalite Division of Great Lakes Carbon Corp., since 1930. Because of approaching exhaustion of economic reserves on the property the company for some time had been supplementing local mine output by hauling considerable quantities of crude diatomite from its Lompoc, Calif., quarry to the Walteria mill. More recently the company obtained a quarry permit to mine a nearby 165-acre diatomite deposit only 3 miles from the Walteria mill.[4] It was announced that the mined area would be graded and reforested as the excavation proceeds. The operation would be so conducted as to minimize dust, and the pit would be shielded from view. When the diatomite has been removed the hill will be available for residential purposes.

Johns-Manville Corp. began constructing a new plant at Lompoc, Calif., in which synthetic silicates will be produced by reacting diatomite with lime or magnesia under pressure.[5] Products to be made in the new plant include a variety of synthetic silicates especially designed for use as inert adsorbents, filter aids, extenders, and fillers and in petroleum refining and other fields. The new facilities, which were expected to be completed early in 1956, will be adjacent to the firm's existing plant at Lompoc, Calif.

Kenite Corp., the principal producer in Washington, installed a two-stage drying system at its processing plant at Quincy.

Diatomaceous earth claims formerly held by Kittitas Diatomite Co. near Ellensburg, Wash., were purchased by Western Ventures, Inc., and the latter company produced a limited quantity during the latter half of 1954.[6] However, it planned to install calcining facilities and extend its product line and market coverage.

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[3] Gay, T. E., Jr., and Hoffman, S. R., Mines and Mineral Deposits of Los Angeles County, Calif.: Calif. Jour. Mines and Geol., vol. 50, Nos. 3–4, July–October 1954, pp. 467–709.

[4] Pit and Quarry, Great Lakes Carbon Corp. to Open New 165-Acre Diatomite Pit: Vol. 46, No. 9, March 1954, pp. 121, 124.

Chemical and Engineering News, More Crude Diatomite: Vol. 32, No. 7, Feb. 15, 1954, p. 574.

[5] Paint, Oil and Chemical Review, Johns-Manville Corp. Begins New Plant for Synthetic Silicates: Vol. 117, No. 11, June 3, 1954, p. 23.

[6] Mining World (news item), vol. 16, No. 7, June 1954, p. 90.

Johns-Manville Corp. and Great Lakes Carbon Corp., took options on diatomite lands in the Drewsey area of Harney County, Oreg., and planned programs of exploration to outline existing reserves. Oregon deposits in northern Malheur County were explored by Malheur Wunder Earth, Inc.

Incorporation papers were granted to Miro-Kohl Products, Inc., Reno, Nev., which planned to prepare and market diatomite.[7]

Through the early months of 1954 James H. Rhodes Pumice, Inc., Santa Fe, N. Mex., mined diatomite near Espanola, N. Mex., and prepared an oil-water absorbent material at its Santa Fe plant. However, because no market could be found for a surplus of byproduct fines, the company closed its operation in late spring.

Diatomaceous earth was mined at a pit 10 miles north of Mammoth, Ariz., crushed to minus ⅛-inch, and used as aggregate, mainly in concrete block, by Builders Supply Corp., Phoenix, Ariz.

CONSUMPTION AND USES

The diatomite industry in the United States continued to develop new uses for its products and supply its customers with dependable, high-quality material. Large deposits of relatively uniform crude diatomite permitted adherence to specifications—an important factor in the industry's successful development of markets.

Filtration Medium.—The major market for diatomite was again in the filtration of sugar, beverages, water, pharmaceuticals, oils, and many other liquids. Fifty-one percent of the 1954 output was used for this purpose.

Mineral Fillers.—Twenty-nine percent of the 1954 diatomite output was used as filler in rubber, paper, asphalt products, plastics, explosives, insecticides, paints, fertilizers, and many other products.

Insulation Material.—Owing to its high percentage of voids and high melting point, diatomite was used as a heat and sound insulator in industrial equipment and structures. Eight percent of the production was so used in 1954.

Abrasive Uses.—Three percent of the total 1954 production of diatomite was used for various abrasive applications.

Miscellaneous Uses.—Diatomite was also used as an absorbent, as a catalyst carrier, in ceramics and glazes, as a pozzolanic material in concrete, as a raw material for ultramarine pigment and sodium silicate, and in various other ways. Nine percent of the 1954 production was consumed for miscellaneous purposes.

PRICES

The Oil, Paint and Drug Reporter quoted the following 1954 prices per short ton for regular domestic diatomite: In bags, carlots, delivered in California, $50; same, delivered on east coast, $61; less than carlots, $90–$100. Prices per short ton quoted for purified domestic diatomite

[7] Mining and Industrial News (news item), vol. 22, No. 4, April 1954, p. 13.

in 1954 were: In bags, carlots, delivered in California, $65; same, delivered on east coast, $75; less than carlots, $100–$110.

As reported to the Bureau of Mines, the average values per short ton, f. o. b. mill, of domestically produced diatomite sold for various uses in 1954 were as follows: Filtration, $32.60; insulation, $32.13; abrasives, $41.59; fillers, $29.13; other uses, $21.57. The average mill value of all diatomite produced and sold in the United States in 1954 was $30.87 per short ton.

FOREIGN TRADE

Export and import statistics of diatomite were not reported separately by the United States Department of Commerce. Crude diatomite was imported into the United States free of duty under paragraph 1775 of the Tariff Act of 1930 as crude material n. s. p. f. (not specifically provided for).

TECHNOLOGY

PROCESSING

A method of flux-calcining relatively impure diatomaceous earth without previous drying, or even with the addition of water, was disclosed in a patent.[8] It was claimed that this technique can provide good filter-grade material at low cost and that it permits utilization of diatomaceous earth deposits of lower grade than were formerly considered usable.

TESTING

A method of determining particle-size distribution of dry powders, including fine-ground diatomite, ranging in particle size from 1 to 250 microns was described.[9] The apparatus reportedly makes possible rapid and accurate analyses of a wide variety of industrial powders.

UTILIZATION

Abrasives.—An article described the preparation of diatomite polishes for applications requiring mild abrasiveness combined with minimum wearing down of the polished surface.[10] Natural, air-floated, diatomite fines generally have been preferred for automobile cleaners and polishes.

High-quality diatomite mixed with calcium silicate was used in testing ruboff of plasticizer from flexible vinyl sheeting.[11] Rubbing with the mixture of dry powders was reported to provide a better measure of plasticizer loss than either of the alternate methods; extraction by oil or soapy water.

A silver cleaning and polishing paste, in which fine-ground diatomite is the active abrasive agent, was patented.[12]

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[8] Fennell, J. E. (assigned to The Eagle-Picher Co., Cincinnati, Ohio), Treatment of Diatomaceous Earth: U. S. Patent 2,693,456, Nov. 2, 1954.

[9] Eadie, F. S., and Payne, R. E., Particle-Size Distribution Analyzed Quickly, Accurately: Iron Age, vol. 174, No. 10, Sept. 2, 1954, pp. 99–102.

[10] Weymouth, L. E., and Martinson, P. A., Diatomite as an Abrasive for Cleaners and Polishes for Automobiles: Soap and Sanitary Chemicals, vol. 30, No. 2, February 1954, pp. 139, 141, 143, 145, 175.

[11] Reed, M. C., Klemm, H. F., and Schulz, E. F., Removal (of Plasticizers in Vinyl Chloride Resins) by Oil, Soapy Water, and Dry Powders: Ind. Eng. Chem., vol. 46, No. 6, June 1954, pp. 1344–1349.

[12] Avedikian, S. Z., Silver Cleaning and Polishing Composition: U. S. Patent 2,691,593, Oct. 12, 1954.

Catalyst Carriers.—A series of patents covered the use of diatomite as the carrier for solid catalysts used for hydrocarbon conversion reactions involving olefins. Other materials used in producing the catalysts were: Phosphoric acid and a manganese compound;[13] a solid carbonaceous material such as graphite, lampblack, powdered coke or coal, or charcoal;[14] and phosphoric acid and an oxide, hydroxide, or salt of a metal with a specific gravity greater than 5.5 selected from the members of the right column of group IV on the Periodic Table.[15] In each instance the mixture of raw materials is dried and calcined.

According to a patent, hydrogenation catalysts such as cobalt and nickel can be deposited on purified diatomaceous earth and used in ethylene polymerization.[16] For most efficient operation 300 to 1,000 parts of diatomite is used for each 100 parts of hydrogenation catalyst.

A patent cited the use of diatomite as the nonadsorbent material in a granular cupric chloride catalyst used to sweeten cracked naphthas that contain objectionable percentages of mercaptans.[17]

Fillers and Carriers.—Calcined diatomite can be employed as the carrier for a herbicidal agent in a patented product claimed to have improved properties with respect to length of active service, resistance to abrasion and disintegration due to climatic conditions.[18] Another patented herbicide also listed diatomite as a satisfactory carrier.[19]

It was claimed that diatomite can be used as the inert carrier material for an ion-exchange resin useful for a wide variety of commercial applications.[20]

Diatomaceous earth was listed in a patent as a useful filler material in dental impression compositions comprising also a gel-forming agent, a suitable metallic ion or compound, and a set controllant.[21]

A patent describes the use of lime-treated diatomite to keep ammonium nitrate fertilizers free flowing.[22]

It was claimed in a patent that the physical characteristics of napalm compositions used in manufacturing gelled gasoline can be improved by adding 5 to 20 percent, by weight, of minus-100-mesh diatomite or other fine-ground inert carrier material.[23]

Filtration.—The effect of body feed (additions of diatomite filter aid to the untreated water) on the economy of filtration of water through diatomite was investigated.[24] The relationship between the quantity

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13 Mavity, J. M., and Bielawski, M. S. (assigned to Universal Oil Products Co., Chicago, Ill.), Production of Phosphoric Acid and Manganese Containing Catalysts: U. S. Patent 2,692,241, Oct. 19, 1954.

14 Bielawski, M. S., and Mavity, J. M. (assigned to Universal Oil Products Co., Chicago, Ill.), Manufacture of Improved Solid Catalysts: U. S. Patent 2,694,048, Nov. 9, 1954.

15 Bielawski, M. S., and Mavity, J. M. (assigned to Universal Oil Products Co., Chicago, Ill.), Production of Tin or Lead Containing Phosphoric Acid-Siliceous Catalyst: U. S. Patent 2,692,242, Oct. 19, 1954.

16 Boyd, T., and Dickey, R. M. (assigned to Monsanto Chemical Co., St. Louis, Mo.), New Catalytic Process for the Polymerization of Ethylene: U. S. Patent 2,666,756, Jan. 19, 1954.

17 Krause, J. H. (assigned to Standard Oil Co., Chicago, Ill.), $CuCl_2$ Sweetening of Cracked Naphthas: U. S. Patent 2,695,263, Nov. 23, 1954.

18 Kenney, J. W., Jr., and Girard, J. W. (assigned to Great Lakes Carbon Corp., New York, N. Y.), Method and Compositions for Killing Weeds: U. S. Patent 2,695,839, Nov. 30, 1954.

19 Leppla, P. W. (assigned to Great Lakes Carbon Corp., New York, N. Y.), Methods and Compositions for Killing Weeds: U. S. Patent 2,695,840, Nov. 30, 1954.

20 D'Alelio, G. F. (assigned to Koppers Co., Inc., a Corporation of Delaware), Ion-Exchange Resins From Dihydroxy Benzenes or Phenol Sulfonic Acid and Polyfunctional Unsaturated Compounds: U. S. Patent 2,687,383, Aug. 24, 1954.

21 Noyes, S. E., and Lochridge, E. H. (assigned to Dental Perfection Co., Glendale, Calif.), Gel Point Indicating Impression Materials: U. S. Patent 2,678,280, May 11, 1954.

22 Studebaker, M. L. (assigned to Phillips Petroleum Co., a corporation of Delaware), Lime-Treated Diatomaceous Earth as a Parting-Agent for Ammonium Nitrate: U. S. Patent 2,690,389, Sept. 28, 1954.

23 Herron, A. O. (assigned to Safety Fuel & Chemical Corp., South Meriden, Conn.), Process of Preparing a Napalm Composition Containing a Finely Divided Inert Carrier: U. S. Patent 2,684,339, July 20, 1954.

24 Babbitt, H. E., and Baumann, E. R., Effect of Body Feed on the Filtration of Water Through Diatomite: University of Illinois Eng. Exp. Sta. Bull. 425, 1954, 40 pp.

of body feed required to secure most economical use of diatomite and the quality of the raw water was shown graphically. It was stated that, although the use of diatomite for small public water-supply systems has increased since World War II, wider use of such filters has been inhibited because of lack of information on their performance and economy.

Diatomite filter aid was reported used in pressure filtration of the public water supplies of four New York towns.[25] The filter plants were described and the economic considerations discussed.

A patent was granted on a diatomite-type filter apparatus in which the filter areas are in vertical positions and can be back-washed without opening the filter.[26] This feature is particularly desirable where the liquid being filtered is so valuable that maximum recovery is imperative.

Insulation.—A structural sheet material composed of diatomite, asbestos fiber, and an inorganic binder was marketed.[27] Originally developed for marine fireproofing, it was reported to have found industrial applications in widely diversified fields where its light weight, thermal properties, and strength permit it to function both as structure and insulation.

A patent covered conversion of a number of siliceous minerals, including diatomaceous earth, to more chemically reactive forms having properties that make them suitable for manufacturing lightweight, heat-insulating materials of high strength.[28] This objective is accomplished by reacting the silica-containing material with an alkaline-earth silicate-producing compound, such as lime, and acidifying the resulting composition.

A patent described the use of several lightweight mineral aggregates, including diatomite, in manufacturing heat-insulating molded panels.[29] The light weight of the product is maintained principally by foaming the mixture; the dry, absorbent aggregates are added mainly to take up the excess moisture therein.

Miscellaneous.—A method was patented for producing microspherular siliceous aggregates by kneading or pugging a mixture of fine-ground diatomite with water and a small percentage of clay, then flash-drying, densifying, spherulizing, and classifying the agglomerated particles and finally calcining the granules.[30] Crushed, uncalcined, relatively pure diatomite in which at least 50 percent of the particles is less than 5 microns in size is preferred.

According to a patent, normally hydrophilic diatomite can be rendered hydrophobic by treatment with certain organic compounds of silicon, for instance, tertiaryalkoxy halosilanes.[31] The product was said to be useful where resistance to wetting by water is desirable, for example, in oil-base polishes, paints, and coatings.

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[25] Fraser, J. K., Diatomaceous-Earth Filtration in New York State: Jour. American Water Works Assoc., vol. 46, No. 2, February 1954, pp. 151–155: Discussion by Cox, C. R., and Maneri, C. S., pp. 156–159.

[26] Armbrust, H. N. (assigned to Proportioneers, Inc., a Corporation of Rhode Island), Method of Discharging a Filter: U. S. Patent 2,681,153, June 15, 1954.

[27] Materials and Methods, New Structural Insulating Material: Vol. 40, No. 6, December 1954, pp. 96–97.

[28] Shea, F. L., and Hsu, H. L. (assigned to Great Lakes Carbon Corp., Morton Grove, Ill.), Siliceous Composition and Method for Manufacturing the Same: U. S. Patent 2,698,256, Dec. 28, 1954.

[29] Willson, C. D., Making Molded Panels: U. S. Patent 2,674,775, Apr. 13, 1954.

[30] Stewart, M. M. (assigned to Johns-Manville Corp., New York, N. Y.), Siliceous Contact Material and Method of Manufacture: U. S. Patent 2,686,161, Aug. 10, 1954.

[31] Pedlow, G. W., Jr., and Miner, C. S., Jr. (assigned to Minnesota Mining & Manufacturing Co., St. Paul, Minn.), Hydrophobic Inorganic Particulate Minerals: U. S. Patent 2,668,151, Feb. 2, 1954.

Diatomite was cited in a patent as a satisfactory electrolyte carrier in an electric dry cell.[32] The high porosity of diatomite reportedly enables it to equalize the moisture throughout the interior of the cell.

The various types of natural pozzolanic materials, including diatomite, were discussed and evaluated.[33] Details of processing the materials were given. Tests showed that intergrinding diatomite with certain air-entraining agents produced a very effective pozzolanic material.

A patent described a "mud" composition suitable for pumping into drill holes to seal or plug porous or cracked formations through which well-drilling fluid is being lost.[34] Approximately equal parts, by weight, of expanded perlite, expandable-type bentonite, and either diatomaceous earth or expanded perlite fines are dry mixed. Fifty to eighty pounds of this mixture per barrel of water is made into slurry and pumped down through the drill string. When lodged in formation pores or cracks, the bentonite continues over a period of time to absorb water and swell and with the perlite and diatomaceous earth forms a plug or seal. As the materials are relatively inert, it was claimed that the resulting seal will perform well under the pressures, temperatures, and chemical conditions that normally exist in oil and gas wells.

WORLD REVIEW

EUROPE

Finland.—Limited quantities of diatomite occur in Finland. One company, Suomen Mineraali Oy, excavated the material from peat bogs at Komu-morass, Kuona, Kilo, and Ihotti and used it largely in manufacturing heat-insulating materials.[35] Smaller quantities were used as a filter aid and for abrasive purposes.

AFRICA

Algeria.—Of the diatomaceous earth produced in Algeria, about half was consumed locally and half exported, mainly to France, United Kingdom, and the Netherlands.[36]

Kenya.—Extensive deposits of diatomite were reported to occur in old Pleistocene lake beds in Kenya.[37] At Gilgil, on the East African Railway line about 75 miles north of Nairobi, a 100-foot-thick bed of unusual purity was being mined and sold locally, largely for use in hand soaps. The diatomite band quarried is dazzling white, has a wet bulk density of about 28 lb. per cu. ft. and a loose bulk density of 7½–9 lb. per cu. ft., and is composed mainly of the diatom "Melosira." The material was quarried on 5-foot benches, and inclusions of pumicite and tuff were readily rejected. Production had increased steadily since 1945, and increasing quantities were being exported.

[32] Raag, N., Electric Dry Cell: U. S. Patent 2,679,548, May 25, 1954.
[33] Bauer, W. G., Technical Considerations in Natural Pozzolan Production: Pit and Quarry, vol. 47, No. 4, October 1954, pp. 41–42, 44–46; No. 5, November 1954, pp. 83–86.
[34] Armentrout, A. L., Material for Recovering Lost Circulation in Wells: U. S. Patent 2,683,690, July 13, 1954.
[35] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 2, February 1954, p. 58.
[36] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 6, June 1954, p. 47.
[37] Pulfrey, W., The Geology and Mineral Resources of Kenya: Geological Survey of Kenya (Nairobi), Bull. 1, 1954, 27 pp.

TABLE 2.—World production of diatomite, by countries,[1] 1945–49 (average) and 1950–54, in short tons [2]

(Compiled by Helen L. Hunt)

Country [1]	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Canada	69	49	92	28	103	104
Costa Rica	36	8	500	750	430	595
United States	220,000	[3] 300,000	[3] 300,000	[3] 300,000	[3] 300,000	[3] 300,000
South America: Chile	1,103	170	(4)	(4)	(4)	(4)
Europe:						
Austria	2,650	3,621	4,292	4,300	3,435	3,532
Denmark:						
Diatomite	3,859	4,544	5,356	3,756	[5] 4,400	[5] 4,400
Moler [5]	53,000	80,000	105,000	110,000	110,000	110,000
Finland	1,082	1,130	1,483	1,236	1,985	1,810
France	32,293	39,021	40,785	44,092	58,422	[5] 45,000
Germany, West	[5 6] 32,700	37,156	48,449	52,748	55,501	59,745
Italy	3,835	12,662	11,646	10,505	11,023	11,261
Sweden	1,894	1,962	2,036	1,733	1,503	1,516
United Kingdom:						
Great Britain	5,583	4,184	10,304	19,040	13,974	[5] 11,000
Northern Ireland	9,026	7,216	9,773	9,742	8,139	4,675
Africa:						
Algeria	8,686	15,113	23,140	22,064	28,334	37,283
Egypt	1,377	1,171	3,034	784	131	173
Kenya	1,093	2,880	4,725	6,644	4,903	3,649
Union of South Africa	751	480	96	1,190	120	1,047
Oceania:						
Australia	4,948	6,968	9,776	7,130	4,973	6,091
New Zealand	277	133	133	228	115	[5] 100
World total (estimate) [1]	440,000	570,000	640,000	650,000	660,000	660,000

[1] Diatomaceous earth believed to be also produced in Argentina, Brazil, Hungary, Japan, Korea, Norway, Portugal, Rumania, Spain, and U. S. S. R., but complete data are not available; estimates by senior author of chapter included in total.
[2] This table incorporates a number of revisions of data published in previous Diatomite chapters.
[3] Average annual production, 1950–54.
[4] Data not available; estimate by author of chapter included in total.
[5] Estimate.
[6] Average, 1948–49.

Feldspar, Nepheline Syenite, and Aplite

By Brooke L. Gunsallus[1] and Gertrude E. Tucker[2]

FELDSPAR

PRODUCTION of crude feldspar and flotation concentrate in 1954 decreased 9 percent in tonnage and 24 percent in value from 1953. Ground-feldspar sales decreased 8 percent in quantity and 9 percent in value, but sales to the enamel industry in 1954 increased 26 percent compared with 1953. The increased feldspar consumption in the enamel industry resulted from a partial recovery of the trade lost to substitutes in 1953.

Salient achievements in the feldspar industry in 1954 were: Completion of the first plant in the United States to produce high-potash-feldspar flotation concentrate from pegmatites; increase in the quantity of feldspar produced by flotation; and continued modernization of mining and plant facilities.

Imports of crude feldspar in 1954 were negligible; imports of crude nepheline syenite have been negligible since 1950. In 1954 imports of ground nepheline syenite increased 7 percent over 1953, and production of aplite increased 2 percent.

TABLE 1.—Salient statistics of the feldspar industry in the United States, 1945–49 (average) and 1950–54

	1945–49 (average)	1950	1951	1952	1953	1954
Crude feldspar:						
Domestic sales:						
Long tons	434,287	407,925	[1] 400,439	[1] 420,831	[1] 452,600	[1] 411,018
Value	$2,373,879	$2,558,390	$2,815,587	$3,696,018	$4,594,450	$3,490,466
Average per long ton	$5.47	$6.27	$7.03	$8.78	$10.15	$8.49
Imports:						
Long tons	18,969	12,367	17,128	5,576	5,901	79
Value	$138,946	$84,136	$146,565	$53,016	$60,501	$3,357
Average per long ton	$7.32	$6.80	$8.56	$9.51	$10.25	$42.49
Ground feldspar: Sales by merchant mills:						
Short tons	445,557	446,523	454,615	458,920	463,876	428,895
Value	$5,505,108	$6,343,619	$6,932,878	$6,712,481	$7,148,689	$6,517,458
Average per short ton	$12.36	$14.21	$15.25	$14.63	$15.41	$15.20

[1] Includes flotation concentrate.

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

DOMESTIC PRODUCTION [3]

Crude Feldspar.—Crude feldspar (including concentrate obtained by flotation of feldspathic rocks and sands) sold or used by domestic producers in 1954 (table 2) decreased 9 percent in quantity and 24 percent in value compared with 1953. The tonnage produced and the value were both the smallest since 1951. The average value per long ton, which had increased progressively from 1946 through 1953, dropped to $8.49 in 1954 from $10.15 in 1953. Production was reported from 11 States in 1954, compared with 10 in 1953.

In 1954 Colorado and California were the only States that reported increases over 1953. North Carolina continued to be the largest producer, with 56 percent of the quantity (59 percent in 1953, 57 percent in 1952, and 42 percent in 1951).

The tonnage of feldspar and feldspathic rock treated in flotation plants became a factor in feldspar output in 1951 and increased steadily through 1952 and 1953; in 1954 feldspar obtained by flotation represented about 37 percent of all marketable feldspar.

TABLE 2.—Crude feldspar sold or used by producers in the United States, 1945–49 (average) and 1950–54

Year	Long tons	Value: Total	Value: Average per ton	Year	Long tons	Value: Total	Value: Average per ton
1945–49 (average)	434,287	$2,373,879	$5.47	1952 [1]	420,831	$3,696,018	$8.78
1950	407,925	2,558,390	6.27	1953 [1]	452,600	4,594,450	10.15
1951 [1]	400,439	2,815,587	7.03	1954 [1]	411,018	3,490,466	8.49

[1] Includes flotation concentrate.

TABLE 3.—Crude feldspar [1] sold or used by producers in the United States, 1952–54, by States

State	1952 Long tons	1952 Value	1953 Long tons	1953 Value	1954 Long tons	1954 Value
Colorado	38,268	$224,385	43,508	$267,642	(2)	(2)
Connecticut	10,929	87,432	9,829	63,049	9,280	$60,463
Maine	18,644	147,371	17,637	117,090	} 44,990	} 375,087
New Hampshire	(2)	(2)	28,961	286,069		
North Carolina	240,364	2,416,031	268,042	3,290,495	230,744	2,220,707
South Dakota	40,163	220,954	50,601	321,026	(2)	(2)
Texas	2,600	31,200			(2)	(2)
Other States [3]	69,863	568,645	34,022	249,079	126,004	834,209
Total	420,831	3,696,018	452,600	4,594,450	411,018	3,490,466

[1] Includes flotation concentrate.
[2] Included with "Other States" to avoid disclosing individual company operations.
[3] Includes Arizona, California, Colorado (1954), Georgia (1954), New Hampshire (1952), South Dakota (1954), Texas (1954), Virginia, and Wyoming (1953).

[3] Production data for 1954 were collected jointly with the Bureau of the Census (U. S. Department of Commerce). Production totals will be compared with the Census totals when they are available and differences adjusted or explained.

Ground Feldspar.—Ground feldspar sold by merchant mills in the United States decreased 8 percent in quantity and 9 percent in value in 1954 compared with 1953. The average selling price per short ton decreased from $15.41 in 1953 to $15.20 in 1954. The number of producing States was 15 in 1954 compared with 13 in 1953.

As has been the case for several years, North Carolina again was by far the largest producer of ground feldspar, followed by Colorado, Tennessee, and South Dakota. Ground-feldspar production in each of the large producing States decreased in 1954 compared with 1953.

TABLE 4.—Ground feldspar sold by merchant mills [1] in the United States, 1945–49 (average) and 1950–54

Year	Active mills	Domestic feldspar			Canadian feldspar			Total	
		Short tons	Value		Short tons	Value		Short tons	Value
			Total	Average		Total	Average		
1945–49 (average)	28	429, 664	$5, 151, 258	$11. 99	15, 893	$353, 850	$22. 26	445, 557	$5, 505, 108
1950	23	429, 787	5, 952, 019	13. 85	16, 736	391, 600	23. 40	446, 523	6, 343, 619
1951	23	441, 816	6, 633, 378	15. 01	12, 799	299, 500	23. 40	454, 615	6, 932, 878
1952	24	448, 839	6, 473, 203	14. 42	10, 081	239, 278	23. 74	458, 920	6, 712, 481
1953	22	454, 692	6, 909, 177	15. 20	9, 184	239, 512	26. 08	463, 876	7, 148, 689
1954	24	427, 161	6, 471, 621	15. 15	1, 734	45, 837	26. 43	428, 895	6, 517, 458

[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, 1952–54, by States

State	1952			1953			1954		
	Active mills	Short tons	Value	Active mills	Short tons	Value	Active mills	Short tons	Value
Arizona	(2)	(2)	(2)	1	60, 204	$766, 832	(2)	(2)	(2)
Colorado	(2)	(2)	(2)	2			(2)	(2)	(2)
Connecticut	2	19, 109	$386, 191	2	11, 647	226, 300	(3)	(3)	(3)
New Jersey	1			(2)	(2)	(2)	(3)	(3)	(3)
Maine	3	16, 791	317, 365	3	17, 901	354, 639	(4)	(4)	(4)
New Hampshire	2	28, 592	605, 342	2	32, 397	700, 653	[5] 5	[5] 38, 444	[5] $725, 852
New York	1			1			[6] 4	[6] 14, 149	[6] 260, 257
North Carolina	3	270, 775	3, 714, 084	2	272, 059	3, 891, 684	2	254, 781	3, 763, 211
Tennessee	1			1			1		
Texas	1	2, 000	30, 000				1	1, 604	10, 524
Other States [7]	10	121, 653	1, 659, 499	8	69, 668	1, 208, 581	11	119, 917	1, 757, 614
Total	24	458, 920	6, 712, 481	22	463, 876	7, 148, 689	24	428, 895	6, 517, 458

[1] Excludes potters and others who grind for consumption in their own plants.
[2] Included with "Other States" to avoid disclosing individual company operations.
[3] Included with New York.
[4] Included with New Hampshire.
[5] Includes Maine.
[6] Includes Connecticut and New Jersey.
[7] Includes (number of active mills in parentheses) Arizona (1 in 1952 and 1954), California (2), Colorado (2 in 1952 and 1954), Georgia (1 in 1954), Illinois (1), New Jersey (1 in 1953), South Dakota (2), and Virginia (2).

The percentage of total shipments of ground feldspar in 1954, by groups of States, was: North Carolina-Tennessee, 59 percent; Arizona, Colorado, Georgia, and Virginia, 19 percent; Maine and New Hampshire, 9 percent; Connecticut, New York, and New Jersey, 3 percent; all others, 10 percent.

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-scale 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 all or part of their requirements, crude and crushed, and ground it to their own specifications in their own mills.

Ground Feldspar.—Glass, pottery, and enamel industries in 1954 consumed 96 percent of the ground feldspar sold by merchant mills compared with 97 percent in 1953 and 99 percent in each of the 3 previous years. In 1954 glass composed 53 percent (55 percent in 1953 and 1952, and 43 percent in 1951); pottery, 39 percent (39 percent in 1953 and 1952 and 51 percent in 1951); and enamel, 4 percent (3 percent in 1953 and 5 percent in 1952 and 1951). The remaining 4 percent was consumed by other industries, including soap and abrasive. Of the tonnage shipped to the 3 principal classes of consumers, enamel showed a 26-percent increase in 1954 compared with 1953, whereas shipments to the pottery industry decreased 6 percent and to the glass industry, 11 percent.

The uses of ground feldspar sold by merchant mills in the United States, 1938–54, are listed in table 6. There has been a 50-percent increase in ground tonnage in this period, but the quantity consumed annually by each of the following—glass, pottery, enamel—bore about the same ratio to total annual production in 1954 as in 1938. In 1954 glass used 53 percent (55 percent in 1938); pottery, 39 percent (37 percent in 1938); and enamel, 4 percent (9 percent in 1938).

The percentage of total consumption by States in 1954 (the comparable 1953 figures are shown in parentheses) was as follows: Pennsylvania, 19 percent (1953—14 percent); Ohio, 14 percent (1953—14 percent); Illinois, 14 percent (1953—13 percent); West Virginia, 11 percent (1953—11 percent); New Jersey, 8 percent (1953—10 percent); and New York, 7 percent (1953—7 percent).

TABLE 6.—Ground feldspar sold by merchant mills in the United States, 1938–54, in short tons, by uses

Year	Glass	Pottery	Enamel	Other [1]	Total
1938	117,800	74,035	19,395	3,284	214,514
1939	138,336	87,209	28,356	5,293	259,194
1940	149,623	104,586	26,420	5,084	285,713
1941	182,878	127,140	34,841	9,558	354,417
1942	195,601	106,081	13,899	12,205	327,786
1943	214,668	97,887	7,147	16,108	335,810
1944	220,734	106,341	8,464	7,622	343,201
1945	249,927	111,695	13,755	6,351	381,728
1946	289,559	154,340	22,500	3,800	470,199
1947	266,720	183,829	24,159	7,992	482,700
1948	270,065	202,905	25,282	8,199	506,451
1949	199,852	158,218	25,351	3,286	386,707
1950	212,481	197,817	33,037	3,188	446,523
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

[1] Includes other ceramic uses, soaps, and abrasives.

TABLE 7.—Ground feldspar shipped, by States of destination, from merchant mills in the United States, 1950–54, in short tons

Destination	1950	1951	1952	1953	1954
California	(1)	(1)	(1)	11,386	(1)
Illinois	56,513	53,940	51,808	61,751	60,391
Indiana	28,875	25,692	30,976	20,024	13,864
Maryland	20,861	19,109	17,214	16,871	16,324
Massachusetts	5,733	6,176	4,715	5,010	4,764
New Jersey	53,430	54,968	47,046	45,835	32,465
New York	22,362	31,086	31,614	30,950	28,923
Ohio	68,186	70,245	60,884	63,410	58,198
Pennsylvania	57,190	60,306	65,167	66,302	79,688
Tennessee	11,202	10,679	13,392	14,468	12,618
West Virginia	37,246	37,062	52,421	51,029	46,636
Wisconsin	12,580	11,558	9,880	8,617	6,534
Other destinations [2]	72,345	73,794	73,803	68,223	[3] 68,490
Total	446,523	454,615	458,920	463,876	428,895

[1] Included with "Other destinations."
[2] Includes Arkansas, California (1950–52 and 1954), Colorado, Connecticut, Kentucky, Louisiana, Michigan, Minnesota, Mississippi, Missouri, Oklahoma, Puerto Rico (1950 and 1952–54), Rhode Island, Texas, Washington (1950, 1952, and 1954), shipments that cannot be segregated by States, and small shipments to Belgium, Canada, Cuba, and Mexico. Also includes specified shipments to Alabama (1952–54), Arizona (1952), Florida (1952–54), Georgia (1952–54), Kansas (1952 and 1954), Maine (1950 and 1953), New Hampshire (1953–54), North Carolina (1952–54), North Dakota (1952), and Virginia (1952).
[3] Also includes small shipments to England, Panama, Peru, Philippines, and Venezuela.

Feldspar grinders in the United States in 1954, by States, were as follows:

California:
  Gladding, McBean & Co., Los Angeles.
  Del Monte Properties Co., Pacific Grove.
Colorado: Western Feldspar Milling Co., Salida.
Connecticut: Worth Spar Co., Middletown.
Georgia: Appalachian Minerals Co., Monticello.
Illinois: Abingdon Potteries, Inc., Abingdon.
Maine:
  Topsham Feldspar Co., Topsham.
  Bell Minerals Co., West Paris.
Maryland: Clinchfield Sand & Feldspar Corp., Towson.
New Hampshire: Golding-Keene Co., Keene.
New Jersey:
  Eureka Mica Mining & Milling Co., Trenton.
  J. F. Morton, Inc., Trenton.
North Carolina: Feldspar Milling Co., Burnsville.
Tennessee:
  Consolidated Feldspar Dept., International Minerals & Chemical Corp., Erwin.
  North Carolina Feldspar Corp., Erwin.
Texas: Dezendorf Marble Co., Austin.

Apparent Consumption.—Domestic production, imports, and apparent domestic consumption for 1926–54 are shown in table 8. Domestic production increased 96 percent from 1926 to 1954, while the increase in apparent domestic consumption during the same period was only 71 percent, reflecting the decreased imports. The average value per long ton of domestic crude feldspar sold or used in 1926 was $7.65 compared with $4.37 in 1940 and $8.49 in 1954. The average value per long ton of apparent domestic consumption in 1926 was $7.75 compared with $4.46 in 1940 and $8.50 in 1954.

TABLE 8.—Crude feldspar sold or used by producers in the United States, imports, and apparent domestic consumption, 1926–54

Year	Production		Imports		Apparent domestic consumption	
	Long tons	Value	Long tons	Value	Long tons	Value
1926	209,989	$1,607,101	29,941	$251,896	239,930	$1,858,997
1927	202,497	1,424,755	27,424	206,856	229,921	1,631,611
1928	210,811	1,418,975	27,857	224,920	238,668	1,643,895
1929	197,699	1,276,640	29,927	241,852	227,626	1,518,492
1930	171,788	1,066,636	21,006	167,157	192,794	1,233,793
1931	147,119	861,059	10,719	95,096	157,838	956,155
1932	104,715	539,641	1,872	14,346	106,587	553,987
1933	150,633	778,826	3,239	21,877	153,872	800,703
1934	154,188	853,136	9,744	67,258	163,932	920,394
1935	189,550	1,005,021	8,937	56,175	198,487	1,061,196
1936	244,726	1,303,090	10,786	68,198	255,512	1,371,288
1937	268,532	1,383,249	12,956	91,885	281,488	1,475,134
1938	196,119	895,081	7,651	56,126	203,770	951,207
1939	253,466	1,112,857	7,460	52,141	260,926	1,164,998
1940	290,763	1,271,995	12,522	80,274	303,285	1,352,269
1941	338,860	1,519,456	11,253	73,236	350,113	1,592,692
1942	316,166	1,546,702	9,525	69,798	325,691	1,616,500
1943	308,180	1,646,277	10,758	83,073	318,938	1,729,350
1944	327,408	1,813,937	11,686	95,956	339,094	1,909,893
1945	373,054	2,021,529	14,924	114,917	387,978	2,136,446
1946	508,380	2,594,099	16,365	127,517	524,745	2,721,616
1947	459,910	2,410,940	16,685	124,587	476,595	2,535,527
1948	460,713	2,564,387	31,047	219,785	491,760	2,784,172
1949	369,378	2,278,441	15,826	107,925	385,204	2,386,366
1950	407,925	2,558,390	12,367	84,136	420,292	2,642,526
1951	400,439	2,815,587	17,128	146,565	417,567	2,962,152
1952	420,831	3,696,018	5,576	53,016	426,407	3,749,034
1953	452,600	4,594,450	5,901	60,501	458,501	4,654,951
1954	411,018	3,490,466	79	3,357	411,097	3,493,823

PRICES

Price quotations for crude feldspar do not appear in the trade press. Average values are computed from the returns of producers reporting their output annually to the Bureau of Mines. In 1954 the average selling price per long ton for feldspar mined in the United States was $8.49 compared with $10.15 in 1953, $8.78 in 1952, and $7.03 in 1951.

The average selling price per short ton for ground feldspar in 1954 was $15.20—a 1-percent decrease from 1953 but a 4-percent increase over 1952. Of the large producing States, the one having the highest average selling price per short ton was New York—$26.43 ($26.08 in 1953, $23.74 in 1952, and $23.40 in 1951), followed by Illinois, $20.78 ($21.27 in 1953, $21.49 in 1952, and $20.47 in 1951). North Carolina, by far the largest producer, received only $14.82 per short ton in 1954 ($14.22 in 1953, $13.71 in 1952, and $14.68 in 1951).

Quotations on ground feldspar in E&MJ Metal and Mineral Markets for December 1954 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). Quotations on Virginia feldspar were not listed in E&MJ for 1952, 1953, and 1954. The following prices were given for 1951: No. 1, 230-mesh, $18.50 per ton, and 200-mesh, $17.50; No. 17 glassmakers' feldspar, $11.75, and No. 18, $12.50. Enamelers' feldspar was listed at $15 to $18.

FOREIGN TRADE [4]

Crude-feldspar imports for consumption in 1954, all from Canada, totaled only 79 long tons valued at $3,357, the smallest in the history of the industry. Imports in 1953 were 5,901 long tons valued at $60,501. The 1954 figures represented a 99-percent decrease in tonnage and a 94-percent decrease in value compared with 1953.

According to reports by the merchant grinders to the Bureau of Mines, ground-feldspar exports from the United States in 1954 totaled 4,235 short tons, an increase of 42 percent over 1953. Countries of destination were Canada, Panama, Mexico, Cuba, Puerto Rico, Peru, Venezuela, England, Belgium, and the Philippines.

TABLE 9.—Feldspar imported for consumption in the United States, 1945–49 (average) and 1950–54

[U. S. Department of Commerce]

Year	Crude		Ground		Year	Crude		Ground	
	Long tons	Value	Long tons	Value		Long tons	Value	Long tons	Value
1945–49 (average)	18,969	$138,946	(1)	$66	1952	5,576	$53,016		
1950	12,367	84,136			1953	5,901	60,501	98	$2,740
1951	17,128	146,565	(1)	26	1954	79	3,357	898	22,449

[1] Less than 1 ton.

Cornwall Stone.—Beginning January 1, 1954 import statistics of unmanufactured cornwall stone were not separately classified. Imports of ground cornwall stone, all from the United Kingdom, increased 15 percent in 1954 over 1953.

TABLE 10.—Cornwall stone imported for consumption in the United States, 1945–49 (average) and 1950–54

[U. S. Department of Commerce]

Year	Unmanufactured		Ground		Year	Unmanufactured		Ground	
	Long tons	Value	Long tons	Value		Long tons	Value	Long tons	Value
1945–49 (average)	779	$10,741	73	$1,644	1952	300	$3,170	30	$800
1950	1,128	11,792	111	2,160	1953	655	7,018	53	1,376
1951	944	9,453	110	3,462	1954	(1)	(1)	61	1,758

[1] Beginning Jan. 1, 1954 not separately classified.

TECHNOLOGY

The Appalachian Minerals Co., Monticello, Ga., was purchased by Feldspar Flotation Corp. of Spruce Pine, N. C., and a modern flotation plant to recover high-potash feldspar from pegmatites was built and placed in operation in December 1954. This plant, the first of its kind in the United States, was built to supply concentrate to the glass trade and, after further beneficiation, to the pottery, enamel, and other divisions of the ceramic industry. The application of froth flotation

[4] Figures on imports are 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.

to pegmatites has provided the feldspar industry with a new source of raw material. Feldspar and byproduct quartz and mica are separated from impurities, such as pyrite, tourmaline, free iron, in successive operations. Feldspar produced by this method is remarkably pure and uniform in composition.

The Feldspar Milling Co. of Burnsville, N. C., completed mechanizing its mining operations and installed a modern grinding plant. This company dry-grinds hand-cobbed feldspar only. A 3-year program of exploration and development for high-potash feldspar was completed in 1954.

The Bell Minerals Co. completed the rehabilitation, begun in 1953, of its mining and milling facilities in Maine and developed two new feldspar mines in 1954.

International Minerals & Chemical Corp. moved its feldspar-grinding plant from Rochester, N. Y., and consolidated all milling at Buckingham, Quebec, Canada, without decreasing production facilities.

A bulletin was published that described pegmatite investigations in the White Picacho district, Arizona.[5] The pegmatite belt is about 250 miles long and 30 to 80 miles wide and extends southeastward from Lake Mead to a point south of Phoenix. The geography, general geology, and structural features of the district were described briefly. Three general types of pegmatites were recognized: (1) Sample, (2) zoned, and (3) zoned-lithium pegmatites. Bulges are common in many pegmatites. The bulbous parts of the White Picacho pegmatites usually are zoned and contain feldspar in commercial quantities.

WORLD REVIEW

The estimated world production of feldspar in 1954 showed a 4-percent increase compared with 1953. The outputs of China and of U. S. S. R., for which no data are available, are not included in the total.

The proportion of United States output to estimated world output in 1954 was 51 percent compared with 58 percent in 1953, 53 percent in 1952, and 51 percent in 1951.

Canada.—Production of feldspar totaled 15,439 short tons (all from Quebec) valued at Can$307,741 in 1954 compared with 21,246 tons valued at Can$347,164 in 1953. (The 1953 figures are revised.) Imports totaled 398 tons of ground feldspar valued at Can$8,078 in 1954 compared with 350 tons valued at Can$7,085 in 1953. The United States supplied all the 1954 imports. Exports totaled 1,056 tons valued at Can$28,206 in 1954 compared with 6,848 tons valued at Can$64,234 in 1953. Of the 1954 exports, the United States received 1,053 tons valued at Can$27,946, Colombia, 2 tons valued at Can$180, and West Germany, 1 ton valued at Can$80.[6]

[5] Jahns, R. H., Pegmatites Deposits of the White Picacho District, Maricopa and Yavapai Counties, Ariz.: Econ. Geol., vol. 49, No. 3, May 1954, pp. 1-105.

[6] Bruce, C. G., Feldspar in Canada, 1954 (Prelim.): Canada Dept. of Mines and Tech. Surveys, Ottawa, 1954, 2 pp.

TABLE 11.—World production of feldspar by countries,[1] 1945–49 (average) and 1950–54, in long tons [2]

(Compiled by Helen L. Hunt)

Country [1]	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Canada (sales)	34,534	31,739	36,383	18,096	18,970	13,785
United States (sold or used)	434,291	407,925	400,439	420,831	452,600	411,018
Total	468,825	439,664	436,822	438,927	471,570	424,803
South America:						
Argentina	6,419	(3)	(3)	(3)	(3)	(3)
Brazil [4]	2,264	11,811	(3)	(3)	(3)	(3)
Chile	273	857	1,181	592	2,047	(3)
Peru	206		129			
Uruguay	1,439	699	664	884	779	696
Total [4]	10,600	18,000	19,000	20,000	21,000	22,000
Europe:						
Austria	1,028	3,847	3,692	2,537	1,332	2,137
Czechoslovakia	[4] 7,700	(3)	(3)	(3)	(3)	(3)
Finland	5,893	7,874	8,069	9,635	9,180	12,062
France	37,700	46,973	58,830	63,974	59,053	61,021
Germany, West	29,612	75,501	96,680	101,284	94,190	138,323
Italy	9,427	17,786	28,684	25,036	23,229	30,373
Norway	18,171	23,321	30,627	28,834	18,411	[4] 22,600
Portugal	1,077		461	689	59	(3)
Spain (quarry) [5]	2,186	1,624	1,732			(3)
Sweden	30,716	35,462	40,423	47,115	37,333	(3)
Total [4]	143,500	217,000	274,000	284,000	248,000	311,000
Asia:						
India	1,035	1,772	3,385	2,020	3,746	[4] 3,000
Israel	22					
Japan [6]	14,495	12,979	26,109	23,812	24,682	[4] 25,000
Total	15,552	14,751	29,494	25,832	28,428	[4] 28,000
Africa:						
Egypt	13					
Eritrea	[7] 172				3	6
Kenya	43					
Madagascar	2				24	
Southern Rhodesia		3,464	1,130			
Union of South Africa	1,968	5,906	3,290	7,361	5,480	3,525
Total	2,198	9,370	4,420	7,361	5,507	3,531
Oceania: Australia [8]	8,549	13,066	14,842	13,589	6,883	16,384
World total (estimate) [1]	650,000	710,000	780,000	790,000	780,000	810,000

[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.
[3] Data not available; estimate by senior author of chapter included in total.
[4] Estimate.
[5] In addition, the following quantity of feldspar is reported as ground, but there is no crude production data to support this ground figure: 1950, 8,124 tons; 1951, 10,869 tons; 1952, 10,195 tons; 1953, 10,495 tons; 1954, data not available.
[6] In addition, the following quantities of aplite and other feldspathic rock were produced: 1950, 44,958 tons; 1951, 58,973 tons; 1952, 70,287 tons; 1953, 71,263 tons; 1954, data not available.
[7] Average for 1946–49.
[8] Includes some china stone.

NEPHELINE SYENITE

Domestic Deposits.—Nepheline syenite occurs in Arkansas, New Jersey, California, and other localities in the United States, but thus far no commercial production has been reported.

Uses and Consumption.—Nepheline syenite was introduced commercially about 1940 and was used almost entirely in manufacturing glass, particularly container glass where a high alumina content is desired. Later its use was extended to other branches of ceramics, mostly as a vitrifying agent in whiteware and sanitary ware and as a source of alumina and alkalies in glazes and porcelain enamels. It was used also as a ceramic bond in abrasive grinding wheels and in refractory cements.

Domestic consumption of nepheline syenite increased progressively from 1944 through 1954 owing mainly to increased requirements in the glass-container industry.

TABLE 12.—Nepheline syenite imported for consumption in the United States, 1945–49 (average) and 1950–54

[U. S. Department of Commerce]

Year	Crude		Ground		Year	Crude		Ground	
	Short tons	Value	Short tons	Value		Short tons	Value	Short tons	Value
1945–49 (average)	50,561	$195,637	5,689	$80,336	1952	4	$125	68,398	$984,050
1950	8,966	36,453	54,242	703,008	1953	181	659	89,195	1,308,058
1951			65,773	936,256	1954			95,782	[1] 1,436,325

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

Prices.—Prices of processed nepheline syenite at the close of 1954 were as follows, 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 free of duty.[7]

Foreign Trade—Imports of ground nepheline syenite increased 7 percent in 1954 over 1953. The average value per ton (foreign market value) of ground nepheline syenite imported was $15 in 1954 ($14.67 in 1953, $14.39 in 1952, and $14.23 in 1951).

World Review.—In 1954, the International Minerals & Chemical Corp. began to build a plant at Blue Mountain, Ontario, Canada, to process nepheline syenite and expected to be operating early in 1956. This will be the second plant to process this mineral in the Western Hemisphere, the other being The American Nepheline, Ltd., Lakefield, Ontario, Canada. The cost of the Blue Mountain mill will be about $1.5 million.

[7] Bruce, C. G., Nepheline Syenite in Canada, 1954 (Prelim.): Canada Dept. of Mines and Tech. Surveys, Ottawa, 1954, p. 3.

TABLE 13.—Canadian production, trade, and consumption of nepheline syenite, 1953–54 [1]

	1953		1954	
	Short tons	Value	Short tons	Value
Production, crude (ore transported to storage)	160,918	(2)	159,885	(2)
Shipments:				
Ground:				
Glass grade	80,677	(2)	86,098	(2)
Pottery grade	22,577	(2)	27,365	(2)
Miscellaneous	8,918	(2)	8,639	(2)
Total	112,172	(2)	122,102	(2)
Crude	1,173	(2)	1,567	(2)
Total shipments	113,345	$1,576,271	123,669	$1,770,528
Exports, crude and processed materials:				
United States	72,031	1,044,978	79,967	1,197,031
Netherlands	551	9,922	1,658	29,841
United Kingdom	585	10,483	824	14,776
Puerto Rico	2,700	45,900	800	14,000
Other countries	508	9,498	703	13,450
Total	76,375	1,120,781	83,952	1,269,098

[1] Nepheline Syenite in Canada, 1954 (Prelim.): Canada Dept. of Mines and Tech. Surveys, Ottawa, 1954, p. 2.
[2] Data not available in detail, included in total.

APLITE

The tonnage of aplite produced in the United States in 1954 increased 2 percent over 1953. In 1954 sales decreased 11 percent compared with 1953. As has been true for a number of years, there were only two aplite producers in the United States: Dominion Minerals, Inc., and International Minerals & Chemical Corp. Mines and processing plants of both companies were in the vicinity of Piney River, Va.

Ferroalloys

By P. H. Royster[1] and Hilda V. Heidrich[2]

THE TERM "ferroalloy" is a class name used by the Bureau of Mines as a practical method of grouping 16 somewhat diverse elements that have little in common other than the fact they are used in substantial quantities in producing steel. The term is widely employed to designate the chemical elements, other than iron and carbon, that enter into the composition of iron and steel. Factual material presented in this chapter refers only to the alloying elements as they are used in manufacturing iron and steel products. Additional information concerning these mineral commodities may be found in other chapters of the Minerals Yearbook on individual ferroalloy elements. In order of average consumption in the production of steel ingots these alloying elements are: Manganese, silicon, chromium, nickel, aluminum, molybdenum, phosphorus, titanium, tungsten, vanadium, cobalt, zirconium, columbium, tantalum, boron, and calcium.

Two elements, manganese and silicon, compose over 80 percent of the ferroalloying elements produced in 1954. Manganese is added to all steel ingots, regardless of grade, type, composition, or use, and essentially all killed and semikilled ingots receive additions of silicon at some stage of production.

Steel production reached an alltime high of 111.6 million tons of ingots in 1953, but declined 23.3 million in 1954 to 88.3 million tons. This drop (21 percent) was accompanied by a 22-percent decrease in the production of ferromanganese and ferrosilicon. Alloy-steel production, which totaled 10.3 million tons in 1953, dropped 30 percent to 7.2 million tons in 1954. Ferroalloy production, other than ferromanganese and ferrosilicon, followed this decrease with 25-percent lower production.

Although the production of alloy steel decreased 30 percent, AISI consumption figures of the three principal alloying elements in steel in 1954 declined less, that is, 27 percent for chromium, 21 percent for nickel, and 19 for molybdenum. Columbium-tantalum were the only alloying elements that showed an increase.

DOMESTIC PRODUCTION AND SHIPMENTS

Production and shipments of ferroalloys in 1953 and 1954 are given in table 1. This table is comparable to similar tables in previous Ferroalloys chapters in the Minerals Yearbook, with two exceptions. On

[1] Metallurgist.
[2] Statistical assistant.

TABLE 1.—Ferroalloys produced and shipped from furnaces in the United States, 1953–54

Alloy	1953			1954		
	Production (short tons)	Shipments		Production (short tons)	Shipments	
		Short tons	Value		Short tons	Value
Ferromanganese [1]	1, 036, 286	1, 025, 557	$212, 909, 998	827, 235	799, 710	$159, 341, 957
Ferrosilicon	[2] 391. 456	[2] 382, 277	[2] 54, 672, 312	286, 350	2[illegible], 584	38, 292, 436
Silvery iron	417, 149	390, 420	31, 424, 307	363, 600	328. 803	24, 505, 679
Ferrochromium [3]	[2] 283, 294	[2] 252, 191	[2] 97, 558, 659	181, 673	187. 780	72, 805, 903
Ferrotitanium }	----------	----------	----------	4, 409	4, 805	1, 997, 971
}	11, 954	11, 824	13, 757, 060	----------	----------	----------
Ferrovanadium }	----------	----------	----------	(4)	(4)	(4)
Ferrophosphorus	[2] 67, 407	[2] 40, 826	[2] 1, 895, 964	74, 121	56, 089	1, 200, 608
Other [5]	140, 287	108, 449	53, 793, 466	67, 210	83, 534	45, 893, 202
Total	[2] 2, 347. 833	[2] 2, 211, 544	[2] 466, 011, 766	1, 804. 598	1, 707, 305	344, 037, 756

[1] Includes silicomanganese and manganese briquets.
[2] Revised figure.
[3] Includes ferrochrome-silicon, chrom-X, and chrom sil-X.
[4] Included with Other ferroalloys.
[5] Includes Alsifer, ferroboron, ferrocolumbium, ferronickel, ferrotantalum-columbium, ferrotungsten, miscellaneous allovs, molybdenum products, simanal, spiegeleisen, zirconium ferrosilicon, and ferrovanadium as indicated by footnote, not available for publication.

the first line of present table 1, ferromanganese includes not only high-carbon, medium-carbon, and low-carbon ferromanganese (whether bulk or briquetted) but also the high-silicon, low-carbon alloy, manganese silicide grade (so-called silicomanganese). According to its composition and use, high-silicon ferromanganese is functionally equivalent to the other grades of high-manganese alloy, although this alloy has previously been included under "Other ferroalloys."

In table 1 iron-silicon alloys are reported under two items—ferrosilicon and silvery iron. Ferrosilicon includes several grades of alloy containing 40 to 95 percent silicon. Silvery iron includes the conventional 10-percent high-silicon pig iron made in the blast furnace and the 15- to 20-percent alloy made in the electric furnace. In line 4, ferrochromium includes the high-carbon and low-carbon grades, as well as the high-silicon alloy, chrome silicide. Because of wide diversity in composition, character, price, and use, the ferroalloying elements are discussed individually in the following sections:

Manganese Alloys.—In 1954, 1.6 million short tons of manganese ore, averaging 44.04 percent manganese, was smelted in 6 blast-furnace plants and 13 electric-furnace plants located in 11 States and operated by 10 companies. The production of ferromanganese of all grades was 827,235 tons, with an average manganese content of 73.81 percent. All but 3.3 percent of the alloy produced was sold at a reported value of $199.25 per short ton (13.49 cents per pound of contained manganese).

Blast furnaces used 61 percent of the total manganese ore consumed (or 1 million tons) to produce 511,644 tons of ferromanganese with an average manganese content of 74.30 percent. The ore used contained 444,669 tons of manganese. Of the quantity, 64,471 tons of manganese was lost in smelting, and 380,198 tons was recovered as ferromanganese. The smelting loss was 14.50 percent, equivalent to 145,200 tons of ore.

Thirty-nine percent of the ore (636,415 tons, 43.45 percent manganese) was smelted in electric furnaces to produce 315,591 tons of alloy averaging 73.15 percent manganese. The ore charged in the electric furnaces contained 276,522 tons of manganese. Smelting losses were 45,667 tons, and 230,855 tons of manganese was recovered. The electric-furnace smelting loss (16.51 percent) was 10 percent higher than the corresponding (14.50 percent) blast-furnace smelting loss.

In blast-furnace ferromanganese operations in 1954 an average of 3,939 pounds of coke was consumed per ton of alloy made. Coke consumption ranged from 3,770 to 4,111 pounds for the several plants reporting. Average manganese recovery also was not constant. Half the plants used 4,038 pounds of coke with 89.72-percent recovery. The other half used 3,883 pounds of coke and reported recoveries averaging 83.03 percent.

Only one plant produced a substantial tonnage of spiegeleisen in 1954. Production of this low-manganese alloy is included under the heading "Other alloys" in table 1. Consumption of spiegeleisen by the steel industry during 1954 was 41,500 tons. With a 19.65-percent manganese content, the spiegeleisen contained 8,155 tons of manganese, representing only 1 percent of the total manganese consumption during the year.

Ferrosilicon.—In 1954 ferrosilicon, an iron-silicon alloy containing 40 to 95 percent silicon, was produced by 11 companies operating 23 electric-furnace plants in 12 States. The 286,350 tons of alloy produced contained 157,156 tons of silicon. Seven percent of this quantity was not sold, while 266,584 tons of ferrosilicon, averaging 54.64 percent silicon, was shipped at a reported average value of $143.64 per short ton of alloy. This corresponds to 13.19 cents per pound of silicon contained. The price of silicon was about the same as that of manganese (13.49 cents per pound).

Silvery Iron.—High-silicon pig iron carrying 9 to 20 percent silicon was produced in 3 blast furnace and 1 electric furnace plant operated by 4 companies and located in 3 States. The average silicon content of this alloy was 12.90 percent. The silicon content of blast-furnace silvery pig averaged 9.50 percent, while the electric-furnace product averaged 15.92 percent. The 328,803 tons shipped was valued at $77.57 per short ton.

Chromium Alloys.—Ferrochromium was produced in 16 electric-furnace plants in 9 States, operated by 7 companies. A total of 483,565 short tons of chrome ore was used in ferroalloys and metal containing 153,048 tons of the element (average ore analysis—31.65 percent chromium, 46.26 percent chromic oxide, Cr_2O_3). The 182,000 tons of ferrochromium produced averaged 66.39 percent chromium and contained 120,621 tons of the element.

Shipments of ferrochromium were valued at $387.72 per ton of alloy, equivalent to 29.20 cents per pound of contained chromium. Imports were reported as 14,756 tons of high-carbon ferrochromium (55.05 percent chromium) and 2,017 tons of the low-carbon alloy (71.34 percent chromium) valued at 16.94 and 26.04 cents per pound of chromium, respectively.

Ferrophosphorus.—During 1954 phosphate chemicals were produced by 8 companies operating 10 electric-furnace plants in 7 States. As an unavoidable byproduct of the smelting of phosphate rock, 74,121 tons of ferrophosphorus was produced, with an average phosphorus content of 22.94 percent. This alloy production was caused by the reduction of iron in the phosphate rock treated. The quantity produced was determined by the iron content of the rock processed and was not related to market demand for ferrophosphorus.

At the beginning of the year producers reported stocks of 73,358 tons of ferrophosphorus. During 1954 less than half of the 74,121 tons produced was sold, and 38,032 tons of unsold alloy was relegated to producers' stocks, bringing a rapidly accumulating producers' inventory to a year-end total of 109,390 tons. No ferrophosphorus was imported. Two-thirds (24,342 tons) of the year's sales was exported; the remaining 13,690 tons sold was apparently shipped to domestic consumers. The American Iron and Steel Institute reported that the steel industry used 12,063 tons of ferrophosphorus during 1954.

Increased production of, and decreased demand for, ferrophosphorus combined to lower the average value of this alloy from its 1953 high of $46.44 per ton to $33.27 in 1954. Producers' stocks of ferrophosphorus at year end (109,390 tons) were equivalent to 9 years of steel-industry requirements.

Molybdenum Products.—In 1954 two companies in Pennsylvania produced ferromolybdenum. As used in the production of alloy steel, molybdenum is marketed in three conventional forms: Molybdic oxide, ferromolybdenum and molybdate salts. About one-third of the oxide used in ferrous metal production was shipped as briquets.

A small tonnage of calcium and other molybdates was produced, which was priced at the oxide level. Molybdenum oxide is so readily reduced that, when the oxide is added to molten steel, conversion to metallic molybdenum is rapid and substantially complete. Since oxide molybdenum is lower priced than metallic molybdenum, an appreciable saving results from substituting the oxide for the alloy.

Ferrovanadium.—Ferrovanadium was produced in four conventional forms. They were: A 57-percent vanadium ferroalloy; a 52-percent tool-steel grade; a special tool-steel grade; and a 40-percent vanadium ferroalloy for use in the production of vanadium-bearing iron castings. Ferrovanadium was marketed by two producing companies.

Titanium Alloys.—Most of the titanium used in alloy steels was produced and marketed as relatively lowgrade ferroalloys. Ferrocarbontitanium, a high-carbon product, represented about 60 percent of the production in 1954 and averaged 17.41 percent titanium. It sold at an average price of 45.32 cents per pound of titanium contained. Other grades of titanium alloy contained less carbon and averaged 36.50 percent titanium. The average value of the low-carbon alloys was $1.22 per pound of contained titanium, a figure that varied with grade from $1 to $2.75. The titanium content ranged between 25 and 45 percent.

Zirconium Alloys.—Ferrozirconium was produced in the form of a low-grade ferroalloy containing about 14 percent zirconium. The silicon content ranged as high as 40 percent, with the carbon content held to 0.2 percent and under. Zirconium was also contained in certain types of grain refining alloys used as steel additives. In these, zirconium was combined with 10 to 15 percent aluminum and 20 percent titanium and was usually accompanied by a fractional percentage of boron. The quantity of zirconium alloy consumed in 1954, as reported by the AISI, was 3,780 tons, a 27-percent decline from the reported 1953 consumption rate. The average value of ferrozirconium in 1954 was $166.32 per ton, corresponding to a price of 59.40 cents per pound of the element.

Ferrocolumbium.—Only one company produced columbium in 1954. This metal was marketed as a ferroalloy averaging 57 percent columbium at a reported value of $7.86 per pound of the element.

Ferrocolumbium-Tantalum.—In addition to ferrocolumbium, a companion alloy, ferro-columbium-tantalum, was produced. This binary alloy contained an average of 42 percent columbium and 20 percent tantalum. The average value of the alloy shipped was $3.12 per pound.

Ferroboron.—Two producers shipped ferroboron alloy in 1954. The boron content of several grades produced ranged from 15 to 25 percent and averaged 15.28 percent. The average price was 95 cents per pound of alloy, equivalent to $6.22 per pound of contained boron. This represented a 6-percent decline from the 1953 price ($6.66).

Ferrotungsten.—Tungsten is added to steel as ferrotungsten, in other metallic forms, or as scheelite (calcium tungstate). According to the AISI, consumption of ferrotungsten declined 30 percent—from 1,197 short tons in 1953 to 833 tons gross weight in 1954. The total quantity of the element used by the steel industry in ferrotungsten or other forms declined 40 percent—from 1,690 tons in 1953 to 1,007 tons in 1954. During both years the ferrotungsten produced averaged 77.75 percent tungsten.

The value of ferrotungsten declined 12 percent—from $4.24 per pound of contained tungsten in 1953 to $3.74 in 1954.

Nickel.—Next to chromium, nickel was the most important alloying element used by the steel industry. Nickel is added to steel chiefly in the form of the relatively pure metal and to a smaller extent as nickel oxide. There was no significant domestic production of nickel, although the production of ferronickel was begun in 1954 at Riddle, Oreg., by Hanna Nickel Smelting Co., which smelted a low-grade nickel silicate ore.

Reports to the Bureau of Mines indicate that 34,036 short tons of nickel was used in the production of steel—a tonnage that includes oxide nickel but not nickel-bearing scrap. According to the AISI, nickel used by the industry, exclusive of scrap, was 31,226 tons, a total falling 8 percent under the tonnage reported to the Bureau. Estimates indicate that 35 percent of the nickel was added as oxide and 65 percent as metal.

Cobalt.—Consumption of cobalt in the United States, which had exceeded 5,000 tons annually in 1952 and 1953, declined 32 percent to 3,675 tons in 1954.

Special Deoxidizers.—In certain types of steel, where a high degree of deoxidation is required, aluminum and calcium are added. Aluminum is used as the pure metal or in the form of special deoxidizing alloys containing aluminum, silicon, iron, manganese, titanium, and zirconium. Calcium metal is not used directly in steel owing to its low density and high vapor pressure. Excessive quantities of calcium are lost by vaporization when the metal is added to the molten steel. It is customarily added as a calcium-silicon alloy (calcium silicide) containing about 32 percent calcium and 62 percent silicon. Manganese is sometimes incorporated in the several calcium deoxidants. Alloys of this type contain about 18 percent calcium, 16 percent manganese, and 56 percent silicon.

CONSUMPTION AND USES

In 1954 steel-ingot production declined 23.3 million tons from its 1953 alltime high of 111.6 million tons. To conform to the consequent reduction in market demand, overall production of ferroalloys was reduced 23 percent. At the end of 1953, 6 percent of the year's ferroalloy production remained unsold, and 136,289 tons of ferroalloys valued at $28.7 million was added to inventory. In spite of the 1954 cutback in production, shipments were 5 percent under production, thus diverting 97,293 tons of ferroalloys to producers' stocks and $19.6 million to the reported value of the unsold tonnage.

In the face of restricted demand, the value of all ferroalloys shipped in 1954 averaged $201.51 per short ton, 4 percent under the alltime high of $210.72 average value for 1953. Imports of ferroalloys, which totaled 175,834 tons in 1953, fell to 94,926 tons in 1954, indicating a 46-percent reduction in the use of imported ferroalloys. In the restricted market no shortages in the supply of ferroalloys developed.

Manganese Alloys.—Reports on the consumption and stocks of the several grades of manganese alloys were received from 620 consumers. This information is combined with import and export figures supplied by the Bureau of the Census in table 2. Consumer inventory increased from a 70-day supply on hand January 1, 1954, to an 87-day supply at the end of the year.

The manganese content of all manganese alloys used by ingot producers in 1954 was 556,895 tons. This manganese was contained in 669,701 tons of low-silicon ferromanganese, average grade 75.04 percent; 68,502 tons of high-silicon alloy (silicomanganese), average grade 66 percent; 41,500 tons of spiegeleisen, average grade 19.65 percent; and 996 tons of 99-percent manganese. The metallic manganese content of the alloying metals used in producing 88.3 million tons of ingots corresponds to an average addition of 12.612 pounds per short ton of steel.

In manufacturing 1,000,833 tons of steel castings produced by foundries not producing ingots, 24,308 tons of manganese was used, which corresponds to an average addition of 48.57 pounds of manganese per ton of castings. The manganese devoted to castings totaled 4.19 percent of that used in producing ingots and steel castings combined.

Most of the 42,171 tons of manganese alloys attributed to "Other products" in table 2 was employed in producing gray and malleable iron castings, with some of the tonnage diverted to nonferrous alloys and other miscellaneous uses.

In 1954 high-carbon ferromanganese represented 84 percent of the manganese used in the production of steel. This standard alloy contained an average of 6.35 percent carbon and 75.04 percent manganese. In average plant practice, 16.81 pounds of ferromanganese was added to each ton of molten steel, adding 0.053 percent to its carbon content. In higher carbon grades of steel, an increment of 0.05 percent carbon is seldom objectionable. In the lower carbon grades, such an addition of carbon is always important and frequently serious. In such instances medium-carbon and low-carbon grades of ferromanganese are employed, as well as the high-silicon alloy silicomanganese, which also is low in carbon.

TABLE 2.—Consumption, stocks, imports, and exports of ferromanganese (excluding spiegeleisen) in 1954, in short tons

Item	High-carbon grade	Medium- and low-carbon grade	High-silicon (silicomanganese)	Briquets, all grades	Total
Consumed in—					
Ingots	619, 951	49, 750	68, 502		738, 203
Steel castings	20, 021	3, 445	6, 961	1, 351	31, 778
Other products	19, 816	3, 927	4, 796	13, 632	42, 171
Total	659, 788	57, 122	80, 259	14, 983	812, 152
Stocks, Jan. 1, 1954	127, 524	9, 832	13, 894	3, 917	155, 167
Stocks, Dec. 31, 1954	166, 056	9, 291	13, 689	3, 972	193, 008
Imports	47, 538	9, 234	2, 395		59, 167
Exports	1, 602	130			1, 732

The pattern of use of the several grades of manganese alloys in steel-ingot production has changed little in recent years. From 1949 to 1953 average consumption of manganese was: 90.12 percent used as ferromanganese, 7.92 percent as silicomanganese, 1.85 percent as spiegeleisen, and 0.10 percent as manganese metal. Manganese additions for the 5-year period averaged 13.13 pounds per ton of ingots. Distribution in 1954 was: 90.23 percent as ferromanganese, 8.12 percent as silicomanganese, 1.46 percent as spiegeleisen, and 0.17 percent as metallic manganese. The 1954 manganese addition (12.61 pounds per ton) was 4 percent below the preceding 5-year average. In 1954 the use of ferromanganese and spiegeleisen differed little from the 5-year average. Consumption of silicomanganese, however, was 14 percent above the preceding average, while use of metallic manganese increased 70 percent.

It was previously noted that 15.6 percent of the manganese in the manganese ores smelted was lost in producing the ferromanganese (84.37-percent recovery). When ferromanganese is added to molten steel, there is a second loss, which frequently is greater than the smelting loss. No reliable data are available for estimating the average value of this loss. As far as determination is possible, the loss sustained in the steelmaking process may be taken at 22 percent (78-percent recovery). The overall manganese recovery from original ore to finished ingot may not therefore exceed 66 percent.

Ferrosilicon.—Consumption, stocks, and receipts of ferrosilicon in 1954 are tabulated in table 3, where consumption figures for the 6 standard grades of alloy are given, as well as for metallic silicon and ferrosilicon briquets.

Twenty-four ingot producers, representing 2.97 percent of the country's total ingot capacity in 1954, did not report their consumption of ferrosilicon to the Bureau. Ferrosilicon used in ingot production may therefore be extrapolated to be 172,750 tons.

The Bureau received consumption reports from only 48 percent of the larger steel foundries. Coverage for steel castings, on a tonnage basis, however, is estimated at 54 percent for steel casting, indicating that total consumption of silicon alloys for steel castings (item 2 of table 3) was 20,202 tons.

Consumption figures were received from 390 firms using ferrosilicon for various purposes other than the production of ingots and steel castings. The Bureau's survey is estimated to account for 85 percent of the ferrosilicon reported under "Other products." The nominal 50-percent grade comprised about half of the total tonnage of ferrosilicon consumed by these miscellaneous users. Production of aluminum, magnesium, and other nonferrous alloys used 13,971 tons of technical-grade metallic silicon. Silicon alloys assignable to "Other products" may be estimated to total 80,989 tons.

Estimated total ferrosilicon consumption for all 3 purposes is 273,954 tons, with receipts from domestic producers placed at 265,989 tons.

Ferrosilicon used in producing 88.3 million tons of ingots in 1954 averaged 3.80 pounds per ton of steel. The average silicon content of the ferrosilicon consumed was 56.03 percent, corresponding to 2.13 pounds of silicon per ingot ton. Ferrosilicon has long been the accepted deoxidizing agent for producing the so-called killed and semikilled steels as distinguished from the effervescent or rimming steels, to which little or no silicon is added. Unfortunately separate figures for individual tonnages of these types of ingots do not appear in any published statistics. Silicon is generally regarded merely as a steel additive and not an alloying element, except in electrical sheets.

TABLE 3.—Consumption and stocks of silicon alloys in 1954, in short tons

Item	Nominal grade, based on percentage of silicon contained in products								
	40	50	65	75	85	95	Metal	Briquets 58	Total
Consumed in—									
Ingots	20,300	87,586	25,365	27,717	3,155	3,335	34	301	167,793
Steel castings	1,540	6,594	152	634	96	23	2	1,868	10,909
Other products	3,520	15,188	176	6,151	1,565	3,114	13,935	25,192	68,841
Total	25,360	109,368	25,693	34,502	4,816	6,472	13,971	27,361	247,543
Stocks, Jan. 1, 1954	4,800	20,670	1,706	5,462	990	1,496	1,669	5,812	42,605
Stocks, Dec. 31, 1954	3,940	16,925	1,580	5,502	893	905	1,392	4,339	35,476

Silvery Iron.—High-silicon pig iron (silvery iron) is produced in 2 grades, 1 nominally containing 10 percent and the other 15 percent silicon. Consumption, stocks, and imports for 1954 are shown in table 4. No exports of silvery iron were reported in 1954. Imports of the alloy contributed 11 percent to the total silicon contained in the silvery iron used. In addition to the tonnage of alloy itself, the tonnage of silicon contained in the alloy is reported for each of the two

TABLE 4.—Consumption, stocks, and imports of silvery iron in 1954, in short tons

Item	Nominal grade, based on percentage of silicon contained in products					
	10		15		Total	
	Alloy	Silicon contained	Alloy	Silicon contained	Alloy	Silicon contained
Consumed in:						
Ingots	7,171	678	47,489	7,560	54,660	8,238
Steel castings	14,849	1,405	4,968	791	19,817	2,196
Other products	128,958	12,201	104,240	16,595	233,198	28,796
Total	150,978	14,284	156,697	24,946	307,675	39,230
Stocks, Jan. 1, 1954	26,895	2,544	43,802	6,973	70,697	9,517
Stocks, Dec. 31, 1954	21,248	2,010	40,781	6,492	62,029	8,502
Imports	----------	(1)	17,567	[2] 3,760	17,567	3,760

[1] No imports or exports reported.
[2] Imported alloy, 21.40 percent silicon.

grades. Receipts from domestic producers were 281,440 tons of silvery pig iron with a silicon content of 34,455 tons. When this quantity of silicon is added to the 160,637 tons of silicon contained in ferrosilicon (table 3), the total silicon consumption by the iron and steel industry, 195,092 tons, is obtained.

It is noted that 73 percent of the silicon contained in silvery iron was used in products other than ingots and steel castings. Over 90 percent of this went into the production of iron castings. Although the quantity of silvery pig iron produced in 1954 (328,803 tons) would list this alloy tonnagewise second in importance to ferromanganese, the silicon content of the silvery iron used in ingot production was only 5.35 percent (10,434 tons) of the steel industry's total silicon consumption.

Carbon and Alloy Steel.—In 1954 total steel-ingot production was 88.3 million tons, of which 91.81 percent (81 million tons) was carbon steel, to which no alloying elements were added other than the conventional additives manganese and silicon. The remaining 7,236,263 tons of ingots which were not carbon steel are commonly classed as alloy steel.

Alloy steels comprised 8.19 percent of the 1954 ingot production, distributed among 54 types and grades of steel and 701,070 tons of alloy steel of undescribed composition. The quantities of various types were: 4,846,516 tons of the 12 grades of heat-treatable, engineering or constructional steels; 902,429 tons of silicon sheets of transformer grades; 546,646 tons of so-called high-strength, low-alloy steels not generally heat-treated; 478,714 tons grouped into the 20 types of 18–8 nickel-chrome stainless steels (AISI 300 series); 396,460 tons of the 19 grades of nickel-free, heat-resistant chrome steels (AISI 400 and 500 series); and 72,386 tons of high-speed and alloy tool steels.

One or more of the 14 ferroalloying elements used primarily in alloy steels were consumed in producing these 50-odd types and grades of steel. In addition, about 110,000 tons of manganese and 50,000 tons of silicon were added to the alloy ingots. The cost of these 14 ferroalloying elements was small ($118 million) compared with the dollar value of the steel produced, but their industrial and strategic importance was considerable.

Chromium Alloys.—Domestic alloy producers shipped 187,780 tons of ferrochromium in all forms. The chromium contained in the alloy shipped was 117,381 tons. The AISI statistical report for 1954 quoted chromium consumption as 117,578 tons.

With the additives manganese and silicon excluded, chromium was the most widely used and cheapest alloying element in alloy steels. Chromium was the principal alloying element in engineering and constructional steels. It was the major constituent of steels resistant to atmospheric and chemical corrosion and almost the exclusive alloy in the many grades of heat-resisting steels. Minor quantities of chromium appeared in the high-strength, low-alloy steels, as well as in many of the types of alloy tool steels.

In 1954, 478,714 tons of 18–8 nickel-chrome stainless steel was produced containing 87,174 tons of chromium (18.21 percent average chromium). Heat-resistant grades averaged 16.72 percent chromium and contained 61,774 tons of the element. Together, 848,174 tons of the 2 types contained 148,948 tons of chromium including chromium contained in scrap accounting for 87.31 percent of the chromium used in ingot production.

Chromium was used as an alloying element in 60 percent of the tonnage of constructional heat-treatable steels, appearing in 5 of the 12 reported grades. These steels (2,914,132 tons) contained 16,931 tons of chromium and accounted for 9.93 percent of the chromium in alloy ingots. Chromium used in the low-alloy steel was estimated to total 3,850 tons, with only 770 tons in the high-speed and alloy tool steels. The chromium content of the 4 types of steel listed above was 170,499 tons. The consumption of ferrochromium in 1954, by grades and by uses, consumers' stocks, and imports and exports are shown in table 5.

TABLE 5.—Consumption, stocks, imports, and exports of chromium alloys in 1954, in short tons

Item	Ferrochromium		Other	Total
	High carbon, 63.22 percent chromium	Low carbon,[1] 61.77 percent chromium		
Consumption in alloy steels	66,978	136,024	3,386	206,388
Stocks, Jan. 1, 1954	9,180	15,683	488	25,351
Stocks, Dec. 31, 1954	6,463	12,999	1,068	20,530
Imports	14,756	2,295	143	17,194
Exports [2]	550	1,153	129	1,832

[1] Low-carbon ferrochromium includes both the low-silicon and high-silicon grades.
[2] Distribution of exports by grades estimated.

Nickel in Alloy Steel.—In the production of alloy steel, nickel is used either in the form of relatively pure metal or directly as oxide. Over half of the nickel contained in alloy steels in 1954 was derived from nickel-bearing steel scrap.

The 21 types of nickel-bearing stainless steel produced in 1954 averaged 9.92 percent nickel and accounted for 72 percent (47,680 tons) of the total nickel contained in all alloy steels. Nickel was used in 4 of the 12 grades of engineering steels. These nickel-bearing, heat-treatable steels (1,393,901 tons) contained 17,328 tons of nickel. The tonnage of this alloying element in both grades totaled 65,008.

Industry reports to the Bureau showed a 1954 consumption of 20,399 tons of nickel in stainless steel and 13,637 tons in engineering alloy steel—a combined total of 34,036 tons. Steel foundries reported nickel consumption to the Bureau; these data were not included in the AISI survey. Neither the Bureau nor the AISI surveys covered nickel contained in nickel-bearing scrap.

Molybdenum in Alloy Steels.—Like nickel, molybdenum may be added to steel either as a ferroalloy or in the form of its nonmetallic oxides. In 1954 about two-thirds of the element was used in the nonmetallic form. The AISI has reported a 1954 consumption of 10,810 tons of "molybdenum products," containing 7,090 tons of molybdenum. These products consisted of 2,528 tons of ferromolybdenum and 8,282 tons of molybdic oxide.

The maximum quantity of molybdenum added to engineering steels (0.25 percent) is too small materially to alter the metal's chemical properties. The element was used exclusively to increase response to heat treatment. Molybdenum was present in 5 of the 12 grades of engineering steel. The molybdenum content of the 2,773,610 tons of these alloy steels in 1954 was 5,680 tons.

Molybdenum is an important constituent of many grades of tool steel. Class A high-speed steel contains 5.5 to 9.25 percent of the element, while Class B grades contain 1.25 percent or less. The average content of all 15,355 tons of high-speed steels produced in 1954 was 6.10 percent, representing 940 tons of molybdenum. Chromium-base, hotwork die steels possibly accounted for an additional 150 tons. An estimated 870 tons of molybdenum was used in producing the 40,342 tons of tool steels grouped under the broad term "Other alloy tool steels." The 1954 consumption of molybdenum in engineering and tool-steel grades combined is estimated at 7,600 tons.

Ferrozirconium.—Zirconium has had rather limited use in alloy steels. The reported effect of zirconium on the hardenability of heat-treatable engineering steel, pound for pound, is identical with that of molybdenum. Although the 1954 value of zirconium (59.2 cents per pound of element) was only half that of molybdenum ($1.21 per pound of element), 8,899 tons of molybdenum and only 529 tons of zirconium were used during the year.

Zirconium, like manganese, reduces or eliminates the difficulties encountered in the hotworking of steel caused by its sulfur content and 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 the production of sound ingots. In spite of these characteristics, zirconium is not specified in the analysis of any of the standard grades of alloy steel for which production is reported.

Consumption of ferrozirconium by the steel industry has averaged 6,964 tons per year since 1947, when consumption figures became available. Consumption, relative to ingot production, has declined steadily during the reported period at the rate of about 7 percent per year. Consumption in 1954 was only 3,780 tons of alloy (529 tons of zirconium). Large domestic reserves of zirconium minerals are known. Less than 10 percent of the annual supply, however, is devoted to the production of ferrozirconium.

Ferrovanadium.—Vanadium is used in producing high-speed and other grades of tool steel, as well as being an essential constituent of chrome-vanadium ingots (AISI 6100 series). This heat-treatable steel has an average vanadium content of 0.12 percent for the lower carbon and 0.18 percent for the higher carbon grades. In 1954 production of 41,284 tons of chrome-vanadium ingots was reported, estimated to contain 70 tons of the alloying element.

Vanadium in steel promotes depth hardenability if the amount does not exceed 5 pounds per ingot ton. When more is present, response to heat treatment is adversely affected. In 1954 vanadium in chrome-vanadium steels accounted for only 8.6 percent of the 817 tons of the element reported as consumed by the steel industry.

It is estimated that 338 tons of vanadium appeared in the 15,355 tons of high-speed tool steel produced in 1954, 312 tons in chromium-base tool and die steels, and 60 tons in hotwork steels. Vanadium contained in the 4 grades of steel totaled 780 tons. An undetermined quantity of the alloy element was used in producing 40,342 tons of "Other alloy tool steels" of unspecified analysis.

Columbium and Tantalum.—Most of the columbium used as an alloying agent sold as a 57-percent ferrocolumbium. Since columbium and tantalum occur together in the mineral tantalite, alloys produced from this mineral were marketed as the twin alloy, ferrocolumbium-tantalum. The presence in steel of either of these related elements decreases hardenability, and neither is used in heat-treatable constructional steels. Columbium is employed principally as additive to 1 of the 20 types of nickel-chromium stainless steels (AISI type 347). A minimum of 0.80 percent columbium is specified for this chemically resistant steel.

When a stainless steel is heated to high temperatures, carbon segregates, and the metal becomes subject to intergranular corrosion. Columbium, tantalum, or titanium is added to such stainless steels to inhibit this tendency to carbon segregation.

Owing to its smaller atomic weight, columbium, pound for pound, combines with twice as much carbon as does tantalum, and its effectiveness in stabilizing carbon is probably twice that of tantalum when the two elements are added to steel.

An unreported but increasing tonnage of columbium and tantalum has been employed in recent years as carbon stabilizer in several newly developed heat-resisting steels used in gas turbines and jet engines. Some grades of metal for this service carry as high as 3 percent of columbium and tantalum. The tonnage of the two elements used for this purpose in 1954 has not been reported.

Ferrotitanium.—Evidence is that titanium, like zirconium, can replace some or all of the manganese required to minimize the adverse effect of sulfur on the rolling and forging of steel. The element is an effective deoxidizer and degasifier for both carbon and alloy steel. 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.

Relatively little titanium has been used in steel for its alloying effect. In 1954 the titanium content of ferroalloy consumed is reported by the AISI, as 1,789 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, 0.23 percent titanium must be added.

At 1954 price levels, stabilizing nickel-chrome stainless steels with columbium was eight times as expensive as treating it with titanium. The 16 pounds of columbium ($7.85 per pound) required per ton of ingot cost $125.60. The average cost of the 12 pounds of titanium ($1.22 per pound) used for the same purpose as the columbium was only $14.64.

Throughout the past 10-year period, an average of 53 percent of the stabilized stainless steels (types 321 and 347) has been treated with columbium-tantalum and 47 percent with titanium. The respective positions of the two stabilizing agents have varied year to year. Titanium, for example, was used in 84 percent of the stabilized grades in 1952 but only in 17 percent in 1949. In 1954, 73 percent of stabilized stainless was treated with titanium and 27 percent with columbium-tantalum.

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. Use of boron increased to a high of 9.52 percent in 1952, dropped to 5.7 percent in 1953, and reached a low of only 4.0 percent in 1954. This downward trend might indicate that, in actual practice, the beneficial effects of boron were not realized. Although the cost of boron in 1954 was high (39 cents per ounce), the value of the boron was only 13 cents per ton of steel treated, obviously not an obstacle to its wider use.

Tungsten in Alloy Steel.—The 12,815 tons of Class A High-Speed tool steel shipped in 1954 averaged 4.21 percent tungsten and contained 539 tons of the element. The 2,540 tons of Class B High-Speed steel shipped averaged 19.61 percent and contained 498 tons of tungsten. Shipments of the two grades contained 1,037 tons of tungsten.

In addition to 15,355 tons of high-speed tool steel, 57,031 tons of "Other alloy tool steel" was marketed; this metal contained an unreported quantity of tungsten. Tungsten has seldom been used as an alloying element in constructional steels.

Cobalt in Alloy Steel.—Cobalt is one of the few ferroalloying elements that cause a decrease in hardenability of alloy steels. It is therefore not used in heat-treatable constructional and engineering steels. Thirty-five percent of the cobalt consumed during the year was used in the several grades of high-temperature alloys that contain cobalt, chromium, tungsten, and molybdenum. Twenty-nine percent of the total went into magnetic alloys, only a fraction of which was classed as alloy steel. Alloy magnets contain 5 to 52 percent cobalt, usually combined with other ferroalloying elements. The 703 tons of cobalt attributed by the AISI to steel production represented only 19 percent of the total consumption, showing that steel is not a dominant factor in the cobalt market.

Cobalt enters into 3 of the 7 grades of Class A and in 1 of the 3 grades of Class B High-Speed tool steel. Each of these grades carries a minimum of 3.5 percent cobalt. The cobalt used in all the high-speed tool steels was only 84 tons. A like quantity (83 tons) was used in cemented carbide cutting tools.

Special Deoxidizers.—In 1954, 27,164 tons of relatively pure metallic aluminum was used in the production of all types of steel. In the production of low-carbon effervescing ingots, a controlled degree of oxidation is required and this is generally achieved by adding small quantities of aluminum to the steel in the ladle or in the ingot molds. Aluminum is a very powerful deoxidizer and is frequently used in killed steel to remove final traces of oxygen from the ingot.

Complex alloys of aluminum, silicon, manganese, and other elements are 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 is used principally to effect rigorous deoxidation and to control grain size rather than for its rather mild alloying effect on heat treatment.

Alloys of calcium with silicon or with silicon and titanium are 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 is 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 is 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 1953 and 1954, as reported by the Bureau of the Census, United States Department of Commerce, are shown in table 6.

In 1954, 95,000 tons of ferroalloys valued at $17.7 million was imported. This was equivalent to 6 percent of the quantity and 5 percent of the value of ferroalloy shipments by domestic producers. Ferromanganese represented 62 percent of the total imports, ferrochromium 18 percent, and ferrosilicon about 19 percent. Imports of all other ferroalloying materials were approximately 1 percent of the total. Total exports of ferroalloys, other than ferrophosphorus, totaled only 6,456 tons; this was less than 1 percent of the total domestic production of ferroalloys in 1954.

[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 6.—Ferroalloys and ferroalloy metals imported for consumption in the United States, 1953–54, by varieties

[U. S. Department of Commerce]

Variety of alloy	1953			1954		
	Gross weight (short tons)	Content (short tons)	Value	Gross weight (short tons)	Content (short tons)	Value
Calcium silicide	---	---	---	89	(1)	$22,055
Chromium metal	177	(1)	$300,141	143	(1)	224,707
Chromium silicon	---	---	---	278	(1)	54,324
Ferrocerium and other cerium alloys	2	(1)	18,464	3	(1)	21,571
Ferrochrome or ferrochromium:						
Containing 3 percent or more carbon	18,094	10,100	3,656,204	14,756	8,124	2,752,347
Containing less than 3 percent carbon	15,188	10,504	6,741,729	2,017	1,439	749,510
Ferrochromium tungsten, chromium tungsten, and chromium cobalt tungsten (tungsten content)	(1)	(2)	5,330	(1)	32	97,749
Tungsten nickel, and other compounds of tungsten, n. s. p. f. (tungsten content)	(1)	66	257,494			
Ferromanganese:						
Containing not over 1 percent carbon	18,805	14,195	3,356,477	138	129	56,000
Containing over 1 and less than 4 percent carbon	27,718	23,011	9,039,048	9,096	7,594	2,510,454
Containing not less than 4 percent carbon	79,995	61,001	14,785,484	47,538	37,021	8,336,376
Ferromolybdenum, molybdenum metal and powder, calcium molybdate, and other compounds and alloys of molybdenum (molybdenum content)	(1)	(3)	988	(1)	(4)	1,512
Ferrosilicon	13,803	2,206	834,712	17,567	3,760	1,244,151
Ferrosilicon-aluminum, ferroaluminum-silicon, and Alsimin	252	(1)	94,254	---	---	---
Ferrotitanium	172	(1)	114,507	5	(1)	4,268
Ferrotungsten	377	302	1,686,690	309	250	837,418
Ferrovanadium	9	(1)	12,584	---	---	---
Manganese silicon (manganese content)	(1)	158	33,986	(1)	1,581	280,206
Silicon-aluminum and aluminum-silicon	44	(1)	16,330	238	(1)	96,532
Silicon metal (silicon content)	(5)	(6)	633	244	239	84,016
Spiegeleisen	785	(1)	63,149	---	---	---
Spiegeleisen containing not more than 1 percent carbon and manganese boron (manganese content)	(1)	(7)	324	---	---	---
Tungsten and combinations, in lump, grains, or powder:						
Tungsten metal (tungsten content)	(1)	33	224,924	(1)	77	342,584
Tungsten carbide (tungsten content)	(1)	8	79,653			
Combinations containing tungsten or tungsten carbide (tungsten content)	(1)	(8)	226			
Tungstic acid and other alloys of tungsten, n. s. p. f. (tungsten content)	(1)	(9)	364	(1)	1	3,136

[1] Not recorded.
[2] 83 pounds.
[3] 10 pounds.
[4] 50 pounds.
[5] 3 pounds.
[6] 2 pounds.
[7] 300 pounds.
[8] 23 pounds.
[9] 122 pounds.

TABLE 7.—Ferromanganese and ferrosilicon imported for consumption in the United States, 1953–54, by countries

[U. S. Department of Commerce]

Country	Ferromanganese (manganese content), excluding silicomanganese				Ferrosilicon (silicon content)			
	1953		1954		1953		1954	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
North America:								
Canada	286	$94,221	1,315	$339,226	2,124	$819,386	3,760	$1,244,151
Mexico	70	16,075						
Total	356	110,296	1,315	339,226	2,124	819,386	3,760	1,244,151
South America: Chile			264	40,500				
Europe:								
France	16,827	4,464,421	14,508	3,246,162				
Germany, West	38,894	9,358,900	11,794	2,808,175	(1)	153		
Norway	24,604	9,223,263	14,078	3,815,696				
Yugoslavia	81	16,380	406	67,604				
Total	80,406	23,062,964	40,786	9,937,637	(1)	153		
Asia:								
Japan	17,445	4,007,749	2,379	585,467				
Taiwan					82	15,173		
Total	17,445	4,007,749	2,379	585,467	82	15,173		
Grand total	98,207	27,181,009	44,744	10,902,830	2,206	834,712	3,760	1,244,151

[1] Less than 1 ton.

TABLE 8.—Ferroalloys and ferroalloy metals exported from the United States, 1951–54, by varieties

[U. S. Department of Commerce]

Variety of alloy	1951		1952		1953		1954	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Spiegeleisen	85	$4,130	34	$3,888				
Ferrochrome	240	96,635	1,274	518,721	607	$285,900	2,105	$995,797
Ferromanganese	633	206,614	1,453	474,686	1,112	389,064	1,732	614,544
Ferromolybdenum	742	1,224,257	545	925,324	323	548,502	124	237,698
Ferrophosphorus	55,044	2,218,790	44,351	2,592,245	22,959	1,147,707	24,342	792,671
Ferrosilicon	2,775	387,664	7,240	1,439,465	1,698	287,539	2,080	365,338
Ferrotitanium and ferrocarbon-titanium	175	107,718	325	88,664	185	48,722	172	39,885
Ferrotungsten	142	1,007,424	148	1,150,465	18	122,949	5	3,963
Ferrovanadium	61	190,346	147	529,360	[1] 78	[1] 296,157	[1] 70	[1] 237,333
Other ferroalloy	274	131,641	193	73,680	703	256,029	168	102,748
Total	60,171	5,575,219	55,710	7,796,498	27,683	3,382,569	30,798	3,389,977

[1] Due to changes in classification, data not strictly comparable to earlier years.

Fluorspar and Cryolite

By John E. Holtzinger [1] and Louise C. Roberts [2]

DOMESTIC demand for fluorspar dropped sharply in 1954, reflecting decreased consumption by the steel industry and a major reduction of fluorspar inventories at steel plants. Prices, which had reached an alltime high in 1953, fell abruptly after the spring of the year, and poor market conditions depressed domestic production to the lowest level since 1949. Several mines and mills shut down during the year or operated on a part-time basis. Compared with the record achieved in 1953, imports also declined but supplied a larger share of consumer requirements than in that year. A study of the effect of fluorspar imports on the domestic industry was initiated by the United States Tariff Commission acting pursuant to a resolution of the Senate Finance Committee. The General Services Administration was authorized to purchase domestic metallurgical-grade fluorspar for the National Stockpile but made no purchases during the year. An increase in the depletion allowance for fluorspar from 15 to 23 percent was provided in the Internal Revenue Code of 1954.[3]

TABLE 1.—Salient statistics of fluorspar in the United States, 1945–49 (average) and 1950–54, 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
1945–49 (average)	299,968	84,149	1,159	357,382	29,261	118,690	[2] 147,951
1950	301,510	164,634	740	426,121	19,038	164,685	[2] 183,723
1951	347,024	181,275	1,173	497,012	13,283	169,126	[2] 182,409
1952	331,273	352,503	675	520,197	27,464	252,193	[2] 279,657
1953	318,036	359,569	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

[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, and 26,100 tons in 1954.

DOMESTIC PRODUCTION

Production of finished fluorspar of domestic origin totaled 247,700 short tons in 1954, including 202,900 tons of flotation concentrate. In 1953 output of finished fluorspar totaled 322,700 tons, of which 208,500 tons was flotation concentrate. About 16,500 tons of the

[1] Commodity-industry analyst.
[2] Statistical clerk.
[3] Internal Revenue Code of 1954, sec. 613(b)(2).

output of finished fluorspar in 1954 was derived from crude ore that had been mined before 1954; and total new production, expressed in terms of finished fluorspar, was 241,200 tons compared with 339,600 tons in 1953. Of the output in 1954, 6 mines (producing over 10,000 tons each) supplied 130,600 tons or 54 percent; 5 mines (producing 5,000 to 10,000 tons each) supplied 33,700 tons or 14 percent; 26 mines (producing 1,000 to 5,000 tons each) supplied 62,700 tons or 26 percent; and 7 mines (producing 500 to 1,000 tons each) supplied 5,700 tons or 2 percent. Thus 44 mines produced 232,700 tons or 96 percent of the total "new" mine production. The remainder was produced from crude ore mined at an undetermined number of small mines or prospects or from tailings of previous milling operations.

Mines operated by consumers produced an equivalent of 87,400 tons of finished fluorspar in 1954; and the total output from consumer-operated mills, including production from stockpiled and purchased crude ore and tailings, was 110,300 short tons. In 1953 captive mines produced an equivalent of 105,900 tons of finished fluorspar and captive mill output totaled 122,700 tons (revised figure) of finished fluorspar. Most of the captive production was acid grade, produced by the 3 major producers of aluminum and 2 chemical manufacturers. Two steel companies also produced metallurgical-grade fluorspar in 1954, but both operations closed during the year.

As in the past, the Illinois-Kentucky district was the principal domestic source of fluorspar although the proportionate supply from Western States increased.

Illinois maintained its rank as the largest fluorspar-producing State, but for the second consecutive year output declined. The total output in 1954 was 109,500 tons of finished fluorspar, including 98,100 tons of flotation concentrate, compared with 168,100 tons in 1953, of which 111,300 tons was a flotation product. Several properties in Illinois were inactive during part or all of the year. The Rosiclare Lead & Fluorspar Mining Co. pulled the pumps and permitted its Rosiclare mine to flood to the 220-foot level. All damageable underground equipment was removed. Dewatering and resumption of

TABLE 2.—Shipments of domestic fluorspar, 1953–54, by State of origin

State	1953			1954		
	Short tons	Value		Short tons	Value	
		Total	Average		Total	Average
Colorado	53.276	$2.872.360	$53.91	59,197	$3.197.252	$54.01
Illinois	163.303	8.567.026	52.46	107.830	5,989.219	55.54
Kentucky	47,244	2,100.493	44.46	35.831	1,510.344	42.15
Utah	15,527	374,944	24.15	4,403	82,353	18.70
Other States:						
Montana	5.932	729,523	40.93	15,102	1,553,611	40.49
New Mexico	11,890			8,876		
Idaho	18,487	963,832	52.14	14,389		
Nevada						
Arizona	1,951	128,730	54.16			
Tennessee	426					
Total	318.036	15,736,908	49.48	245,628	12,332,779	50.21

TABLE 3.—Shipments [1] of domestic fluorspar by State of origin, 1945–49 (average) and 1950–54, with shipments of maximum year and cumulative shipments from earliest record to end of 1954, in short tons [2]

State	Maximum shipments		Shipments by years							Total shipments [1] from earliest record to end of 1954	
	Year	Short tons	1945–49 (average)	1950	1951	1952	1953	1954 Short tons	1954 Percent of total	Short tons	Percent of total
Arizona	1953	1,951	1,047	952	1,623	434	1,951				
Nevada	1953	(5)	7,355	7,577	9,408 (Nevada and Idaho)	14,798 (Nevada and Idaho)	18,487	14,389 (Arizona, Nevada and Idaho)	5.9	178,710	2.0
Idaho	1951	(5)									
California	1934	181								341	(3)
Colorado [4]	1944	65,209	33,430	18,489	20,661	29,185	53,276	59,197	24.1	736,936	8.1
Illinois [4]	1951	204,328	152,475	154,623	204,328	188,293	163,303	107,830	43.9	4,807,932	53.0
Kentucky [4]	1941	142,862	79,374	80,137	68,635	48,308	47,244	35,831	14.6	2,794,495	30.8
Montana	1952	16,160	148	41		16,160	5,932	15,102	6.1	37,975	.4
New Hampshire	1917	1,274								8,302	.1
New Mexico	1944	42,973	19,474	20,036	24,402	16,443	11,890	8,876	3.6	382,644	4.2
Tennessee	1953	[6] 426			140	[6] 348	[6] 426			2,111	(3)
Texas	1944	4,769	1,645	719						14,779	.2
Utah	1950	18,936	4,986	18,936	17,827	17,304	15,527	4,403	1.8	107,320	1.2
Washington	1945	132	34							382	(3)
Wyoming	1944	19								19	(3)
Total	1944	413,781	299,968	301,510	347,024	331,273	318,036	245,628	100.0	9,071,946	100.0

[1] Figures for 1880–1905 represent production.
[2] Quantity and value figures, by States, for 1880–1925 in Mineral Resources, 1925, pt. 2, pp. 13–14, and for 1910–40 in Minerals Yearbook Review of 1940, p. 1297.
[3] Less than 0.05 percent.
[4] Figures on production not recorded for Colorado before 1905, for Illinois before 1880, and for Kentucky before 1886 and for 1888–95. Total unrecorded production (estimated) included in "Total shipments" column as follows: Colorado, 4,400 tons; Illinois, 20,000 tons; and Kentucky, 600 tons.
[5] Figures withheld to avoid disclosure of individual company operations.
[6] Synthetic calcium fluoride recovered by TVA.

mining were said to depend on improved market conditions.[4] The mill remained in operation using stockpiled ore. The Rosiclare mine has a production record dating back more than 100 years with mining reportedly starting around 1842–43.[5] Another major producer in Illinois, the Minerva Oil Co., was reported to have operated its mines and mills on a 3-day week for part of the year. The Hicks Creek mine of the P. M. T. Mining Co. was closed March 2, and February 1 the Victory mine of the Victory Fluorspar Mining Co. suspended operations for an indefinite period.[6] The Deardorff and W. L. Davis properties of the Ozark-Mahoning Co. were closed for about 4 months, but the company reopened them in October.[7]

In Kentucky production declined to 34,700 tons of finished fluorspar in 1954 compared with 42,400 tons in 1953. This was the seventh consecutive year that production declined in Kentucky. In April the United States Steel Corp. suspended fluorspar operations in the Kentucky field and pulled pumps at the Lafayette mine near Mexico and the Big Four near Sheridan. According to an announcement made at the time of the shutdown, it was "economically unsound to continue operations," although the suspension did not mean abandonment of the property.[8] In June Inland Steel Co. closed its Kentucky fluorspar

[4] Engineering and Mining Journal, vol. 155, No. 8, August 1954, p. 141.
[5] L. W. Currier, Economic Geology: Illinois State Geol. Survey Bull. 41, Geology of Hardin County 1920, p. 293.
[6] Engineering and Mining Journal, vol. 155, No. 4, April 1954, p. 136.
[7] Engineering and Mining Journal, vol. 155, No. 11, November 1954, p. 142.
[8] Engineering and Mining Journal, vol. 155, No. 6, June 1954, p. 134.

mill near Marion. Most of the equipment and supplies were reportedly shipped to other Inland Steel plants, except the heavy-medium separation plant, which was sold.[9] The Inland Steel Co. had formerly operated the Hillside mine in Illinois and the Klondike mine in Kentucky but ceased mining operations at the former in 1948 and the latter in 1950.

Output in some Western States increased. Production in Colorado, the second largest producing State, increased to 58,500 tons in 1954 compared with 53,800 tons in 1953. All but a few tons of the production in both years has been acid-grade flotation concentrate, produced at mills operated by the Ozark-Mahoning Co. at Jamestown, Boulder County, and Northgate, Jackson County; the General Chemical Division of Allied Chemical & Dye Corp. at Jamestown, Boulder County; and the Reynolds Mining Co. at Salida, Chaffee County. The Reynolds Mining Co. closed its mill in November. In Montana production by the Cummings-Roberts firm from the Crystal Mountain deposits, Ravalli County, increased to 16,936 tons in 1954, compared with output of 9,820 tons in 1953. All Montana production was metallurgical grade.

Production reported from other Western States, Arizona, Nevada, New Mexico, and Utah, declined compared with 1953. A small tonnage of fluorspar was produced in San Bernardino County, Calif., but no shipments were reported.

Studies of fluorspar deposits in Utah by the Federal Geological Survey were summarized in a publication that describes the geology of producing mines and prospects examined and gives data on production and reserves.[10] Fluorspar mineralization near Challis, Custer County, Idaho, also was described.[11] The Idaho fluorspar deposits have been discovered in the northern part of the Bayhorse district, on Keystone Mountain, and in several mines near the old town of Bayhorse. The deposits occur along the crest and flanks and on faulted offsets of the Bayhorse anticline, as fissure and breccia fillings in the Bayhorse dolomite.

The trend toward increased production of flotation concentrate by the domestic industry continued in 1954. Shipments in 1954 comprised 43,900 short tons of gravel and lump fluorspar (including 2,800 tons of flotation concentrate which was blended with fluxing gravel) and 201,700 tons of flotation concentrate (including pelletized concentrate). Almost all of the fluxing gravel and lump fluorspar went to steel plants and iron foundries, much smaller tonnages being shipped to ferroalloy plants, smelters of secondary metals, producers of fluxing compounds, and for export. Of the flotation concentrate shipped, about 80 percent went for the manufacture of hydrofluoric acid or to Government stockpiles and about 14 percent to glass and enamel plants. The remainder was shipped to manufacturers of steel and ferroalloys, aluminum- and magnesium-reduction works, welding-rod manufacturers, and smelters of secondary metals. Of the total shipments in 1954, 17,100 tons went by river or river-rail for delivery to consumers compared with 64,900 tons in 1953.

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[9] Engineering and Mining Journal, vol. 155, No. 8, August 1954, pp. 141, 142.

[10] Thurston, W. R., Staatz, M. H., Cox, D. C., and others, Fluorspar Deposits of Utah: Geol. Survey Bull. 1005, 1954, 53 pp.

[11] Anderson, A. L., A Preliminary Report on the Fluorspar Mineralization Near Challis, Custer County, Idaho: Idaho Bureau of Mines and Geology Pamph. 101, August 1954, 13 pp.

TABLE 4.—Shipments of domestic fluorspar, 1953–54, by uses

Use	1953				1954			
	Quantity		Value		Quantity		Value	
	Percent of total	Short tons	Total	Average	Percent of total	Short tons	Total	Average
Steel	34.4	109,250	$3,873,430	$35.45	19.9	48,978	$1,390,653	$28.39
Iron foundry	1.0	3,141	130,117	41.42	.3	769	28,845	37.51
Glass	8.7	27,535	1,277,119	46.38	9.7	23,683	993,917	41.97
Enamel	1.6	5,033	273,595	54.36	1.7	4,145	216,975	52.35
Hydrofluoric acid	50.0	[1] 159,196	[1] 9,478,649	[1] 59.54	65.6	[1] 161,145	[1] 9,394,805	[1] 58.30
Miscellaneous	4.1	13,186	667,092	50.59	2.6	6,429	283,746	44.14
Exported	.2	695	36,906	53.10	.2	479	23,838	49.77
Total	100.0	318,036	15,736,908	49.48	100.0	245,628	12,332,779	50.21

[1] Includes shipments to General Services Administration.

TABLE 5.—Shipments of domestic fluorspar, by grades and industries, 1953–54, in short tons

Grade and industry	1953	1954	Grade and industry	1953	1954
Fluxing gravel and foundry lump:			Ground and flotation concentrates—Continued		
Ferrous	[1] 103,833	[1] 41,888	Exported	640	440
Nonferrous	45	345			
Miscellaneous		1,607	Total	[1] 214,103	[1] 201,749
Exported	55	39			
			All grades:		
Total	[1] 103,933	[1] 43,879	Ferrous	[1] 118,654	[1] 50,230
			Nonferrous	4,482	1,001
Ground and flotation concentrates:			Glass and enamel	32,568	27,828
			Hydrofluoric acid	[3] 159,196	[3] 161,145
Ferrous [2]	[1] 14,821	[1] 8,342	Miscellaneous	2,441	4,945
Nonferrous	4,437	656	Exported	695	479
Glass and enamel	32,568	27,828			
Hydrofluoric acid	[3] 159,196	[3] 161,145	Grand total	[1] 318,036	[1] 245,628
Miscellaneous	2,441	3,338			

[1] Fluxing gravel includes (and flotation concentrates exclude) the following quantities of flotation concentrates blended with fluxing gravel: 1953, 9,812 tons; 1954, 2,804 tons.
[2] Includes pelletized gravel.
[3] Includes shipments to General Services Administration.

Data in table 6 (compiled by the United States Tariff Commission) show the distribution of shipments of domestic and foreign fluorspar to principal consuming States for 1953–54. Shipments data reported by the Tariff Commission include small quantities of foreign fluorspar blended with domestic material and therefore are not strictly comparable with Bureau of Mines statistics for domestic fluorspar, which include finished fluorspar of domestic origin only. Imports of fluorspar duty-free for United States Government use are excluded from the Tariff Commission data on foreign shipments. Substantial quantities of both domestic and foreign shipments are reported under "destination unknown;" but much of the material reported in this category represents shipments for the account of the United States Government, therefore the data given for the various States closely approximate the pattern of distribution to commercial consumers. Reported consumption by States is shown in table 11.

TABLE 6.—Shipments of domestic and foreign fluorspar to principal consuming States, 1953–54, by grades, in short tons [1]

[United States Tariff Commission]

Year and State	Metallurgical grade				Acid grade				Ceramic grade				Total, all grades			
	Domestic		Foreign		Domestic		Foreign		Domestic		Foreign		Domestic		Foreign	
	Quantity	Percent of total	Quantity	Percent of total	Quantity	Percent of total	Quantity	Percent of total	Quantity	Percent of total	Quantity	Percent of total	Quantity	Percent of total	Quantity	Percent of total
1953:																
Pennsylvania	37,078	29.7	30,569	21.8	3,459	2.0	7,001	6.4	9,365	26.2	1,893	46.8	49,902	14.8	39,463	15.5
Ohio	29,929	23.9	18,480	13.2	11,672	6.6	3,375	3.1	4,356	12.2	48	1.2	45,957	13.6	21,903	8.6
Illinois	7,287	5.8	13,219	9.5	53,132	30.0	2,320	2.1	1,629	4.6	103	2.6	62,048	18.4	15,642	6.2
Indiana	15,828	12.7	9,763	7.0	2,231	1.3	----	----	4,028	11.3	119	2.9	22,087	6.5	9,882	3.9
Kentucky	4,434	3.6	2,266	1.6	16,767	9.5	1,525	1.4	1,666	4.7	----	----	22,867	6.8	3,791	1.5
New Jersey	519	.4	----	----	603	.3	30,006	27.3	2,725	7.6	506	12.5	3,847	1.1	30,512	12.0
Alabama	6,528	5.2	14,568	10.4	411	.2	----	----	----	----	----	----	[2] 6,939	2.1	14,568	5.7
Arkansas	----	----	----	----	22,600	12.7	4,124	3.7	----	----	----	----	22,600	6.7	4,124	1.6
Louisiana	----	----	----	----	20,479	11.5	51	(3)	----	----	----	----	20,479	6.0	51	(3)
Maryland	----	----	1,056	.8	2	(3)	290	.3	135	.4	856	21.2	137	(3)	2,202	.9
Texas	94	.1	1,630	1.2	10,172	5.7	6,699	6.0	639	1.8	54	1.3	10,905	3.2	8,383	3.3
Delaware	----	----	350	.3	1,032	.6	4,137	3.8	----	----	----	----	1,032	.3	4,487	1.8
Missouri	664	.5	1,825	1.3	----	----	97	.1	463	1.3	----	----	1,127	.3	1,922	.8
California	608	.5	55	(3)	18,859	10.6	343	.3	323	.9	----	----	19,790	5.9	398	.1
West Virginia	4,002	3.2	830	.6	110	.1	----	----	2,558	7.2	119	2.9	6,670	2.0	949	.4
New York	2,376	1.9	4,932	3.5	125	.1	56	.1	3,251	9.1	79	2.0	5,752	1.7	[2] 5,067	2.0
Michigan	1,556	1.2	9,571	6.8	----	----	----	----	1,208	3.4	----	----	2,764	.8	9,571	3.8
Georgia	----	----	1,014	.7	----	----	----	----	----	----	----	----	----	----	1,014	.4
Massachusetts	57	(3)	1,585	1.1	50	(3)	----	----	336	.9	----	----	443	.1	1,585	.6
Minnesota	1,100	.9	3,992	2.9	----	----	----	----	----	----	----	----	1,100	.3	3,992	1.6
Colorado	27	(3)	2,567	1.8	----	----	----	----	----	----	----	----	[2] 27	(3)	2,567	1.0
Utah	2,750	2.2	----	----	----	----	----	----	----	----	----	----	2,750	.8	----	----
All other States	355	.3	563	.4	582	.3	116	.1	2,295	6.4	72	1.8	3,232	1.0	751	.3
Destination unknown	9,910	7.9	21,172	15.1	[2] 15,146	8.5	[4] 49,741	45.3	697	2.0	194	4.8	[2] 25,753	7.6	[4] 71,107	28.0
Total	125,102	100.0	140,007	100.0	[2] 177,432	100.0	[2] 109,881	100.0	35,674	100.0	4,043	100.0	338,208	100.0	[2] 253,931	100.0
1954:																
Pennsylvania	11,139	21.8	25,330	26.2	2,863	1.7	8,311	5.8	7,192	25.3	1,262	20.1	21,194	8.6	34,903	14.2
Ohio	10,660	20.9	16,096	16.6	15,505	9.2	919	.7	4,243	14.9	159	2.5	30,408	12.3	17,174	7.0
Illinois	3,390	6.6	9,457	9.7	55,743	33.2	3,673	2.6	2,591	9.1	248	3.9	61,724	24.9	13,378	5.4
Indiana	11,219	22.0	50	.1	----	----	----	----	4,025	14.2	123	2.0	15,244	6.2	173	.1
Kentucky	1,001	1.9	147	.2	13,576	8.1	2,708	1.9	1,854	6.5	----	----	16,431	6.6	2,855	1.2

New Jersey	140	.3	100	.1	714	.4	24,535	17.1	632	2.2	1,845	29.3	1,486	.6	26,480	10.7
Alabama	5,609	11.0	2,801	2.9	394	.2	--------	--------	--------	--------	--------	--------	6,003	2.4	2,801	1.1
Arkansas	--------	--------	--------	--------	18,835	11.2	2,165	1.5	57	.2	--------	--------	18,892	7.6	2,165	.9
Louisiana	--------	--------	--------	--------	16,672	9.9	2,264	1.6	--------	--------	--------	--------	16,672	6.7	2,264	.9
Maryland	--------	--------	--------	--------	--------	--------	469	.3	120	.4	562	8.9	120	(3)	[2] 1,031	.4
Texas	152	.3	1,788	1.8	618	.4	9,678	6.8	472	1.7	--------	--------	1,242	.5	11,466	4.7
Delaware	--------	--------	--------	--------	1,475	.9	28,543	20.0	--------	--------	--------	--------	1,475	.6	28,543	11.6
Missouri	294	.6	4,816	5.0	--------	--------	3,205	2.2	189	.7	321	5.1	483	.2	8,342	3.4
California	789	1.6	--------	--------	12,562	7.5	1,040	.7	--------	--------	462	7.4	13,351	5.4	1,502	.6
West Virginia	422	.8	790	.8	--------	--------	--------	--------	1,742	6.1	162	2.6	[2] 2,164	.9	952	.4
New York	547	1.1	2,252	2.3	5	(3)	6	(3)	1,872	6.6	881	14.0	2,424	1.0	3,139	1.3
Michigan	1,531	3.0	8,996	9.3	--------	--------	480	.3	410	1.4	--------	--------	1,941	.8	9,476	3.8
Georgia	31	.1	194	.2	--------	--------	--------	--------	35	.1	--------	--------	66	(3)	194	.1
Minnesota	1,021	2.0	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	1,021	.4	--------	--------
Colorado	76	.1	6,572	6.8	--------	--------	--------	--------	--------	--------	--------	--------	76	(3)	6,572	2.7
Utah	2,059	4.0	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	2,059	.8	--------	--------
All other States	984	1.9	832	.9	547	.3	38	(3)	2,569	9.0	238	3.8	4,100	1.7	[2] 1,108	.4
Destination unknown	--------	--------	16,491	17.1	[5] 28,629	17.0	[4] 55,147	38.5	445	1.6	23	.4	[5] 29,074	11.8	[4] 71,661	29.1
Total	51,064	100.0	96,712	100.0	[2] 168,138	100.0	143,181	100.0	28,448	100.0	6,286	100.0	[2] 247,650	100.0	246,179	100.0

[1] Based on reports to the United States Tariff Commission covering all shipments of domestic fluorspar and shipments of imported fluorspar approximately equivalent to dutiable imports (excluding duty-free imports for United States Government use).

[2] Figure revised by Bureau of Mines.

[3] Less than 0.05 percent.

[4] Includes substantial quantities of dutiable material imported by regular importers for U. S. Government use.

[5] Includes substantial quantities of domestic fluorspar shipped for account of U. S. Government.

Employment and Wages.—Employment data for 1948 through 1954 and man-hours worked and average hourly wages for 1949, 1951, 1953, and 1954, as reported by the Tariff Commission, are shown in tables 7 and 8. Heretofore such data have not been published in this chapter.

Employment in the domestic industry fluctuated considerably in the 7-year period for which data were reported. The number of workers employed increased during the Korean emergency to a postwar peak of about 2,000 mine and mill employees but declined thereafter and in 1954 was lower than in any of the previous 6 years. The drop in employment from 1953 to 1954 was considerably more severe in the Illinois-Kentucky district than in the Western States. In 1954, total man-hours worked in Illinois and Kentucky were about 47 percent less than in 1953, while in the Western States total man-hours worked in 1954 were about 26 percent less than in 1953 (see table 8). Average hourly earnings of mine employees increased about 44 percent from 1949 to 1954, while wages of mill employees increased approximately 40 percent from 1949 to 1954. In all years hourly earnings of both mine and mill employees in the Western States were slightly higher than those reported for the Illinois-Kentucky district.

TABLE 7.—Number of employees in the United States fluorspar industry, 1948–54

[United States Tariff Commission]

Year	Mines [1]	Mills	Total	Year	Mines [1]	Mills	Total
1948	962	584	1,546	1952	1,254	764	2,018
1949	824	531	1,355	1953	1,156	734	1,890
1950	718	512	1,230	1954	634	576	1,210
1951	1,053	620	1,673				

[1] Represents data for fluorspar mines that in 1953 supplied 90.8 percent of the total domestic production of crude fluorspar adjusted to include estimated employment for unreported operators.

CONSUMPTION AND USES

Consumption of fluorspar declined in 1954 to 480,400 tons compared with the record of 586,800 short tons reported consumed in 1953. Most of the decrease in consumption was attributable to curtailment of operations by the steel industry, historically the largest consumer of fluorspar. Consumption for the production of hydrofluoric acid, the second largest use in past years, increased to a new record and for the first time exceeded consumption by the steel industry.

One of the factors affecting consumption by the steel industry was the use of less fluorspar to produce 1 ton of steel. In 1954 consumption of fluorspar per long ton of steel produced in basic open-hearth furnaces averaged 4.9 pounds, compared with 5.9 pounds per long ton of steel in 1953. Consumption and stocks of fluorspar and production of basic open-hearth steel for 1945 through 1954 are given in table 10. Illinois, Pennsylvania, and Ohio were the 3 largest consuming States, accounting for about 42 percent of the total.

TABLE 8.—Employment of production and related workers, man-hours worked, wages paid, and average hourly earnings in United States fluorspar mines and mills, by regions and total, specified years, 1949–54

[United States Tariff Commission]

Item	Illinois-Kentucky				Western States				Total United States			
	1949	1951	1953	1954	1949	1951	1953	1954	1949	1951	1953	1954
Mines:												
Number of firms reporting	9	11	14	14	8	11	16	16	17	22	30	30
Average number of workers	589	653	774	351	109	236	163	166	698	889	937	517
Man-hours:												
Total (thousand hours)	1,065	1,452	1,589	669	211	438	476	375	1,276	1,890	2,066	1,044
Per production worker	1,808	2,223	2,053	1,907	1,934	1,857	2,923	2,257	1,828	2,126	2,205	2,019
Wages paid, total (thousand dollars)	1,334	2,030	2,556	1,138	266	651	841	740	1,600	2,681	3,398	1,878
Average hourly earnings	$1.25	$1.40	$1.61	$1.70	$1.26	$1.48	$1.77	$1.98	$1.25	$1.42	$1.64	$1.80
Mills:												
Number of firms reporting	9	11	15	14	4	6	9	6	13	17	24	20
Average number of workers	348	386	418	319	60	98	140	102	408	484	558	421
Man-hours:												
Total (thousand hours)	737	864	907	646	127	207	370	250	864	1,071	1,278	896
Per production worker	2,117	2,237	2,171	2,025	2,113	2,114	2,645	2,452	2,117	2,212	2,290	2,129
Wages paid, total (thousand dollars)	872	1,169	1,401	1,053	156	297	620	434	1,028	1,466	2,021	1,487
Average hourly earnings	$1.18	$1.35	$1.54	$1.63	$1.23	$1.44	$1.67	$1.74	$1.19	$1.37	$1.58	$1.66

TABLE 9.—Fluorspar (domestic and foreign) consumed and in stock in the United States, by industries, 1953–54, in short tons

Industry	1953		1954	
	Consumption	Stocks at consumers' plants, Dec. 31	Consumption	Stocks at consumers' plants, Dec. 31
Basic open-hearth steel	252,442	171,177	174,198	103,589
Electric-furnace steel	35,027		21,409	
Bessemer steel	138		460	
Iron foundry	12,432	5,725	8,778	2,871
Ferroalloys	5,224	1,366	[1] 3,240	[1] 1,048
Hydrofluoric acid [2]	223,359	37,261	225,096	26,094
Primary aluminum [3]	4,022	1,856	3,609	1,838
Primary magnesium	3,180	445	540	218
Glass	32,955	5,486	29,746	4,596
Enamel	5,863	1,057	5,737	1,114
Cement	319	782	[1] 216	[1] 594
Miscellaneous	11,837	2,356	[1] 7,345	[1] 1,851
Total	586,798	227,511	480,374	143,813

[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 10.—Production of basic open-hearth steel and consumption and stocks of fluorspar (domestic and foreign) at basic open-hearth steel plants, 1945–49 (average) and 1950–54

	1945–49 (average)	1950	1951	1952	1953	1954
Production of basic open-hearth steel ingots and castings ....long tons..	64,103,000	76,873,000	83,118,000	75,297,000	85,690,000	70,625,000
Consumption of fluorspar in basic open-hearth steel production........short tons..	180,456	212,928	242,180	237,483	252,442	174,198
Consumption of fluorspar per long ton of basic open-hearth steel made........pounds..	5.6	5.5	5.8	6.3	5.9	4.9
Stocks of fluorspar at basic open-hearth steel plants at end of year......short tons...	79,520	128,300	133,100	195,700	163,600	95,200

TABLE 11.—Fluorspar (domestic and foreign) consumed in the United States, by States, 1953–54, in short tons

State	1953	1954 [1]	State	1953	1954 [1]
Alabama, Florida, Georgia, Mississippi, North Carolina, and South Carolina	18,556	13,098	Maryland	6,649	5,479
Arkansas, Kansas, Louisiana, and Oklahoma	51,331	51,053	Massachusetts and Rhode Island	1,829	545
California	26,914	22,261	Michigan	24,149	12,584
Colorado, Utah, and Wyoming	23,512	16,497	Missouri	5,216	4,843
Connecticut	1,370	449	New York	21,308	15,100
Delaware, District of Columbia, and New Jersey	47,737	58,711	Ohio	74,065	57,462
Illinois	100,079	83,286	Oregon and Washington	2,775	1,517
Indiana	29,898	27,692	Pennsylvania	92,003	60,668
Iowa, Minnesota, Nebraska, South Dakota, and Wisconsin	5,009	4,648	Tennessee	594	736
Kentucky	24,920	19,809	Texas	22,394	15,539
			Virginia	307	99
			West Virginia	6,183	4,777
			Undistributed	--------	3,521
			Total	586,798	480,374

[1] Consumption estimated from sample canvass of consumers who accounted for more than 95 percent of total usage in 1953.

STOCKS

According to reports of producers, the quantity of fluorspar in stock at mines or shipping points at the end of 1954 totaled 210,500 short tons, of which 26,400 tons was finished fluorspar and 184,100 tons crude fluorspar estimated as equivalent to 59,500 tons of finished fluorspar.

Consumers' stocks at the end of 1954 totaled 143,800 tons compared with 227,500 tons at the end of 1953. Reduction of stocks at steel plants experienced most of the drop in consumer stocks, reflecting decreased consumption of fluorspar by the steel industry and a cutback in the supply of fluorspar held in inventory. At the end of 1954 fluorspar stocks at steel plants totaled 103,600 short tons—about 6 months' supply at the December rate of consumption. At the end of 1953 stocks of fluorspar at steel plants were equivalent to about 9 months' supply at the December 1953 rate of usage, and at the end of 1952 stocks were equivalent to about 7 months' supply at the December 1952 rate of consumption. The decline in fluorspar stocks at steel plants was a major factor in the poor market for metallurgical-grade fluorspar in 1953 and 1954. Fluctuations in stocks at producers' plants and at other consumers' plants were of less significance.

TABLE 12.—Stocks of fluorspar at mines or shipping points in the United States, by States, at end of year, 1952–54, in short tons

	1952		1953		1954	
	Crude [1]	Finished	Crude [1]	Finished	Crude [1]	Finished
Arizona		10			287	
California					200	
Colorado	49,417	1,263	88,213	1,693	119,509	1,077
Idaho	100	100				
Illinois	42,380	11,118	57,725	15,920	32,941	18,128
Kentucky	11,190	12,404	10,009	7,515	7,759	6,465
Montana		1,227		5,115	5,988	
Nevada	6,351	1,205	20,301 (Nevada and New Mexico)	1,069	17,459	700
New Mexico	12,707	119				
Tennessee		18		134		
Utah				450		
Total	122,145	27,464	176,248	31,896	184,143	26,370

[1] This crude (run-of-mine) fluorspar must be beneficiated before it can be marketed.

PRICES

The price structure for fluorspar deteriorated rapidly after the spring of 1954. Metallurgical-grade fluorspar containing 70 percent or more effective CaF_2 [12] was quoted at $42.50 per short ton, f. o. b Illinois-Kentucky mines until March, when the quoted price fell to $37 per short ton. In April the price for this grade, f. o. b. Illinois-Kentucky, declined to $35 per short ton and in August to $33 per short ton. Metallurgical-grade fluorspar containing 60 percent effective CaF_2 was quoted at $38 per ton, f. o. b. Illinois-Kentucky, until March, when the price dropped to $33 per short ton. The

[12] The effective CaF_2 content is determined by subtracting from the percentage of CaF_2 2½ times the SiO_2 present.

price for 60 percent effective grade was further reduced to $32 per short ton in April and to $29 per ton in August. Foreign metallurgical-grade fluorspar, c. i. f. United States ports, duty paid, was quoted at $38 per short ton in January, $36 in February, $35 in March, $33 in April, $32 in June, and $28 from October until the end of the year. Prices for Mexican metallurgical-grade fluorspar, containing 72½ percent effective CaF_2, were quoted at $25 per short ton, all rail, duty paid, f. o. b. shipping point, or $28 per short ton on barges at Brownsville. In October these prices were reduced to $24.50 and $26.75, respectively.

Ceramic-grade fluorspar, containing a minimum of 95 percent CaF_2, calcite and silica variable and 0.14 percent Fe_2O_3, was quoted at $50 per short ton, in bulk, f. o. b. Rosiclare, Ill., until March, when the price was reduced to $48 per ton. The price was reduced further to $44 per ton in July. Ceramic-grade fluorspar in 100-pound bags was offered at $4 per ton above the prices quoted for bulk shipments throughout the year.

Acid-grade concentrates, f. o. b. Rosiclare, Ill., were quoted at $57.50 per short ton until March, when the price was reduced to $55 per ton. The Rosiclare price was reduced further to $52.50 per ton in April and $47.50 per ton in October. Acid-grade concentrates, f. o. b. Boulder, Colo., were quoted at $57.50 per short ton until August, when the price dropped to $52.50 per short ton. A price of $60 per short ton was quoted throughout the year for concentrates f. o. b. Northgate, Colo. Foreign acid-grade fluorspar, c. i. f. United States ports, duty paid, was quoted at $60 per short ton until March when the price was reduced to $55 per short ton. A further reduction to $52.50 per short ton was reported in May.

FOREIGN TRADE [13]

Imports.—Imports in 1954 declined considerably from the record established in 1953 but continued to exceed domestic output. Mexico, the leading foreign supplier, shipped about 45 percent of the total imports. Imports free of duty by the United States Government totaled 50,774 short tons in 1954 compared with 109,369 (revised) tons in 1953. In addition, in 1954 virtually all dutiable imports of acid-grade fluorspar from Canada were acquired by the United States Government under a contract executed in 1952 by the Defense Materials Procurement Agency.

Acting pursuant to a resolution of the Senate Finance Committee, the United States Tariff Commission initiated a study of the domestic fluorspar industry and effects of imports on domestic production, consumption, and trade. Public hearings were held October 19 and 20, at which representatives of producers, labor, and importers appeared. The Commission reported its findings in June 1955, and some of the statistical data collected in its investigation have been included in this chapter.[14] The Commission report was confined to a factual presentation and did not discuss the question of whether or not, or to what extent, existing tariff classifications and rates for

[13] 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.

[14] United States Tariff Commission, Fluorspar: June 1955, 141 pp.

fluorspar should be changed. Fluorspar containing more than 97 percent CaF_2 is dutiable at a rate of $1.87½ per short ton; that containing no more than 97 percent CaF_2 is subject to a duty of $7.50 per short ton.

The Commission concluded that imports of metallurgical-grade fluorspar were directly competitive with domestic output of this grade and that the large volume supplied by foreign sources in recent years had displaced a considerable tonnage previously supplied from domestic mines. The Commission stated that the increase in imports of metallurgical grade resulted from a more favorable price and quality of these imported materials, and that, while Congress could increase the statutory duty without conflicting with any existing international obligation, there was a question as to how much imports

TABLE 13.—Fluorspar imported for consumption in the United States in 1954, 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:						
Buffalo			61	$2,180	61	$2,180
Philadelphia	34,694	$1,456,349			34,694	1,456,349
Total Canada	34,694	1,456,349	61	2,180	34,755	1,458,529
Mexico:						
Arizona	147	5,125	165	2,415	312	7,540
Buffalo			35	1,250	35	1,250
Dakota	13	340			13	340
El Paso	10,444	225,419	14,811	261,204	25,255	486,623
Galveston	58	2,423			58	2,423
Laredo	41,828	1,279,398	56,780	801,399	98,608	2,080,797
Maine and New Hampshire			61	766	61	766
Philadelphia	6,638	253,596	3,670	139,485	10,308	393,081
Total Mexico	59,128	1,766,301	75,522	1,206,519	134,650	2,972,820
Total North America	93,822	3,222,650	75,583	1,208,699	169,405	4,431,349
Europe:						
France: Philadelphia	221	6,800			221	6,800
Germany, West: Philadelphia	35,125	1,452,602	559	9,668	35,684	1,462,270
Italy:						
Philadelphia	40,137	1,800,297	4,891	84,454	45,028	1,884,751
Virginia	2,751	120,000			2,751	120,000
Total Italy	42,888	1,920,297	4,891	84,454	47,779	2,004,751
Spain:						
Buffalo			3,892	49,763	3,892	49,763
Maryland			1,108	13,708	1,108	13,708
Philadelphia	33,719	972,854	711	9,400	34,430	982,254
Total Spain	33,719	972,854	5,711	72,871	39,430	1,045,725
Total Europe	111,953	4,352,553	11,161	166,993	123,114	4,519,546
Africa: Tunisia: Philadelphia			801	10,700	801	10,700
Grand total: 1954	205,775	[1] 7,575,203	87,545	1,386,392	293,320	[1] 8,961,595
1953	[2] 207,893	[2] 8,669,511	151,676	2,757,983	[2] 359,569	[2] 11,427,494

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

[2] Revised figure. Changes in Minerals Yearbook, 1953: P. 472 should read as follows: Containing more than 97 percent calcium fluoride–Italy, 44,288 short tons ($2,172,958), Philadelphia, 40,932 tons ($2,012,458). Total—Italy, 52,218 tons ($2,318,927), Philadelphia, 48,862 tons ($2,158,427).

could be excluded and the needs of the domestic steel industry adequately met. With respect to acid-grade fluorspar, the Commission reported that foreign supply was more directly competitive with domestic production than in former years but had not displaced an appreciable volume of domestic production and was less severely competitive, being more supplemental than the imports of metallurgical grade. It was pointed out that the duty on fluorspar containing more than 97 percent CaF_2—the classification under which entries are principally acid-grade fluorspar—was subject to a concession in a trade agreement and that any legislation increasing the rate of duty on this classification would conflict with existing international obligations. The Commission stated that imports of fluorspar for ceramic use were principally supplemental to, rather than competitive with, the domestic output of ceramic grade.

As shown in table 14, which was compiled from data supplied by importers and domestic operators milling or otherwise handling imported fluorspar, most imports were sold to steel producers and manufacturers of hydrofluoric acid. The quantities in table 14 represent the finished product recovered from milling or drying foreign ores or concentrates, rather than the crude ores milled or concentrates dried.

One of the principal factors in competition between domestic and imported material is the transportation charge. Table 15, compiled from data reported by the Tariff Commission, compares the 1954 delivered value of fluorspar from domestic sources with that of foreign fluorspar in principal consuming States. Another important factor in competition between foreign and domestic suppliers of metallurgical-grade fluorspar was grade of material. Table 16 compares the effective calcium fluoride content of domestic metallurgical-grade fluorspar shipped in 1953 with the content of imports of metallurgical grade sold to consumers in 1954.

TABLE 14.—Imported fluorspar delivered to consumers in the United States, 1953–54, by uses

Use	1953			1954		
	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	[1] 161,827	[1] $5,186,789	$32.05	81,310	$2,131,112	$26.21
Hydrofluoric acid	[1] 80,961	4,585,249	56.64	74,223	3,817,980	51.44
Ferroalloys	1,029	32,718	31.80	68	1,511	22.22
Glass and enamel	6,215	387,294	62.32	6,582	359,670	54.64
Other	11,491	504,335	43.89	10,937	363,018	33.19
Total	[1] 261,523	10,696,385	40.90	173,120	6,673,291	38.55

[1] Partly estimated

TABLE 15.—Average costs in the United States of transportation, insurance, and other handling charges for selected and total shipments of fluorspar from domestic and foreign sources, and average delivered value, 1954

[United States Tariff Commission]

Grade	Mode of shipments	Source and shipping point	Consuming State	Quantity (short tons)	Average cost of transportation, insurance and other handling charges from shipping point to destination, per short ton	Average delivered value per short ton
Metallurgical	Barge	Domestic:				
		Illinois-Kentucky	Western Pennsylvania[1]	10,060	$3.92	$42.34
			Ohio	4,722	5.00	28.95
			Indiana	2,067	5.28	34.82
		Foreign:				
		United States-Mexican border.	Western Pennsylvania[1]	12,778	10.37	33.70
			Ohio	12,355	12.19	37.79
			Illinois	4,597	8.49	35.49
	Rail	Domestic:				
		Illinois-Kentucky	Western Pennsylvania[1]	952	10.59	45.94
			Ohio	5,938	10.97	50.47
			Indiana	1,821	7.95	42.44
			Alabama	5,609	8.07	45.09
			Michigan	1,531	10.53	42.62
		Western States	Utah	2,059	9.00	34.05
			Illinois	3,005	17.00	41.02
			Indiana	7,331	17.00	41.83
		Foreign:				
		United States-Mexican border	Western Pennsylvania[1]	1,091	19.44	43.98
			Eastern Pennsylvania[1]	1,280	14.00	37.00
			Colorado	6,572	8.76	29.61
			Alabama	2,801	15.00	37.92
			Michigan	7,989	19.29	42.96
			Ohio	3,741	17.47	49.11
			Illinois	4,860	15.63	39.06
		Eastern seaboard	Eastern Pennsylvania[1]	10,070	3.59	33.35
			New York	1,520	10.00	46.99
		Total shipments of domestic material.	All States	51,064	9.47	41.40
		Total shipments of foreign material.	All States	96,712	[2] 11.66	[2] 36.94
Acid	Rail	Domestic:				
		Illinois-Kentucky	Illinois	55,743	4.99	70.99
			Ohio	15,505	9.84	61.84
			Kentucky	13,576	3.86	56.50
			Arkansas	1,732	9.30	51.14
		Western States	Arkansas	17,103	12.79	68.47
			Louisiana	16,672	15.24	57.49
			California	12,562	8.27	71.09
			Delaware	1,475	21.11	59.57
		Foreign:				
		United States-Mexican border	Texas	9,769	8.84	59.20
			Arkansas	2,165	9.00	51.10
			Louisiana	2,264	11.00	46.00
			California	1,040	16.47	58.30
			Missouri	3,205	13.60	47.26
			Illinois	3,673	12.68	50.25
		Eastern seaboard	Pennsylvania	8,256	7.07	50.54
			New Jersey	24,535	3.84	67.14
			Delaware	28,543	4.00	54.26
		Total shipments of domestic material.	All States	168,278	[2,3] 8.39	[2,3] 66.54
		Total shipments of foreign material.	All States	143,181	[2,3] 6.43	[2,3] 62.07

See footnotes at end of table.

TABLE 15.—Average costs in the United States of transportation, insurance, and other handling charges for selected and total shipments of fluorspar from domestic and foreign sources, and average delivered value, 1954—Continued

Grade	Mode of shipments	Source and shipping point	Consuming State	Quantity (short tons)	Average cost of transportation, insurance and other handling charges from shipping point to destination, per short ton	Average delivered value per short ton
Ceramic	Rail	Domestic:				
		Illinois-Kentucky	Pennsylvania	7,192	10.64	50.89
			Ohio	4,243	10.53	54.48
			Indiana	4,025	8.32	46.57
			Illinois	2,591	7.53	52.50
			West Virginia	1,742	10.24	55.80
		Foreign:				
		United States-Mexican border	California	462	15.69	55.60
			Missouri	321	13.06	54.35
			Illinois	248	10.14	53.33
		Eastern seaboard	Pennsylvania	1,462	8.74	65.26
			New Jersey	1,736	4.00	64.50
			New York	777	5.00	65.50
			Maryland	562	4.00	64.50
		Total shipments of domestic material.	All States	28,448	[2] 9.69	[3] 51.78
		Total shipments of foreign material.	All States	6,286	[2] 8.14	[3] 62.19

[1] The geographic division of Western Pennsylvania includes Johnstown and the area west of that city, and Eastern Pennsylvania covers the area east of Johnstown.
[2] Does not include shipments for which destination is unknown.
[3] Does not include shipments for account of U. S. Government.

TABLE 16.—Metallurgical fluorspar: United States shipments of domestic fluorspar in 1953 and foreign fluorspar in 1954, by percent of effective calcium fluoride

[United States Tariff Commission]

Percent of effective calcium fluoride	Quantity (short tons)	Total net selling value, f. o. b. United States shipping point for domestic fluorspar and duty paid, f. o. b. port of entry for imports	Percent of total quantity	Percent o total value
	Domestic fluorspar, 1953			
60	89,799	$3,334,944	71.8	72.0
70	16,438	636,806	13.2	13.8
72-½	1,678	72,602	1.3	1.6
75-80	2,912	103,228	2.3	2.2
Over 80	14,275	481,205	11.4	10.4
	125,102	4,628,785	100.0	100.0
	Imported fluorspar, 1954			
70	9,994	331,604	10.1	13.7
72-½	41,276	1,002,527	41.5	41.5
75-80	37,165	821,934	37.5	34.0
Over 80	10,783	261,004	10.9	10.8
	[1] 99,218	2,417,069	100.0	100.0

[1] The small difference between the total quantity shown here and the total quantity of United States shipments of imported metallurgical fluorspar shown in other tables of this report reflects slightly different answers given in response to separate inquiries of the questionnaire used in the investigation.

TABLE 17.—Fluorspar reported by producers as exported from the United States, 1945–49 (average) and 1950–54

Year	Short tons	Value		Year	Short tons	Value	
		Total	Average			Total	Average
1945–49 (average)	1,151	$42,151	$36.61	1952	665	$31,173	$46.88
1950	728	29,746	40.86	1953	695	36,906	53.10
1951	1,148	51,809	45.13	1954	479	23,838	49.77

TECHNOLOGY

Increased industrial importance of fluorspar was stressed at a symposium conducted by the Industrial Minerals Division at the annual meeting of the American Institute of Mining and Metallurgical Engineers. Papers on world resources, resources in the United States, Mexico, Newfoundland, and Europe, and on geology, milling, and on phosphate rock as a source of fluorine were presented.[15] Fluorspar requirements in the United States were forecast to be over one million tons annually by 1975 and the need for dependable sources was emphasized.[16] The possibility of atomic energy as a potentially large consumer of fluorine was pointed out. Another paper reviewed domestic fluorspar supplies.[17] Total reserves of "economically usable material" were estimated at 21,000,000 tons—8,500,000 tons in the Illinois-Kentucky district, 11,800,000 tons in Western States, and 700,000 tons in Alaska.

Geologic features of domestic fluorspar deposits also were discussed.[18] According to the paper, fluorite is a persistent mineral found in many types of rock and mineral deposits, but commercial fluorspar deposits generally are of the telethermal or epithermal types. Studies of inclusions in fluorite and of mineral assemblages, textures, and wall-rock alteration indicate that deposits were formed at relatively shallow depths and low temperatures. Fluorspar mineralization is considered of Cretaceous age in the Illinois-Kentucky district and of Cretaceous-Tertiary age in western deposits, although the age of the host rock may vary from pre-Cambrian to Tertiary.

Production of acid-grade fluorspar flotation concentrates from old tailings at the Pennsylvania Salt Manufacturing Co. mill, Mexico, Ky., was described.[19] Mill feed averaged 26.04 percent CaF_2, but about 10 percent was waste rock and coarse gravel (assaying about 8 percent CaF_2), which was bound together by sticky clay slimes, and an ore-handling problem was presented. This problem was solved by pulping the feed, screening out plus-⅛-inch material, which contained relatively little CaF_2, and conveying the ore by pumping. The flotation circuit was made up of 24 No. 18, 28- by 28-inch cells, consisting of a rougher of 8 cells and 8 stages of 2-cell cleaners. Output from the

[15] AIME, Industrial Minerals Division, Abstracts of Technical Papers, Technical Sessions: February 1954, 6 pp.
[16] Barr, J. A., Fluorspar Requirements for the United States: Unpublished paper presented at Fluorspar Symposium, Industrial Minerals Division, AIME, February 1954.
[17] Sutton, A. H., Fluorspar Supplies in the United States: Unpublished paper presented at Fluorspar Symposium, Industrial Minerals Division, AIME, February 1954.
[18] Van Alstine, R. E., Geologic Features of the Fluorspar Deposits of the United States: Unpublished paper presented at Fluorspar Symposium, Industrial Minerals Division, AIME, February 1954.
[19] West, LaMont, and Walden, R. R., Milling Kentucky Fluorspar Tailings: Min. Eng., vol. 6, No. 5, May 1954, pp. 542–544.

mill was about 20 tons of acid-grade concentrates daily, with an overall recovery of about 76 percent.

A method for rapid colorimetric estimation of fluorspar and cryolite flotation products, by measuring their transparency, was reported.[20] Colorimetric estimation of transparent minerals was said to have been successfully applied to mill products at the Pennsylvania Salt Manufacturing Co. cryolite flotation mill at Natrona, Pa., and tests indicated that the technique could be used to estimate the grade of fluorspar concentrate containing over 90 percent CaF_2 but was not accurate for lower grade fluorspar concentrate.

The potentialities of fluorine resources in phosphate rock were reviewed.[21] The authors estimated that known domestic phosphate rock reserves contained over 470 million short tons of fluorine and that in 1950 the fluorine contained in phosphate rock used in domestic production of superphosphate, phosphoric acid, and phosphorus totaled about 295,000 short tons, almost equal to domestic shipments of all grades of fluorspar in that year (301,500 short tons). An estimated 82,000 tons of this fluorine was liberated, but less than 20 percent was recovered. Fluorine is recovered from phosphate-rock processing in the form of fluosilicic acid and fluosilicates, principally sodium fluosilicate, and the total output of these chemicals in 1950 was equivalent to about 14,000 short tons of fluorine. Several types of phosphate-rock processing in which fluorine is evolved were reviewed, and data were given on fluorine volatilization at various stages of manufacturing distribution of fluorine in products, and disposal of evolved fluorine. It was concluded that improved methods of recovering the fluorine would yield a substantial contribution to expanding industrial requirements for hydrofluoric acid.

Interest in fluorinated-carbon compounds continued. Properties of fluorinated resins, polytrifluorochloroethylene and polytetrafluoroethylene, were reviewed.[22] Among the newest and most effective materials for controlling corrosion, the resins were reported to have unusual chemical inertness, ability to withstand exposure to temperatures ranging from minus 100° to 500° F., high compressive strength, excellent dielectric properties, and zero water absorption. Another article discussed properties of Teflon (a polytetrafluoroethylene resin) pipe, hose, and allied products and their uses in chemical process industries and other applications where corrosion, temperature variations, and other severe stresses must be encountered.[23] The manufacture of polytetrafluoroethylene in Great Britain under the trade name "Fluon" and applications in chemical process industries was reported.[24] Fluorocarbon grease compounds were described in a patent.[25]

Development of a new fluorine-production cell by Union Carbide & Carbon Co. and design of a 36-cell plant capable of producing 2 tons of fluorine daily was reported.[26] The new cell was said to have a life

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[20] Sun, S. C., Fisher, H. M., and Snow, R. W., Rapid Estimation of Mill-Product Purity by Transparency Measurement: Min. Eng., vol. 6, No. 9, September 1954, pp. 919–922.

[21] Hill, W. L., and Jacobs, K. D., Phosphate Rock as an Economic Source of Fluorine: Min. Eng., vol. 6, No. 10, October 1954, pp. 994–1000.

[22] Chemical Engineering, Fluorinated Resins: Vol. 61, No. 11, November 1954, p. 200.

[23] Chemical and Engineering News, Teflon Pipe Handles Corrosives: Vol. 32, No. 7, Feb. 15, 1954, p. 673.

[24] Chemical Age (London), "Fluon" Polytetrafluoroethylene: Vol. 20, No. 1815, April 1954, pp. 929–932.

[25] Petersen, W. H., and Saarni, W., Fluorocarbon Grease Compounds Thickened With an Inorganic Gelling Agent (assigned to Shell Development Co.): U. S. Patent 2,679,479, May 1954.

[26] Industrial and Engineering Chemistry, Cheaper Fluorine: Vol. 46, No. 11, November 1954, p. 11A.

double that of previous equipment and to make possible lower costs and less operating time. Improvements include a stress-relieved, nickel-base-alloy, inner shell, additional center cooling tubes, and a baffled water jacket. Fewer but wider anodes are employed to increase the effective anode area and the head altered to a single unit with multiple gas outlets and welded Monel skirts.

WORLD REVIEW

NORTH AMERICA

Canada.—The production of fluorspar in Canada reached a new high of 120,078 short tons in 1954 compared with 88,569 tons in 1953, according to reports to the Department of Mines and Technical Surveys, Ottawa.[27] Exports also reached a new record, increasing from 22,079 short tons in 1953 to 34,694 tons in 1954. All exports were to the United States. For the second consecutive year imports declined, totaling 16,240 tons in 1954, compared with 20,161 tons in 1953 and 22,314 tons in 1951. Mexico was the leading foreign source in all these years, smaller quantities being supplied from the United States, United Kingdom, Spain, and other countries. Consumption of fluorspar in Canada totaled 83,116 short tons in 1953, of which 59,556 tons was used in producing heavy chemicals and at nonferrous smelters, 22,730 tons at steel plants, 672 tons for glass manufacture, 152 tons for enameling and glazing, and 6 tons for white-metal alloys. In 1952 usage totaled 68,748 short tons, including 45,399 tons for heavy chemical and nonferrous smelters, 22,576 tons at steel plants, 642 tons for glass, and 131 tons for enameling and glazing.

TABLE 18.—World production of fluorspar, by countries 1945–49 (average) and 1950–54, in short tons [1]

(Compiled by Helen L. Hunt)

Country	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Canada	54,316	64,213	74,211	82,187	88,569	118,969
Mexico (exports)	54,915	72,474	73,591	198,680	173,162	146,198
United States (shipments)	299,968	301,510	347,024	331,273	318,036	245,628
Total	409,199	438,197	494,826	612,140	579,767	510,795
South America:						
Argentina (shipments)	2,722	5,512	7,937	7,882	[2] 8,000	[2] 8,000
Bolivia (exports)	119	67	42	88	21	213
Brazil	470	[2] 660	([3])	---	---	---
Total	3,311	[2] 6,200	[2] 8,600	7,970	[2] 8,000	[2] 8,200
Europe:						
Belgium	[4] 3,961	([3])	([3])	([3])	([3])	([3])
France	31,931	45,915	59,961	72,853	60,296	64,595
Germany:						
East [2]	[2] 74,400 (East and West)	70,000	80,000	90,000	90,000	90,000
West		101,986	154,753	161,566	177,719	181,881
Italy	20,601	32,169	45,216	63,546	103,426	85,041
Norway	2,389	924	995	750	777	488
Spain	29,627	36,561	62,472	68,899	56,426	[2] 38,600
Sweden (sales)	3,143	4,722	5,607	4,926	7,510	4,773
United Kingdom	63,925	70,569	83,725	84,922	88,624	92,607
Total [2] [5]	230,000	365,000	495,000	550,000	590,000	560,000

See footnotes at end of table.

[27] Canada Department of Mines and Technical Surveys, Fluorspar in Canada in 1954 (Prelim.): Ottawa, 4 pp.

TABLE 18.—World production of fluorspar, by countries 1945–49 (average) and 1950–54, in short tons[1]—Continued

Country	1945–49 (average)	1950	1951	1952	1953	1954
Asia:						
China	[2] 6,800	(3)	(3)	(3)	(3)	(3)
India	97					
Japan	1,021	2,673	4,405	4,356	7,206	6,771
Korea:						
Korea, Republic of	} [2] 20,000	6,026	4,677	6,121	12,139	9,780
North Korea		(3)	(3)	(3)	(3)	(3)
Turkey	[6] 136			277	110	
U. S. S. R.[2] [5]	80,000	90,000	90,000	90,000	90,000	110,000
Total [2] [5]	110,000	110,000	105,000	110,000	135,000	195,000
Africa:						
French Morocco	100	44	2,169	3,642	3,188	1,188
Southern Rhodesia	89	493	122		373	120
South-West Africa		80	859	4,870	5,641	3,063
Tunisia	201			2,723	2,249	
Union of South Africa	4,829	7,659	13,537	11,343	16,029	21,996
Total	5,219	8,276	16,687	22,578	27,480	26,367
Oceania: Australia	982	645	548	96	373	21
World total (estimate)	760,000	930,000	1,120,000	1,300,000	1,340,000	1,300,000

[1] This table incorporates a number of revisions of data published in previous Fluorspar chapters.
[2] Estimate.
[3] Data not available; estimate by author of chapter included in total.
[4] Average for 1947–49.
[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 1946–49.

Almost all of the fluorspar produced in Canada was mined in Newfoundland by St. Lawrence Corp. of Newfoundland, Ltd., and Newfoundland Fluorspar, Ltd. St. Lawrence operated 4 properties, with its Iron Springs mine supplying about 34 percent of the total output. All output was treated at the company mill about 1 mile west of St. Lawrence. Production in 1954 totaled 55,713 short tons of a submetallurgical-grade product, all of which was exported to Wilmington, Del., for further concentration at a flotation mill operated by St. Lawrence Fluorspar Corp., an affiliated company. Operations of these two companies and recent expansion programs in Newfoundland and at Wilmington were discussed at the fluorspar symposium conducted at the annual meeting of the AIME.[28] The St. Lawrence Corp. of Newfoundland, Ltd., modernized its mill by removing the jigging section and replacing it with a double drum separator heavy-medium separation plant. At Wilmington, Del., St. Lawrence Fluorspar Co. completed installing a 300-ton-per-day flotation mill. Newfoundland Fluorspar, a subsidiary of the Aluminum Co. of Canada, operated the Director mine and sink-float plant about 1½ miles west of St. Lawrence. Output in 1954 totaled 52,249 tons of submetallurgical grade (75 percent CaF_2), all of which was shipped to Arvida, Quebec, for further concentration by flotation. The geology

[28] Seibert, W. E., Jr., New Fluorspar Milling at St. Lawrence, Newfoundland, and Wilmington, Del.: Unpublished paper presented at Fluorspar Symposium, AIME, Industrial Minerals Division, February 1954.

of the Newfoundland fluorspar deposits, mining operations, and beneficiation processes employed were described in an article.[29]

In Ontario the Kilpatrick mine of Huntingdom Fluorspar Mines, Ltd., produced a small tonnage of fluorspar from a deposit about 1 mile southwest of Madoc.[30] Other deposits of fluorspar in Canada were listed in Ross Township, Renfrew County, Ontario; Huddersfield Township, Pontiac County, Quebec; in the Lake Ainslie district, Cape Breton Island, Nova Scotia; and near Grand Forks, British Columbia. A reportedly extensive occurrence of fluorite in association with witherite, barite, and quartz was reported located in 1953 at Lower Liard Crossing in Northern British Columbia and was being explored by Conwest Exploration Co., Ltd.

Mexico.—Mexico continued to be the leading foreign supplier of fluorspar to the United States, exporting a total of 134,700 tons to this country in 1954 (see table 13). Production in Mexico was estimated at about 146,000 tons compared with 173,000 tons in 1953. A bulletin describing the Mexican fluorspar industry was published by the Government of Mexico.[31] A history of the industry, data on exploration, mining and milling, taxes, and freight rates, and descriptions of many of the deposits are included. Fluorspar deposits in several States are described, including deposits in Chihuahua, Coahuila, Durango, Guerrero, Mexico, Zacatecas, San Luis Potosi, Sonora, and others.

A new deposit of fluorspar was reported discovered near the end of 1953 about 60 kilometers south of the city of San Luis Potosi, near a village called Saliterera.[32] Development in 1954 was said to have established the discovery as a major source of metallurgical-grade fluorspar. The fluorspar occurs in lenses up to 8 meters in width and 100 meters in length, in decomposed volcanic rock, in or near 2 faults, each trending N. 70° W., which have dropped Tertiary volcanics against Cretaceous limestone. Mining in 1954 by open-pit methods was reported. The ore, described as fine-grained, could be concentrated to 90 percent CaF_2 by screening and sorting, but attempts to achieve further concentration by flotation were unsuccessful. Narrow veins of fluorspar in volcanic rock also were reported discovered near the village of Paso Las Lligaras, about 75 kilometers south-southeast of San Luis Potosi. Activities in northern Mexico were described as quiet. However, flotation plants operated by the American Smelting & Refining Co. at Agujita, Coahuila, and Fluorita de Mexico, at Muzquiz, Coahuila, operated steadily throughout the year.

SOUTH AMERICA

Brazil.—Intermittent production of fluorspar from small deposits in northeast Brazil and in Minas Gerais, principally for consumption at the national steel mill, was reported.[33] According to a news bulletin, output of fluorspar in northeast Brazil was 1,100 metric tons in 1952. Another report stated that about 2,000 tons of high-grade

[29] Carr, G. F., Newfoundland Fluorspar: Canadian Min. and Met. Bull., vol. 47, No. 502, February 1954, pp. 81-85.
[30] Work cited in footnote 27.
[31] Prado, Jose Jesus, La Fluorite: Instituto Nacional Para da Investigacion de Recursos Minerales, Bol. 1-E, 1954, 87 pp.
[32] Gillson, J. L., Industrial Minerals in 1954: Min. Cong. Jour., vol. 41, No. 2, February 1955, pp. 105-106.
[33] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 3, September 1954, p. 54.

fluorspar had been mined at Campo Alegre, Bahia, by the end of 1954 but that costs were higher than the price of imported fluorspar.[34]

EUROPE

France.—A series of articles reviewed the fluorspar industry in France during the period 1950–53.[35] The following 10 mines were reported in production at the end of 1953. Operations at each of these mines were described, and a brief discussion of the geology of the deposits was included. Information also was reported on other mines and prospects worked intermittently during the period. According to the author, a vein of fluorspar 4 meters wide was discovered in March 1953 at Coutery, Paulinet Commune, in the fluorspar district of St. Jean-de-Jeannes. Reportedly the deposit has been proved to a depth of 40 meters for length of 200 meters. It was reported that a production rate of 10 tons per hour was possible and by the end of December 1953, 1,820 tons of 90 percent fluorspar had been shipped and 275 tons of the same grade stockpiled at the station St. Juery.

Deposit	*Commune*	*Department*	*Producer*
Voltennes	La Petite Verriere	Saône-et-Loire	M. L. de Champeaux
Le Beix	Saint Germain Pres. Herment	Puy-de-Dôme	Établissements Teisset Kessler
Les Sauces	Chavanide-Lafayette	Haute-Loire	Veuve A. Delabre
La Barlet	Langeac	Do.	Compagnie Pechiney
Costes Bois Marsange	Do.	Do.	M. Lebrat
Le Kaymar	Pruines	Aveyron	M. Campanac
Saint-Laurent-les-Bains	Saint-Laurent-les-Bains	Ardeche	Société Française du Spath-Fluor
Saint-Jean-de Jeannes	Paulinet et Rayssac	Tarn	Société d'Électrochimie, d'Électrométallurgie et des Aciéries Électriques d'Ugine
En Bournegeade	Curvalle-Plaisance	Do.	Société-Minière d'Alban
Font Sante	Tanneron	Var	Société d'Entreprises, Carrières et Mines de l'Esterel (S. E. C. M. E.)

Italy.—Production of fluorspar totaled 85,000 short tons in Italy in 1954, a slight decrease compared with output in 1953 (see table 18). According to official statistics, exports in 1954 totaled 45,761 short tons valued at 1,063,846,000 lire, of which 39,578 tons valued at 925,585,000 lire went to the United States, 3,443 tons valued at 75,414,000 lire to West Germany, and the remainder to other countries (625 lire equals US$1.00).

Spain.—Construction of a sink-float plant in the Pyrenees was scheduled to begin in December[36] as part of a reported $1 million

[34] Mining Journal (London), vol. 244, No. 6231, Jan. 21, 1955, p. 68.
[35] Chermette, A., Le Spathfluor Francais au cours de la period 1950–53, L'Echo des Mines et de la Metallurgie (Paris), No. 3469, June 1954, pp. 389–398; No. 3470, July 1954, pp. 457–463; No. 3471, August 1954, pp. 525–529; No. 3472, September 1954, pp. 599–601; No. 3473, October 1954, pp. 679–680; No. 3474, November 1954, pp. 763–765.
[36] Engineering and Mining Journal, vol. 155, No. 12, December 1954, p. 166.

development program by Fluoruros S. A., a leading fluorspar producer in Spain. The Southwestern Engineering Co., Los Angeles, Calif., was awarded the contract to install the mill, which has a daily planned capacity of 400 tons. The development program was financed in part by a $400,000 Export-Import Bank loan. Efforts were made to encourage exportation of Spanish fluorspar to the United States during the year. In September the export exchange rate for fluorspar was changed from 30.65 pesetas to the U. S. dollar to 37.65 pesetas to the U. S. dollar,[37] and in October exports of fluorspar were exempted from the 3-percent ad valorem mine production tax.[38] Spain has been a major supplier of fluorspar to the United States for several years.

AFRICA

Rhodesia.—Output of fluorspar, all from Southern Rhodesia, totaled 120 short tons valued at £937 in 1954, compared with 373 tons valued at £2,191 in 1953.[39]

CRYOLITE

The only known commercial-size deposit of cryolite is at Ivigtut, Greenland, although minor noncommercial occurrences have been reported in the St. Peter's Dome District, Colo., at Miask in the Urals, and in Canada.[40] Synthetic cryolite was produced in the United States at East St. Louis, Ill., by Aluminum Co. of America, and at Bauxite, Ark., by Reynolds Metals Co. These two companies and the Kaiser Aluminum & Chemical Co. also recovered cryolite from scrap linings of aluminum-reduction cells.

Imports of cryolite for 1945 through 1954 are shown in table 19. The import statistics do not distinguish between natural and synthetic cryolite, but it is believed that virtually all of the shipments from countries other than Greenland was synthetic cryolite. Natural cryolite from Greenland was imported into the United States in crude form and processed by the only importer, the Pennsylvania Salt Manufacturing Co., at its Natrona, Pa., flotation mill.

Exports of cryolite in 1954 totaled 86 short tons valued at $24,400. Most of the exports went to Canada and Mexico, smaller quantities being shipped to Brazil, Indonesia, and Union of South Africa.

[37] U. S. Department of Commerce, Foreign Commerce Weekly: Vol. 52, No. 13, Sept. 27, 1954, p. 12.
[38] U. S. Department of Commerce, Foreign Commerce Weekly: Vol. 52, No. 22, Nov. 29, 1954, p. 14.
[39] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 2, August 1955, p. 37.
[40] Mudd, H. T., Fluorspar and Cryolite chapter, Industrial Minerals and Rocks: AIME, 1949, p. 398.

TABLE 19.—Cryolite imported for consumption in the United States, 1950–54, by countries, in short tons

[U. S. Department of Commerce]

Country	1950			1951		
	Short tons	Value		Short tons	Value	
		Total	Average		Total	Average
Belgium-Luxembourg	110	$15,500	$140.91			
Canada						
Denmark				110	$3,615	$32.86
France						
Germany, West				[1] 66	[1] 15,080	[1] 228.48
Greenland [2]	17,024	962,675	56.55	38,675	2,171,428	56.15
Italy						
Total	17,134	978,175	(3)	38,851	2,190,123	(3)

Country	1952			1953			1954		
	Short tons	Value		Short tons	Value		Short tons	Value	
		Total	Average		Total	Average		Total	Average
Belgium-Luxembourg									
Canada	103	$19,585	$190.15						
Denmark				245	$13,430	$54.82	542	$33,174	$61.21
France				2,203	498,008	226.06	219	52,475	239.61
Germany, West	667	151,854	227.67	6,743	1,536,889	227.92	5,125	1,201,026	234.35
Greenland [2]	36,922	2,778,869	75.26	19,398	1,297,239	66.87	13,652	580,688	42.54
Italy	681	174,493	256.23	868	182,582	210.35	1,603	348,524	217.42
Total	38,373	3,124,801	(3)	29,457	3,528,148	(3)	21,141	2,215,887	(3)

1 Classified by U. S. Department of Commerce as Germany.
2 Crude natural cryolite.
3 Cryolite statistics do not show separately crude natural cryolite, refined natural cryolite, and synthetic cryolite; consequently, the average value of total imports has no significance.

The state-owned cryolite company in Greenland was reported to have begun extensive investigations to find new deposits and to determine whether cryolite of lower quality in the old mines can be beneficiated into marketable material by modern methods.[41] According to the report, the deposit was expected to be exhausted in about 10 years.

41 Engineering and Mining Journal, vol. 155, No. 11, November 1954, p. 182.

Gem Stones

By John D. McLenegan,[1] George Switzer,[2] and Eleanor V. Blankenbaker[3]

GEM-STONE production in the United States in 1954 continued to depend upon the efforts of amateur collectors to provide cuttable material. A few small companies operated deposits, chiefly for turquois, opal, tourmaline, and jade.

Because only a small percentage was mined on a commercial scale, complete statistics were not compiled on the value of the domestic output of gem stones. The value of the crude uncut stone was estimated at $600,000 to $700,000.

The many forms of quartz, such as agate, jasper, and petrified wood, composed the largest output, with kunzite second, jade third, and turquois fourth. California, Texas, Oregon, Washington, and Wyoming were the chief producing States.

The gem-stone collecting and cutting hobby continued to increase in 1954, particularly in central and eastern United States. An increased number of amateur rock collectors was in the field in the Western States; however, many focused their attention on uranium prospecting instead of the collection of gem stones.

DOMESTIC PRODUCTION

The reported sources of gem materials in the United States in 1954 are listed in table 1. The principal gem-stone production, in areas where more detailed information was obtained, is given as follows:

Agate.—Production of agate in Montana increased in 1954. Of the reported $20,000 production, about half was scenic and banded agate from the Yellowstone River. The remainder was moss agate and lower grade banded material.

The value of Oregon agate produced in 1954 approximated $12,000. Plume thunder-egg agate from 20 miles north of Madras, Oreg., ranged in price from $0.50 to $10 per square inch of slab material.

Agate production valued at $5,000 was reported from the Alpine area of Brewster County, Tex., in 1954. The total agate production in the State was considered to be greater in 1954 than in any previous year.

Gravels in Imperial County, Calif., produced several varieties of agate. The value of this material, combined with that from the Hauser geode beds in the northern part of the county, was about $5,000 in 1954. Riverside County production was reported to be approximately 1 ton of rough agate valued at $400.

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[1] Commodity-industry analyst.
[2] Smithsonian Institution; consulting mineralogist to the Bureau of Mines.
[3] Literature-research clerk.

TABLE 1.—Localities in the United States where gem materials were reported to have been found in 1954

State	County	Locality	Gem material
Alaska	1st Judicial division	Baranof (southeast Alaska)	Petrified wood and agate.
Do	4th Judicial division	Circle	Jade.
Do	2d Judicial division	Kobuk River on the north	Do.
Do	do	Noatak River	Jasper.
Arizona	Apache		Petrified wood.
Do	do	Fort Defiance	Pyrope garnet.
Do	Gila		Obsidian.
Do	do	Globe (Salt River Canyon)	Serpentine.
Do	do	Globe-Miami area	Chalcedony, turquois, garnet, amethyst, agate, and apache tears (volcanic glass).
Do	do	Miami	Turquois.
Do	do	San Carlos Reservation	Peridot.
Do	Greenlee		Obsidian.
Do	do	Morenci	Shattuckite and turquois.
Do	Maricopa	Cave Creek	Plume agate and jasper.
Do	do	Four Peak Mountain	Amethyst.
Do	do	New River	Plume agate.
Do	do	Saddle Mountain	Fire agate.
Do	Maricopa and Yavapai.	Agua Fria River	Jasper.
Do	Maricopa and Yuma	Gila River	Agate.
Do	Pima	Ajo	Shattuckite.
Do	Pinal	Florence	Chalcedony.
Do	do	Superior	Obsidian.
Do	Yavapai	Mayer	Calcite onyx.
Do	Yuma		Dumortierite and shattuckite.
Do	do	Yuma	Garnet, petrified wood, jasper, agate, chalcedony (desert roses) and turquois.
Arkansas	Garland	Hot Springs	Quartz crystal and novaculite.
Do	Montgomery		Quartz crystal.
California	Alameda	Berkeley hills	Agate.
Do	Alpine	Markleeville	Do.
Do	Calaveras	Valley Springs	Chalcedony.
Do	El Dorado	Placerville	Idocrase, vesuvianite, and garnet.
Do	Humboldt	Along ocean	Agate, petrified wood, jasper, and jade.
Do	Imperial	Midway Well	Opal.
Do	do	Ogilby	Petrified palm root.
Do	do	Picacho Peak	Agate.
Do	do	Salton Sea area	Desert roses.
Do	Inyo	Bigpine	Quartz crystal.
Do	do	Bishop	Garnet.
Do	do	Death Valley (Wingate Pass).	Agate.
Do	do	Independence	Turquois.
Do	Kern	Boron	Agatized wood.
Do	do	Mojave	Petrified palm and agate.
Do	do	Rosamond	Rhodonite.
Do	Los Angeles	Los Angeles	Agate.
Do	do	Newhall	Do.
Do	do	Randsburg area	Agate and rhodonite.
Do	do	Rosemead (Gem Hill)	Do.
Do	Marin	Bolinas Bay	Agatized whalebone.
Do	Mendocino	Covelo	Jade.
Do	do	Eel River (Round Valley)	Jasper and jade.
Do	Monterey	Monterey	Jade (nephrite), serpentine, and rhodonite.
Do	Nevada	Nevada City	Opalized wood.
Do	do	North Bloomfield	Opal.
Do	Riverside	Coon Hollow (Wiley Well)	Agate.
Do	do	Hemet	Agate and jasper.
Do	do	Midland	Rhodonite crystals and spinel.
Do	do	Sage	Rubellite.
Do	Sacramento	Folsom	Opal and agate.
Do	do	Sacramento	Jade (nephrite).
Do	San Benito		Benitoite crystals.
Do	do	New Idria	Jadeite.
Do	San Bernardino	Needles	Agatized wood.
Do	do	San Bernardino	Rhodonite.
Do	do	Yermo (Calico Mountains or Mule Canyon).	Agatized palm.
Do	San Diego	Himalaya mine (Mesa Grande).	Tourmaline.
Do	do	Pala	Kunzite, spodumene, tourmaline and lepidolite.
Do	San Luis Obispo	Nipomo	Sagenite and agate.
Do	Siskiyou	Happy Camp	Jade (nephrite) and californite.
Do	Solano	Fairfield	Travertine onyx.

TABLE 1.—Localities in the United States where gem materials were reported to have been found in 1954—Continued

State	County	Locality	Gem material
California	Trinity	Trinity River	Jade.
Do	Tulare	Porterville	Jade and chrysoprase.
Colorado	Fremont	Canon City	Agate and onyx.
Do	Mineral		Jasper and petrified wood.
Do	Rio Grande		Agate and petrified wood.
Do	Saguache	Villa Grove-Turquoise mine.	Turquois and lazulite.
Do	Teller	Florissant	Jade.
Do	Weld	Stoneham	Petrified wood, barite crystals, and agate.
Connecticut	Middlesex	Gillette Quarry (Haddam Neck).	Tourmaline.
Florida	Hillsborough	Tampa Bay (Ballast Point).	Agatized coral.
Do	Pinellas	St. Petersburg	Agatized ancient shark bone.
Georgia	Troup	La Grange	Aquamarine.
Idaho	Benewah	Emerald Creek	Garnet.
Do	Owyhee	Homedale	Agate and jasper.
Illinois	Hancock	Hamilton	Geodes.
Do	do	Nauvoo	Do.
Iowa	De Moines	Burlington	Do.
Do	Fremont		Fossils.
Do	Henry	New Lincoln	Agate, jasper, and petrified wood.
Do	Lee	Keokuk	Geodes.
Do	Page	Clarinda	Agate.
Kansas	Cherokee	Galena	Marcasite and sphalerite.
Do	Wyandotte	Kansas City	Agate.
Louisiana	Vernon (Parish)	Hornbeck	Opalized and petrified wood.
Maine	Androscoggin	Livermore	Cinnamon garnet.
Do	Oxford	Albany	Rose quartz.
Do	do	Kezar Lake	Amethyst.
Do	do	Newry	Rose quartz.
Do	do	Norway	Tourmaline.
Do	do	Stoneham	Smoky quartz.
Do	do	Stow	Amethyst.
Maryland	Allegany	Frostburg	Siderite and barite crystals.
Do	Baltimore	Powder Mill Conversion Tunnel (Baltimore City).	Quartz, garnet, tourmaline, and serpentine.
Do	do	Texas	Calcite crystals.
Do	do	White Marsh	Jasper and quartz.
Do	Garrett	State Line	Williamsite, rhodochrome, picrolite, and serpentine.
Do	Montgomery	Chain Bridge vicinity	Placer gold.
Michigan	Emmet	Petoskey	Agate, devonion fossils, and Peto skey stones (coral fossils).
Do	Houghton	Houghton	Agate.
Do	Keweenaw	Ahmeek	Domeykite (metal with quartz).
Do	do	Eagle Harbor	Agate, datolite, and thomsonite.
Do	do	Five Mile Point to Keweenaw.	Agate, thomsonite, and chlorastrolites.
Do	do	Mohawk	Domeykite (metal with quartz)
Do	Marquette	Ishpeming	Jasper and jaspilite.
Do	do	Marquette	Jasper.
Do	do	Negaunee	Do.
Do	do	Republic	Jasper and jaspilite.
Do	Ontonagon	Mass	Datolite, malachite, and tenorite
Do	do	Silver City	Agate.
Minnesota	Cook	North shore of Lake Superior.	Thomsonite.
Do	do	Paradise Beach	Agate.
Do	Lake	Beaver Bay	Agate and thomsonite.
Do	St. Louis	Duluth	Agate.
Missouri	Bollinger		Agate and jasper.
Do	Cape Girardeau		Do.
Do	Clark	Wayland	Geodes.
Do	Crawford	Cherry Valley mine (near Steelville).	Amethyst.
Do	Franklin	Ruepple mine (near Stanton).	Do.
Do	Jackson		Do.
Do	Lewis	La Grange	Agate.
Do	Madison		Agate and jasper.
Do	St. Louis	St. Louis	Geodes, agate, barite, and galena.
Do	Wayne		Agate and jasper.
Montana	Beaverhead		Quartz.
Do	do	Camp Creek	Corundum.
Do	Custer	Miles City	Agate.
Do	Dawson	Glendive	Do.
Do	Deer Lodge	Oro Fino-Dry Cottonwood district.	Sapphire.
Do	Gallatin	Bozeman	Corundum.

TABLE 1.—Localities in the United States where gem materials were reported to have been found in 1954—Continued

State	County	Locality	Gem material
Montana	Granite	Phillipsburg	Sapphire.
Do	do	Rock Creek	Do.
Do	Jefferson	Bernice	Barite.
Do	do	Boulder Basin district	Tourmaline.
Do	do	Toll Mountain, R. S	Amethyst.
Do	Judith Basin	Yogo Gulch	Sapphire.
Do	Lewis and Clark	Helena	Do.
Do	Madison	Cliff Lake	Serpentine.
Do	do	Ennis	Garnet.
Do	do	Granite Creek	Pegmatite.
Do	do	Mill Canyon	Tourmaline.
Do	do	Renova	Orthoclase crystal.
Do	do	Rochester	Quartz crystal.
Do	do	Sheridan	Pegmatite.
Do	do	Silver Star	Jasper.
Do	do	South Boulder Creek	Quartz.
Do	do	Sweetwater Creek	"Montana onyx."
Do	do	Virginia City	Garnet.
Do	Park	Carbella	Petrified wood, amethyst, and fairy stones.
Do	do	Clyde Park	Iceland spar.
Do	do	Gardiner	Petrified wood and travertine
Do	do	Jardine	Arsenopyrite.
Do	do	Livingston	Petrified wood.
Do	do	Springdale	Iceland spar.
Do	do	Yellowstone Valley	Garnets.
Do	Powell	Elliston	Agate.
Do	do	Lost Creek Falls	Amazonstone.
Do	Prairie	Fallon	Agate.
Do	Ravalli	Rye Creek	Fluorite.
Do	Rosebud	Forsyth west to Sidney	Agate.
Do	Silver Bow	Browns Gulch	Sapphire.
Do	do	Butte	Amethyst.
Do	do	Highlands	Epidote and garnet.
Do	do	Nissler	Fluorite.
Do	Yellowstone	Billings	Agate.
Do	do	Custer	Agate and jasper.
Nebraska	Sioux	Orella	Chert.
Nevada	Humboldt	Rainbow Ridge mine (Virgin Valley).	Opal and rhodonite.
Do	Lander	Battle Mountain	Turquois.
Do	Lincoln	Fish Lake Valley	Agatized wood.
Do	White Pine	Ely	Garnet.
New Hampshire	Carroll	Conway	Topaz, smoky quartz, and amethyst crystals.
Do	do	Passaconaway	Topaz and smoky quartz.
Do	Coos	Stark	Smoky quartz and amethyst.
New Jersey	Morris	Montville	Serpentine.
Do	do	Stirling	Carnelian.
Do	Passaic	Paterson	Prehnite.
Do	do	Prospect Park	Prehnite, agate, and amethyst.
Do	Sussex	Franklin	Willemite, garnet, rhodonite, and friedelite.
Do	do	Sparta	Ruby corundum.
New Mexico	Luna	Deming	Agate.
Do	Rio Arriba	La Madera	Dumortierite, pink and green feldspar, and blue-green beryl.
Do	Sierra	Elephant Butte Lake	Petrified wood.
Do	do	Engle	Petrified wood and agate.
New York	Warren	Barton mine (North River)	Garnet.
Do	do	North Creek	Do.
North Carolina	Alexander		Hiddenite.
Do	Avery	Cranberry Iron mine	Epidote.
Do	Buncombe	Goldsmith mine (Democrat)	Moonstone.
Do	Burke		Amethyst.
Do	Haywood	Emerald mine (Crabtree Mountain).	Emerald.
Do	Macon	Corundum Hill	Ruby and sapphire.
Do	Mitchell	Geo. Howell mine	Oligoclase.
Do	do	McKinney mine	"Moonglo" and "sunstone."
Do	do	Roan Mountain	Moonstone, epidote, and unakite.
Do	Rutherford		Emerald.
Do	Warren		Amethyst.
Do	Yancey	Little Gibbs mine	Oligoclase.
Do	do	Ray mine	Emerald.
North Dakota	Adams		Agatized wood.
Oklahoma	Dewey	Seiling	Jasper, agatized wood, jaspagate, agate, denderite, chalcedony, and jadite.
Do	do	Taloga	Do.
Do	Major	Fairview	Do.

TABLE 1.—Localities in the United States where gem materials were reported to have been found in 1954—Continued

State	County	Locality	Gem material
Oregon	Baker	Greenhorn	Tempskya (agatized fern).
Do	do	Huntington	Agate and jasper.
Do	Coos	Bandon	Fossil wood.
Do	Crook	Eagle Rock bed	Agate.
Do	do	Lucky Strike bed	Moss agate.
Do	do	Ochoco bed	Agate.
Do	do	Post	Do.
Do	Deschutes	Hampton	Jasp-agate.
Do	do	Terrebonne	Thunder eggs and agate.
Do	Douglas	Sutherlin	Agate.
Do	do	Yoncalla	Do.
Do	Grant	Galena	Agate and petrified wood.
Do	do	Meadow Creek	Agate, petrified wood, and jasp-agate.
Do	Harney	Burns	Agate.
Do	Jackson	Eagle Point and Butte Falls	Petrified wood, opalized and agatized wood, jasper, jasp-agate, bloodstone, and rhodonite.
Do	Jefferson	Ashwood	Opal.
Do	do	Gateway	Agate.
Do	do	Madras	Agate and thunder eggs.
Do	do	Pony Butte bed	Agate.
Do	Lake	Glass Buttes bed	Obsidian.
Do	do	Lakeview	Thunder eggs.
Do	do	Plush (Hart Mountain)	Opal.
Do	Lane	Crooked River at Bear Creek.	Agatized petrified wood.
Do	Lincoln	Agate Beach	Agate, bloodstone, sardonyx, jasper, jasp-agate, agatized coral, petrified wood, and fossil bone.
Do	do	Yachats	Agate, jasper agatized wood, and sagenite.
Do	Malheur	Nyssa	Thunder eggs.
Do	do	Sucker Creek	Agate.
Do	Morrow	Peter's Butte (Opal Butte)	Thunder eggs and agate.
Do	Wasco	Antelope	Chalcedony, jade, sagenite, agate, jasper, bloodstone, geodes, amethyst crystals, and quartz.
Do	Wheeler	Clarno bed (fossil)	Agate.
Pennsylvania	Adams	Greenstone	Cuprite.
Do	Bedford		Quartz, calcite, and spar.
Do	do	New Enterprise	Quartz, calcite, and flint.
Do	do	Salemville	Quartz.
Do	do	Waterside	Spar, quartz, calcite, and flint.
Do	Somerset	Confluence	Smoky quartz.
Do	Westmoreland		Petrified wood and flint.
South Carolina	Chesterfield	Jefferson (Old Brewer gold mine).	Topaz.
South Dakota	Custer	Black Hills	Rose quartz.
Do	do	Custer	Agate, tourmaline, and rose quartz.
Do	do	Fairburn	Breccia and agate.
Do	Fall River	Minnekahta	Agatized wood.
Do	Lawrence	Deadwood area	Garnet and rose quartz.
Do	Pennington	Quinn	Jasp-agate, chert, chalcedony, and agate.
Do	do	Scenic	Chalcedony.
Do	do	Sheep Mountain	Do.
Do	Pennington and Shannon.	Bad Lands	Agate, jasper, and petrified wood.
Do	Shannon	Pine Ridge	Chert.
Tennessee	Carter	Shell Creek	Unakite.
Texas	Brewster	Alpine	Jasper, agate, labradorite, opal, and amethyst.
Do	do	Marathon	Agate and novaculite.
Do	do	Terlingua	Agate, jasper, agatized and jasperized wood.
Do	Burnet	Marble Falls	Garnet and topaz.
Do	Culberson	Van Horn	Agate.
Do	Duvall	Freer	Do.
Do	Fayette	Carmine	Petrified, agatized, and opalized wood.
Do	do	Flatonia	Do.
Do	Gillespie	Fredericksburg	Petrified, agatized, and opalized wood, garnet, and topaz.
Do	Hudspeth	Sierra Blanca	Agate.
Do	Jeff Davis	Fort Davis	Agate and adularia (moonstone).
Do	Live Oak	George West	Agate and petrified wood.
Do	Llano	Llano	Garnet and topaz.

TABLE 1.—Localities in the United States where gem materials were reported to have been found in 1954—Continued

State	County	Locality	Gem material
Texas	Mason		Topaz, smoky quartz, amazonite, and cassiterite.
Do	do	Streeter	Topaz.
Do	McMullen	Tilden	Petrified, agatized, and opalized wood.
Do	Presidio	Marfa	Agate.
Do	Reeves	Balmorhea	Agate, onyx, and sardonyx.
Do	Terrell	Sanderson	Agate.
Do	Walker	Huntsville	Petrified, agatized, and opalized wood.
Do	Webb	Laredo	Agate and jasper.
Do	Zapata	Zapata	Do.
Do	Brewster, Presidio, Jeff Davis, Pecos, and Reeves.	Big Bend area	Agate, carnelian, petrified wood, jasper, jasp-agate, moonstone, chalcedony, opal, amethyst, and citrine.
Utah	Beaver		Petrified wood.
Do	do	Blue Valley (Beaver)	Agate.
Do	do	Milford	Quartz crystals.
Do	Emery		Petrified wood.
Do	do	Green River	Agate.
Do	Garfield	Escalante	Agatized wood.
Do	do	Henry Mountains	Barite nodules.
Do	Grand		Petrified wood and agate.
Do	Juab	Jericho	Agate.
Do	do	Levan	Do.
Do	do	Thomas Range	Topaz.
Do	Millard	Black Rock	Obsidian.
Do	do	Kanosh	Do.
Do	Salt Lake	Murray	Onyx.
Do	Sevier	Salina	Agate.
Do	Washington	Hurricane	Do.
Do	do	St. George	Do.
Do	Wayne	Fruita	Barite nodules.
Virginia	Amelia	Amelia Court House	Amazonite.
Do	Madison	Syria	Unikite.
Do	Page	Ida	Jasper.
Do	Rockbridge	Vesuvius	Unikite.
Washington	Chelan	Wenatchee	Thulite.
Do	Douglas	Bridgeport	Thulite and jadeite.
Do	Kittitas	Ellensburg	Petrified wood and jasper.
Do	do	Vantage	Petrified wood.
Do	Klickitat	Lyle	Agatized and opalized wood, jasper, and agate.
Do	Snohomish	Roosevelt	Petrified, agatized, and opalized wood.
Do	Yakima	Saddle Mountain area	Do.
Do	do	Sunnyside	Do.
Do	do	Yakima	Petrified wood.
Wisconsin	Clark		Agate and jasper.
Do	Ashland, Bayfield, Douglas, and Iron.	Lake Superior area	Agate.
Wyoming	Albany	Marshall area	Petrified, agatized, and opalized wood, and agate.
Do	Carbon	Leo	Jade.
Do	do	Medicine Bow	Do.
Do	do	Rawlins	Do.
Do	Fremont		Rhodonite.
Do	do	Lander	Agate, jade, and jade (nephrite).
Do	Natrona		Amazon stone.
Do	do	Casper	Agate.
Do	Sweetwater	Eden Valley	Territilla (agatized snails), jade, agate, and petrified wood.
Do	do	Farson	Petrified and agatized wood, jade, jasper, agate, and chalcedony.
Do	do	Granger	Agate.
Do	do	Green River	Agatized wood, agate, jasper and corundum.
Do	do	Wamsutter	Territilla (agatized snails) and agate.

Several tons of plume agate, worth $5 a pound in some instances, was produced in Maricopa County, Ariz. Production from the Saddle Mountain area, Pinal and Graham Counties, in 1954, was estimated to be somewhat larger than in 1953.

About 100 tons of rough agate of undetermined value was produced from the agate fields near Deming, Luna County, N. Mex. Agatized fossils, valued at about $2,000, were found on the shores of Lake Superior, Mich.

Jade.—Production of jade in Wyoming was about 50 tons in 1954. It was mostly dark olive but included pink and green, pink, and some dark green varieties. Gem-quality, apple-green and black jade were scarce and high priced. Apple-green jade retailed at $40 to $100 per pound, good black at $10 per pound, and other varieties at $5 per pound.

Alaskan jade production in 1954 amounted to an estimated value of about $10,000, mostly from the Shungnak district in the Northwestern Alaskan region. There was increased interest in the jade industry, due to the success of the Indian Arts and Crafts Board, which utilized jade from the deposits near Shungnak to produce finished jewelry.

Topaz.—Production of topaz from the Streeter-Kotempsie area of Mason County, Tex., continued in 1954. An estimated 8,000 grams of this gem material, valued at $4,200, was found, principally by amateur lapidarists.

Tourmaline.—A pocket of gem-green tourmaline containing an estimated 10,000 carats valued at $20 to $100 a caret was discovered at Norway, Maine. A 23-carat emerald-green stone was the largest cut from the material.

Turquois.—Two hundred pounds of turquois from the Villa Grove area, Saguache County, Colo., was produced in 1954. This was mostly high-grade material valued at $20 to $100 per pound. The Royal Blue Mines Co., formerly operated by Lee F. Hand of Battle Mountain, Nev., was operated by the new owner, Wendall King. Production in 1954 was not reported, although it was estimated to be about the same as in 1953. Gila County, Ariz., reported about the same production of chalk-grade turquois as in 1953. Total Arizona production of turquois in 1954 was valued at about $13,000.

Other Natural Gem Stones.—About 600 tons of opalized wood was produced in Yakima County, Wash., from the prehistoric shoreline of Lake Bonneville. Limb sections ½ inch to 3 inches in diameter and up to 6 inches long retailed for about $2 per pound. Minnesota reported the production of thomsonite valued at $3,000 in 1954. The use of gem material in the St. Paul-Minneapolis area increased about 200 percent during the year owing in part to the increased use of tumblers to polish rough stone, which previously was unused because of slow methods of finishing. The polished stone was marketed in baroque form. Production of 1,300 pounds of aquamarine was reported from Troup County, Ga., mostly for markets in Ohio. The Idaho production of moss agate, opal, thunder eggs, and garnet had a retail value of about $3,000. About 500 pounds of gem quality and over 2 tons of specimen quartz crystal was reported mined at Crystal Springs, Ark. About 5 tons of onyx valued at $1,500 in the rough was mined in Utah County, Utah.

A deposit in Arizona of serpentine containing chrysolite was discussed as to location and occurrence in the Mineralogist.[4]

Details on a deposit of onyx in California were published in the Mineralogist.[5]

The use of tempskya, a petrified palm root, as a gem material was reported from Pasco, Wash. The only reported occurrence of this material in the United States is the old "Chinese diggings" near the former town of Greenhorn in the southwestern part of Baker County, Oreg. Total production through 1954 was estimated at 8 tons and valued up to $2 per pound.[6]

Synthetic Gems.—Diamonds were synthesized in 1954 by the General Electric Co., Schenectady, N. Y., although the accomplishment was not announced until February 15, 1955.

Of fundamental importance to success of the project was development of a vessel that could be operated at pressures up to at least 1,500,000 pounds per square inch and temperatures about 5,000° F. and the ability to maintain these pressure-temperature conditions simultaneously for long periods. Details of the design of the pressure vessel were not revealed.[7]

A new synthetic spinel closely resembling lapis lazuli was produced in Idar-Oberstein, Germany. The stones could be differentiated from natural lapis lazuli by X-ray powder photographs or observation under a Chelsea color filter. Genuine lapis lazuli has specks of iron pyrite that usually can be detected at some point on the surface. The makers of lapis-colored spinel can provide the stones with specks of gold if so desired, in which instance pyrites (fool's gold) would indicate the genuine stone and gold would represent the imitation.[8]

The world's second largest synthetic emerald, weighing 1,014 carats, was added to the Smithsonian Institution's mineralogical collection. The crystal was produced by the Chatham Research Laboratories in San Francisco, Calif.[9]

CONSUMPTION

Total sales of diamonds and gem stones by retail dealers increased slightly in 1954 compared with 1953. Sales of gem and industrial diamonds during 1954 totaled approximately $182 million compared with $176 million in 1953. The proceeds realized from sales of diamonds effected through the Central Selling Organization on behalf of South African and other producers and diamonds drawn from stocks held by the Diamond Corp. were as follows: Gem diamonds, $127.6 million; industrial diamonds, $46.4 million; total, $174 million. Corresponding figures in 1953 were: Gem, $121 million; industrials, $49.9 million; total, $171 million.[10]

The rise in the sales of gem diamonds in 1954 more than offset the decline in sales of industrial diamonds.

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[4] Mineralogist, Arizona's Chrysolite Asbestos: Vol. 22, No. 6, September 1954, pp. 297-300.
[5] Mineralogist, California Onyx Location: Vol. 22, No. 3, March 1954, pp. 99-100.
[6] Gentzier, Joseph S., letter to Bureau of Mines, Mar. 10, 1955.
[7] Switzer, George, 30th Annual Report on the Diamond Industry, 1954: Jewelers' Circ.-Keystone, 1955, pp. 12-13.
[8] Anderson, B. W., A New Substitute for Lapis Lazuli: Gems and Gemology, vol. 8, No. 3, Fall 1954, pp. 88-89.
[9] Mineralogist, vol. 29, No. 5-6, May-June 1954, p. 244.
[10] Switzer, George, 30th Annual Report on the Diamond Industry, 1954: Jewelers' Circ.-Keystone, 1955, p. 3.

The consumption of semiprecious gem stones by amateur lapidarists increased in 1954. The chief factor in the increase was continued development of mechanical tumbling and faceting equipment. Commercial semiprecious gem cutters considered that the larger volume of their sales came from gem collectors rather than jewelry manufacturers.

PRICES

The first appreciable change in diamond prices since 1945 occurred in December 1954, when the Diamond Corp. announced a 2½-percent increase in the price of rough diamonds. This price increase was attributed to the unexpected high demand for gem stones in the United States.

United States excise tax on jewelry was reduced from 20 to 10 percent in April 1954.

FOREIGN TRADE [11]

Imports of gem stones into the United States increased in 1954 compared with 1953 (table 2). Because of changes in tabulating procedures by the United States Department of Commerce, the 1954 data were not comparable to those for earlier years. Diamonds ranked first, with 85 percent of the imports, based on value, followed by other precious and semiprecious stones, 12 percent; and pearls (natural and cultured), 3 percent.

TABLE 2.—Precious and semiprecious stones (exclusive of industrial diamonds) imported for consumption in the United States, 1953–54

[U. S. Department of Commerce]

Item	1953		1954	
	Carats	Value	Carats	Value
Diamonds:				
Rough or uncut (suitable for cutting into gem stones), duty-free	[1] 730,350	[1] $57,001,329	887,273	$59,428,768
Cut but unset, suitable for jewelry, dutiable	[1] 444,362	[1] 50,571,535	594,772	62,758,349
Emeralds:				
Rough or uncut, duty-free	15,561	27,987	(2)	(2)
Cut but not set, dutiable	26,952	320,739	24,460	385,063
Pearls and parts, not strung or set, dutiable:				
Natural		264,873		503,753
Cultured or cultivated		3,769,758		[3] 4,333,890
Other precious and semiprecious stones:				
Rough or uncut, duty-free		203,667		[2] [3] 265,837
Cut but not set, dutiable		2,218,868		[3] 1,848,989
Imitation, except opaque, dutiable:				
Not cut or faceted		40,720		[3] 37,902
Cut or faceted:				
Synthetic		677,029		[3] 283,302
Other		14,872,795		[3] 13,651,937
Imitation, opaque, including imitation pearls, dutiable		127,641		[3] [4] 35,014
Marcasites, dutiable:				
Real		94,813		61,073 (Real and Imitation)
Imitation		2,589		
Total		[1] 130,194,343		[3] 143,593,877

[1] Revised figure.
[2] Effective January 1, 1954, not separately classified; included with precious and semiprecious stones, rough or uncut.
[3] Due to changes in tabulating procedures by the U. S. Department of Commerce data known not to be comparable to earlier years.
[4] Due to changes in classifications data not strictly comparable to earlier years.

[11] 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.—Diamonds (exclusive of industrial diamonds) imported for consumption in the United States, 1953–54, by countries

[U. S. Department of Commerce]

Country	Rough or uncut			Cut but unset		
	Carats	Value		Carats	Value	
		Total	Average		Total	Average
1953						
North America:						
Bermuda	8,985	$502,677	$55.95	----	----	----
Canada	4,744	448,338	94.51	95	$88,241	$928.85
Dominican Republic	----	----	----	1	235	235.00
Mexico	----	----	----	165	10,239	62.05
Total	13,729	951,015	69.27	261	98,715	378.22
South America:						
Argentina	----	----	----	18	4,263	236.83
Brazil	398	99,448	249.87	34	8,722	256.53
British Guiana	2,307	83,958	36.39	30	2,847	94.90
Venezuela	51,779	1,587,872	30.67	3	745	248.33
Total	54,484	1,771,278	32.51	85	16,577	195.02
Europe:						
Belgium-Luxembourg	19,116	1,818,663	95.14	215,438	25,554,634	118.62
France	11,631	280,922	24.15	1,098	170,306	155.11
Germay, West	167	1,667	9.98	22,196	1,633,341	73.59
Italy	----	----	----	48	30,647	638.48
Netherlands	4,171	374,437	89.77	29,365	3,491,370	118.90
Switzerland	7,820	841,026	107.55	493	171,765	348.41
United Kingdom	524,826	47,625,107	90.74	3,271	526,641	161.00
Total	567,731	50,941,822	89.73	271,909	31,578,704	116.14
Asia:						
Hong Kong	----	----	----	1	93	93.00
India	----	----	----	2,974	52,853	17.77
Israel and Palestine	----	----	----	122,218	10,276,874	84.09
Japan	----	----	----	55	4,919	89.44
Malaya	560	65,162	116.36	----	----	----
Total	560	65,162	116.36	125,248	10,334,739	82.51
Africa:						
Belgian Congo	----	----	----	300	63,603	212.01
British West Africa	121	726	6.00	----	----	----
French Equatorial Africa	39,963	940,002	23.52	----	----	----
Gold Coast	450	4,219	9.38	----	----	----
Union of South Africa	[1] 53,312	[1] 2,327,105	[1] 43.65	[1] 46,556	[1] 8,477,426	[1] 182.09
Total	93,846	3,272,052	34.87	46,856	8,541,029	182.28
Oceania: Australia	----	----	----	3	1,771	590.33
Grand total 1953	[1] 730,350	[1] 57,001,329	[1] 78.05	[1] 444,362	[1] 50,571,535	[1] 113.81
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

[1] Revised figure.

TABLE 3.—Diamonds (exclusive of industrial diamonds) imported for consumption in the United States, 1953–54, by countries—Continued

[U. S. Department of Commerce]

Country	Rough or uncut			Cut but unset		
	Carats	Value		Carats	Value	
		Total	Average		Total	Average
1954—Continued						
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	31,619	1,721,853	54.46	46,347	8,057,384	173.85
Total	51,478	2,513,929	48.84	46,347	8,057,384	173.85
Grand total 1954	887,273	59,428,768	66.98	594,772	62,758,349	105.52

TECHNOLOGY

H. C. Dake described methods for calculating the potential value of large masses of gem materials.[12] The techniques of sawing, grinding, sanding, polishing, and setting malachite were published.[13] The art of cabochon making was described.[14] The techniques, equipment, knowledge, and tools required for the amateur to collect mineral specimens in various parts of the United States were listed.[15]

A new gem stone, sinhalite, has been found and identified by the British Museum and the Smithsonian Institution.[16]

A historical and technical article, Turquois in Nevada, was published.[17]

The historical and technical properties of jade were reviewed.[18]

An exhaustive list of gem stones that are luminescent under ultraviolet light was published.[19]

A new pearl weight estimation chart and table for drilled and undrilled pearls was developed that provided the weight of pearls of any size in pearl grains, mommes, carats, and grams. Momme is a

[12] Dake, H. C., Calculating Rough Gem Values: Mineralogist, vol. 22, No. 2, February 1954, pp. 57–62.
[13] Sinkankas, John, The Treatment of Malachite: Rocks and Minerals, vol. 29, No. 11–12, November-December 1954, pp. 599–601.
[14] Bingham, W. J., Cabochons: Earth Science, vol. 7, No. 4, January–February 1954, pp. 34–38.
[15] Dake, H. C., Where to Collect Minerals: Mineralogist, vol. 22, No. 11, November 1954, pp. 400, 406.
[16] Rocks and Minerals, Sinhalite, A New Gem Stone: Vol. 29, No. 5–6, May–June 1954, p. 251.
[17] California Mining Journal, Turquois in Nevada: Vol. 23, No. 8, April 1954, p. 23.
[18] Parker, R. J., The Nature of Jade: Gems and Gemology, vol. 8, No. 2, Summer 1954, pp. 38–46.
[19] Webster, Robert, Gemstone Luminescence: Gemmologist, vol. 23, No. 273, April 1954, pp. 77–78.

Japanese term used in cultered-pearl wholesaling. One momme equals to 0.0132 ounce.[20]

Three methods were devised to distinguish naturally colored diamonds from those colored by nuclear bombardment.[21]

A new brilliant cut was calculated that has a light output improvement of 21 to 28 percent. In addition, the cut enabled smaller stones to be utilized because of its lower height.[22]

A modified electrostatic separation process was developed at the Diamond Research Laboratory, Johannesburg, South Africa, to treat the finer sizes of gravity concentrate at various alluvial diamond mines. The new electrostatic separator recovered diamonds too small for satisfactory recovery by grease belts.[23]

WORLD REVIEW

Total world diamond production in 1954 was the highest on record and slightly higher than in 1953. Most of the increase came from the Union of South Africa and Tanganyika.

Table 4 shows world production of diamonds, with accurate figures from most countries. The total world production was estimated to be 1 to 2 percent higher than the figures given in the table.

Angola.—A report on the 1954 operation of the Companhia de Diamantes de Angola was published.[24]

TABLE 4.—World production of diamonds, 1951–54, by countries, in metric carats

(Including industrial diamonds)

	1951	1952	1953	1954
Africa:				
Angola	734, 324	743, 302	729, 337	721, 607
Belgian Congo	10, 564, 667	11, 608, 763	12, 580, 256	12, 619, 378
French Equatorial Africa	136, 000	163, 400	140, 144	152, 529
French West Africa	101, 000	136, 080	180, 000	216, 000
Gold Coast	1, 752, 878	2, 189, 557	[4] 2, 180, 728	2, 135, 141
Sierra Leone	475, 759	451, 426	472, 934	398, 608
South West Africa	478, 075	541, 027	617, 411	683, 536
Tanganyika	108, 625	143, 023	[4] 172, 304	326, 009
Union of South Africa:				
Lode	1, 967, 272	2, 093, 138	2, 397, 755	[1] 2, 544, 305
Alluvial	[2] 289, 063	[2] 282, 681	[2] 300, 000	[2] 314, 000
South America:				
Brazil	200, 000	200, 000	200, 000	[3] 200, 000
British Guiana	43, 260	38, 305	35, 306	30, 073
Venezuela	63, 226	98, 291	84, 790	96, 983
Other countries	3, 000	5, 000	5, 000	[3] 5, 000
Grand total	16, 917, 000	18, 694, 000	[4] 20, 096, 000	20, 440, 000

[1] Pipe mines under De Beers control but including 75,225 carats from alluvial diggings at Kleinzee.
[2] Includes an estimated 100,000 carats from the State mines of Namaqualand.
[3] Estimate.
[4] Revised figure.

SOURCE: Jewelers' Circ.-Keystone, 30th Annual Report on the Diamond Industry, 1954: 1955, p. 7.

[20] Small, J., Weight Estimations of Pearls: Gems and Gemology, vol. 8, No. 4, Winter 1954–55, pp. 99–105.
[21] Custer, J. F. H., and Dwyer, H. B., Discrimination Between Natural Blue Diamonds, and Diamonds Colored Blue Artificially: Gems and Gemology, vol. 8, No. 2, Summer 1954, pp. 35–37.
[22] Parker, R. L., Suggestion for a New Brilliant Cut: Gemmologist, vol. 23, No. 279, October 1954, pp. 177–179.
[23] Optima, Recovery of Small Diamonds: Vol. 4, No. 1, March 1955, pp. 33–34.
[24] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 2, February 1955, pp. 46–49.

Brazil.—Increased prices for industrial diamonds in Brazil encouraged expansion of diamond mining in 1954.[25]

There was a minor diamond rush in the Diamantino area, in the State of Mato Grosso, where the population was reported to be increasing at the rate of 1,000 a month. Miners found it more profitable to search for alluvial diamonds than to recover quartz crystals, which had been their chief mainstay before the diamond rush.

British Guiana.—Diamond production in British Guiana during 1954 amounted to 27,400 metric carats, a decrease of 8,000 carats from 1953.[26]

Canada.—In 1954 a substantial deposit of garnet was discovered in Dana township, 25 miles north of Sturgeon Falls, Ontario. The garnet, of alamandite type, was found in a zone of soft mica schist suitable for opencut mining.[27]

Ceylon.—Gem-stone mining in Ceylon was limited to small-scale open pits operated by 5 to 10 men. The pits, usually rectangular, were limited to a depth of 10 to 15 feet by ground-water conditions. Usual operations consisted of two men bailing while the other men dig and pile the gravel on the surface. When a pit was completed, the gravel was washed in cone-shaped baskets of bamboo or cane, and the gem stones were picked out.[28]

No production statistics were available, but it is estimated that the value of annual output was approximately $400,000 in 1954.[29]

Principal gem-stone localities in Ceylon follow:

Sabaragamuwa Province

Ratnapura	Kotamulla	Marapona
Balangoda	Karangoda	Pathakada
Pelmadulla	Hangomuwa	Elapatha
Adandawela	Urupollalawn	Modduwa

Southern Province

Ambalangoda Meethiyagoda Karandeniya	There were several moonstone and amethyst mines near these villages. The most precious moonstones are found here (dark sky-blue).

Central Province

Matale Rattota Gammaduwa East and West Matale	Fine color amethysts have been mined near these villages.

Colombia.—It was announced that the Muzo emerald mine, operated by the Banco de la Republica, had reopened in November 1953. The operations were being expanded gradually, and production was expected to equal that of 1949. The mine was closed in 1949 because of internal disorders throughout Colombia.[30]

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[25] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 4, April 1955, pp. 41, 42.
[26] Mining Journal (London), Annual Review, May 1955, p. 178.
[27] Engineering and Mining Journal, vol. 155, No. 11, November 1954, p. 160.
[28] Jayasinghe, W. D. S., Communication to E. R. Ruhlman, dated Oct. 27, 1955.
[29] Mining Journal (London), Annual Review, May 1955, p. 198.
[30] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 2, February 1954, p. 51.

India.—The Indian Bureau of Mines investigated the area near Ramaelakota (Andhra), and found evidence of a once-flourishing diamond-mining industry. It recommended a careful search for volcanic plugs; the original source of diamonds in Andhra.[31]

Japan.—The Japanese pearl-shell expedition that had been operating in the Arafura Sea under the terms of an interim agreement between the Governments of Australia and Japan discontinued diving in October 1954, when its quota was reached. The limit of shells agreed upon was 975 tons.[32]

Madagascar.—Production of precious and semiprecious gem stones in Madagascar was valued at $30,000 in 1954, about the same as in 1953. Among the stones produced were beryl, tourmaline, topaz, opal, sapphire, garnet, and amethyst.[33]

A comprehensive report of the gem stones of Madagascar was published.[34]

South-West Africa.—Industrial Diamonds of South Africa, Ltd., discovered a raised diamond-bearing marine terrace near Luderitz. The diamonds were similar in quality to those mined at the Saddle Hill Terrace.[35]

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[31] Chemical Age (London), vol. 71, Aug. 21, 1954, p. 368.
[32] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 4, October 1954, p. 56.
[33] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 6, June 1954, pp. 56–57.
[34] Jeannelle, H. F., Mineralogist: Vol. 22, No. 2, February 1954, pp. 85–90.
[35] Mining World, vol. 16, No. 12, November 1954, p. 37.

Gold

By James E. Bell [1] and Kathleen M. McBreen [2]

MINE production of gold in the United States in 1954 failed to maintain the gains made in the preceding year. The domestic output of gold was 6 percent less in 1954 than in 1953; further, it was smaller than in any other year since 1893, except in the war period 1943–46. However, the production rate of gold in Alaska, California, and South Dakota together, which are the principal producers of gold by straight gold-mining operations, was nearly the same in 1954 as in 1953. Most of the decline in production in 1954 was due to lower yield from base-metal ores containing byproduct gold, notably in Utah, where output dropped because of curtailed copper-ore mining in the early part of the year and labor strikes in the latter part.

South Dakota again was the leading State in gold production, followed in order by Utah, Alaska, and California, the same as in 1953. These 4 areas supplied 78 percent of the total domestic gold production in 1954. The South Dakota output was obtained almost entirely from gold ore produced at the Homestake mine in Lawrence County; most of Utah's gold was a byproduct from large-scale mining operations of low-grade copper ore in the West Mountain (Bingham) district; virtually all of the Alaska production came from placer operations, mainly bucketline dredging; and the California yield resulted principally from straight gold mining, both lode and placer. Of the domestic gold production in 1954, 23 percent was recovered by placer mining, 39 percent by amalgamation and cyanidation, and 38 percent in smelting ores and concentrates.

Outside of the United States, gold production increased 5 percent in 1954 compared with 1953, owing principally to substantial gain in Union of South Africa. Production rose also in Canada, Australia, Gold Coast, and the Federation of Rhodesia and Nyasaland. The world production rate of gold in postwar years has remained well below prewar averages.

In Union of South Africa a larger tonnage of ore of slightly higher average grade was milled in 1954 than in the preceding year. The average profit from gold per ton of ore increased slightly despite higher working costs. Recovery of byproduct uranium from gold mining in the Union, which was begun late in 1952, attained major importance in 1954 as a source of additional revenue and profit to the industry. Moreover, several mines that might otherwise have

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[2] Statistical assistant.

closed were able to continue operations because the combined gold-uranium content of the ore made it economic. Increasing prosperity in Union of South Africa appeared to be in the making as new gold fields in Orange Free State, the West Witwatersrand area, and the Klerksdorp district added their production to the output of the long-established Witwatersrand area.

The United States Treasury continued to purchase gold at $35 per fine troy ounce in 1954. There was a net outflow of gold from the United States during most months of the year, which resulted in a decline in Treasury gold reserves that exceeded 300 million dollars.

Legislation introduced in the United States in 1954 comprised a bill to authorize private selling, holding, and using of gold, but no action on this proposal was taken by Congress.

TABLE 1.—Salient statistics of gold in the United States,[1] 1945–49 (average) and 1950–54

	1945–49 (average)	1950	1951
Mine production, fine ounces	1,728,860	2,394,231	1,980,512
Ore (dry and siliceous) produced (short tons):			
Gold ore	2,784,171	3,584,360	2,606,202
Gold-silver ore	402,961	433,461	368,184
Silver ore	349,068	627,349	492,143
Percentage derived from—			
Dry and siliceous ores	39	43	39
Base-metal ores	31	31	36
Placers	30	26	25
Net consumption in industry and the arts	$93,071,961	$97,845,753	$69,476,979
Imports	$1,091,766,733	$162,748,661	$81,258,502
Exports	$204,076,640	$534,035,794	$630,381,566
Monetary stocks (end of year) [3]		$22,706,000,000	$22,695,000,000
Price, average, per fine ounce [4]	$35.00	$35.00	$35.00
World production, fine ounces (estimated)	28,750,000	32,700,000	33,500,000

	1952	1953	1954
Mine production, fine ounces	1,893,261	[2] 1,958,293	1,837,310
Ore (dry and siliceous) produced (short tons):			
Gold ore	2,339,160	2,198,688	2,248,604
Gold-silver ore	237,211	81,658	46,345
Silver ore	502,208	555,050	680,442
Percentage derived from—			
Dry and siliceous ores	40	40	43
Base-metal ores	38	39	34
Placers	22	21	23
Net consumption in industry and the arts	$96,350,540	$75,000,000	$44,443,000
Imports	$740,254,160	$47,024,515	$37,852,514
Exports	$55,921,206	$44,808,300	$21,293,551
Monetary stocks (end of year) [3]	$23,186,000,000	$22,030,000,000	$21,213,000,000
Price, average, per fine ounce [4]	$35.00	$35.00	$35.00
World production, fine ounces (estimated)	[2] 34,300,000	[2] 33,700,000	35,100,000

[1] Includes Alaska.
[2] Revised figure.
[3] Owned by Treasury Department; privately held coinage not included.
[4] Price under authority of Gold Reserve Act of Jan. 31, 1934.

In December 1954 the Bureau of the Mint announced that the United States Assay Office in Seattle, Wash., would be closed permanently in January 1955. Established in 1898, the office purchased gold bullion, amalgam, and nuggets from Alaska mines, as well as from mines in the Pacific Northwest.

The London gold market under the Bank of England was reopened on a restricted basis in 1954 after a suspension of nearly 15 years. The reopening was considered a step toward increasing the importance of London as an international financial center and furthering the restoration of currency convertibility.

Sale of substantial quantities of gold to world markets by the U. S. S. R., which began in 1953, continued in the first quarter of 1954. It was estimated that the total sold in 1954 amounted to at least 1 million ounces; most was consigned to free markets in Western Europe.

The litigation by some domestic gold-mining claimants to obtain compensation from the Government for damages caused by the promulgation of War Production Board Limitation Order L-208, which restricted gold mining during a period in World War II, was reported in the chapter on Gold and Silver, vol. I, Minerals Yearbook, 1952. The matter of such damages was under study by the United States Court of Claims during 1953, and the Report of the Court Commissioner was made in March 1954. The finding was favorable to the gold-mining industry and permitted submission of test cases to the Court. A decision on such test cases, however, had not been handed down to the end of 1954.

Agitation for higher official national gold prices based on raising the United States Treasury price for gold of $35 per ounce, carried on vigorously in recent years by many gold producers and some foreign governments, was markedly less in volume in 1953 and 1954, due apparently to the decline of premiums on the free gold markets. Meanwhile, no encouragement for a higher Treasury price for gold could be taken from utterances on the subject by officials of the Administration.[3]

PREMIUM PRICE OF GOLD

Developments in transactions in gold at premium prices and in private hoarding of gold have been reported in the chapter on Gold of Bureau of Mines Minerals Yearbooks for several years.

Action by the International Monetary Fund in September 1951, permitting member gold-producing countries to ease restrictions on the sale of newly mined gold on the free market, resulted in a greater quantity of gold becoming available for such disposal. Sales of gold on world markets by the U. S. S. R. in 1953 and 1954 also added to the supply. Meanwhile, improvement in political, economic, and currency stability in some parts of the world led to diminishing interest in gold for private hoarding. As a consequence of these factors, the premium price of gold, which had ranged from around $39 to $36.75 per ounce in 1952 and from $38 to $35 in 1953, remained close to parity ($35 per ounce) in 1954. It was estimated that sales of gold on the free market declined from around 12 million ounces in 1952 to 9 million in 1953 and to 5 million in 1954.

A forecast made in June 1954 on the prospects for premium prices in gold was as follows:[4]

> Looking to the near future, there seems to be little prospect of a substantial premium in the price of gold reappearing in the free market, barring, of course, a sudden war scare or a plunge into renewed inflation. A substantial volume of potential selling overhangs the free market, especially now that most producing countries have abandoned their restrictions on sales of gold in the free market and that South African producers are free to offer gold in refined bars. There is

[3] de Wet, J. P., Soviet Russia Now a Hard-Currency Paying Nation: Precambrian, vol. 27, No. 2, February 1954, pp. 9-10, 23.

[4] Bareau, Paul, The Free Market in Gold: Optima, vol. 4, No. 2, June 1954, pp. 24-28.

not only a substantial volume of newly-mined gold; but, as soon as a substantial premium re-emerged, there would be further sales from Russian reserves and offerings by speculative holders of gold who had been anxiously awaiting a profitable rise in the free market price. In the circumstances, therefore, it would seem improbable, in the absence of a fundamental change in the hoarding demand for gold, that we shall again see the wide disparities between the free market and official prices that were a commonplace of the eight post-war years.

According to information available to the Bureau of Mines, sales of natural gold in recent years on the domestic open market at prices higher than the United States Treasury price of $35 per ounce amounted to between 1,000 and 2,000 ounces annually. Much of the "natural gold" sold was in nugget form for use in making jewelry, for which a premium of $3 to $8 per ounce was paid, depending on the fineness, size, and color of the nuggets.

DOMESTIC PRODUCTION [5]

Production of gold in the United States is measured at mines and refineries. Both measures are tabulated by States of origin, but there is a small annual variation between them, explained largely by time lag. Over a period of years the deviations are found to be negligible. Compared with the mine reports compiled by the Bureau of Mines, the refinery reports compiled by the Bureau of the Mint in cooperation with the Bureau of Mines for the 50 years, 1905–54, show a total excess of gold of 60,190 ounces (a difference of 0.04 percent).

TABLE 2.—Gold produced in the United States,[1] 1905–54, according to mine and mint returns, in fine ounces of recoverable metal

Year	Mine	Mint	Year	Mine	Mint
1905–49	151,383,437	151,567,800	1953	[2] 1,958,293	1,970,000
1950	2,394,231	2,288,708	1954	1,837,310	1,859,000
1951	1,980,512	1,894,726			
1952	1,893,261	1,927,000	Total 1905–54	161,447,044	161,507,234

[1] Includes Alaska.
[2] Revised figure.

MINE PRODUCTION

The domestic mine output of recoverable gold declined 6 percent in 1954 compared with 1953 and was smaller than in any postwar year since 1946; it also was only 38 percent of the alltime high established in 1940. Part of the drop was due to suspension or curtailment of smaller straight gold-mining operations in several areas due to mounting costs for labor and supplies in relation to the fixed price of gold. However, most of the decrease resulted from lower yield of byproduct gold from base metal ores, chiefly because of reduced output of copper ore in Utah. Gold production was maintained at nearly the 1953 rate in Alaska, California, and South Dakota, where virtually all the gold output was recovered by placer mining or from dry gold ores.

[5] Production data or 1954 were collected jointly with the Bureau of the Census (U. S. Department of Commerce). Production totals will be compared with the Census totals when they are available and differences adjusted or explained.

All tonnage figures used in this report are short tons of 2,000 pounds "*dry weight*"; *that is, they do not include moisture.* Figures in cubic yards used in measuring material treated in placer operations are "bank measure"; that is, the material is measured in the ground before excavation. The weight unit for gold is the troy ounce (480 grains). The totals are calculated upon the basis of recovered or recoverable fine gold shown by assays to be contained in ore, bullion, or other material produced.

TABLE 3.—Mine production of gold in the United States[1] in 1954, by months

	Fine ounces		Fine ounces
January	137,788	August	160,764
February	131,791	September	172,348
March	142,283	October	162,999
April	138,705	November	155,003
May	140,057	December	156,040
June	178,006		
July	161,526	Total	1,837,310

[1] Includes Alaska.

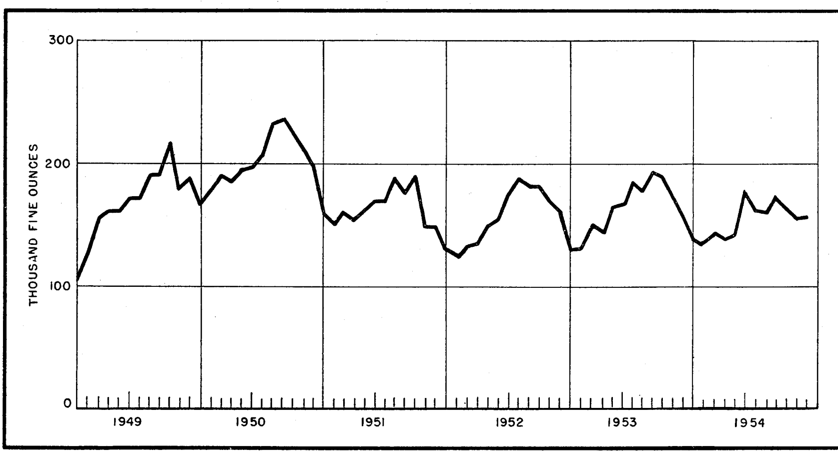

FIGURE 1.—Mine production of gold in the United States, 1949–54, by months, in terms of recoverable gold.

Mines are grouped in two main classes—placers and lodes. The placers are those in which gold (and, in a few placers, platinum) is recovered from gravel as native metal; a small but variable quantity of silver is always alloyed with the gold. Except for such small-scale hand methods as those utilizing the gold pan, the rocker, or the dry washer, most placer recovery methods employ sluice boxes; methods are distinguished by the means used for delivering the gravel to the sluices. Those methods where gravel is delivered mechanically include bucketline dredging, dragline dredging, and treatment in nonfloating washing plants of gravel delivered by power shovel, dragline excavator, truck, slackline scraper, or other mechanical means. In the hydraulic method the gravel is mined from the bank by a powerful jet of water; in some small-scale hand methods the gravel is shoveled into sluices; and in drift operations the gravel is mined underground and delivered to sluices at the surface. The lode mines are those yielding gold and silver from ore (as distinguished from gravel), mainly from underground workings, and, in addition to those worked chiefly for one or both of the precious metals, include those that yield ore mined chiefly for copper, lead, zinc, or other metals but contribute the precious metals as byproducts. As far as possible, the mine unit used is not the operator but the mining claim or group of claims.

PRINCIPAL MINING DISTRICTS AND LEADING MINES

Lawrence County (Lead), S. Dak., which long had been the leading gold producer in the United States, was surpassed in 1943–45 by the West Mountain (Bingham), Utah, copper district. In 1946 Lawrence County regained the lead, a position held through 1954; the West Mountain district has ranked second in this period. The Yuba River, Calif., gold-dredging district rose from ninth place in 1953 to third in 1954; and the Grass Valley-Nevada City, Calif., gold-ore district dropped from third to seventh. The two leading districts produced about 50 percent of the total domestic output of 1954.

Of the 25 leading gold producers operating in the United States in 1954, 10 were lode-gold mines, 6 were placers worked by bucketline dredges, 6 were copper mines, 2 were lead-zinc mines, and 1 was a copper-lead-zinc mine. The entire 25 mines on the list supplied about 85 percent of the domestic output of 1954.

TABLE 4.—Mine production of recoverable gold in the United States, 1945–49 (average) and 1950–54, by districts that produced 10,000 fine ounces or more during any year (1950–54), in fine ounces [1]

District or region	State	1945–49 (average)	1950	1951	1952	1953	1954
Lawrence County	South Dakota	323,574	567,996	458,040	482,511	534,984	541,445
West Mountain (Bingham)	Utah	278,591	428,313	407,196	417,607	450,882	369,760
Yuba River	California	(2)	(2)	(2)	(2)	(2)	(2)
Chelan County	Washington	35,003	64,711	46,458	[3] 54,135	[3] 61,468	[3] 66,477
Republic (Eureka)	do	22,093	24,929	(2)	(3)	(3)	(3)
American River (Folsom)	California	86,264	91,260	86,867	73,366	65,275	61,885
Grass Valley-Nevada City	do	(2)	(2)	(2)	(2)	(2)	(2)
Cripple Creek	Colorado	40,270	5,779	27,699	48,527	51,559	48,935
Warren (Bisbee)	Arizona	14,519	13,695	25,338	26,697	29,840	40,208
Robinson	Nevada	39,989	49,878	60,055	59,521	61,093	34,139
Ajo	Arizona	33,087	37,632	33,805	36,372	36,599	32,708
Park City Region	Utah	17,272	24,125	18,476	13,827	27,919	27,900
Upper San Miguel	Colorado	30,797	52,567	34,030	34,822	39,876	21,514
Bullion	Nevada	12,600	20,405	(2)	17,824	(2)	(2)
Big Bug	Arizona	10,367	19,328	19,724	17,317	17,788	17,802
Summit Valley (Butte)	Montana	14,723	23,092	15,674	16,918	19,871	17,325
Battle Mountain	Nevada	(2)	(2)	(2)	(2)	(2)	(2)
Klamath River	California	(2)	1,181	154	37	3,727	13,838
Pioneer	Arizona	8,900	14,392	12,207	11,665	14,480	13,382
Redcliff (Battle Mountain)	Colorado	1,053	5,636	2,793	1,700	3,750	10,121
Alleghany	California	(2)	14,314	10,776	9,683	13,112	8,483
California (Leadville)	Colorado	(2)	(2)	(2)	18,405	9,321	5,438
Mother Lode	California	(2)	24,513	(2)	7,127	3,524	842
Animas	Colorado	16,071	12,874	9,407	9,657	2,225	312
Oroville (Palermo)	California	17,640	(2)	(2)	2,946	47	67
Scott River	do	(2)	12,289	3,919	6	14	61
Round Mountain	Nevada	1	(2)	(2)	(2)	60	23
Fairplay	Colorado	(2)	(2)	(2)	2,019		
Potosi	Nevada	(2)	(2)				
Yellow Pine	Idaho	25,489	48,472	19,605	17,638		

[1] Exclusive of Alaska.
[2] Figure withheld to avoid disclosure of individual company operations.
[3] Chelan and Ferry Counties combined in 1952–54 to avoid disclosure of individual company operations.

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TABLE 5.—Twenty-five leading gold-producing mines in the United States in 1954, 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	Natomas Co	Do.
6	Copper Queen-Lavender Pit	Warren (Bisbee)	Arizona	Phelps Dodge Corp	Copper ore.
7	Empire Star Group	Grass Valley-Nevada City	California	Empire Star Mines, Ltd	Gold ore.
8	New Cornelia	Ajo	Arizona	Phelps Dodge Corp	Copper ore, copper tailings.
9	Mayflower-Galena	Blue Ledge	Utah	New Park Mining Co	Lead-zinc ore.
10	Knob Hill	Republic	Washington	Knob Hill Mines, Inc	Gold ore.
11	Ajax Group	Cripple Creek	Colorado	Golden Cycle Corp	Do.
12	Gold King	Wenatchee River	Washington	Lovitt Mining Co. Inc	Do.
13	Goldacres	Bullion	Nevada	London Extension Mining Co	Do.
14	Holden Group	Chelan Lake	Washington	Howe Sound Co	Copper ore.
15	Treasury Tunnel, etc	Upper San Miguel	Colorado	Idarado Mining Co	Copper-lead-zinc ore.
16	New York-Alaska	Aniak	Alaska	New York-Alaska Gold Dredging Co	Dredge.
17	Brunswick	Grass Valley-Nevada City	California	Idaho Maryland Mines Corp	Gold ore.
18	Iron King	Big Bug	Arizona	Shattuck Denn Mining Corp	Lead-zinc ore.
19	Nome Unit	Nome	Alaska	U. S. Smelting, Refining & Mining Co	Dredge.
20	Portland, etc	Bald Mountain	South Dakota	Bald Mountain Mining Co	Gold ore.
21	Greenan Placers	Battle Mountain	Nevada	Natomas Co	Dredge.
22	Siskon	Klamath River	California	Siskon Corp	Gold ore.
23	Magma	Pioneer (Superior)	Arizona	Magma Copper Co	Copper ore.
24	Cresson	Cripple Creek	Colorado	Cresson Consolidated Gold Mining & Milling Co.	Gold ore.
25	Morris Brooks Pit	Robinson	Nevada	Consolidated Coppermines Corp	Copper ore.

TABLE 6.—Mine production of recoverable gold in the United States, 1944–54, with production of maximum year, and cumulative production from earliest record to end of 1954, by States, in fine ounces

	Maximum production [1]		Production by years											Total production from earliest record to end of 1954
	Year	Quantity	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	
Western States and Alaska:														
Alaska	1906	1,066,030	49,296	68,117	226,781	279,988	248,395	229,416	289,272	239,486	240,557	253,783	248,511	28,112,987
Arizona	1937	332,694	112,162	77,223	79,024	95,860	109,487	108,993	118,313	116,093	112,355	112,824	114,809	11,756,893
California	1852	3,932,631	117,373	147,938	356,824	431,415	421,473	417,231	412,118	339,732	258,176	234,591	237,886	104,633,841
Colorado	1900	1,391,364	111,455	100,935	142,613	168,279	154,802	102,618	130,390	116,503	124,594	119,218	96,146	40,070,493
Idaho	1871	212,850	25,008	17,780	42,975	64,982	58,454	77,829	79,652	45,064	32,997	17,630	13,245	8,230,602
Montana	1865	870,750	50,021	44,597	70,507	90,124	73,091	52,724	51,764	30,502	24,161	24,768	23,660	17,422,915
Nevada	1910	913,265	119,056	92,265	90,680	89,063	111,532	130,399	178,447	121,036	117,203	101,799	79,067	26,445,547
New Mexico	1915	70,681	6,918	5,604	4,009	3,146	3,414	3,249	3,414	3,959	2,949	2,614	3,539	2,209,119
Oregon	1940	113,402	1,369	4,467	17,598	18,979	14,611	16,226	11,058	7,927	5,509	8,488	6,520	5,780,870
South Dakota	1939	618,536	11,621	55,948	312,247	407,194	377,850	464,650	567,996	458,101	482,534	534,987	541,445	24,881,058
Texas	1929	1,279			9	45	57	40	49	32	39			8,552
Utah	1953	483,430	344,223	279,979	178,533	421,662	368,422	314,058	457,551	432,216	435,507	483,430	403,401	13,959,225
Washington	1950	92,117	47,277	57,860	51,168	34,965	70,075	71,994	92,117	67,405	54,776	62,560	66,740	2,699,302
Wyoming	1869	7,498	20	2	105	1,486	115	389		9	1	1	407	80,449
Total			995,799	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	286,291,853
West Central States: Missouri	1900	33												33
States east of the Mississippi:														
Alabama	1936	4,726		5	1									49,495
Georgia	1882	12,094	5		21	76	19	18		3		[2] 2		870,663
Indiana	(3)	(3)												(4)
Maryland	1937	1,040							20	1				6,123
Michigan	1890	4,354												33,297
North Carolina	1887	10,884	21					13					214	1,164,815
Pennsylvania	1942	2,499	2,115	1,588	1,150	1,518	2,200	1,645	1,764	2,179	1,500	1,134	1,317	[5] 38,541
South Carolina	1941	15,508												318,801
Tennessee	1930	696	222	148	95	303	156	171	160	108	241	293	218	22,615
Vermont	1954	185	100	104	165	100	104	120	146	156	162	171	185	[6] 1,563
Virginia	1938	2,943	132	12										167,558
Total			2,595	1,857	1,432	1,997	2,479	1,967	2,090	2,447	1,903	[2] 1,600	1,934	2,673,471
Grand total			998,394	954,572	1,574,505	2,109,185	2,014,257	1,991,783	2,394,231	1,980,512	1,893,261	[2] 1,958,293	1,837,310	288,965,357

[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] Revised figure.

[3] Figure not available.

[4] Small, figure not available.

[5] 1908–54 only.

[6] 1905–54 only.

ORE PRODUCTION, CLASSIFICATION, METAL YIELD, AND METHODS OF RECOVERY

Tables 7 to 12 give details on classes of ore, metal yield in fine ounces of gold to the ton, and gold output by classes of ore and by methods of recovery, embracing all ores that yielded gold in the United States in 1954. These tables were compiled from the individual State chapters in volume III, in which more detailed data are presented.

The classification of ores originally adopted in 1905, on the basis of smelter terminology, smelter settlement contracts, and metal recovery has been used continuously in succeeding years, except for modification necessitated by the improvement in metallurgy and the lowering of the grade of complex ores treated. Details of the current basis of ore classification are given below:

Copper ores include smelting ores that contain 2.5 percent or more recoverable copper and ores and tailings concentrated or leached chiefly for their copper content. Ores leached in place or ores for which the tonnage cannot be calculated are excluded; slags smelted for their copper content are included.

Lead ores are those that contain 5 percent or more recoverable lead, irrespective of the precious metal content; and ores, tailings, or slags that are treated chiefly for their lead content.

Zinc concentrating ores and tailings include those from which a marketable zinc concentrate is made, irrespective of precious metal content. Virtually no zinc ore is now smelted directly except for cold slags, which when fumed are classified as smelting ore and may contain as little as 5 percent recoverable zinc.

TABLE 7.—Ore, old tailings, etc., yielding gold produced in the United States, and average recoverable content, in fine ounces of gold per ton in 1954 [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	19,721	0.051				
Arizona	1,330	.380	2,376	0.230	9,093	0.022
California	194,904	.497			1,753	.010
Colorado	141,759	.359	2,216	.140	95,455	.097
Idaho	3,557	.142	2,208	.863	379,706	.002
Montana	4,040	.524	17,875	.112	2,778	.012
Nevada	170,529	.140	2,555	.225	21,306	.035
New Mexico	120	1.808	995	.108	101	.040
Oregon	868	.597	2,004	.500		
South Dakota	1,600,784	.338				
Texas						
Utah	308	.266	16,116	.046	170,220	.025
Washington	109,089	.421			30	.033
Wyoming	1,420	.285				
Total	2,248,429	.340	46,345	.155	680,442	.022
States east of the Mississippi	175	1.223				
Total	2,248,604	.340	46,345	.155	680,442	.022

See footnotes at end of table.

TABLE 7.—Ore, old tailings, etc., yielding gold produced in the United States, and average recoverable content, in fine ounces of gold per ton in 1954 [1]—Con.

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	26	0.115				
Arizona	43, 126, 983	.002	4, 309	0.050		
California	8, 558	.066	4, 799	.015		
Colorado	213	.127	34, 937	.036		
Idaho	162, 145	.009	119, 681	.001	63	0.016
Montana	3, 789, 454	.002	8, 641	.102	894	.004
Nevada	9, 615, 197	.004	11, 403	.129		
New Mexico	6, 734, 682		45, 200			
Oregon	44	.182				
South Dakota						
Texas			10			
Utah	24, 100, 099	.015	11, 798	.047		
Washington	449, 664	.046	600			
Wyoming	25	.080				
Total	87, 987, 090	.006	241, 378	.019	957	.005
States east of the Mississippi	4, 600, 625		74			
Total	92, 587, 715	.006	241, 452	.019	957	.005

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					19, 747	0.051
Arizona	2, 727	0.011	337, 974	0.053	43, 484, 792	.003
California	122	.033	21, 381	.008	231, 517	.422
Colorado	200, 130	.007	498, 467	.063	973, 177	.097
Idaho	[2] 127, 786		1, 165, 816	.002	[2] 1, 960, 962	.003
Montana	54, 945	.001	1, 225, 661	.009	5, 104, 288	.004
Nevada	505	.016	21, 707	.042	9, 843, 202	.006
New Mexico					6, 781, 098	.001
Oregon					2, 916	.524
South Dakota					1, 600, 784	.338
Texas					10	
Utah	[3] 16, 940	.001	541, 683	.066	24, 857, 164	.016
Washington	150		992, 608		1, 552, 141	.043
Wyoming					1, 445	.282
Total	403, 305	.004	4, 805, 297	.021	96, 413, 243	.015
States east of the Mississippi	2, 049, 697		2, 826, 298		[4] 9, 476, 869	([4])
Total	2, 453, 002	.001	7, 631, 595	.013	105, 890, 112	.013

[1] Missouri excluded.
[2] Includes 111,689 tons of old zinc slag.
[3] Zinc slag.
[4] Excludes magnetite-pyrite ore and gold and silver therefrom. Includes material classified as fluorspar ore mined in Illinois and Kentucky.

The mixed ores are combinations of those enumerated above; they will be designated by the names of their constituent base metals in alphabetical order, irrespective of the predominance of value.

Gold, gold-silver, and silver ores with the base-metal content too small to be classified in accordance with the above are "dry" ores, irrespective of the ratio of concentration. The dry ores are thus ores, chiefly siliceous, valuable for their silver and gold content and in some instances for their fluxing properties, regardless of method of treatment. Dry gold ores are defined as those in which the gold value equals or exceeds three-fourths of the combined gold and silver values; dry silver ores are those in which the silver value equals or exceeds three-fourths of the combined gold and silver values. In dry gold-silver ores both the gold and silver values equal or exceed one-fourth of the combined gold and silver values. Tailings and slags follow the same scheme of classification as ores.

The classifications are not to be modified by considerations of payments of metals by smelters or customs mills, or by method of treatment by the smelters.

The lead, zinc, and lead-zinc ores in most districts in the States east of the Rocky Mountains carry no appreciable quantity of gold; such ores are excluded from this report unless othewise indicated.

TABLE 8.—Mine production of gold in the United States,[1] 1945–49 (average) and 1950–54, 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	
1945–49 (average)	30.0	39.4	22.7	0.5	0.3	7.1	1,728,860
1950	25.5	43.1	23.1	.7	.1	7.5	2,394,231
1951	24.8	38.9	27.5	.5	.2	8.1	1,980,512
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	[2] 1,958,293
1954	22.8	42.8	28.6	.3	.1	5.4	1,837,310

[1] Includes Alaska.
[2] Revised figure.

TABLE 9.—Mine production of gold in the United States in 1954, 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	247,509	999	3					248,511
Arizona	78	1,255	95,233	217		30	17,996	114,809
California	140,197	96,886	564	72		4	163	237,886
Colorado	1,555	60,493	27	1,273		1,309	31,489	96,146
Idaho	6,693	3,115	1,438	155	1	6	1,837	13,245
Montana	1,529	4,160	6,034	878	4	80	10,975	23,660
Nevada	17,246	25,217	34,201	1,474		8	921	79,067
New Mexico	14	328	3,176	21				3,539
North Carolina		214						214
Oregon	4,992	1,520	8					6,520
Pennsylvania			[1] 1,317					[1] 1,317
South Dakota		541,445						541,445
Tennessee							218	218
Utah		5,011	362,070	558		16	35,746	403,401
Vermont			185					185
Washington	118	45,919	20,653				50	66,740
Wyoming		405	2					407
Total	419,931	786,967	524,911	4,648	5	1,453	99,395	1,837,310

[1] From magnetite-pyrite ore.

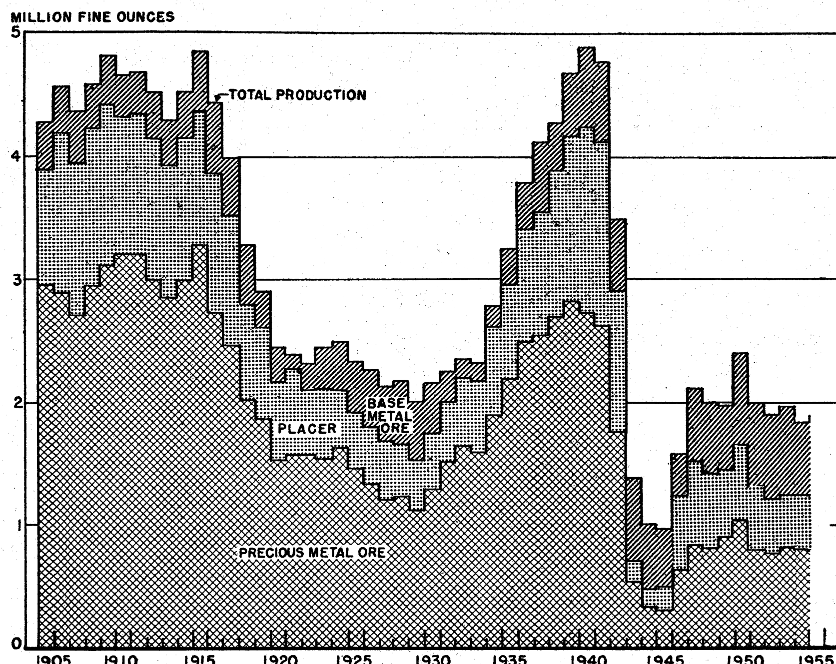

FIGURE 2.—Gold production in the United States, 1905–54.

TABLE 10.—Gold produced in the United States from ore and old tailings in 1954, 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	19,747	19,719	971	6	26	28	5
Arizona	[2] 40,357,494	[2] 39,605,855	2,337	1,337,628	77,302	751,639	35,092
California	231,517	221,030	83,595	9,615	13,153	10,487	941
Colorado	973,177	868,655	58,956	114,845	24,881	104,522	10,754
Idaho	[3] 1,960,962	1,836,190	1,438	210,667	4,499	124,772	615
Montana	5,104,288	4,974,479	516	429,171	17,402	129,809	4,213
Nevada	9,843,202	9,744,828	21,761	262,426	34,384	98,374	5,676
New Mexico	6,781,098	6,672,467	48	201,926	2,988	108,631	489
Oregon	2,916	2,872	251	169	1,265	44	12
South Dakota	1,600,784	1,600,784	541,445	--------	--------	--------	--------
Texas	10	--------	--------	--------	--------	10	--------
Utah	24,857,164	24,620,983	--------	835,157	396,928	236,181	6,473
Washington	1,552,141	1,499,349	4,912	69,845	40,710	52,792	21,000
Wyoming	1,445	1,420	317	1	88	25	2
Total	93,285,945	91,668,631	716,547	3,471,456	613,626	1,617,314	85,272
States east of the Mississippi	[4] 9,476,869	9,476,748	--------	562,412	1,934	121	--------
Grand total	102,762,814	101,145,379	716,547	4,033,868	615,560	1,617,435	85,272

[1] Missouri excluded.
[2] Excludes 3,127,298 tons of ore leached from which no gold or silver was recovered.
[3] Includes 111,689 tons of old zinc slag.
[4] Excludes magnetite-pyrite ore from Pennsylvania. Includes material classified as fluorspar ore mined in Illinois and Kentucky.

TABLE 11.—Gold produced at amalgamation and cyanidation mills in the United States and percentage of gold recoverable from all sources, 1945–49 (average) and 1950–54 [1]

Year	Bullion and precipitates recoverable (fine ounces)		Gold from all sources (percent)			
	Amalgamation	Cyanidation	Amalgamation	Cyanidation	Smelting [2]	Placers
1945–49 (average)	314,306	231,921	18.2	13.4	38.5	29.9
1950	547,118	300,783	22.9	12.6	39.0	25.5
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

[1] Includes Alaska.
[2] Both crude ore and concentrate.

TABLE 12.—Gold produced at amalgamation and cyanidation mills in the United States in 1954, 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	971		0.39	
Arizona	8	2,329	.01	2.03
California	51,649	31,946	21.71	13.43
Colorado	10,111	48,845	10.52	50.80
Idaho	1,438		10.86	
Montana	516		2.18	
Nevada	735	21,026	.93	26.59
New Mexico	48		1.36	
Oregon	251		3.85	
South Dakota	363,831	177,614	67.20	32.80
Washington		4,912		7.36
Wyoming		317		77.89
Total	429,558	286,989	23.40	15.64
States east of the Mississippi				
Grand total	429,558	286,989	23.38	15.62

PLACERS

Production of placer gold in the United States rose 3 percent to 419,900 ounces in 1954 and accounted for 23 percent of the domestic total output. Among the placer gold-producing areas, gains were scored in California, Idaho, and Nevada; and drops were reported in Alaska, Colorado, and Oregon.

Of the domestic 1954 production of placer gold, 85 percent was recovered by bucketline dredges. The total quantity of gold recovered by bucketline dredges in the United States to the end of 1954 is recorded as 23,281,018 ounces, of which 13,577,000 ounces was produced in California, 6,937,000 in Alaska (some from single-dipper dredges and hydraulicking), 787,000 in Montana, 708,000 in Idaho, and 1,336,000 in other States.

TABLE 13.—Gold production at placer mines in the United States, by class of mine and method of recovery, 1945–49 (average) and 1950–54 [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:						
1945–49 (average)	53	71	100, 140, 841	408, 141	$14, 284, 942	$0. 143
1950	43	63	108, 250, 189	492, 939	17, 252, 865	. 159
1951	36	56	93, 214, 943	404, 305	14, 150, 675	. 152
1952	37	56	69, 940, 758	358, 492	12, 547, 220	. 179
1953	21	41	65, 313, 835	343, 132	12, 009, 620	. 184
1954	22	44	62, 082, 120	356, 018	12, 460, 630	. 201
Dragline dredges:						
1945–49 (average)	44	42	5, 619, 354	30, 136	1, 054, 760	. 188
1950	23	21	4, 623, 474	21, 032	736, 120	. 159
1951	25	23	2, 342, 647	8, 820	308, 700	. 132
1952	16	16	1, 936, 587	8, 517	298, 095	. 154
1953	14	13	659, 600	2, 453	85, 855	. 130
1954	15	15	554, 460	4, 184	146, 440	. 264
Becker-Hopkins dredges:						
1945–49 (average)	—	—	1, 000	6	224	. 224
1950–54	—	—	—	—	—	—
Suction dredges:						
1945–49 (average)	7	7	96, 091	549	19, 222	. 200
1950	17	14	263, 800	1, 422	49, 770	. 189
1951	13	9	180, 500	717	25, 095	. 139
1952	9	9	74, 100	305	10, 675	. 144
1953	7	8	87, 700	341	11, 935	. 136
1954	3	3	3, 800	53	1, 855	. 488
Nonfloating washing plants:						
1945–49 (average)	121	120	3, 983, 275	49, 349	1, 727, 208	. 434
1950	185	183	8, 510, 139	85, 932	3, 007, 620	. 353
1951	117	115	7, 049, 566	69, 592	2, 435, 720	. 346
1952	103	102	4, 795, 100	54, 866	1, 920, 310	. 400
1953	128	128	4, 019, 325	58, 295	2, 040, 325	. 508
1954	128	128	2, 973, 510	52, 491	1, 837, 185	. 618
Gravel hydraulically handled:						
1945–49 (average)	131	—	1, 850, 312	21, 849	764, 708	. 413
1950	88	—	639, 585	4, 342	151, 970	. 238
1951	51	—	257, 800	3, 460	121, 100	. 470
1952	33	—	130, 401	1, 326	46, 410	. 356
1953	48	—	440, 290	1, 923	67, 305	. 153
1954	48	—	258, 100	2, 079	72, 765	. 282
Small-scale hand methods:						
Wet:						
1945–49 (average)	256	—	427, 385	6, 779	237, 279	. 555
1950	250	—	261, 562	4, 856	169, 960	. 650
1951	148	—	99, 804	3, 106	108, 710	1. 089
1952	119	—	101, 152	2, 598	90, 930	. 899
1953	139	—	152, 565	2, 534	88, 690	. 581
1954	112	—	171, 780	3, 248	113, 680	. 662
Dry:						
1945–49 (average)	12	—	3, 414	148	5, 173	1. 515
1950	7	—	2, 200	88	3, 080	1. 400
1951	4	—	550	27	945	1. 718
1952	—	—	—	—	—	—
1953	3	—	9, 875	103	3, 605	. 365
1954	3	—	905	78	2, 730	3. 017
Underground placers (drift):						
1945–49 (average)	27	—	9, 798	512	17, 913	1. 828
1950	34	—	12, 790	802	28, 070	2. 195
1951	19	—	4, 275	498	17, 430	4. 077
1952	14	—	4, 370	159	5, 565	1. 273
1953	13	—	3, 778	172	6, 020	1. 593
1954	23	—	9, 130	304	10, 640	1. 165
Unclassified placers:						
1945–49 (average)	—	—	—	—	—	—
1950–53	—	—	—	—	—	—
1954	—	—	—	[2] 1, 476	[2] 51, 660	(2)
Grand total placers:						
1945–49 (average)	[3] 651	—	112, 131, 470	517, 469	18, 111, 429	. 162
1950	647	—	122, 563, 739	611, 413	21, 399, 455	. 175
1951	413	—	103, 150, 085	490, 525	17, 168, 375	. 166
1952	331	—	76, 982, 468	426, 263	14, 919, 205	. 194
1953	373	—	70, 686, 968	408, 953	14, 313, 355	. 202
1954	354	—	66, 053, 805	419, 931	14, 697, 585	. 223

[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.

The gold-placer-mining method second in importance in 1954 was nonfloating washing plants, with mechanical earth-moving equipment for gravel delivery. Dragline dredging, small-scale hand methods, and hydraulic mining were in third, fourth, and fifth places, respectively.

Alaska supplied 59, California 33, Nevada 4, Idaho 2, and Oregon 1 percent of the United States placer-gold yield in 1954. Alaska led in recovery by bucketline dredging, nonfloating washing plants, and hydraulic mining; and California in dragline dredging, small-scale hand methods, and underground placer mining. A small output by dry placer mining was reported in 1954 by Arizona and New Mexico.

Table 13 shows the placer gold produced in the United States, classified by mining methods, in 1950–54. Additional information on placer mining may be found in the State reviews of volume III.

REFINERY PRODUCTION

Table 14 contains official estimates of gold production in the United States made by the Bureau of the Mint, based upon arrivals at United States mints and assay offices and at privately owned refineries. The mints and assay offices determine the State source of all newly mined, unrefined material when deposits are received. The State source of material received by privately owned refineries is determined from information submitted by them and by intervening smelters, mills, etc., involved in the reduction processes.

TABLE 14.—Gold refined in the United States, 1945–49 (average) and 1950–54, and approximate distribution by source (State) in 1954, in fine ounces

[U. S. Bureau of the Mint]

State or Territory	Fine ounces	State or Territory	Fine ounces
1945–49 (average)	1,700,799	1954—Continued	
1950	2,288,708	New Mexico	3,500
1951	1,894,726	North Carolina	80
1952	1,927,000	Oregon	7,100
1953	1,970,000	Pennsylvania	1,320
1954:		South Dakota	543,500
Alaska	259,800	Tennessee	230
Arizona	114,000	Utah	410,230
California	236,000	Vermont	190
Colorado	96,800	Washington	68,000
Idaho	14,000	Wyoming	250
Montana	24,000		
Nevada	80,000	Total	1,859,000

CONSUMPTION AND USES IN INDUSTRY AND THE ARTS

Gold has been used for coinage in most nations of the world for centuries. Since about 1933 gold coins have been withdrawn from circulation almost universally, and the use of gold mostly as a reserve in the form of bullion to give stability to paper currency and for settlement of international balances has become its chief monetary function.

The popularity and uses of gold for jewelry and allied articles are well known; the esteem in which gold is held is explained largely by its attractive color and freedom from ordinary corrosion. In addition to the natural yellow gold, white, green, blue, and purple gold can be produced by alloying with other metals. Varying proportions of silver, copper, zinc, nickel, or palladium added give white gold; cadmium, green gold; iron, blue gold; and aluminum, purple gold.

Numerous articles are prepared by covering their surfaces with gold, in which several processes are used, including electroplating and gold filling. By the latter process gold sheet is soldered or welded to a block of ordinary metal, and the whole is rolled to the desired thickness; the gold coating remains in the same proportional thickness to the other metal as in the original block. Articles coated with the thicker coverings of gold have high wearing qualities.

TABLE 15.—Gold produced in the United States, 1792–1954 [1]

Period	Fine ounces	Value [2]
1792–1847	1,187,170	$24,537,000
1848–73	60,021,278	1,240,750,000
1874–1954	230,818,723	5,676,195,080
Total	292,027,171	6,941,482,080

[1] Includes Alaska. From Report of the Director of the Mint. The estimates for 1792–1873 are by R. W. Raymond, Commissioner of Mining Statistics, Treasury Department, and since then, by the Director of the Mint.
[2] Gold valued in 1934 and thereafter at $35 per fine ounce; before that date, at $20.67+ per fine ounce.

Goldleaf is used for window signs, printing titles on books, and decorating picture frames and many other articles. In making goldleaf the extreme malleability of gold is utilized. Most goldleaf is prepared by hand hammering the metal in "goldbeaters' skin" to a thickness of about five-millionths inch; around 250 square feet of leaf can be obtained from 1 ounce of gold.

Because of its excellent workability and resistance to mouth secretions, gold is widely used in dentistry, principally as dental fillings, dentures, and wires.

Based on its resistance to corrosion and other chemical action, gold finds some application in industry. Gold alloy is used for hairsprings of marine chronometers, in galvanometers, and in various other delicate instruments. Gold and gold alloys, both in massive form and as lining of other metals, are used considerably for laboratory ware and equipment in chemical plants.

The net absorption of gold in the arts and industry in the United States in 1954 equaled about 69 percent of the total new gold produced from domestic mines during the year.

TABLE 16.—Net industrial[1] consumption of gold in the United States, 1945–49 (average) and 1950–54

[U. S. Bureau of the Mint]

Year	Gold (dollars)		
	Issued for industrial use	Returned from industrial use	Net industrial consumption
1945–49 (average)	135, 371, 397	42, 299, 437	93, 071, 961
1950	134, 587, 773	36, 742, 020	97, 845, 753
1951	105, 012, 094	35, 535, 115	69, 476, 979
1952	127, 189, 489	30, 838, 949	96, 350, 540
1953	112, 379, 041	37, 379, 041	75, 000, 000
1954	78, 266, 265	33, 823, 265	44, 443, 000

[1] Including the arts.

PRICE AND MONETARY STOCKS

Since January 1934 the price of gold at the United States Mint has been $35 per fine troy ounce.

According to information published in the Federal Reserve Bulletin, gold holdings of the United States Treasury dropped $317 million from $22,030 million on December 31, 1953 to $21,713 million on December 31, 1954. Most of the decline took place in the latter part of the year. The net outflow was due in large part to foreign aid programs of the United States Government. Total world gold reserves are not positively known, since reports of some countries are not received. However, the Federal Reserve Board estimated that the world monetary reserves of gold rose to $37,350,000,000 in 1954, exclusive of holdings of the Soviet Union.

FOREIGN TRADE [6]

The excess of exports over imports of gold that prevailed in 1950 and 1951 was replaced by an excess of imports over exports in 1952 and 1953 and again in 1954. Imports of gold plus domestic output exceeded domestic net consumption in 1954, and gold stocks thus increased.

TABLE 17.—Value of gold imported into and exported from the United States, 1945–49 (average) and 1950–54

[U. S. Department of Commerce]

	Imports	Exports	Excess of imports over exports [1]
1945–49 (average)	$1, 091, 766, 733	$204, 076, 640	$887, 690, 093
1950	162, 748, 661	534, 035, 794	−371, 287, 133
1951	81, 258, 502	630, 381, 566	−549, 123, 064
1952	740, 254, 160	55, 921, 206	684, 332, 954
1953	47, 024, 515	44, 808, 300	2, 216, 215
1954	37, 852, 514	21, 293, 551	16, 558, 963

[1] Excess of exports over imports indicated by minus sign.

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

TABLE 18.—Gold imported into the United States in 1954, 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:					
Bermuda	35	$1,225			
Canada	339,241	11,847,503			
Cuba	677	23,676			
El Salvador	5,310	185,869			
Guatemala	1	35			
Honduras	26,489	925,119			
Mexico	101,445	3,535,619			$20,000
Netherlands Antilles	7	240			
Ncaragua	87,387	3,052,543			
Painama	309	10,832			
Total	560,901	19,582,661			20,000
South America:					
Bolivia	671	23,472	214,313	$7,500,948	
Brazil	1,026	36,265			
British Guiana	13,920	487,576			
Chile	20,228	707,406			
Colombia	17,425	607,894			
Ecuador	17,399	604,571			
Peru	42,188	1,470,068	43,836	1,533,864	
Venezuela	253	8,858			
Total	113,110	3,946,110	258,149	9,034,812	
Europe:					
Belgium-Luxembourg	128	4,327	174	6,085	
France	73	2,550			
Greece	92	3,220			
Norway	30	1,036			
Portugal	19,869	691,586			
Switzerland	3	115			
Turkey	1,316	46,065			
United Kingdom	3,032	106,301	48	1,690	
Total	24,543	855,200	222	7,775	
Asia:					
Israel	629	22,000			
Japan	22	770			
Philippines	112,004	3,912,630			
Total	112,655	3,935,400			
Africa:					
British East Africa [1]	224	7,840			
Federation of Rhodesia and Nyasaland [1]	3,339	116,832			
Union of South Africa	60	2,100			
Total	3,623	126,772			
Oceania: Australia	7,852	274,495	1,950	69,289	
Grand total	822,684	28,720,638	260,321	9,111,876	20,000

[1] Effective July 1954 Nyasaland excluded from British East Africa and combined with Northern and Southern Rhodesia as Federation of Rhodesia and Nyasaland.

TABLE 19.—Gold exported from the United States in 1954, by countries of destination

[U. S. Department of Commerce]

Country of destination	Ore and base bullion		Bullion, refined		Foreign coin (value)
	Troy ounces	Value	Troy ounces	Value	
North America:					
Canada			20,559	$720,492	$1,939,045
Cuba			33	1,166	
El Salvador			16,143	565,002	
Honduras					2,017
Panama			137	4,978	
Total			36,872	1,291,638	1,941,062
South America:					
Brazil			217	7,588	
Chile			1,612	56,380	
Venezuela			56,635	2,007,986	
Total			58,464	2,071,954	
Europe:					
Belgium-Luxembourg			95	3,340	
Germany, West			14,863	527,021	
Portugal			21,893	766,495	
Switzerland			412	16,223	
Turkey			1,711	59,895	
United Kingdom	3,495	$122,343	1,692	59,300	
Total	3,495	122,343	40,666	1,432,274	
Asia:					
Lebanon			251,265	8,794,260	
Philippines			103,195	5,640,020	
Total			354,460	14,434,280	
Grand total	3,495	122,343	490,462	19,230,146	1,941,062

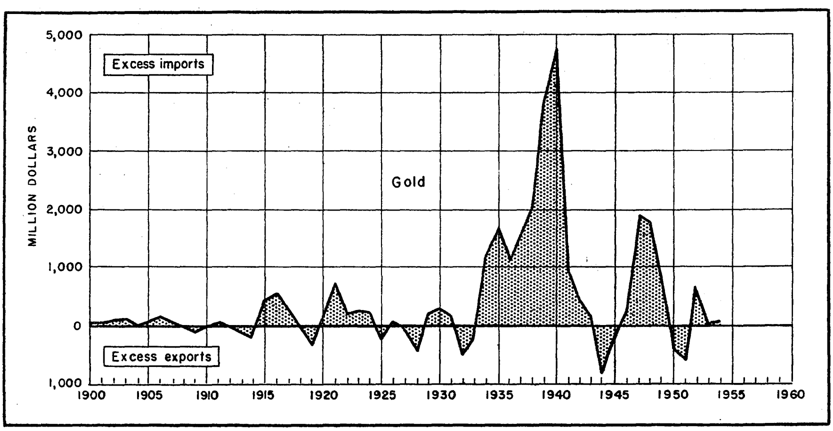

FIGURE 3.—Net imports or exports of gold, 1900–54.

WORLD REVIEW

The world output of gold rose 4 percent in 1954 compared with 1953, owing mostly to gains in Union of South Africa and Canada. The 1954 output was 7 percent under the average for the 5 prewar years 1936–40.

According to the Bureau of the Mint, the world output of gold from 1493 to 1954 was 1,820,108,100 fine ounces valued at $47,483,110,800. It has been estimated that, of the total gold output of the world, governments and central banks hold 60 percent and private interests 25 percent and that 15 percent has been lost or dissipated.

Australia.—With a 4-percent gain in 1954, Australia's gold output rose for the fourth successive year; over 75 percent of the total was produced in Western Australia. A subsidy to provide Government aid to the gold-mining industry was adopted in 1954, by which mining companies received three-fourths of the excess of the average cost per ounce of gold over A£13 10s. ($30.51) to a maximum payment of A£2 ($4.52) per ounce.

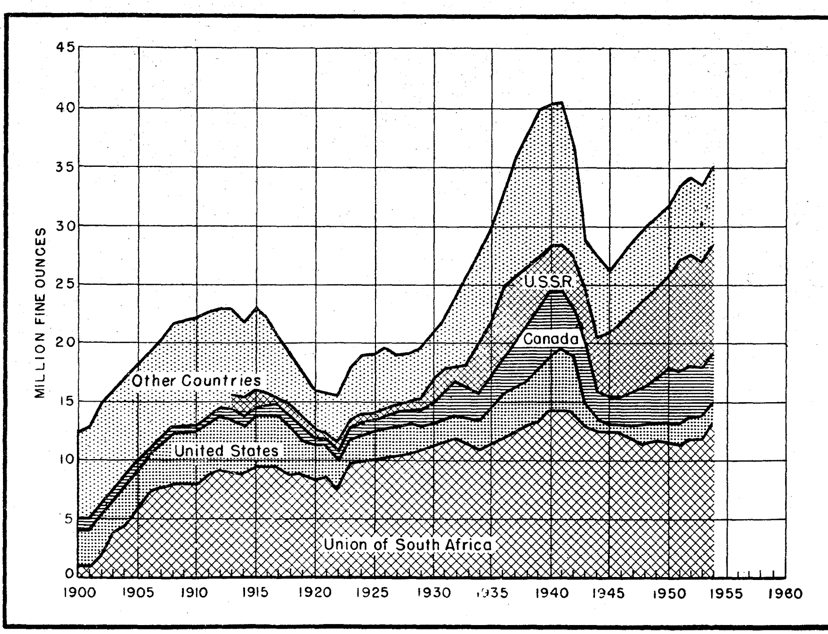

FIGURE 4.—World production of gold, 1900–54.

TABLE 20.—World production of gold, 1945–49 (average) and 1950–54, by countries,[1] in fine ounces [2]

(Compiled by Pauline Roberts and Berenice B. Mitchell)

Country [1]	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
United States (including Alaska) [3]	1,698,101	2,288,708	1,894,726	1,927,000	1,970,000	1,859,000
Canada	3,257,656	4,441,227	4,392,751	4,471,725	4,055,723	4,366,440
Central America and West Indies:						
Costa Rica [4]	1,535	115	1	----	----	----
Cuba [4]	1,584	6,915	835	881	1,181	677
Dominican Republic [4]	434	475	411	332	----	----
Guatemala [4]	32	397	7	4	3	1
Haiti	23	----	----	----	----	----
Honduras	16,283	36,545	31,216	31,967	47,523	20,429
Nicaragua (exports)	212,072	229,206	251,160	254,675	261,899	232,212
Panama	[5] 2,131	1,118	2,897	----	----	----
Salvador (exports)	19,390	29,053	27,097	27,682	23,359	5,326
Mexico	431,540	408,122	394,007	459,370	483,483	386,870
Total	5,640,800	7,441,900	6,995,100	7,173,600	6,843,200	6,871,000
South America:						
Argentina [6]	7,084	8,000	8,000	8,000	8,000	8,000
Bolivia	16,583	7,716	3,200	10,770	22,923	[5] 14,388
Brazil [6]	178,920	195,500	200,000	180,000	180,000	180,000
British Guiana	20,202	12,366	13,485	22,237	19,247	26,938
Chile	186,276	192,390	174,868	177,054	130,693	124,970
Colombia	404,326	379,412	430,723	422,231	437,297	377,466
Ecuador	76,374	96,403	12,601	24,294	29,239	18,479
French Guiana	16,738	12,249	12,056	8,231	2,576	1,512
Peru	134,394	127,458	144,765	130,944	140,228	147,298
Surinam	4,530	4,546	6,494	6,134	6,482	6,771
Uruguay	[6] 200	----	----	----	----	----
Venezuela	51,667	34,462	2,861	4,797	27,304	56,074
Total [6]	1,097,300	1,070,500	1,009,000	995,000	1,004,000	962,000
Europe:						
Austria	[6] 1,400	(7)	(7)	(7)	(7)	(7)
Bulgaria	[6] 2,400	(7)	(7)	(7)	(7)	(7)
Czechoslovakia	1,904	(7)	(7)	(7)	(7)	(7)
Finland	10,230	8,198	18,069	19,741	19,483	16,976
France	46,711	63,755	68,127	68,706	58,000	(7)
Germany:						
East	[6] 600	(7)	(7)	(7)	(7)	(7)
West	[6] 890	[6] 1,500	1,498	2,009	6,398	(7)
Hungary	[6] 1,500	(7)	(7)	(7)	(7)	(7)
Italy	10,070	10,674	12,089	14,854	12,153	5,208
Portugal	8,925	15,465	18,358	17,940	14,854	15,794
Rumania	89,716	(7)	(7)	(7)	(7)	(7)
Spain	10,032	13,217	12,777	8,944	8,263	(7)
Sweden	80,942	78,866	70,474	65,877	88,254	110,277
U. S. S. R.[6] [8]	6,400,000	8,000,000	9,500,000	9,500,000	[9] 9,000,000	9,000,000
Yugoslavia	22,660	42,760	21,380	36,266	36,620	(7)
Total [6]	6,700,000	8,400,000	9,800,000	9,900,000	9,400,000	9,400,000
Asia:						
Burma	105	150	173	43	647	107
China	[6] 51,150	108,000	100,000	[6] 100,000	[6] 100,000	(7)
India	163,296	196,925	226,364	253,264	223,020	240,708
Indonesia [6]	19,800	42,000	(7)	(7)	(7)	(7)
Japan	62,800	135,180	177,521	200,935	228,255	237,272
Korea:						
North [6]	[6] 244,600 (North and Republic of)	200,000	(7)	(7)	(7)	(7)
Republic of		14,854	7,620	18,647	15,882	52,406
Malaya	5,975	18,436	17,018	19,806	18,283	20,955
Philippines	115,329	333,991	393,602	469,408	480,625	416,052
Sarawak	506	1,440	931	843	442	531
Saudi Arabia	55,761	66,202	73,104	69,394	81,566	34,298
Taiwan (Formosa)	9,980	30,446	30,511	33,147	24,821	21,541
Thailand	[6] 2,400	(7)	(7)	(7)	(7)	(7)
Total [6] [8]	732,000	1,150,000	1,290,000	1,430,000	1,440,000	1,440,000

See footnotes at end of table.

TABLE 20.—World production of gold, 1945–49 (average) and 1950–54, by countries,[1] in fine ounces [2]—Continued

Country [1]	1945–49 (average)	1950	1951	1952	1953	1954
Africa:						
Angola	499	201	61	40	20	36
Bechuanaland	6,036	261	493	1,245	1,109	1,216
Belgian Congo [10]	322,671	339,415	352,308	368,737	371,020	365,490
Egypt	3,759	10,724	16,469	17,059	14,234	17,387
Eritrea	2,738	1,042	675	699	1,363	1,484
Ethiopia	44,357	43,524	32,937	27,291	26,696	33,894
French Cameroon	11,876	7,170	5,422	2,604	1,022	686
French Equatorial Africa	67,760	54,996	52,849	51,655	54,180	45,307
French Morocco	624	119	2,069	4,051	2,533	3,566
French West Africa	35,858	[11] 96,000	5,700	1,500	1,608	418
Gold Coast	606,499	689,441	698,676	691,460	730,963	787,075
Kenya	26,774	22,945	19,765	10,210	9,603	6,607
Liberia	14,192	11,025	[5] [12] 9,806	[5] [12] 949	863	1,135
Madagascar	3,118	1,935	1,951	1,784	1,640	1,363
Mozambique	5,258	997	861	831	1,034	2,027
Nigeria	4,121	2,238	1,566	1,348	689	730
Rhodesia and Nyasaland, Federation of:						
Northern Rhodesia [13]	2,050	1,432	857	2,523	3,308	2,694
Southern Rhodesia	535,638	511,163	486,907	496,731	501,057	535,852
Sierra Leone	1,518	3,484	3,261	2,638	1,451	2,254
South-West Africa	134	32	----	----	----	----
Sudan	3,342	3,503	1,495	1,545	2,175	[6] 2,000
Swaziland	4,017	1,794	322	1	----	----
Tanganyika	54,611	65,127	65,583	64,693	69,886	72,212
Uganda (exports)	1,529	509	223	201	511	568
Union of South Africa	11,728,394	11,663,713	11,516,450	11,818,681	11,940,616	13,237,119
Total	13,487,000	13,535,000	13,275,000	13,570,000	13,740,000	15,120,000
Oceania:						
Australia:						
Commonwealth	839,012	867,837	895,551	980,435	1,075,181	1,117,077
New Guinea	47,893	80,099	94,085	122,431	120,568	86,195
Papua	233	788	248	149	141	318
Fiji	93,763	103,421	93,635	78,282	76,970	[6] 75,000
New Zealand	107,734	76,527	75,115	59,151	38,656	41,713
Total	1,088,635	1,128,672	1,158,634	1,240,448	1,311,516	1,320,000
World total (estimate)	28,750,000	32,700,000	33,500,000	34,300,000	33,700,000	35,100,000

[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.
[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] Estimate based on reported production.
[12] Year ended September 30 of year stated.
[13] Included is yield from Nkana mine-refinery slimes: 1946–49 (average), 2,278 ounces; 1950, 1,296; 1951, 756; 1952, 2,503; 1953, 2,999; and 1954, 2,516.

Canada.—Due largely to termination of labor strikes that had closed some mines for long periods in the latter part of 1953, Canada gained 8 percent in gold production in 1954. Canada was exceeded in gold output only by Union of South Africa and (probably) U. S. S. R. For many years, gold was the leading mineral in Canada in output value, but in 1953 gold was forced into fourth place, exceeded in order by petroleum, nickel, and copper, and this same ranking continued for 1954. Mining was handicapped by rising costs for labor and supplies and by lower revenue realized for gold because of the over-par exchange value of the Canadian dollar in relation to the United States dollar. On the other hand, gold producers were aided by the Canadian Government under the Emergency Gold Mining Assistance Act, through subsidy payments as determined by formula. All straight gold producers received cost aid in 1954, with payments averaging $4.30 per ounce of gold output.

The total gold output of Canada in 1954 was 4,366,440 ounces, of which British Columbia produced 6 percent, Manitoba 3, Northwest Territories 7, Ontario 54, Quebec 26, Saskatchewan 2, and Yukon 2, and Alberta, Newfoundland, and Nova Scotia together less than 1. Of the total output of 1954, 2 percent was obtained by placer mining, 12 percent as a byproduct of base-metal mining, and 86 percent from straight lode-gold mining.

Colombia.—Colombia was the leading gold-producing country in South America by a wide margin; most of the output was obtained by placer mining. Gold production dropped 14 percent in 1954 compared with 1953. Three foreign companies produced 81 percent of the total; several small operations were shut down because of rising costs. As an aid to small gold-mining companies (defined as those whose gold production in the first half of 1953 did not exceed 180 fine ounces of gold) the Colombian Government authorized in 1954 a reduction in the production tax on gold and a premium payment to those who sold their gold to the Bank of the Republic at the official price of $35 per ounce.

Philippines.—Gold production in the Philippines dropped about 14 percent to 416,100 ounces in 1954. The decline reflected the depressed condition of the gold-mining industry because of rising costs, despite action by the Government in 1953 exempting gold mines from various taxes. Efforts in 1954 by the Philippine Gold Producers Association to obtain further relief led to enactment of the Gold Subsidy Law in September. Under this law the Gold Subsidy Board had authority to promulgate rules and regulations and to determine the benefit allowable to each operator.

Union of South Africa.—A 6-percent increase in tonnage of ore milled, with an average grade 4 percent higher, led to an 11-percent gain in gold production in Union of South Africa in 1954; improvement in the power and native labor situation also was a factor.[7] In the new gold field in Orange Free State 4 mines reached a preliminary production stage in 1954, making a total of 8; 5 additional mines were still under development. Production in the new field increased 154 percent to 1,095,540 ounces in 1954, with most of the ore treated still coming from development workings. To the end of 1954 development on the Basal Reef in the new field totaled more than 1,500,000 linear feet. Reef exposures in most mines showed a higher gold content than was indicated by the original drilling results.

Interesting figures on production to the end of 1953 and estimated future production of Union of South Africa were published, as follows:[8]

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[7] Mining Journal, Improved Labor and Power Supply Eases Production Problems in South African Mines: Vol. 243, No. 6218, Oct. 22, 1954, p. 450.

[8] Stokes, R. S. G., Future Resources and Problems of the Witwatersrand Goldfield: South African Min. and Eng. Jour., vol. 65, pt. 1: No. 3205, July 17, 1954, pp. 761–771.

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	Production to date			Future production		Final aggregate		
	Tons milled (millions)	Ounces gold (millions)	Average dwt. (per ton)	Tons milled (millions)	Ounces gold (millions)	Tons milled (millions)	Ounces gold (millions)	Average dwt. (per ton)
Old Rand (Randfontein-E. R. P. M.)	1,138.0	284.0	5.0	285	47.4	1,423	332	4.7
Far East Rand	736.0	205.0	5.6	297	56.8	1,033	262	5.1
West Wits-Klerksdorp	44.0	13.3	6.0	551	203.0	595	216	7.3
Orange Free State	3.5	.7	[1] 4.0	722	224.6	725	225	6.2
Total	1,921.5	503.0	5.23	1,855	531.8	3,776	1,035	5.5

[1] Grade lowered by dilution in early stages of production.

Production of byproduct uranium from gold mining in Union of South Africa advanced substantially in 1954; this was reflected in declared uranium profits, which increased fourfold to more than £8 million. It was demonstrated that at some properties additional revenue from uranium would permit mining ore containing less gold. Further information on the production of byproduct uranium from gold mining in Union of South Africa will be found in the chapter in this volume on Uranium.

TABLE 21.—Salient statistics of gold mining in the Union of South Africa, 1945–49 (average) and 1950–54

[Transvaal Chamber of Mines]

	1945–49 (average)	1950	1951	1952	1953	1954
Ore milled (tons)	56,340,930	59,515,200	58,645,800	60,500,000	58,772,000	62,534,500
Gold recovered (fine ounces)	11,722,396	11,663,713	11,516,450	11,818,681	11,440,830	12,682.328
Gold recovered (dwt. per ton)	3.991	3.759	3.756	3.767	3.893	4.068
Working revenue	[1] £100,126,810	[2] £139,491,029	£137,494,860	£141,271,310	£142,198,156	£158,630,787
Working revenue per ton	35s. 6d.	46s. 11d	46s. 11d	47s. 1d.	48s. 5d.	50s. 11d.
Working cost	£72,644,532	£87,956,643	£93,494,860	£102,525,003	£107,306,956	£120,435,001
Working cost per ton of ore	25s. 10d.	29s. 7d.	31s. 10d.	34s. 2d.	36s. 6d.	38s. 8d.
Working cost per ounce of metal	129s. 4d.	157s. 3d.	169s. 6d.	181s. 6d.	187s. 7d.	189s. 11d
Working profit	£27,481,270	£51,534,386	£44,157,054	£38,746,307	£34,891,200	£38,195,786
Working profit per ton	9s. 9d.	17s. 4d	15s. 1d.	12s. 11d.	11s. 11d	12s. 3d.
Premium gold sales				£3,699,124	£1,934,421	£12,999
Estimated uranium profits				£125,000	£1,828,067	£8,105,744
Dividends	£13,824,227	£24,699,544	£22,787,806	£19,804,928	£18,994,307	£19,946,297

[1] 1 £ Jan. 1, 1945 to Sept. 19, 1949—$4.03 (approx. average).
[2] 1 £ after Sept. 19, 1949—$2.80.

Graphite

By Donald R. Irving[1] and Eleanor V. Blankenbaker[2]

THE NATURAL-GRAPHITE INDUSTRY in 1954 was characterized by sharp decreases in production in the United States, Canada, and Mexico; a moderate decline in world production and world consumption; a continued surplus of Madagascar crystalline flake and fines; and a substantial decrease in United States imports and exports. The decreased world demand for graphite resulted in part from reduced world tension and a trend toward a peacetime economy.

At the end of 1954 there was no known production of flake graphite in the Western Hemisphere, as a result of permanent closing of the single Canadian mine and temporary suspension of operations by United States producers. Also, the Government-owned Benjamin Franklin graphite mine and mill was closed in December after the quantity and quality of graphite that could be produced was demonstrated.

DOMESTIC PRODUCTION[3]

The mine of the largest domestic producer of crystalline flake graphite—Southwestern Graphite Co., Burnet, Tex.—was idle during all of 1954, but stocks of standard grades of graphite were ample, and blending, pulverizing, sizing to customer specifications, and shipments continued throughout the year. The only other crystalline-flake-graphite producer—Alabama Flake Graphite Co., Ashland, Ala.—also was idle most of the year. Graphite Mines, Inc., Cranston, R. I., continued to produce amorphous graphite at about the same rate as in 1953. Major factors in the decreased production of domestic crystalline flake graphite were attainment of the National Stockpile objective for "Lubricant and Packing Grade" graphite, the continued availability of imported graphite from most sources, and reduced consumption resulting from a peacetime economy.

Manufactured (artificial)-graphite powder and products were produced by National Carbon Co., Division of Union Carbide & Carbon Corp., in plants at Niagara Falls, N. Y., and Columbia, Tenn.; Great Lakes Carbon Corp., in plants at Niagara Falls, N. Y., and Morganton, N. C.; and Speer Carbon Co., Division of International Graphite & Electrode Corp., with a plant at St. Marys, Pa.

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[1] Assistant chief, Branch of Ceramic and Fertilizer Materials.
[2] Literature-research clerk.
[3] Data collected jointly by the Bureau of Mines (U. S. Department of the Interior) and Bureau of the Census (U. S. Department of Commerce) for Census Year 1954.

TABLE 1.—Salient statistics of the graphite industry in the United States, 1953–54

	1953		1954	
	Short tons	Value	Short tons	Value
Domestic graphite produced	6,281	(1)	(2)	(2)
Domestic graphite sold	4,850	$488,008	(2)	(2)
Natural graphite consumed [3]	[4] 34,884	[4] 4,778,981	33,038	$4,386,760
Imports:				
Crystalline flake	10,579	1,608,960	8,464	1,198,665
Lump, chip, or dust	79	7,958	653	100,191
Amorphous (natural)	40,382	1,176,613	31,510	970,771
Artificial	283	15,647	212	11,629
Total imports	51,323	2,809,178	40,839	2,281,256
Exports:				
Crystalline flake, lump, or chip	94	38,178	49	18,806
Amorphous (natural)	1,571	153,900	608	66,802
Other natural graphite	95	8,032	141	19,990
Total exports	1,760	200,110	798	105,598

1 Figure not available.
2 Figure withheld to avoid disclosure of individual company operations.
3 Minimum quantities as reported by consumers to the Bureau of Mines.
4 Revised figure.

TABLE 2.—Production and shipments of natural graphite in the United States, 1945–49 (average) and 1950–54

Year	Production (short tons)	Shipments		Year	Production (short tons)	Shipments	
		Short tons	Value			Short tons	Value
1945–49 (average)	6,180	6,094	$337,817	1952	5,606	5,081	$594,618
1950	5,102	5,605	427,908	1953	6,281	4,850	488,008
1951	7,135	6,808	771,434	1954	(1)	(1)	(1)

1 Figure withheld to avoid disclosure of individual company operations.

CONSUMPTION AND USES

Table 3 shows the quantity and value of natural graphite consumed in the United States, 1947–49 (average) and 1950–54, as reported to the Bureau of Mines by consumers.

The coverage of the Bureau of Mines consumption canvass was expanded during 1954 to obtain data from many consumers who previously were not requested to report, but the canvass remained incomplete. It was considered impracticable to attempt to attain a strict accounting of the uses for which available graphite was consumed, because of the large number of small consumers. Some duplication resulted from reporting of the same material as "processed for resale" by one establishment and as "used" by another establishment; in many instances, it was not possible for the consumers to identify the types and varieties of graphite present in mixtures obtained from suppliers. However, the discrepancies were mostly in the data for Mexican amorphous graphite and the less critical uses, such as foundry facings, paints, and similar applications.

TABLE 3.—Consumption of natural graphite in the United States, 1947–49 (average) and 1950–54

Year	Consumption		Year	Consumption	
	Short tons	Value		Short tons	Value
1947–49 (average)	18,142	$2,452,848	1952	26,911	$4,048,787
1950	20,878	3,010,761	1953	[1] 34,884	[1] 4,778,981
1951	38,318	5,083,527	1954	33,038	4,386,760

[1] Revised figure.

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 1954 data are presented in table 4.

TABLE 4.—Consumption of natural graphite in the United States in 1954, by uses

Use	Crystalline flake		Ceylon amorphous		Other amorphous [1]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Batteries	(2)	(2)	(2)	(2)	2,186	$161,891	(2)	(2)
Bearings	24	$8,494	111	$51,200	(2)	(2)	(2)	(2)
Brake lining	330	119,400	163	53,300	161	30,029	654	$202,729
Carbon brushes	48	23,833	306	157,356	99	16,262	453	197,451
Crucibles, retorts, stoppers, sleeves, and nozzles	2,715	590,233	(2)	(2)			(2)	(2)
Foundry facings	610	97,568	370	56,115	10,557	806,916	11,537	960,599
Lubricants	688	175,674	508	118,087	3,059	319,131	4,255	612,892
Packings	196	115,392	77	30,649	110	23,912	383	169,953
Paints and polishes	7	2,416	(2)	(2)	780	31,509	(2)	(2)
Pencils	108	49,637	842	305,575	953	121,413	1,903	476,625
Rubber	84	18,508	(2)	(2)	(2)	(2)	(2)	(2)
Steelmaking	91	16,439	(2)	(2)	6,860	698,642	(2)	(2)
Other [3]	313	74,960	94	53,408	588	58,811	13,853	1,766,511
Total	5,214	1,292,554	2,471	825,690	25,353	2,268,516	33,038	4,386,760

[1] Includes small quantity of mixtures of natural and manufactured graphite.
[2] Included with "Other."
[3] Includes adhesives, carbon resistors, chemical equipment and processes, electronic tubes, 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 1954. Quotations in E&MJ Metal and Mineral Markets were as follows: Per pound, carlots, f. o. b. shipping point (United States), crystalline flake, natural 85–87 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, 85–87 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[4]

Graphite imports for consumption in the United States decreased 20 percent in quantity and 19 percent in value from 1953 and represented the smallest quantity reported since 1949. Decreases were recorded for all countries of origin except Ceylon, Norway, and British East Africa. Imports were received from Hong Kong for the first time from a recently developed deposit on West Brother Island. The decrease in total imports was attributable to the 34-percent drop in the quantity of Mexican amorphous graphite imported for consumption in 1954. This decrease resulted, in part, from labor difficulties.

Imports for consumption from Canada decreased 33 percent. The only Canadian graphite producer ceased mining at the end of March; shipments were continued through August 1954.

TABLE 5.—Graphite (natural and artificial) imported for consumption in the United States, 1945–49 (average) and 1950–54

[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
1945–49 (average)	2,935	$300,435	1,250	$138,619	35,187	$1,071,174	69	$2,999	39,441	$1,513,227
1950	6,130	725,172	100	7,514	37,255	1,335,142	184	12,518	43,669	2,080,346
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										
North America:										
Canada	292	67,463			2,762	264,977	281	15,200	3,335	347,640
Mexico					34,136	553,443			34,136	553,443
Total	292	67,463			36,898	818,420	281	15,200	37,471	901,083
South America: Colombia					28	3,866			28	3,866
Europe:										
France	2	662							2	662
Germany, West	347	50,115	1	863	1,137	126,190			1,485	177,168
Norway					678	50,945			678	50,945
Switzerland					5	1,922	2	447	7	2,369
United Kingdom			1	445	12	2,145			13	2,590
Total	349	50,777	2	1,308	1,832	181,202	2	447	2,185	233,734
Asia: Ceylon			77	6,650	1,570	171,204			1,647	177,854

[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 5.—Graphite (natural and artificial) imported for consumption in the United States, 1945–49 (average) and 1950–54—Continued

	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
1953—Continued										
Africa:										
British East Africa	11	$1,356			27	$1,168			38	$2,524
Madagascar	9,927	1,489,364							9,927	1,489,364
Union of South Africa					27	753			27	753
Total	9,938	1,490,720			54	1,921			9,992	1,492,641
Total 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
Total 1954	8,464	1,198,665	653	100,191	31,510	970,771	212	11,629	40,839	2,281,256

The United States tariff rates on graphite, effective January 1, 1948, remained in force during 1954. 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, 1950–52, were: 1950, 1,397 tons, $173,700; 1951, 1,504 tons, $195,948; 1952, 1,786 tons, $211,125. Data for 1953 and 1954, by countries of destination and tariff classifications, are shown in table 6.

TABLE 6.—Graphite exported from the United States, 1953–54, 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
1953						
North America:						
Bahamas					7	$732
Canada	1,341	$115,847	17	$12,298	88	7,169
Cuba	19	2,563	13	2,778		
El Salvador			(1)	165		
Mexico	3	549	22	8,884		
Netherlands Antilles			3	1,620		
Nicaragua			(1)	129		
Total	1,363	118,959	55	25,874	95	7,901
South America:						
Chile	16	3,917	7	2,715		
Colombia	2	282	(1)	412		
Ecuador			(1)	101		
Peru			3	1,104		
Venezuela	23	3,810	5	1,277		
Total	41	8,009	15	5,609		
Europe:						
Austria	3	527				
Denmark	11	2,223	(1)	124		
France	11	1,414				
Germany, West	38	5,026				
United Kingdom	19	2,750				
Total	82	11,940	(1)	124		
Asia:						
India	10	870	(1)	126		
Israel and Palestine	4	703	6	1,544		
Japan	35	7,819				
Philippines	20	3,057	18	4,901		
Saudi Arabia					(1)	131
Total	69	12,449	24	6,571	(1)	131
Africa:						
French Morocco	6	953				
Union of South Africa	10	1,590				
Total	16	2,543				
Total 1953	1,571	153,900	94	38,178	95	8,032
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

See footnote at end of table.

TABLE 6.—Graphite exported from the United States, 1953–54, by countries of destination—Continued

Country	Amorphous		Crystalline flake, lump, or chip		Natural, n. e. c.	
	Short tons	Value	Short tons	Value	Short tons	Value
1954—Continued						
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				
Total 1954	608	66,802	49	18,806	141	19,990

[1] Less than 1 ton.

TECHNOLOGY

The genesis of the graphite in the Crystal graphite mine near Dillon Mont., was discussed.[5]

A number of articles were published during the year on various aspects of the manufacture, properties, and uses of manufactured graphite and carbon.[6] A bibliography on carbon and graphite electrodes was prepared.[7] North American Aviation Co., Inc., and the Atomic Energy Commission announced plans to build a 20,000-kw. reactor at Santa Susana, Calif., using liquid sodium for cooling and moderated by manufactured graphite.[8]

A method of refining natural graphite was described wherein graphite particles were caused to oscillate by means of high alternating-current voltage obtained from neon-sign transformers. Cost estimates for small commercial plants were given.[9]

The thermal conductivity of Canadian natural graphite was measured.[10]

[5] Ford, R. B., Occurrence and Origin of the Graphite Deposits Near Dillon, Mont.: Econ. Geol., vol. 49, No. 1, January-February 1954, pp. 31–43.

[6] Hader, R. N., Gamson, B. W., and Bailey, B. L., Graphite Electrodes: Ind. Eng. Chem., vol. 46, No. 1, January 1954, pp. 2–11. Landry, E. R., Foundry Uses of Carbon and Graphite Increasing: Canadian Metals (Toronto), vol. 17, No. 5, May 5, 1954, pp. 28, 30, 32. Austin, A. E., and Hedden, W. A., Graphitization Processes in Cokes and Carbon Blacks: Ind. Eng. Chem., vol. 46, No. 7, July 1954, pp. 1520–1524. Chemical Engineering, Carbon and Graphite: Vol. 61, No. 11, November 1954, pp. 194–195. Hogue, R. S., Westlake, R. L., and Moga, G. M., Carbon and Graphite Electrodes Evaluated for Use in Ferroalloy Furnaces: Jour. Metals, vol. 6, No. 12, December 1954, pp. 1379–1382. Maire, R., [Carbon as a Refractory in Metallurgy]: Silicates Industry (Brussels), vol. 19, No. 3, March 1954, pp. 108–116.

[7] Small Business Administration, U. S. Department of Commerce, Carbon and Graphite Electrodes: Catalog of Technical Reports, May 1954, 6 pp.

[8] Industrial and Engineering Chemistry, vol. 46, No. 5, May 1954, p. 7A.

[9] Kanaya, Kazuho, and Sekiguchi, Saburo, Refining Natural Graphite Under an Electrostatic Field at Commercial Frequency: Mem. Faculty Technology Tokyo Metropol. Univ., No. 3, 1953, pp. 45–56, 127–138; Chem. Abs., vol. 48, No. 13, July 10, 1954, p. 7857b.

[10] Smith, A. W., Low-Temperature Thermal Conductivity of a Canadian Natural Graphite: Phys. Rev., vol. 95, 1954, pp. 1095–1096.

The experimental mining and milling operations at the Benjamin Franklin graphite mine near Chester Springs, Pa., were concluded in December 1954. These operations were begun in 1953 by F. M. Equipment Corp. for the National Industrial Reserve Division of the General Services Administration. It was demonstrated that slightly more than 25 percent of the graphite recovered from the ore was plus-50-mesh flake suitable for crucible manufacturing and that the minus-50-mesh flake can be upgraded to meet the National Stockpile specifications for "Lubricant and Packing Grade" graphite by ball-mill grinding and flotation. The grade of the ore is low, averaging about 2.5 percent graphitic carbon, and the cost of the products would be at least twice that of comparable imported material.

WORLD REVIEW

Since 1951 the estimated world production of graphite has decreased annually and in 1954 was 84 percent of the 1951 figure and 93 percent of the 1953 figure. Output from Hong Kong, where production was

TABLE 7.—World production of natural graphite, by countries,[1] 1945–49 (average) and 1950–54, in short tons [2]

(Compiled by Helen L. Hunt)

Country [1]	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Canada	2,194	3,586	1,569	2,040	3,466	1,626
Mexico	29,242	27,145	36,691	26,623	33,433	24,013
United States	6,180	5,102	7,135	5,606	6,281	(3)
South America:						
Argentina	[4] 408	(5)	(5)	(5)	(5)	(5)
Brazil	2,123	519	672	938	—	(5)
Europe:						
Austria	7,389	16,187	20,092	21,728	16,185	19,184
Czechoslovakia	11,702	(5)	(5)	(5)	(5)	(5)
Germany, West	6,522	7,234	11,970	9,880	8,222	10,448
Italy	6,444	4,984	4,976	4,837	5,412	4,139
Norway	1,674	2,708	3,806	4,542	3,255	3,993
Spain	277	342	302	863	352	[4] 320
Sweden	86	—	—	—	—	—
Yugoslavia	—	—	—	757	—	—
Asia:						
Ceylon (exports)	11,456	14,363	14,136	8,578	8,084	8,548
China	[4] 2,205	—	(5)	(5)	(5)	(5)
Hong Kong	—	—	—	—	220	2,061
India	1,518	1,776	1,943	2,405	859	(5)
Japan	8,583	4,418	5,370	5,126	4,489	4,431
Korea, Republic of	[6] 30,934	18,058	26,074	16,601	21,416	15,344
Taiwan (Formosa)	(5)	(5)	(5)	772	—	(5)
Africa:						
Egypt	44	—	—	—	—	—
French Morocco	367	82	144	23	108	—
Kenya	1	—	—	39	205	224
Madagascar	8,556	15,447	20,214	20,368	14,847	13,284
Mozambique	116	—	265	—	—	(5)
South-West Africa	1,773	1,521	2,895	1,305	—	44
Spanish Morocco	90	3	—	19	—	(5)
Tanganyika	—	—	28	—	21	—
Union of South Africa	215	269	362	389	413	1,396
Oceania: Australia	250	162	52	89	17	(5)
World total (estimate)[1]	155,000	175,000	220,000	205,000	200,000	185,000

[1] In addition to countries listed, graphite has been produced in 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.
[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.
[6] Average for 1948–49.

reported in 1953 for the first time, increased more than eight fold; production from Union of South Africa more than doubled. Substantial increases also were reported in 1954, compared with 1953, from West Germany, Norway, Austria, and Ceylon. Decreases in production were reported from Canada, Mexico, Korea, Italy, and Madagascar.

Austria.—It was reported that Kaiserberg Graphite Mine Co., Styria, was producing 2 grades of flake graphite (83–86 percent carbon and 90 percent carbon) and that it planned to begin production of an additional grade analyzing up to 99 percent carbon.[11]

Canada.—The Black Donald mine, Calabogie, Ontario, discovered in 1889 and a producer since 1908, closed March 31, 1954, because of exhaustion of ore reserves. In recent years the Black Donald mine, operated by Frobisher, Ltd., has been the only producing graphite mine in Canada.[12]

Ceylon.—Graphite exports from Ceylon, 1950–54, by countries of destination and 1954 exports to the United States, by grade, are given in tables 8 and 9.

The mines of Bogala Graphite Co., Ltd. (closed Dec. 3, 1953 when about 450 workers went on strike), reopened July 1, 1954. The company made shipments from stock during the shut-down.[13]

TABLE 8.—Graphite exported from Ceylon, 1950–54, by countries of destination, in short tons [1]

(Compiled by John E. McDaniel)

Country	1950	1951	1952	1953	1954
North America:					
Canada	229	191	28	112	196
United States	6,409	5,513	2,539	1,938	2,054
Europe:					
Belgium			103		
Denmark	58	56			
France	112	136	143	83	163
Germany	71	86	97	77	20
Italy	402	108	3		8
Netherlands	50	17			11
Poland		113			
Rumania			100		
Sweden	33	29			
United Kingdom	5,588	5,720	3,374	3,429	4,172
Yugoslavia	89		112		
Asia:					
Hong Kong		13			8
India	402	398	244	417	274
Japan		715	1,122	1,588	1,219
Malaya	1	2	212		
Pakistan	83	68	20		91
Thailand	52	47	3	9	
Oceania:					
Australia	798	886	476	303	437
New Zealand		1			
Other countries	8	36	1	128	1
Total	14,385	14,135	8,577	8,084	8,654

[1] Compiled from Ceylon Customs Returns.

[11] Engineering and Mining Journal, vol. 155, No. 7, July 1955, p. 162.

[12] Andersen, A., Black Donald Graphite, 1942–53: Canadian Min. and Met. Bull. (Montreal), vol. 47, No. 510, October 1954, pp. 684–686.

[13] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 6, June 1954, p. 43; vol. 39, No. 3, September 1954, p. 57.

TABLE 9.—Exports of graphite from Ceylon to the United States, by grade, 1954 [1]

Grade	Short tons	Percent of total	Value per ton
97% C, or higher	780	36	$144.43
90%-96% C	1,230	57	112.04
Less than 90% C	157	7	91.54
Total	2,167	100	112.21

[1] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 5, May 1955, pp. 56-59.

Hong Kong.—Amorphous graphite averaging 80 percent graphitic carbon and 1 to 3 percent volatiles was mined during 1954 from a deposit on West Brother Island. The vein was reported to average about 3 feet in thickness with a range of 1 to 10 feet. The graphite was mined with hand tools, and blasting was used only when the mining was in country rock. The ore was loaded in baskets, carried to the mouth of the adit, and dumped into small wooden chutes leading to a storage shed. After air-drying, the graphite was packed in 224-pound bags and loaded directly into small boats from a small wooden jetty. About 30 laborers were employed, and output ranged from 2 to 10 long tons per day.[14]

India.—An occurrence of graphite at Narsipatnam was described.[15]

Kenya.—It was reported that Shah Vershi Devshi & Co. was producing 50 tons per month of flake graphite from a new mine.[16]

Madagascar.—Minimum prices for Madagascar crystalline flake graphite, effective October 24, 1953, as shown in table 10, were revised effective June 7, 1954. The chief modification of the old price schedule was elimination of density tests and simplification of the screen standards. It was specified that large flake graphite must have a minimum of 70 percent and small flake graphite a maximum retention of 25 percent on No. 40 screen. Other screen tests were abolished. This eliminated the premium accorded producers of graphite meeting slightly higher "E. C. A." screen standards.[17] Exports of graphite from Madagascar, 1949–53, by countries of destination, are given in table 11.

[14] Ruxton, B. P., Graphite in Hong Kong: Far Eastern Economic Review (Hong Kong), vol. 18, No. 4, Jan. 27, 1955, pp. 98-100.
[15] Das Gupta, S. K., The Graphite Deposit of Narsipatnam, Madras: Quart. Jour. Geol., Min. Met. Soc. India (Calcutta), vol. 26, 1954, pp. 105-113.
[16] E&MJ Metal and Mineral Markets, vol. 25, No. 51, Dec. 23, 1954, p. 3.
[17] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 6 June 1954, pp. 44-4

TABLE 10.—Prices for Madagascar flake and fines graphite, effective Oct. 24, 1953.

Flake graphite for crucibles (apparent density below 70)

Carbon, percent	Screen	Price per metric ton
85–87.5	Standard	$175
85–87.5	E. C. A.[1]	182
87.6–89.5	Standard	182
89.6–92.5	do	188
92.6 and above	do	208

Flake graphite unsuitable for crucibles (apparent density of more than 70), and fines

Carbon, percent	Screen	Price per metric ton
85–87.5	Standard	$160
72.5–77.5	Fines	80
77.6–82.5	do	95
82.6–87.5	do	110
87.6 and above	do	125

[1] Standards laid down in GSA contracts with Micouin-Pochard, Etablissements Rostaing, and Rene Izouard.

TABLE 11.—Graphite exported from Madagascar, 1949–53, by countries of destination, in short tons [1]

(Compiled by John E. McDaniel)

Country	1949	1950	1951	1952	1953
North America: United States	2,174	6,001	8,296	8,236	10,152
Europe:					
Belgium-Luxembourg	7	55	88	149	39
France	4,601	1,547	3,173	4,055	72
Italy	600	1,945	1,269	2,441	797
Netherlands	60	166	22		
United Kingdom	3,081	2,930	6,195	3,983	1,272
Asia: Japan	681	507		110	110
Oceania: Australia	132	127	353	220	99
Other countries		45	73	73	2,459
Total	11,336	13,323	19,469	19,267	15,000

[1] Compiled from Madagascar Customs Returns.

Mexico.—The production of graphite in Mexico decreased 28 percent in 1954 compared with 1953. The decrease resulted, in part, from a shortage of labor and a high labor turnover at the mines. Agricultural labor was in high demand during the year in areas contiguous to the mines, and many laborers recruited for work in the mines quit after only a few days or weeks and went to work in agriculture.

Scotland.—Graphite deposits near Loch Lochy, Invernesshire, were to be tested with a view to their ultimate commercial development.[18]

[18] Chemical Age (London), vol. 70, No. 1813, Apr. 10, 1954, p. 845.

Gypsum

By Oliver S. North[1] and Nan C. Jensen[2]

NEW RECORDS were set in 1954 for the output of domestic crude gypsum, many gypsum products, and total dollar value of gypsum products. Development of a new major gypsum field in Indiana, in the center of an important market area, was well underway by the end of the year. The high level of demand for nearly all gypsum products caused members of the industry to review expansion and new-plant proposals and possibilities in a number of areas.

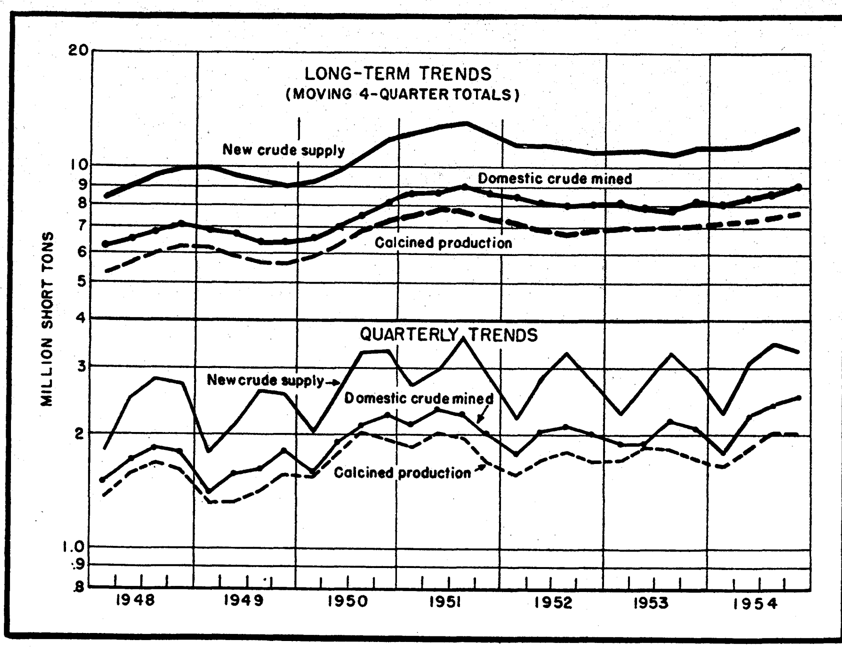

FIGURE 1.—Trends of new crude supply, domestic crude mined, and production of calcined gypsum 1948–54, by quarters.

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

TABLE 1.—Salient statistics of the gypsum industry in the United States, 1945–49 (average) and 1950–54

	1945–49 (average)	1950	1951	1952	1953	1954
Active establishments [1]	86	87	85	89	94	86
Crude gypsum: [2]						
Mined short tons	5,902,398	8,192,625	8,665,534	8,415,300	8,292,876	8,995,960
Imported do	1,915,098	3,219,299	3,436,927	3,087,884	3,184,292	3,368,133
Apparent supply do	7,817,496	11,411,924	12,102,461	11,503,184	11,477,168	12,364,093
Calcined gypsum produced:						
Short tons	[3] 4,735,245	7,341,024	7,454,916	6,874,432	7,166,005	7,617,617
Value	[3] $35,214,631	$60,479,573	$65,761,032	$59,696,410	$66,668,981	$76,170,562
Gypsum products sold: [4]						
Uncalcined uses:						
Short tons	1,791,035	2,218,286	2,530,379	2,705,727	2,656,446	2,745,571
Value	$6,121,077	$7,911,988	$9,413,098	$9,616,780	$9,844,330	$10,592,392
Industrial uses:						
Short tons	200,661	266,192	288,713	252,216	254,148	250,088
Value	$3,242,176	$4,530,159	$5,467,803	$4,999,779	$5,260,875	$5,383,874
Building uses:						
Value	$114,760,580	$192,940,452	$220,954,226	$210,307,189	$229,948,261	$256,176,655
Total value	$124,123,833	$205,382,599	$235,835,127	$224,923,748	$245,053,466	$272,152,921
Gypsum and gypsum products:						
Imported for consumption	$2,173,690	$3,584,152	$3,813,892	$3,694,975	$4,792,191	[5] $5,377,710
Exported	$1,484,137	$1,046,458	$1,584,488	$1,216,294	$1,993,671	$1,600,477

[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 1945–46.
[4] Made from domestic, imported, and byproduct gypsum.
[5] Due to changes in tabulating procedures by the U. S. Department of Commerce data known not to be comparable with previous years.

DOMESTIC PRODUCTION

Crude.—Reversing its downward trend of the 2 preceding years, output of crude gypsum from mines in the United States was at a record high in 1954, 8 percent higher than in 1953 and 4 percent higher than in 1951, the previous record year. Of the States for which production can be shown, increased tonnages were mined in Michigan, New York, and Texas, and minor declines occurred in California, Iowa, and Nevada, compared with 1953. A total of 66 mines, in 21 States, reported production; of these, 50 were open-pit operations, 13 were underground mines, and 3 were combination pit-underground mines.

Calcined.—Fifty plants, with 226 pieces of calcining equipment, were in operation. Six percent more calcined gypsum was produced in 1954 than in 1953. Production of calcined gypsum—the form in which most gypsum is utilized—is considered the most accurate overall measure of activity in the industry, as it reflects consumption of both domestic and imported raw material.

Mine and Products-Plant Developments.—Early development of the recently discovered gypsum deposits in southwestern Indiana was pushed by three companies. National Gypsum Co. and United States Gypsum Co. had plants and mine shafts near Shoals well advanced by the end of 1954, and The Ruberoid Co. had acquired some 1,200 acres of gypsum land in the area and announced its intention to build a plant. Some believed that the gypsiferous bed farther north might show localized occurrences of commercial quality and quantity.[3]

[3] Business Week, Gypsum Edges Nearer Market: No. 1315, Nov. 13, 1954, pp. 168–169.

TABLE 2.—Crude gypsum mined in the United States, 1952–54, by States [1]

State	Active mines			1952		1953		1954	
	1952	1953	1954	Short tons	Value	Short tons	Value	Short tons	Value
California	13	16	15	1,236,430	$2,721,134	1,199,489	$2,855,983	1,161,502	$2,803,862
Iowa	4	4	4	1,122,409	2,797,704	1,151,692	2,939,654	1,106,626	3,035,651
Michigan	4	4	4	1,487,642	4,200,418	1,446,973	4,091,002	1,693,279	5,035,550
Nevada	4	4	4	608,284	1,666,938	701,584	1,975,053	654,422	2,217,273
New York	5	5	5	1,143,920	3,816,148	987,156	3,507,207	1,133,579	4,005,353
Texas	5	5	6	1,021,161	2,682,019	1,067,854	2,860,633	1,218,048	3,773,230
Other:									
Arizona	1	1	2						
Arkansas	1	1	1						
Kansas	2	2	2	446,705	777,975				
Louisiana	1	1	1						
Colorado	3	5	5						
Idaho	1	1	1			586,301	1,323,430	696,215	1,613,529
Montana	2	2	2						
New Mexico			1	170,457	546,373				
South Dakota			1						
Washington	1	1	1						
Wyoming	1	1	3						
Ohio	2	2	2						
Oklahoma	3	3	3						
Utah	2	2	2	1,178,292	3,687,342	1,151,827	3,622,111	1,332,289	4,899,067
Virginia	1	1	1						
Total	56	61	66	8,415,300	22,896,051	8,292,876	23,175,073	8,995,960	27,383,515

[1] Production of some States is not shown separately, to avoid disclosing individual company operations.

TABLE 3.—Calcined gypsum produced in the United States, 1953–54, by districts

District	1953		1954	
	Short tons	Value	Short tons	Value
New Hampshire, Massachusetts, and Connecticut	261,434	$2,569,177	280,957	$2,833,861
Eastern New York, New Jersey, Pennsylvania, Georgia, and Florida	1,331,302	13,086,768	1,427,986	14,180,366
Ohio, Virginia, Indiana, and Maryland	1,055,610	11,328,596	1,106,321	12,496,485
Western New York	654,174	5,969,663	722,966	6,934,060
Michigan	660,908	5,718,867	679,511	6,325,619
Iowa	756,783	6,205,931	758,379	7,217,016
Kansas and Oklahoma	448,897	3,519,841	460,530	3,965,093
Texas	730,083	7,020,270	820,778	8,796,259
Colorado, Montana, and Utah	256,980	2,778,613	[1] 286,978	[1] 3,585,491
California and Nevada	1,009,834	8,471,255	1,073,211	9,836,312
Total	7,166,005	66,668,981	7,617,617	76,170,562

[1] Includes Washington.

In September Kaiser Gypsum Co. officially opened its Seattle, Wash., gypsum plaster and wallboard plant. This facility, first of its kind in the northwest, will manufacture gypsum products from crude material mined at company-owned deposits on San Marcos Island, Mexico. The market area of the new plant was said to include Washington, Oregon, Idaho, and Alaska. Descriptions of the plant, processing methods, and products were published.[4]

The Ruberoid Co., New York, N. Y., added gypsum products to its line of building materials by acquiring the Wheatland, N. Y., gypsum deposits and products plant of Ebsary Gypsum Co.[5] The

[4] Chemical and Engineering News, First Gypsum Plant in Northwest: Vol. 32, No. 39, Sept. 27, 1954, pp. 3852–3853.

Lenhart, W. B., Automatic Controls in Newest Gypsum Plaster and Wallboard Plant: Rock Products, vol. 57, No. 12, December 1954, pp. 72–80, 82, 84, 86, 118–119.

[5] Pit and Quarry (news item), vol. 47, No. 3, September 1954, p. 34.

Ruberoid Co. also operated an asbestos mine in Vermont and a number of asbestos-cement and asphalt roofing plants.

A gypsum-crushing plant was built in Lovelock, Nev., to prepare agricultural material from gypsum quarried in the Humboldt Range near Lovelock.[6] Also at Lovelock, Pabco Products Co. acquired the gypsum deposit formerly owned by Ideal Cement Co. This deposit was believed to be the nearest one of its kind to the San Francisco Bay area.[7]

Columbia Gypsum Products, Inc., Spokane, Wash., which owned and operated a gypsum mine near Windermere, B. C., Canada, was said to have increased its output sharply. Most of its product was used as portland-cement retarder.[8]

A sizable deposit of gypsum was reported to have been discovered on the Navajo Indian Reservation near Flagstaff, Ariz., but it seemed likely that the remoteness would deter any immediate commercial development.[9]

Announced plant expansion and improvement programs included: United States Gypsum Co. at Jacksonville, Fla., Celotex Corp. at Port Clinton, Ohio; Blue Diamond Corp. at Blue Diamond, Nev.; and National Gypsum Co. at Clarence Center, N.Y., Baltimore, New York, and Savannah.

CONSUMPTION AND USES

Expenditures for new construction in the United States totaled approximately $37 billion in 1954 compared with $34.7 billion in 1953 and $32.3 billion in 1952. About 1,200,000 new non-farm-dwelling units were started during the year compared with approximately 1,100,000 in 1953.

In line with the steadily increasing volume of new construction, maintenance, and repair work, the consumption of most gypsum building products, particularly high-value prefabricated materials, was at record or near-record high. There were occasional spot shortages of certain gypsum products, especially wallboard. The high current demand and generally optimistic construction outlook encouraged several members of the industry to announce expansion plans for some plants and to reconsider proposals for building new plants in some areas.

Consumption of gypsum products was normal in the first quarter of 1954, but by the end of the second quarter and throughout the latter half of the year most major gypsum products were consumed in record quantities.

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[6] California Mining Journal (news item), vol. 24, No. 3, November 1954, p. 23.
[7] Rock Products (news item), vol. 57, No. 12, December 1954, p. 62.
[8] Rock Products (news item), vol. 57, No. 6, June 1954, p. 69.
[9] Rock Products (news item), vol. 57, No. 9, September 1954, p. 57.

The growing use of wallboard is indicated by the following percentage gains in quantity for that product in successive quarters compared with its production in the same quarters of 1953: 1, 11, 18, and 20. On the same basis, sanded plasters (containing sand, perlite, or other aggregate) registered percentage gains as follows: 27, 37, 42, and 34. The normal demand for sanded plasters before 1952 was about 125,000 tons annually, but with the growth in use of the perlite-premixed product, sales in 1954 exceeded 400,000 tons.

The most notable tonnage declines were drops of 8 percent each for agricultural gypsum and gaging and molding plasters and 4 percent for Keene's cement. The latter decreases were ascribed to changing construction practices and competition from other products, while agricultural gypsum's decline was due to a number of reasons, including competitive products and reduction of Government financial encouragement for using the material.

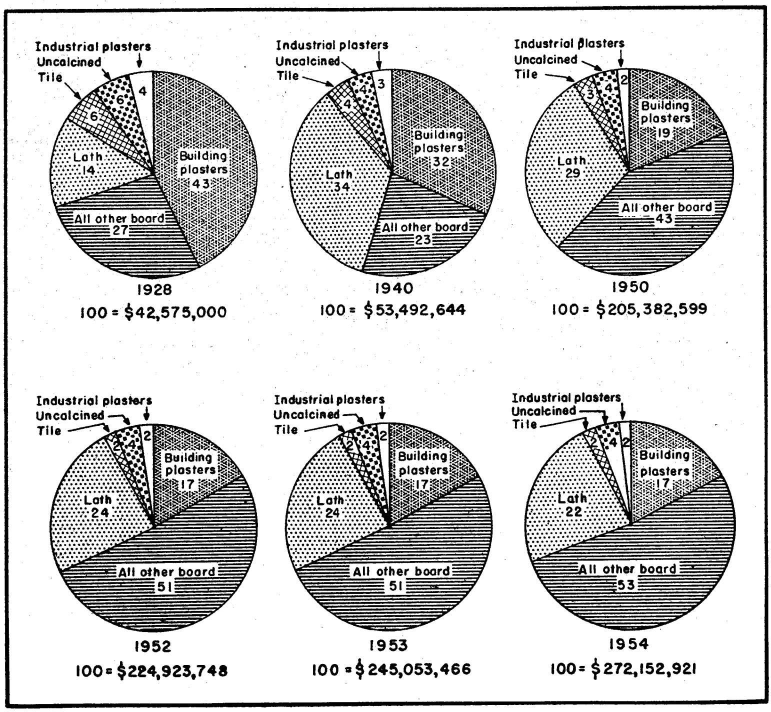

FIGURE 2.—Percentage distribution of total sales value, f. o. b. plant, of gypsum products in 1928, 1940, 1950, and 1952–54, by groups of products.

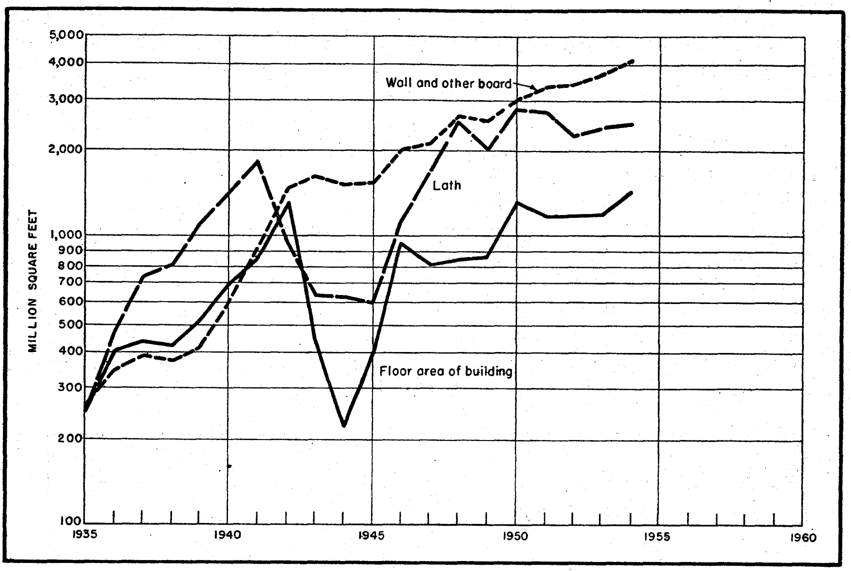

FIGURE 3.—Trends in sales of gypsum lath and wallboard and other boards (including wallboard, laminated board in terms of component board, formboard, and sheathing), compared with Dodge Corp. figures on combined floor area of residential and nonresidential building, 1935–54.

TABLE 4.—Active calcining plants and equipment in the United States, 1952–54, by States

State	1952			1953			1954		
	Calcining plants	Equipment		Calcining plants	Equipment		Calcining plants	Equipment	
		Kettles	Other calciners [1]		Kettles	Other calciners [1]		Kettles	Other calciners [1]
California	5	11	8	5	12	8	5	12	8
Iowa	5	24	4	5	22	4	5	21	4
Michigan	4	20	1	4	20	1	4	20	--------
New York	7	22	6	7	22	6	7	21	7
Texas	4	30	1	4	31	1	4	28	--------
Other States [2]	25	74	23	23	71	21	25	82	23
Total	50	181	43	48	178	41	50	184	42

[1] Includes rotary and beehive kilns, grinding-calcining units, and hydrocal cylinders.
[2] Comprises calcining plants in 1952–54 as follows: 1 each in Connecticut, Florida, Georgia, Indiana, Maryland, Massachusetts, Montana (2 in 1952), New Hampshire, Oklahoma, Pennsylvania, and Washington (1954); 2 each in Colorado, Kansas, Nevada, New Jersey (1 in 1952–53), Ohio, Utah (3 in 1952), and Virginia.

TABLE 5.—Gypsum products (made from domestic, imported, and byproduct crude gypsum) sold or used in the United States, 1953–54, by uses

Use	1953			1954			Percent of change in—	
	Short tons	Value		Short tons	Value			
		Total	Average		Total	Average	Tonnage	Average value
Uncalcined:								
Portland-cement retarder	1,907,031	$6,842,516	$3.59	2,050,985	$7,694,811	$3.75	+8	+4
Agricultural gypsum	721,993	2,646,389	3.67	663,042	2,498,601	3.77	−8	+3
Other uses [1]	27,422	355,425	12.96	31,544	398,980	12.65	+15	−2
Total uncalcined uses	2,656,446	9,844,330	3.71	2,745,571	10,592,392	3.86	+3	+4
Industrial:								
Plate-glass and terra-cotta plasters	60,290	754,116	12.51	53,492	725,597	13.56	−11	+8
Pottery plasters	43,957	824,381	18.75	43,576	838,703	19.25	−1	+3
Orthopedic and dental plasters	10,613	401,192	37.80	9,339	342,427	36.67	−12	−3
Industrial molding, art, and casting plasters	69,560	1,286,249	18.49	80,602	1,564,670	19.41	+16	+5
Other industrial uses [2]	69,728	1,994,937	28.61	63,079	1,912,477	30.32	−10	+6
Total industrial uses	254,148	5,260,875	20.70	250,088	5,383,874	21.53	−2	+4
Building:								
Cementitious:								
Plasters:								
Base-coat	1,727,088	24,815,667	14.37	1,705,633	25,181,231	14.76	−1	+3
Sanded	300,603	6,416,673	21.35	406,391	8,974,116	22.08	+35	+3
To mixing plants	11,570	127,185	10.99	9,645	118,428	12.28	−17	+12
Gaging and molding	168,539	2,842,686	16.87	154,441	2,663,544	17.25	−8	+2
Prepared finishes	12,096	822,317	67.98	11,965	859,442	71.83	−1	+6
Roof-deck	289,177	4,084,194	14.12	336,889	4,895,436	14.53	+16	+3
Other [3]	20,391	1,483,528	72.75	19,613	1,487,175	75.83	−4	+4
Keene's cement	51,475	1,193,135	23.18	49,285	1,175,251	23.85	−4	+3
Total cementitious	2,580,939	41,785,385	16.19	2,693,862	45,354,623	16.84	+4	+4
Prefabricated:								
Lath	1,864,983	58,396,664	[4] 23.96	1,910,622	60,744,726	[4] 24.40	[5] +2	+2
Wallboard	3,178,193	119,967,024	[4] 33.66	3,652,216	139,010,481	[4] 34.69	[5] +12	+3
Sheathing board	126,876	4,366,801	[4] 36.52	139,647	5,010,992	[4] 37.11	[5] +13	+2
Laminated board	3,320	144,050	[4] 49.30	2,087	94,522	[4] 52.28	[5] −38	+6
Formboard for poured-in-place gypsum roof-deck	42,195	1,519,180	[4] 38.44	44,518	1,666,178	[4] 39.47	[5] +7	+3
Tile	153,617	3,769,157	[6] 84.20	174,472	4,295,133	[6] 86.20	[5] +17	+2
Total prefabricated	5,369,184	188,162,876	35.04	5,923,562	210,822,032	35.59	[5] +8	+2
Total building uses		229,948,261			256,176,655			
Grand total value		245,053,466			272,152,921			

[1] Includes uncalcined gypsum for use as filler and rock dust, in brewer's fixe, in color manufacture, and for unspecified uses.
[2] Includes dead-burned filler, granite polishing, and miscellaneous uses.
[3] Includes joint filler, patching, painter's, insulating, and unclassified building plasters.
[4] Average value per thousand square feet.
[5] Percent of change in square footage.
[6] Average value per thousand square feet of partition tile only.

TABLE 6.—Gypsum board and tile sold or used in the United States, 1945–49 (average) and 1950–54, 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]
1945–49 (average)	1,594,195	$31,125,414	$19.52	2,040,005	$53,190,247	$26.07	102,138	$3,112,004	$30.47
1950	2,793,620	60,621,179	21.70	[2] 2,901,947	[2] 84,693,753	[3] 29.16	113,785	3,850,763	33.84
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

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]
1945–49 (average)	28,967	$1,085,356	$37.47	(7)	(7)	(7)	23,864	$2,558,542	$64.76
1950	(2)	(2)	(8)	(7)	(7)	(7)	45,032	4,992,467	75.26
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
1953	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

[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, 1953–54, by thickness

	1953				1954			
	Thousand square feet	Short tons	Value		Thousand square feet	Short tons	Value	
			Total	Average [1]			Total	Average [1]
Lath:								
3/8 inch [2]	2,416,675	1,843,409	$57,771,746	$23.91	2,469,393	1,889,254	$60,133,114	$24.35
1/2 inch	20,806	21,574	624,918	30.04	20,272	21,368	611,612	30.17
Total	2,437,481	1,864,983	58,396,664	23.96	2,489,665	1,910,622	60,744,726	24.40
Wallboard:								
1/4 inch	102,534	59,487	2,834,189	27.64	102,038	57,608	2,880,972	28.23
3/8 inch [3]	1,941,427	1,528,220	62,049,294	31.96	1,926,793	1,535,287	62,831,536	32.61
1/2 inch	1,478,651	1,533,034	53,045,666	35.87	1,920,573	1,979,828	70,378,239	36.64
5/8 inch	41,815	57,452	2,037,875	48.74	57,547	79,493	2,919,734	50.74
Total	3,564,427	3,178,193	119,967,024	33.66	4,006,951	3,652,216	139,010,481	34.69

[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 1,664,000 short tons on hand December 31, 1954, compared with 1,529,000 tons on the same date of the preceding year and 1,689,000 tons at the end of 1952.

PRICES

According to reports from producers, the average value of crude gypsum mined in 1954 was $3.04 per short ton, compared with $2.79 in 1953 and $2.72 in 1952. Among the uncalcined uses, average values of both portland-cement retarder and agricultural gypsum were higher, but the average value of miscellaneous uncalcined gypsum products declined slightly. All industrial plasters were higher in average value except orthopedic and dental plasters. Average values of the building plasters were uniformly higher in 1954 than in 1953. The average values of all prefabricated-product classifications also were slightly higher in 1954 than in 1953.

FOREIGN TRADE [10]

Imports of crude gypsum into the United States increased 6 percent over 1953. Canada supplied 85 percent of the total 1954 imports, compared with 89 percent in 1953. This drop was mostly due to greatly increased shipments of gypsum from Jamaica into the United States; however, Canadian sources still supplied 23 percent of all crude gypsum consumed in the United States. Imports from Dominican Republic in 1954 nearly doubled those in 1953, while imports from Mexico rose moderately. The opening of the new products plant in Seattle, using Mexican gypsum, resulted in a rise in imports from that source.

TABLE 8.—Gypsum and gypsum products imported for consumption in the United States, 1945–49 (average) and 1950–54

[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			
1945–49 (average)	1,915,098	$2,016,923	550	$14,963	35	$888	$92,841	$48,075	$2,173,690
1950	3,219,299	3,276,707	953	23,687	1	173	61,444	222,141	3,584,152
1951	3,426,927	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

[1] Includes imports of jet manufactures, which are believed to be negligible.
[2] Less than 1 ton.
[3] Due to changes in tabulating procedures by the U. S. Department of Commerce data known not to be comparable with previous years.

[10] 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, 1952–54, by countries

[U. S. Department of Commerce]

Country	1952		1953		1954	
	Short tons	Value	Short tons	Value	Short tons	Value [1]
Canada	2,806,799	$2,917,999	2,832,077	$3,914,879	2,873,633	$4,352,767
Dominican Republic	2,240	8,000	11,672	31,384	22,378	58,813
Jamaica	35,784	102,963	58,099	87,427	174,348	197,022
Mexico	243,061	217,181	282,444	254,899	297,774	269,803
Total	3,087,884	3,246,143	3,184,292	4,288,589	3,368,133	4,878,405

[1] Due to changes in tabulating procedures by the U. S. Department of Commerce data known not to be comparable with previous years.

TABLE 10.—Gypsum and gypsum products exported from the United States, 1945–49 (average) and 1950–54

[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		
1945–49 (average)	18,245	$394,664	26,695,663	$806,598	$282,875	$1,484,137
1950	23,678	524,926	13,618,353	428,549	92,983	1,046,458
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

[1] Effective Jan. 1, 1949, calcined gypsum not separable from crude, crushed, or calcined.

TECHNOLOGY

Geology.—A report discussed in detail the geology and theory of origin of the gypsum beds in southwestern Indiana.[11] Subsurface studies revealed extensive deposits of gypsum of varying grade and thickness in the area. Stratigraphic analysis indicated that gypsum and anhydrite accumulated in small basins within larger basins.

The geology of the gypsum deposit in the Palen Mountains of California was described.[12] The deposit, 5 square miles in area, is at the north end of the Palen Mountains, 50 miles northwest of Blythe. The gypsum occurs in massive beds of finely crystalline material interbedded with marble or as thinly laminated, gypsiferous, epidotic schists.

The origin and geology of the Nova Scotia gypsum deposits were studied.[13] The investigator concluded that Nova Scotia calcium sulfate deposits were formed in a lagoon or lagoons during the Lower Carboniferous age. The lagoons were rhythmically replenished by sea waters over a bar or through a permeable barrier. The temperature was high enough to allow stable anhydrite to form. When the

[11] McGregor, D. J., Gypsum and Anhydrite Deposits in Southwestern Indiana: Indiana Dept. of Conservation, Geol. Survey Rept. of Progress 8, 1954, 24 pp.
[12] Hoppin, R. A., Geology of the Palen Mountains Gypsum Deposit, Riverside County, Calif.: California Dept. of Natural Resources, Div. Min., Special Rept. 36, February 1954, 25 pp.
[13] Goodman, N. R., The Geology of Nova Scotian Gypsum: Canadian Min. and Met. Bull. (Montreal), vol. 47, No. 502, February 1954, pp. 75–80.

lagoonal waters were removed, trapped connate waters rapidly altered the top layers of anhydrite to gypsum.

Patents.—A patented material for supporting and insulating electrical apparatus comprises a mixture of stated proportions of gypsum for body, ground silicon dioxide for dielectric properties, and dextrin as a binder.[14] When dried and baked properly, the composition is coated with a layer of one of the organo-silicon oxide polymers in liquid form to provide a moisture-impervious surface seal.

A patent disclosed the use of glass fibers in gypsum-plaster compositions, gypsum wallboard, etc. It was claimed that, compared with many materials used, products manufactured in the manner proposed have better resistance to cracking, improved workability of the resulting plaster, and desirable economic qualities.[15]

A method for making and using preplastered gypsum wallboard was set forth in a patent.[16] Conventional plasterboard is coated at the factory with a base-coat vermiculite-gypsum plaster, which in turn is sprayed with a solution of sodium silicate and sprinkled with a mixture of Keene's cement and hydrated finishing lime. The latter coating constitutes a water-setting, unset layer. After the board is in place on the job, the unset layer is wetted and worked with a brush or trowel like job-placed plaster and subsequently sets in the same way as regular wall plaster. It was claimed that this plasterboard and method of application will be of particular value to amateur plasterers and builders.

Testing.—Gypsum and mixtures of gypsum with silica, alumina, iron oxide, kaolin, and carbon were tested by differential thermal methods to determine the properties of gypsum decomposed under various conditions. Five peaks were observed in the thermogram of gypsum heated in air. The addition of silica, iron oxide, kaolin, or alumina had little effect on the temperature at which the gypsum decomposed, but the addition of 20 percent carbon to the gypsum and heating in a nitrogen atmosphere caused decomposition to start at a temperature as low as 615° C.[17]

An investigation was made to determine the availability of calcium to a growing crop from each of three sources: Gypsum, calcium carbonate, and a green manure crop. Results indicated that the yield of total plant material was higher on the gypsum and green manure treatments than on the calcium carbonate treatment.[18]

Results of a study indicated to the investigators that the sulfur dioxide concentration in the byproduct calcium sulfate called phosphogypsum derived from large wet-process phosphoric acid plants may be high enough to permit economic recovery of sulfur.[19]

The effect of the addition of various materials on the solubility, setting time, and tensile strength of calcined gypsum was investigated, and the results were tabulated in a published paper.[20]

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[14] Drummond, H., Composition of Matter, Method of Embedding an Electrical Element Therein, and the Article Produced Thereby: U. S. Patent 2,691,610, October 12, 1954.

[15] Croce, M., and Shuttleworth, C. G. (assigned to Ce.tain-teed Products Corp., Ardmore, Pa.), Plaster Compositions and Products: U. S. Patent 2,681,863, June 22, 1954.

[16] Cleary, D. E., Plasterboard: U. S. Patent 2,687,359, Aug. 24, 1954.

[17] West, R. R., and Sutton, W. J., Thermography of Gypsum: Am. Ceramic Soc. Jour., vol. 37, No. 5, May 1954, pp. 221–224.

[18] Jacobs, H. S., and Jordan, J. V., Effect of Uptake of Radiocalcium: Agricultural and Food Chem., vol. 2, No. 18, Sept. 1, 1954, pp. 934–937.

[19] Stinson, J. M., and Mumma, C. E., Regeneration of Sulfuric Acid From Byproduct Calcium Sulfate: Ind. Eng. Chem., vol. 46, No. 3, March 1954, pp. 453–457.

[20] Riddell, W. C., Effect of Some Inorganic and Organic Compounds on the Solubility, Setting Time, and Tensile Strength of Calcined Gypsum: Rock Products, vol. 57, No. 10, October 1954, pp. 109, 113, 117.

Results of alkali-soil-reclamation tests in the Tulelake Basin, Calif., demonstrated that alkali soils can be improved or reclaimed by irrigation, proper drainage, and the use of soil correctives such as gypsum.[21]

Use.—Gypsum was reported to improve soil drainage in low-lying fields or "wet spots." Increased water-infiltration rates were believed to be due to flocculation of soil particles by the gypsum.[22]

The use of gypsum to clear water in farm ponds was reported. The gypsum caused clays held in suspension in the water to settle without injury to fish and fish foods present.[23]

An article described apparatus for installing gypsum moisture blocks.[24] These units are used to obtain accurate knowledge of the prevailing moisture conditions in soil, to facilitate proper irrigation timing and quantity of water.

Untreated plaster of paris soil-moisture blocks tend to disintegrate rapidly in very wet soils. Investigation showed that blocks impregnated with a nylon plastic resin are much more durable and possess other improved performance characteristics.[25]

Improved methods of making gypsum plaster models for use in ceramic plants were described.[26] The technique of molding gypsum plaster under a template has made it possible for semiskilled workmen to form good models and permits duplicate models to be formed in a fraction of the time formerly required.

The use of gypsum cement for die-sinking patterns in the automotive and aircraft forging industries was reported to have facilitated this phase of tooling to such a degree that it is now considered an essential tooling medium. Compared with metal or wood die-sinking patterns, the gypsum-cement patterns are said to afford important advantages in pattern-making time, accuracy and stability of dimensions, adaptability to complex shapes, reproduction or duplication of existing patterns and models, quick and easy modification, and comparatively small investment in tools and shop equipment[27].

The various kinds of industrial plasters on the market were discussed in an article. Each kind is intended for a more or less specific use. From a ceramic point of view, by far the most important plasters were said to be those formulated of alpha gypsum.[28]

According to news reports, an Australian firm was precasting the walls and roof of an entire room as a single unit, using gypsum plaster and reinforcing steel wire. Cast at the factory, the units were transported to the site and there juxtaposed to form complete frameworks for dwellings, which were then finished in a variety of ways.[29]

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21 Baghott, K. G., Schoonover, W., and Quick, J., Alkali-Soil-Reclamation Tests: California Agriculture, vol. 8, No. 7, July 1954, pp. 10, 14.
22 Rinehart, J. C., Gypsum Makes Wet Spots Drain: Crops and Soils, vol. 6, No. 7, April–May 1954, pp. 16–17, 34.
23 Phifer, B., Clear Your Muddy Pond: Country Gentleman, vol. 124, No. 5, May 1954, p. 39.
24 Mackaness, F. G., and Rowse, R. L., Equipment for Installing Gypsum Moisture Blocks: Agricultural Eng., vol. 35, No. 5, May 1954, p. 337.
25 Bouyoucos, G. J., More Durable Plaster of Paris Moisture Blocks: Soil Science, vol. 76, No. 6, December 1953, pp. 447–451.
26 Young, M. K., Recent Developments in Plaster Model Making: American Ceramic Soc. Bull., vol. 33, No. 3, March 1954, pp. 83–86.
27 Young, M. K., Gypsum-Cement Patterns Simplify Die Sinking: Tool Eng., vol. 33, No. 4, October 1954, pp. 48–52.
28 Lambe, C. M., and Offutt, J. S., Consistency Classification of Industrial Plasters: Am. Ceram. Soc. Bull., vol. 33, No. 9, September 1954, pp. 272–276.
29 Engineering News-Record, Plaster Precast in Room-Size Units: Vol. 153, No. 8, Aug. 19, 1954, p. 67.

WORLD REVIEW

NORTH AMERICA

Canada.—Coincident to an investigation of magnetite deposits east of St. Georges, Newfoundland, gypsum beds in the same area were examined. Thick beds of gypsum are exposed near the mouth of Sheep Brook and Coal Brook. In many places the outcropping gypsum is white or light gray and relatively pure.[30]

TABLE 11.—World production of gypsum, by countries,[1] 1945–49 (average) and 1950–54, in short tons [2]

(Compiled by Helen L. Hunt)

Country [1]	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Canada [3]	2,419,384	3,780,211	3,928,377	3,553,917	3,839,040	3,947,463
Cuba [4]	15,432	17,000	33,000	33,000	33,000	33,000
Dominican Republic	11,703		23,411	14,179	20,491	29,212
Jamaica	[5] 10,641	25,760	29,953	50,288	82,984	185,712
United States	5,902,398	8,192,625	8,665,534	8,415,300	8,292,876	8,995,960
Total [1 4]	8,390,000	12,043,000	12,724,000	12,177,000	12,380,000	13,300,000
South America:						
Argentina	[4] 123,800	123,459	143,300	176,370	(6)	(6)
Brazil	[4] 55,000	[4] 56,000				
Chile	69,497	72,211	75,991	81,549	77,162	82,673
Colombia	[4] 6,000	4,157	5,386	5,385	9,370	16,535
Ecuador	[5] 494	478	152	43		
Peru	46,535	35,182	34,050	35,159	31,256	(6)
Venezuela [7]	2,176	2,260	1,548	168	(6)	(6)
Total [4]	305,000	294,000	260,427	298,674	230,000	300,000
Europe:						
Austria [3]	23,518	46,628	131,577	206,727	330,633	404,158
Bulgaria [4]	6,000	6,000	6,000	6,000	6,000	6,000
Finland	[4] 2,100	(6)				(6)
France [3]	1,987,292	2,194,709	1,884,141	2,854,322	3,035,206	3,306,930
Germany, West	[8] 314,269	[8] 808,777	[8] 898,322	583,244	687,798	742,390
Greece	1,612	904	19,785	20,944	(6)	(6)
Ireland	50,193	91,126	95,230	82,283	(6)	(6)
Italy	334,185	538,803	638,770	743,482	661,386	685,165
Luxembourg	23,656	19,672	13,580	5,591	10,419	2,118
Poland	15,487	36,182	(6)	(6)	(6)	(6)
Portugal	35,083	39,721	33,062	43,666	51,115	(6)
Spain	1,365,006	2,482,216	2,008,052	1,759,322	1,153,660	(6)
Sweden	64					
Switzerland	125,000	[4] 90,000	135,000	[4] 135,000	140,000	165,000
United Kingdom:						
Great Britian [3]	2,006,569	2,471,060	2,558,533	2,682,069	2,976,517	[4] 3,100,000
Northern Ireland	15		191			
Yugoslavia	[4] 11,000	(6)	17,360	19,138	49,038	(6)
Total [1 4]	7,600,000	10,600,000	11,900,000	12,700,000	12,700,000	13,200,000
Asia:						
Ceylon	115		460	756	480	257
China [4]	50,000	70,000	80,000	90,000	110,000	120,000
Cyprus (exports)	45,460	72,185	25,542	62,339	116,058	111,904
India	91,196	231,130	228,046	460,002	652,640	[4] 725,000
Iran [4 9]	[10] 215,600	417,000	130,000	140,000	180,000	170,000
Iraq [4]	210,000	275,000	275,000	275,000	275,000	275,000
Israel	[4] 15,200	26,040	[4] 22,000	[4] 28,000	[4] 25,000	[4] 31,000
Japan	93,832	126,407	222,052	221,172	298,837	372,106
Pakistan	[4] 15,000	18,659	25,123	32,698	30,831	34,888
Philippines	778	3,178	440			
Syria [11]	1,786	2,205	9,006	6,063	827	827
Taiwan (Formosa)	2,173	2,561	2,740	7,401	2,105	4,082
Thailand (Siam)	134	370	87			
Total [4]	740,000	1,240,000	1,020,000	1,325,000	1,690,000	1,845,000

See footnotes at end of table.

[30] Baird, D. M., The Magnetite and Gypsum Deposits of the Sheep Brook-Lookout Brook Area: Canada Dept. Mines and Tech. Survey, Geol. Survey Canada, Bull. 27, Ottawa, 1954, pp. 20–41.

TABLE 11.—World production of gypsum, by countries,[1] 1945–49 (average) and 1950–54, in short tons [2]—Continued

Country [1]	1945–49 (average)	1950	1951	1952	1953	1954
Africa:						
Algeria	34,025	50,813	90,389	58,643	99,869	(6)
Anglo-Egyptian Sudan	2,218		202	1,599	(6)	(6)
Angola	[12] 876	[12] 2,152	[12] 3,359	[12] 4,023	6,118	9,650
Belgian Congo		[4] 8,000	4,360	4,360	7,215	10,074
Egypt	77,023	171,852	123,520	156,367	205,030	157,016
French Morocco	23,683	683	8,482	8,769	15,840	22,928
Kenya	568	672	91	1,785	942	563
Tanganyika				554	1,904	5,300
Tunisia	16,916	25,424	26,880	25,760	25,133	27,558
Union of South Africa (sales and exports)	84,800	114,318	137,767	164,147	165,777	170,637
Total [1 4]	240,800	374,000	396,000	427,000	530,000	490,000
Oceania:						
Australia	240,762	375,743	408,070	393,465	369,591	492,482
New Caledonia	7,801	16,755	17,391	5,711	21,234	2,910
Total	248,563	392,498	425,461	399,176	390,825	495,392
World total (estimate) [1]	17,500,000	24,900,000	26,700,000	27,300,000	27,900,000	29,600,000

[1] In addition to the countries listed, gypsum is produced in Ethiopia, Mexico, Rumania, and U. S. S. R., but production data are not available. Estimates for these countries are included in the total.
[2] This table incorporates a number of revisions of data published in previous Gypsum chapters.
[3] Includes anhydrite.
[4] Estimate.
[5] Average for 1948–49.
[6] Data not available; estimate by senior author of chapter included in total.
[7] Production in Government quarries only; beginning in 1951 no longer under Government control.
[8] Crude production estimates based on calcined figures.
[9] Year ended March 20 of year following that stated.
[10] Average for 1946–49.
[11] Some pure, some 80 percent gypsum and 20 percent limestone.
[12] Exports.

According to a report on the geology of the Stanford Range, Kootenay District, B. C., extensive deposits of gypsum occur in the area along Windermere, Burnais, Madias, and Tatley Creeks and the Kootenay River. Most of the commercial development through 1954 was on Windermere Creek, with the output largely exported to the northwest part of the United States. Gypsum reserves within the Stanford Range were estimated at more than 500 million tons.[31]

The history of gypsum mining in Nova Scotia, economics of gypsum utilization, and the gypsum development and mining methods practiced in that Province were described.[32] Since about 1785 gypsum has been mined from the huge Nova Scotia deposits for export to the United States. Early gypsum mining in Nova Scotia was done by farmers, but economic factors have concentrated the industry in the hands of a few companies that mine about 3 million tons annually for shipment to gypsum-products plants on the east coast of the United States.

Development work on the National Gypsum Co. new gypsum quarry near Halifax, Nova Scotia, was well advanced by the end of

[31] Henderson, G. G. L., Geology of the Stanford Range of the Rocky Mountains, Kootenay District, British Columbia: British Columbia Dept. Mines, Bull. 35, 1954, 84 pp.
[32] Hume, C. B., Mining of Nova Scotia Gypsum: Canadian Min. and Met. Bull. (Montreal), vol. 47, No. 504, April 1954, pp. 263–275.

1954. It was expected that within a few months the new mine would be supplying raw material to the company's four plants on the Atlantic seaboard.

British Plaster Board, Ltd., London, England, largest manufacturer of gypsum products in the British Isles, acquired the outstanding stock of Western Gypsum Products Ltd., Winnipeg, Manitoba. The latter company was the major manufacturer of gypsum products in the Prairie Provinces of Canada, with a large gypsum deposit at Amaranth, on Lake Manitoba, 110 miles from Winnipeg, and products plants at Winnipeg and Calgary.[33]

Dominican Republic.—The output of gypsum, although still not large, continued to increase in 1954. Much of the production was exported to the United States.

Jamaica.—It was reported that Bellrock Caribbean, Ltd., which mined gypsum from deposits at Kingston, was sold to the United States producer, United States Gypsum Co., which planned to operate the mine under the name Jamaica Gypsum, Ltd.[34] Import data for 1954 showed a sharp increase in the quantity of gypsum received in the United States from Jamaica.

SOUTH AMERICA

Venezuela.—The gypsum deposits of Cristobal Colon were being developed to meet domestic requirements. A 7,000-bag-per-day plaster plant at Pertigaleta, Anzoategui, was planned, and it was expected that crude gypsum would also be used as cement retarder at Venezuelan cement plants.[35]

EUROPE

Hungary.—Large deposits of gypsum were reported to have been found by geologists searching for iron ores between Szentandras and Rudabanya. The gypsum beds occur at a depth of about 400 feet. Previously, Hungary imported its gypsum requirements from East Germany and Rumania.[36]

United Kingdom.—A new British plant will manufacture sulfuric acid and hydraulic cement from anhydrite, using the so-called "anhydrite process," which was developed and is in operation at another British plant. The process consists fundamentally of heating an accurately proportioned mixture of calcium sulfate (anhydrite or gypsum) with materials containing carbon, silica, alumina, and ferric oxide, thereby producing simultaneously cement clinker and gases containing sulfur dioxide. The latter gas is then converted to sulfuric acid by the contact process. Detailed descriptions of the process were published [37] and also thorough descriptions of the mining prac-

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[33] Canadian Mining Journal (Gardenvale, Quebec, Canada), British Plaster Board: Vol. 75, No. 3, March 1954, pp. 114–116.

[34] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 4, October 1954, p. 57.

[35] Chemical Week (news item), vol. 75, No. 14, Oct. 2, 1954, p. 40.

[36] Engineering and Mining Journal, (news item), vol. 155, No. 6, June 1954, pp. 165–166.

[37] Engineering (London), Sulfuric Acid Plant: Vol. 178, No. 4633, Nov. 12, 1954, pp. 640–641.
Mine and Quarry Engineering (London), New Sulphuric Acid Plant: Vol. 20, No. 12, December 1954, pp. 550–552.
Chemical Age (London), Sulphuric Acid From Anhydrite: Vol. 71, No. 1843, Nov. 6, 1954, pp. 975–977.
Chemical and Engineering News, Anhydrite for Acid and Cement: Vol. 32, No. 49, Dec. 6, 1954, p. 4850.

tices at the Billingham mine,[38] the source of anhydrite for the new plant.

Large deposits of anhydrite have been found in northwest England. The beds extend under the sea from the mainland near St. Beeshead, Cumberland. Proposals have been advanced for the erection at Whitehaven of a chemicals plant to use the anhydrite in manufacturing sulfuric acid and cement.[39]

ASIA

Ceylon.—The Ceylon Government cement plant at Kankesanturai was reportedly using local gypsum for the first time.

Cyprus.—Reserves of gypsum in Cyprus were said to be immense. Several mines were active, and one products plant was operated using local material.[40] The bulk of the crude gypsum, plaster, and plasterboard produced was exported.

Pakistan.—The Geological Survey Department was investigating large-scale commercial potentialities for gypsum deposits at Serwan and Petaro, near Kotri, an area in which gypsum was being mined on a small scale.[41] The country's first major fertilizer plant, under construction at Daud Khel, Multan District, will produce ammonium sulfate directly from gypsum.[42] It was anticipated that opening of the fertilizer plant would greatly increase output of gypsum in Pakistan.

OCEANIA

Australia.—Widespread deposits of gypsum sand and gypsum "flour" were reported to occur southeast of Renmark, South Australia,[43] and on Blanchetown Plain, east of the River Murray, South Australia.[44] In both localities the gypsum sand occurs in low dunes covered by varying thicknesses of gypsum "flour" or a mixture of silica sand and gypsum dust. The deposits had not been worked commercially, but flotation and electrostatic separation tests had been made on samples of the material.

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[38] Engineering (London), Drilling Anhydrite Rock; Developments at Billingham Mine: Vol. 178, No. 4622, Aug. 27, 1954, pp. 282–284.
Mine and Quarry Engineering (London), The Billingham Mine: Vol. 20, No. 1, January 1954, pp. 2–11, No. 2, February 1954, pp. 66–75.

[39] Mining World (London), (news item), vol. 16, No. 7, June 1954, p. 78.

[40] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 2, August 1954, p. 57.

[41] Mining World (London), (news item), vol. 16, No. 6, May 1954, p. 64.

[42] Mining World (London), (news item), vol. 16, No. 11, October 1954, p. 68.

[43] Johns, R. K., Gypsum Deposits Southeast of Renmark: South Australia Dept. Mines, Mining Review (Adelaide), No. 96, 1952 (pub. 1954), pp. 45–47.

[44] Johns, R. K., Gypsum Deposits—Blanchetown Plain: South Australia Dept. Mines, Mining Review (Adelaide), No. 96, 1952 (pub. 1954), pp. 48–50.

Iodine

By Henry E. Stipp[1] and Annie L. Marks[2]

WASTE OIL-WELL BRINES constituted the only source of iodine produced in the United States during 1954. Production came entirely from California.

New uses for iodine and iodine compounds in the fields of metallurgy, pharmacy, medicine, and radioactivity were reported during the year.

DOMESTIC PRODUCTION

Iodine was produced in the United States during 1954 by Dow Chemical Co. at Seal Beach, Calif., and Deepwater Chemical Co. at Compton, Calif. The Bureau of Mines is not at liberty to publish statistics on domestic production, as disclosure of these data would reveal individual company figures. A substantial portion of domestic requirements was supplied by these firms.

CONSUMPTION AND USES

Iodine and its compounds were consumed for numerous purposes in industry, agriculture, and medicine. Crude iodine, which usually contains more than 99 percent iodine, was resublimed to greater purity or converted to organic or inorganic compounds. Potassium and sodium iodide were the two principal iodine compounds produced.

The germicide tincture of iodine perhaps has been the most widely known iodine commodity. Although used for many years as a household antiseptic, it met vigorous competition from iodine compounds which are less toxic and corrosive to the skin. Potassium iodide is added to salt to prevent the growth of goiter in humans. In addition to these uses, iodine had many other pharmaceutical and therapeutic applications.

Iodine and its compounds had numerous industrial applications. Two of the most important of these were wet-plate photoengraving and photographic film emulsions. In addition, iodine was used in metallurgy, sanitation, water, disinfectants, rubber, dyes, analytical reagents, and catalysts and for numerous other purposes.

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

TABLE 1.—Crude iodine consumed in the United States, 1953–54

Compound manufactured	1953			1954		
	Number of plants	Crude iodine consumed		Number of plants	Crude iodine consumed	
		Pounds	Percent of total		Pounds	Percent of total
Resublimed iodine	6	149,405	13	6	109,402	8
Potassium iodide	10	796,953	68	10	798,420	59
Sodium iodide	6	55,791	5	4	118,669	9
Other inorganic compounds	8	37,012	3	9	68,817	5
Organic compounds	14	131,261	11	13	252,000	19
Total	[1] 25	1,170,422	100	[1] 23	1,347,308	100

[1] A plant producing over 1 product is counted but once in arriving at total.

PRICES

According to Oil, Paint and Drug Reporter, the price of crude iodine fluctuated during 1954. Prices of iodine and iodine compounds were quoted as follows: Crude iodine, in kegs, $1.30 per pound from January through April, $1.15 per pound from May through November, and $1.45 per pound for the remainder of the year; resublimed iodine, U. S. P., bottles, drums, at $2.55 for January through October and $2.30 to $2.32 from October through December; potassium iodide, drums, at $2.15 per pound from January through October and $1.90 to $1.95 per pound from October to December; sodium iodide, U. S. P., bottles, drums, at $2.80 to $2.92 per pound for January through November and $2.55 per pound for the remainder of the year; ammonium iodide, N. F., jars, at $4.26 to $4.38 for January through December.

FOREIGN TRADE[3]

Crude iodine was imported into the United States from Chile and Japan. From an average of 31,670 pounds in 1945–49, imports of iodine from Japan have increased to 330,131 pounds in 1954.

Exports of iodine and iodine compounds also were substantial, being valued at almost a half million dollars in 1954.

[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 2.—Crude iodine imported for consumption in the United States, 1945–49 (average) and 1950–54, by countries

[U. S. Department of Commerce]

Country	1945–49 (average)		1950		1951		1952		1953		1954	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
South America: Chile	858, 279	$1,065,962	582, 562	$854, 236	667, 426	$1,036,414	471, 077	$858, 092	681, 484	$1,197,379	615, 744	$667, 088
Europe: France											110	493
Asia: Japan	31, 670	40, 570	142, 296	201, 710	184, 681	283, 914	320, 131	504, 817	276, 154	408, 645	330, 131	366, 354
Total	889, 949	1, 106, 532	724, 858	1, 055, 946	852, 107	1, 320, 328	791, 208	1, 362, 909	957, 638	1, 606, 024	945, 985	1, 033, 935

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TABLE 3.—Iodine, iodide, and iodates exported from the United States, 1945–49 (average) and 1950–54

[U. S. Department of Commerce]

Year	Pounds	Value	Year	Pounds	Value
1945–49 (average)	337,110	$599,848	1952	120,789	$264,952
1950	456,847	784,578	1953	274,690	452,387
1951	320,165	612,556	1954	338,258	487,633

TECHNOLOGY

Experiments in developing solid-state batteries were described in a paper by Lehovec and Broder.[4] The authors experimented with systems involving the high-temperature modification of AgI and Ag_2S. A cell of the composition Ag, AgI, Ag_2S, S was constructed which gave an open-circuit voltage of 0.2 at about 200° C. and short-circuit currents of 0.18 amp/cm^2. Shelf life of the cell was about 100 minutes.

Other iodine compounds appeared to be promising for high-current density cells which could operate at lower temperatures.

Silicon of high purity was obtained by thermal decomposition of fractionally distilled silicon tetraiodide in an intermittent-flow system.[5] Silicon tetraiodide was prepared by reacting resublimed iodine and silicon. This compound was subjected to a 16-step distillation at 200-mm. pressure in a packed quartz column. The resistivities of silicon prepared from fractionally distilled tetraiodide were of a higher order than usual, indicating that contaminating elements are removed in the distillation process.

Quaternary ammonium germicides to which halogen elements have been added were reported to be characterized by germicidal activity exceeding that of either the halogen or the quaternary.[6] These products may be prepared by adding a halogen in elemental form or in aqueous or alcoholic solution to an aqueous solution of a quaternary ammonium germicide. Upon mixing, the halogen is taken up by the quaternary ammonium compound and held in a loosely bound elemental form.

The germicidal effect of representative iodophors compared to chlorine and quaternary ammonium compounds was tested by a modified Weber and Black method.[7] The iodophors compared favorably with a quick-acting hypochlorite, especially in the presence of skim milk. Other products tested were appreciably slower acting in killing organisms.

Data on the decontamination of radioactively contaminated water by the use of a clay slurry were presented in 1954.[8] The slurry was

[4] Lehovec, K., and Broder, J., Semiconductors as Solid Electrolytes in Electrochemical Systems: Jour. Electrochem. Soc., vol. 101, No. 4, April 1954, pp. 208–209.

[5] Litton, F. B., and Andersen, H. C., High-Purity Silicon: Jour. Electrochem. Soc., vol. 101, No. 6, June 1954, pp. 287–291.

[6] Dorrough, J. L., Alamo, and House, R., Addition Products of Halogens and Quaternary Ammonium Germicides: U. S. Patent 2,679,533, May 25, 1954.

[7] Johns, C. K., Iodophors as Sanitizing Agents: Canadian Jour. Technol., vol. 32, No. 3, May 1954, pp. 71–77.

[8] Lacy, W. J., Decontamination of Radioactively Contaminated Water by Slurrying with Clay: Ind. Eng. Chem., vol. 46, No. 1, January–June 1954, pp. 1061–1065.

very effective in removing certain radioactive materials; however, its effect on iodine 131 was very poor.

A process for recovering iodine from oil-well brines by volatilization of the iodine from the brine with high-pressure natural gas was patented in 1954.[9] The gas, passed in countercurrent contact with the brine at a rate of about 0.2 to 2.0 cubic feet of gas at standard conditions per cubic foot of brine, removes more than 90 percent of the iodine from the brine in a once-through operation. The contact is effected in a steel pressure tower lined with acidproof brick and containing ceramic ring packing.

A method for consolidating the metal powders of tungsten, molybdenum, tantalum, titanium, and zirconium to form dense coherent metal was patented during the year.[10] In this process powdered metal is pressed into a bar which is heated to a temperature of 1,200° to 1,500° C. in various gaseous atmospheres, one of which is iodine, at low pressure. Advantages claimed were elimination of a presinter or baking step, lower temperature for forming the metals, and acceleration of rate of sintering at any temperature.

A report reviewed the problems encountered and solved in drafting the monograph on sodium radio-iodide. Physical characteristics, pH, limit of total iodide, and radiochemical purity were listed in the monograph. Assaying of radioactivity, packaging and storage, and availability of solutions were described.[11]

WORLD REVIEW

Chile.—Once again Chile was the largest source of iodine in the world. The product was obtained from the mineral lautarite associated with deposits of nitrate in the Provinces of Antofagasta and Taropaca. Chilean production of iodine was reported as 1,295,000 kg. in 1954 as compared with 175,840 kg. in 1953.

Indonesia.—Iodine produced in 1954 totaled 10,668 kg. compared with 9,547 (revised) kg. in 1953.

Italy.—Reported production of bisublimate in 1954 totaled 15,181 kg. valued at 6,500 lire, f. o. b. factory. In 1953, 17,396 kg. of bisublimate valued at 6,500 lire was produced.

Japan.—A total of 468,166 kg. of elemental iodine was recovered by Japan during 1954. The iodine industry in Japan was described in some detail in the Iodine chapter of the Bureau of Mines Minerals Yearbook, vol. I, 1952.

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[9] Allen Joseph C., Recovery of Iodine from Oil-well Brine: U. S. Patent 2,676,092, Apr. 20, 1954.
[10] Hall, Roy D., Sintering of High-Melting-Point Metal Powders: U. S. Patent 2,675,310, Apr. 13, 1954.
[11] Miller, L. C., The U. S. P. *XV*, Monograph On Sodium Radio-Iodide, Drug Standards: Vol. 22, Nos. 7–8, pp. 168–172.

Iron Ore

By Horace T. Reno[1]

THE CHANGING pattern of United States iron-ore supply was brought clearly into focus in 1954 as domestic mine production decreased to the lowest since 1946 while iron-ore imports reached an alltime high and production from complex mineral-dressing plants was significant for the first time.

TABLE 1.—Salient statistics of iron ore in the United States, 1945-49 (average), and 1950–54

	1945–49 (average)	1950	1951	1952	1953	1954
Iron ore (usable;[1] less than 5 percent Mn):						
Production by districts:						
Lake Superior gross tons	72, 303, 904	79, 627, 294	93, 946, 990	77, 094, 762	95, 655, 105	60, 993, 927
Southeastern do	7, 214, 323	7, 507, 508	8, 587, 408	7, 623, 779	7, 691, 745	6, 150, 260
Northeastern do	3, 698, 099	4, 474, 834	5, 180, 959	4, 426, 378	5, 161, 813	4, 083, 608
Western do	3, 917, 454	5, 860, 755	8, 181, 465	8, 030, 331	8, 868, 658	6, 030, 148
Undistributed (byproduct ore) gross tons	516, 613	574, 969	[2] 607, 850	[2] 742, 754	617, 448	836, 052
Total do	87, 650, 393	98, 045, 360	116, 504, 672	97, 918, 004	117, 994, 769	78, 093, 995
Production by types of product:						
Direct gross tons	66, 751, 498	70, 309, 322	85, 281, 923	70, 358, 493	82, 163, 882	49, 103, 936
Concentrates do	16, 627, 633	22, 810, 818	25, 708, 840	22, 037, 106	29, 161, 642	23, 140, 189
Sinter do	3, 754, 650	4, 350, 251	4, 945, 278	4, 918, 264	6, 051, 797	5, 013, 818
Byproduct material (pyrites cinder and sinter) gross tons	516, 612	574, 969	568, 631	604, 141	617, 448	836, 052
Total do	87, 650, 393	98, 045, 360	116, 504, 672	97, 918, 004	117, 994, 769	78, 093, 995
Production by types of ore:						
Hematite gross tons	79, 701, 408	87, 156, 235	101, 530, 954	83, 515, 561	102, 553, 404	66, 382, 284
Brown ore do	1, 310, 493	2, 615, 402	3, 014, 761	2, 729, 524	2, 238, 236	2, 282, 648
Magnetite do	6, 121, 631	7, 698, 754	11, 390, 326	11, 068, 778	12, 585, 681	8, 593, 011
Byproduct material (pyrites cinder and sinter) gross tons	516, 612	574, 969	568, 631	604, 141	617, 448	836, 052
Total do	[3] 87, 650, 393	98, 045, 360	116, 504, 672	97, 918, 004	117, 994, 769	78, 093, 995
Shipments do	87, 410, 150	97, 764, 410	116, 230, 052	97, 972, 584	117, 821, 981	76, 918, 282
Value	$311, 121, 795	$487, 990, 404	$634, 728, 583	$596, 306, 850	$796, 732, 998	$537, 791, 511
Average value per ton at mine	$3. 56	$4. 99	$5. 46	$6. 09	$6. 76	$6. 99
Stocks at mines Dec. 31 gross tons	5, 485, 159	5, 725, 569	5, 599, 466	5, 528, 295	5, 706, 430	7, 078, 652
Imports do	4, 460, 955	8, 281, 237	10, 139, 678	9, 760, 625	11, 074, 035	15, 777, 824
Value	$20, 092, 918	$43, 968, 426	$59, 520, 046	$82, 854, 506	[4] $96, 788, 218	[4] $119, 330, 014
Exports gross tons	2, 377, 102	2, 550, 738	4, 328, 910	5, 122, 644	[4] 4, 251, 955	3, 145, 714
Value	$10, 118, 411	$15, 716, 509	$30. 996, 784	$37, 403, 973	[4] $32, 421, 637	$24, 783, 997
Consumption gross tons	88, 833, 189	106, 610, 273	114, 8[illegible], 112	100, 640, 636	122, 124, 661	94, 229, 135
Manganese-bearing ore (5 to 35 percent Mn):						
Shipments gross tons	1, 122, 741	971, 069	1, 092, 825	900, 909	1, 106, 598	498, 511
Value	$3, 723, 236	$4, 609, 432	$5, 385, 986	$5, 116, 985	$6, 946, 862	$3, 079, 380

[1] Direct shipping ore, washed ore, concentrates, sinter, and byproduct pyrites cinder and sinter.
[2] Includes Puerto Rican ore—39,219 tons in 1951 and 138,613 tons in 1952.
[3] Includes 249 tons of carbonate ore (siderite).
[4] Revised figure.

[1] Assistant chief, Branch of Ferrous Metals and Ferroalloys.

Sudden acceleration of the predicted long-term trend of decreasing United States self-sufficiency in high-grade iron ore and increasing dependence on imports and low-grade deposits was caused by consumers' selectivity in buying, steady progress in the development of foreign mineral deposits, and successful operation of three large beneficiation plants.

DOMESTIC PRODUCTION

Iron-ore production in the United States in 1954 was the lowest since 1946, reflecting an increased proportion of imports and a sharp decline in steelmaking. Despite low total production, much was accomplished toward utilizing low-grade deposits that previously had not been sources of iron. Marked progress was made in beneficiation research and actual plant construction, although production of magnetic taconite concentrate in Minnesota and jasper flotation concentrate in Michigan was relatively small. Increasing emphasis on upgrading ore was evident as low consumer requirements permitted greater selectivity in buying, and more than 55 percent of the crude ore produced was shipped to beneficiation plants.

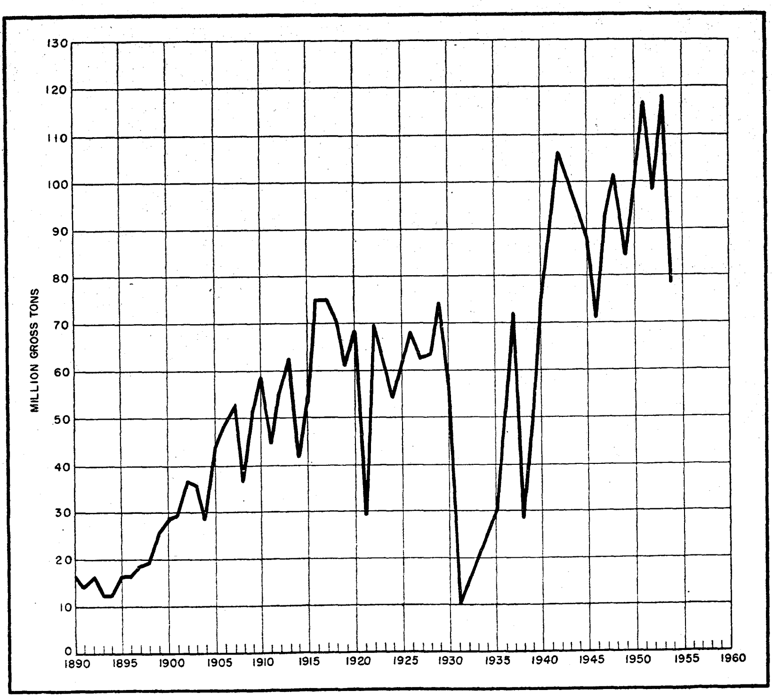

FIGURE 1.—Production of iron ore in the United States, 1890–1954.

Crude-ore production (mine product before being treated to remove waste constituents) decreased more than 30 percent compared with the quantity produced in 1953. Western States, recording the biggest decrease, produced 36 percent less ore than in 1953. Production in the Lake Superior district decreased 33 percent, in the Northeastern States 19 percent, and in the Southeastern States 10 percent. Compared with 1953, the 1954 production of hematite ore decreased 33 percent, of magnetite ore 21 percent, and of brown ore 9 percent.

Open-pit mines produced 32 percent less crude iron ore in 1954 than in 1953. They supplied 78 percent of the total output compared with 79 percent in 1953 and 78 in 1952. Underground mines produced 25 percent less crude ore in 1954 than in 1953.

Minnesota continued to be by far the leading iron-ore-producing State, with 62 percent of the total domestic production and over 6 times as much as Michigan, the second-ranking State with 10.3

TABLE 2.—Crude iron ore mined in the United States, 1953–54, by States and varieties, in gross tons

(Exclusive of ore containing 5 percent or more manganese)

State	Number of mines	Hematite	Brown ore	Magnetite	Total	Rank
1953						
Alabama	[1] 30	7,339,415	3,630,900		10,970,315	3
Arkansas	1	254			254	20
California	4	10,000		[2] 1,617,357	1,627,357	9
Colorado	1		900		900	19
Georgia	[1] 12	250	937,281		937,531	11
Michigan	41	14,326,074			14,326,074	2
Minnesota	182	102,273,577	326,012	1,742,786	104,342,375	1
Missouri	[1] 10	473,463	182,660		656,123	12
Montana	1			6,709	6,709	17
Nevada	8			426,753	426,753	14
New Jersey	5			1,558,384	1,558,384	10
New Mexico	4			7,525	7,525	16
New York	6	(3)		[3] 8,691,395	8,691,395	4
Pennsylvania	1			1,775,524	1,775,524	7
South Dakota	1	1,060			1,060	18
Tennessee	1		[4] 70,281		[4] 70,281	15
Texas	3		3,963,529		3,963,529	6
Utah	8			[2] 4,838,983	4,838,983	5
Virginia	1		(4)		(4)	
Wisconsin	3	1,756,150			1,756,150	8
Wyoming	2	655,097			655,097	13
Total	325	[3] 126,835,340	9,111,563	[3] 20,665,416	156,612,319	
Percent of total		81.0	5.8	13.2	100.0	
1954						
Alabama	[1] 33	5,016,274	4,669,553		9,685,827	3
Arkansas	2	630	430		1,060	19
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						
Tennessee	2	16,012	[4] 26,711		[4] 42,723	15
Texas	4		2,237,169		2,237,169	6
Utah	7			2,918,930	2,918,930	5
Virginia	1		(4)		(4)	
Wisconsin	2	1,491,470			1,491,470	7
Wyoming	2	493,557			493,557	12
Total	265	[3] 84,398,958	8,309,296	[3] 16,255,654	108,963,908	
Percent of total		77.4	7.6	15.0	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.

percent of the total. Alabama produced 9 percent of the total, New York 7 percent, Utah 3 percent, Texas 2 percent, Wisconsin 1 percent, and 13 other States together 6 percent. South Dakota was the only State of the 21 producing iron ore in 1953 that did not produce in 1954. Michigan continued to rank first among the States producing iron ore from underground mines; Alabama was second, Minnesota third, New York fourth, and Wisconsin was fifth. Only nine States had underground iron mines operating in 1954, with Arkansas' small production coming from open-pit rather than underground mines, as in 1953.

TABLE 3.—Crude iron ore mined in the United States, 1953–54, by States and mining methods, in gross tons

(Exclusive of ore containing 5 percent or more manganese)

State	1953			1954		
	Open pit	Underground	Total	Open pit	Underground	Total
Alabama	3,975,618	6,994,697	10,970,315	4,730,954	4,954,873	9,685,827
Arkansas		254	254	1,060		1,060
California	1,627,357		1,627,357	1,299,864		1,299,864
Colorado	900		900	6,049		6,049
Georgia	937,531		937,531	1,008,004		1,008,004
Michigan	1,977,690	12,348,384	14,326,074	1,274,394	9,934,758	11,209,152
Minnesota	100,417,224	3,925,151	104,342,375	65,281,672	2,742,260	68,023,932
Missouri	223,482	432,641	656,123	142,800	283,765	426,565
Montana	6,709		6,709	6,473		6,473
Nevada	426,753		426,753	350,654		350,654
New Jersey		1,558,384	1,558,384		1,025,057	1,025,057
New Mexico	7,525		7,525	3,316		3,316
New York	5,436,909	3,254,486	8,691,395	5,384,341	2,012,175	7,396,516
Pennsylvania	231,406	1,544,118	1,775,524		1,337,590	1,337,590
South Dakota	1,060		1,060			
Tennessee	[1] 70,281		[1] 70,281	[1] 42,723		[1] 42,723
Texas	3,963,529		3,963,529	2,237,169		2,237,169
Utah	4,838,983		4,838,983	2,918,930		2,918,930
Virginia	(1)		(1)	(1)		(1)
Wisconsin	45,127	1,711,023	1,756,150		1,491,470	1,491,470
Wyoming	51,724	603,373	655,097	54,000	439,557	493,557
Total	124,239,808	32,372,511	156,612,319	84,742,403	24,221,505	108,963,908
Percent of total	79.3	20.7	100.0	77.7	22.3	100.0

[1] Small tonnage mined in Virginia included with Tennessee.

Usable ore (from mines and beneficiating plants) production decreased 34 percent in 1954 compared with 1953; shipments decreased 35 percent, and the value of shipments decreased 33 percent. Production of hematite ore decreased 35 percent and production of magnetite ore 32 percent. In contrast, the production of brown iron ore increased almost 2 percent and the production of byproduct iron ore (residue obtained from burning pyrite) 35 percent. Hematite constitued 85 percent, magnetite 11 percent, brown iron ore 3 percent, and byproduct iron ore 1 percent of total production compared with 87, 11, 2 and less than 1 percent, respectively, in 1953. The figures listed for usable iron ore, like crude iron ore, include some gangue minerals and minor quantities of iron minerals other than those under which production is classified. Inasmuch as almost all iron-ore deposits contain more than one iron mineral, production is classified according to the mineral that predominates.

Direct-shipping iron-ore production in 1954 decreased 40 percent, being only 63 percent of the total compared with 70 percent in 1953.

TABLE 4.—Crude iron ore shipped from mines in the United States, 1953–54, by States and disposition, in gross tons

(Exclusive of ore containing 5 percent or more manganese)

State	1953			1954		
	Direct to consumers	To beneficiation plants	Total	Direct to consumers	To beneficiation plants	Total
Alabama	4,443,123	6,520,920	10,964,043	3,470,060	6,225,836	9,695,896
Arkansas	254		254	630	430	1,060
California	1,697,652		1,697,652	650,611	719,653	1,370,264
Colorado	900		900	6,049		6,049
Georgia	28,982	908,549	937,531	23,604	984,400	1,008,004
Michigan	13,134,853	712,539	13,847,392	9,438,076	762,005	10,200,081
Minnesota	54,355,738	49,924,037	104,279,775	29,418,768	38,469,805	67,888,573
Missouri		656,123	656,123		426,565	426,565
Montana	6,709		6,709	6,473		6,473
Nevada	444,081		444,081	351,250		351,250
New Jersey	177,475	1,370,235	1,547,710	18,584	989,913	1,008,497
New Mexico	7,525		7,525	3,316		3,316
New York	85,854	8,606,141	8,691,995	10,809	7,385,908	7,396,717
Pennsylvania		1,703,696	1,703,696		1,280,163	1,280,163
South Dakota	1,060		1,060			
Tennessee	[1] 5,951	64,000	[1] 69,951	[1] 20,335	21,700	[1] 42,035
Texas		3,963,529	3,963,529	35,422	2,201,747	2,237,169
Utah	4,617,288		4,617,288	3,040,646		3,040,646
Virginia	(1)		(1)	(1)		(1)
Wisconsin	1,655,331		1,655,331	1,428,910		1,428,910
Wyoming	654,285		654,285	439,557	54,000	493,557
Total	81,317,061	74,429,769	155,746,830	48,363,100	59,522,125	107,885,225
Percent of total	52.2	47.8	100.0	44.8	55.2	100.0

[1] Small tonnage mined in Virginia included with Tennessee.

Sinter production decreased 12 percent and was more than 7 percent of the total compared with less than 6 percent in 1953. Concentrate production decreased 21 percent below the quantity produced in 1953 but was 30 percent of the total in 1954, compared to less than 25 percent the year before. The ratio of concentration (quantity of crude ore to quantity of sinter and concentrate) was 2.11, the same as in 1953.

The Lake Superior district furnished 79 percent of the usable iron ore produced in the United States in 1954, the Southeastern and Western districts each 8 percent, and the Northeastern district 5 percent.

Minnesota ranked first among the usable iron-ore-producing States in 1954 but furnished only 63 percent of the total compared with 68 percent in 1953; Michigan ranked second with 14 percent compared with 12 percent in 1953; Alabama ranked third with 8 percent; Utah fourth with 4 percent; New York, having slightly less production than Utah, fifth with 4 percent; Wisconsin sixth with 2 percent; California seventh with less than 2 percent; Texas eighth with 1 percent, and Pennsylvania ninth with less than 1 percent. Eleven other States together produced the remaining 2 percent.

Domestic iron ore mined in 1954 averaged 50.90 percent iron compared with 50.44 percent in 1953, 50.27 percent in 1952, and 50.79 percent in 1951. Of the principal producing States, New York with iron ore averaging 63.02 percent iron, produced the highest grade material. Iron ore produced in Minnesota in 1954 contained an average of 50.94 percent iron, an increase in grade of 0.63 percent above the 1953 average of 50.31 percent. The selectivity of con-

TABLE 5.—Iron ore mined in the United States, 1953–54, by mining districts and varities, in gross tons

(Exclusive of ore containing 5 percent or more manganese)

Variety of ore	Lake Superior district	Southeastern States	Northeastern States	Western States	Total
1953					
Crude ore:					
Hematite	118,355,801	7,339,665	(1)	1,139,874	[1]126,835,340
Brown ore	[2]326,012	4,638,462		4,147,089	9,111,563
Magnetite	1,742,786		[1]12,025,303	6,897,327	[1]20,665,416
Total	120,424,599	11,978,127	[1]12,025,303	12,184,290	156,612,319
Usable iron ore:					
Hematite	94,910,804	6,736,359	(1)	906,241	[1]102,553,404
Brown ore	[2]217,760	955,386		1,065,090	2,238,236
Magnetite	526,541		[1]5,161,813	6,897,327	[1]12,585,681
Total	95,655,105	7,691,745	[1]5,161,813	8,868,658	117,377,321
1954					
Crude ore:					
Hematite	78,584,003	5,032,503	(1)	782,452	[1]84,398,958
Brown ore	[2]223,297	5,704,051		2,381,948	8,309,296
Magnetite	1,917,254		[1]9,759,163	4,579,237	[1]16,255,654
Total	80,724,554	10,736,554	[1]9,759,163	7,743,637	108,963,908
Usable iron ore:					
Hematite	[3]60,836,246	4,941,501	(1)	604,537	[1]66,382,284
Brown ore	[2]157,681	1,208,759		916,208	2,282,648
Magnetite			[1]4,083,608	4,509,403	[1]8,593,011
Total	60,993,927	6,150,260	[1]4,083,608	6,030,148	77,257,943

[1] Small tonnage of hematite included with magnetite to avoid disclosure of individual company operations.
[2] Produced in Fillmore County, Minn.; not in the true Lake Superior District.
[3] Includes 557,310 tons magnetite concentrate produced in Minnesota and converted to usable ore by sintering.

sumers was probably the principal cause of the increase in average iron content of domestic ores.

Table 8 shows the shipments of iron ore in the United States in 1954 by States having over 3 producers if the output of 1 producer does not predominate. Shipments are classified by uses in gross tons, with the value given at the mine, exclusive of transportation costs. The average value of iron ore at the mines was $6.99 per gross ton in 1954 and $6.76 per gross ton in 1953. Table 9 shows the production of crude and usable ore in gross tons by States and counties, with the number of mines in each county.

The cumulative production of iron ore from the six ranges of the United States Lake Superior region in gross tons is listed in table 10. The average analysis of Lake Superior ores 1945 to 1949 average and 1950 through 1954 is shown in table 11. Compared with the past 9-year average, iron ores in 1954 contained 0.17 percent more iron, 0.002 percent more phosphorous, 0.22 percent more silica, and 0.06 percent less manganese.

Beneficiated ore was 37.3 percent of the total produced in 1954, an alltime record high percentage of domestic production. It is interesting to note that this record high was established without appreciable production from the widely publicized taconite and jasper ore-dressing plants.

TABLE 6.—Iron ore produced in the United States, 1953–54, by States and types of product, in gross tons

(Exclusive of ore containing 5 percent or more manganese)

State	1953					1954				
	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	4,451,288	1,092,173	1,918,918	7,462,379	37.97	3,461,539	606,200	1,835,582	5,903,321	37.58
Arkansas	254	-----	-----	254	58.66	630	-----	86	716	50.98
California	1,627,357	-----	-----	1,627,357	53.64	580,211	-----	649,819	1,230,030	56.59
Colorado	900	-----	-----	900	48.50	6,049	-----	-----	6,049	69.71
Georgia	28,982	-----	181,682	210,664	43.48	23,604	-----	197,972	221,576	41.45
Michigan	13,613,535	-----	199,806	13,813,341	50.96	10,445,074	-----	305,612	10,750,686	51.10
Minnesota	54,430,622	1,121,052	24,533,940	80,085,614	50.31	29,274,031	1,356,606	18,121,134	48,751,771	50.94
Missouri	-----	-----	274,693	274,693	53.59	-----	-----	173,394	173,394	52.73
Montana	6,709	-----	-----	6,709	50.01	6,473	-----	-----	6,473	40.00
Nevada	426,753	-----	-----	426,753	63.11	350,654	-----	-----	350,654	62.81
New Jersey	236,034	-----	640,134	876,168	61.82	35,144	-----	472,655	507,799	64.98
New Mexico	7,525	-----	-----	7,525	56.33	3,316	-----	-----	3,316	61.01
New York	76,682	2,899,888	287,803	3,264,373	62.75	10,809	2,452,126	404,765	2,867,700	63.02
Pennsylvania	-----	778,561	242,711	1,021,272	57.51	-----	495,755	212,354	708,109	58.96
South Dakota	1,060	-----	-----	1,060	38.00	-----	-----	-----	-----	-----
Tennessee	[2] 5,951	-----	12,751	[2] 18,702	34.00	[2] 21,023	-----	4,340	[2] 25,363	40.31
Texas	-----	160,123	869,204	1,029,327	47.68	35,422	103,131	743,796	882,349	46.82
Utah	4,838,983	-----	-----	4,838,983	54.15	2,918,930	-----	-----	2,918,930	53.09
Virginia	(2)	-----	-----	(2)	-----	(2)	-----	-----	(2)	-----
Wisconsin	1,756,150	-----	-----	1,756,150	53.04	1,491,470	-----	-----	1,491,470	51.84
Wyoming	655,097	-----	-----	655,097	49.96	439,557	-----	18,680	458,237	52.43
Total mined ore	82,163,882	6,051,797	29,161,642	117,377,321	50.36	49,103,936	5,013,818	23,140.189	77,257,943	50.75
Byproduct ore: [3]										
Colorado Delaware Michigan Pennsylvania Tennessee Virginia	-----	617,448	-----	617,448	65.91	-----	836,052	-----	836,052	64.32
Grand total	82,163,882	6,669,245	29,161,642	117,994,769	50.44	49,103,936	5,849,870	23,140,189	78,093,995	50.90

[1] Exclusive of sinter produced at consuming plants.
[2] Small tonnage mined in Virginia included with Tennessee.
[3] Cinder and sinter obtained from pyrites treated in, but not necessarily mined in, States indicated.

TABLE 7.—Iron ore produced in the United States, 1953–54, by States and varieties, in gross tons

(Exclusive of ore containing 5 percent or more manganese)

State	1953				1954			
	Hematite	Brown ore	Magnetite	Total	Hematite	Brown ore	Magnetite	Total
Alabama	6,736,109	726,270		7,462,379	4,925,272	978,049		5,903,321
Arkansas	254			254	630	86		716
California	10,000		1,617,357	1,627,357			1,230,030	1,230,030
Colorado		900		900		6,049		6,049
Georgia	250	210,414		210,664	217	221,359		221,576
Michigan	13,813,341			13,813,341	10,750,686			10,750,686
Minnesota	79,341,313	217,760	526,541	80,085,614	48,594,090	157,681		48,751,771
Missouri	239,830	34,863		274,693	145,670	27,724		173,394
Montana			6,709	6,709			6,473	6,473
Nevada			426,753	426,753			350,654	350,654
New Jersey			876,168	876,168			507,799	507,799
New Mexico			7,525	7,525			3,316	3,316
New York	(1)		[1] 3,264,373	[1] 3,264,373	(1)		[1] 2,867,700	[1] 2,867,700
Pennsylvania			1,021,272	1,021,272			708,109	708,109
South Dakota	1,060			1,060				
Tennessee		[2] 18,702		[2] 18,702	16,012	[2] 9,351		[2] 25,363
Texas		1,029,327		1,029,327		882,349		882,349
Utah			4,838,983	4,838,983			2,918,930	2,918,930
Virginia		(2)		(2)		(2)		(2)
Wisconsin	1,756,150			1,756,150	1,491,470			1,491,470
Wyoming	655,097			655,097	458,237			458,237
Total	[1] 102,553,404	2,238,236	[1] 12,585,681	117,377,321	66,382,284	2,282,648	8,593,011	77,257,943
Byproduct ore:[3] Colorado, Delaware, Michigan, Pennsylvania, Tennessee, Virginia				617,448				836,052
Grand total	[1] 102,553,404	2,238,236	[1] 12,585,681	117,994,769	[1] 66,382,284	2,282,648	[1] 8,593,011	78,093,995

[1] Small tonnage of hematite included with magnetite to avoid disclosure of individual company operations.
[2] Small tonnage mined in Virginia included with Tennessee.
[3] Cinder and sinter obtained from pyrites treated in, but not necessarily mined in, States indicated.

In 1954, 265 mines in the United States produced iron ore. Of this number, 32 mines produced over 1 million tons of crude ore (accounting for 54 percent of the total), and 13 of these mines produced over 1 million tons of usable ore comprising 51 percent of the total usable ore produced. Thirty-two mines producing 500,000 to 1,000,000 tons of usable iron ore supplied 21 and 22 percent, respectively, of the crude and usable ore; 91 mines producing 100,000 to 500,000 tons supplied 22 and 24 percent; and 110 mines producing less than 100,000 tons supplied 3 and 3 percent. Among the million-ton crude-ore mines, 23 were in Minnesota, 3 in New York, 2 in Alabama, and 1 each in Texas, Michigan, Pennsylvania, and California; 27 were open pit, 4 were underground, and 1 was a combination, open-pit underground mine. In 1954, 7 new mines entered the million-ton class, and 18 mines on the list in 1953 were not included—a net decrease of 11.

Table 14 shows the consumption of iron ore in gross tons in 1954, by States, distributed according to use, excluding iron ore containing over 5 percent manganese. Blast furnaces consumed 73 percent of the total, sintering plants 19 percent, steel furnaces 6 percent, and ferroalloy furnaces, cement plants, and other 2 percent. Most of the iron ore that went to the sintering plants was eventually used in blast furnaces; the small remainder went to steel furnaces.

TABLE 8.—Shipments of iron ore in the United States in 1954, by States and uses, in gross tons

(Exclusive of ore containing 5 percent or more manganese)

State	Iron and steel			Cement	Paint	Miscellaneous	Total	
	Direct-shipping ore	Sinter [1]	Concentrates				Gross tons	Value
Mined ore:								
Alabama	3,188,438	606,200	2,118,824				5,913,462	$33,327,083
Arkansas	630		86				716	(2)
California	650,388		619,681			223	1,270,292	(2)
Colorado					6,049		6,049	(2)
Georgia	23,604		197,972				221,576	871,901
Michigan	9,415,948		271,091		19,944	2,184	9,709,167	70,004,504
Minnesota	29,291,880	1,335,379	17,375,793			610,286	48,613,338	319,632,491
Missouri			173,394				173,394	(2)
Montana				6,473			6,473	38,835
Nevada	175,757					175,493	351,250	2,024,794
New Jersey	18,584		456,379	1,229			476,192	6,621,881
New Mexico				3,316			3,316	(2)
New York	10,809	2,452,776	278,975			[3] 60,313	2,802,873	31,706,570
Pennsylvania		495,755	212,354				708,109	(2)
Tennessee	15,912		4,340		[4] 4,423		[4] 24,675	[4] 162,823
Texas		103,196	742,572	35,422			881,190	(2)
Utah	3,035,743			4,903			3,040,646	19,277,434
Virginia					(4)		(4)	(4)
Wisconsin	1,428,910						1,428,910	(2)
Wyoming	439,557		18,680				458,237	(2)
Undistributed								41,747,820
Total	47,696,160	4,993,306	22,470,141	51,343	30,416	848,499	76,089,865	525,416,136
Byproduct ore: [5]								
Colorado Delaware Michigan Pennsylvania Tennessee Virginia		828,417					828,417	12,375,375
Grand total	47,696,160	5,821,723	22,470,141	51,343	30,416	848,499	76,918,282	537,791,511

[1] Exclusive of sinter produced at consuming plants.
[2] Values that may not be shown separately are combined as "Undistributed."
[3] Small tonnage used as earth pigments included with "Miscellaneous."
[4] Small tonnage mined in Virginia included with Tennessee.
[5] Cinder and sinter obtained from pyrites treated in, but not necessarily mined in, States indicated.

Sinter.—Production of agglomerated iron ore, including sinter, nodules, briquets, and pellets, totaled 22.8 million gross tons in 1954, a 12-percent decrease from 1953. The small decrease in agglomerate production in relation to iron-ore and steel production reflected the growing importance of treated blast-furnace feed. Sinter consumption in blast furnaces decreased only 14 percent, but consumption in steel furnaces decreased 35 percent. Iron-bearing material consumed in making sinter included 18 million gross tons of iron-ore fines and concentrate, 7 million gross tons of flue dust, 526,984 gross tons of mill cinder and roll scale, 76,418 gross tons of manganiferous ore, and 57,325 gross tons of pyrite. The total—25.7 million gross tons—was converted to 22.8 million gross tons of sinter for a yield of 89 percent. Sintering plants at mines in 7 States produced 5.6 million tons—25 percent of the total; and plants at blast furnaces and custom mills in 15 States produced 17 million tons or 75 percent. In spite of increased sintering facilities at mines since 1952, the quantity of sinter produced at mines has decreased about 1 percent each year in relation to the total 27 percent in 1952, 26 percent in 1953, and (as noted above) 25 percent in 1954.

TABLE 9.—Iron ore mined in the United States in 1954, by States and counties, in gross tons

(Exclusive of ore containing 5 percent or more manganese)

State and county	Active mines	Crude ore	Usable ore
Alabama:			
Bibb	1		
Blount	1		
Butler	4	1,673,655	332,628
Cherokee	2		
Crenshaw	1		
Franklin	7	2,341,813	514,544
Houston	1		
Jefferson	9	5,016,754	4,925,367
Montgomery	1		
Pike	4	588,905	117,836
Shelby	1	64,700	12,946
Talladega	1		
Total	[1] 33	9,685,827	5,903,321
Arkansas: Nevada	2	1,060	716
California:			
Riverside	1	1,299,641	1,229,807
Shasta	1	223	223
Total	2	1,299,864	1,230,030
Colorado: San Miguel	1	6,049	6,049
Georgia:			
Bartow	5		
Polk	4	1,008,004	221,576
Quitman	1		
Walker	1		
Total	[1] 11	1,008,004	221,576
Michigan:			
Baraga	1	278,137	101,776
Dickinson	2	53,245	53,245
Gogebic	8	2,439,763	2,439,763
Iron	15	3,634,970	3,587,075
Marquette	14	4,803,037	4,568,827
Total	40	11,209,152	10,750,686
Minnesota:			
Crow Wing	14	1,997,290	1,497,296
Fillmore	1	223,297	157,681
Itasca	24	23,137,993	10,804,525
St. Louis	91	42,665,352	36,292,269
Total	130	68,023,932	48,751,771
Missouri:			
Howell	4	55,300	11,152
Oregon			
Ozark			
Shannon	4	371,265	162,242
St. Francois			
Total	[1] 8	426,565	173,394
Montana: Broadwater	1	6,473	6,473
Nevada:			
Douglas	1		
Humboldt	1	87,405	87,405
Nye	1		
Pershing	3	263,249	263,249
Total	6	350,654	350,654
New Jersey:			
Morris	3		
Passaic	1	1,025,057	507,799
Warren	1		
Total	5	1,025,057	507,799
New Mexico: Grant	1	3,316	3,316
New York:			
Clinton	1	3,468,839	1,531,577
Essex	3		
Oneida	1	3,927,677	1,336,123
St. Lawrence	1		
Total	6	7,396,516	2,867,700
Pennsylvania: Lebanon	1	1,337,590	708,109
Tennessee:			
Monroe	1	42,723	25,363
Roane	1		
Total	2	[2] 42,723	[2] 25,363
Texas:			
Cass	1		
Cherokee	2	2,237,169	882,349
Morris	1		
Total	4	2,237,169	882,349
Utah: Iron	7	2,918,930	2,918,930
Virginia: Pulaski	1	(2)	(2)
Wisconsin: Iron	2	1,491,470	1,491,470
Wyoming: Platte	2	493,557	458,237
Grand total	265	108,963,908	77,257,943

[1] Excludes undetermined number of small pits. Estimated output of these mines included in tonnage given.
[2] Small tonnage mined in Virginia included with Tennessee.

TABLE 10.—Iron ore produced in the Lake Superior district, 1854–1954, by ranges, in gross tons

(Exclusive after 1905 of ore containing 5 percent or more manganese)

Year	Marquette	Menominee	Gogebic	Vermilion	Mesabi	Cuyuna	Total
1854–1949	252,188,396	224,023,187	266,219,561	82,851,296	1,656,460,550	41,929,278	2,523,672,268
1950	5,085,500	4,068,458	5,238,781	1,580,217	60,838,025	2,480,843	79,291,824
1951	5,617,935	4,864,831	4,978,369	1,806,818	73,574,908	2,651,724	93,494,585
1952	4,668,550	4,168,465	4,468,039	1,573,748	59,370,538	2,369,180	76,618,520
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
Total	278,016,102	245,370,026	290,015,591	90,827,085	1,971,293,084	53,828,900	2,929,350,788

TABLE 11.—Average analyses of total tonnages (bill-of-lading weights) of all grades of iron ore from all ranges of Lake Superior district, 1945–49 (average) and 1950–54

[Lake Superior Iron Ore Association]

Year	Gross tons	Content (natural), percent				
		Iron	Phosphorus	Silica	Manganese	Moisture
1945–49 (average)	72,515,933	50.94	0.091	10.00	0.75	11.19
1950	77,150,079	50.38	.092	9.85	.77	11.11
1951	93,549,414	50.25	.090	9.87	.77	11.22
1952	77,225,818	50.49	.111	10.05	.77	10.78
1953	95,438,743	50.37	.090	10.25	.75	10.90
1954	59,585,720	50.86	.095	10.22	.70	10.4

TABLE 12.—Beneficiated iron ore shipped from mines in the United States, 1925–29 (average) and 1930–54, in gross tons

(Exclusive of ore containing 5 percent or more manganese)

Year	Beneficiated	Total	Proportion of beneficiated to total (percent)	Year	Beneficiated	Total	Proportion of beneficiated to total (percent)
1925–29 (ave.)	8,653,590	66,697,126	13.0	1942	23,104,945	105,313,653	21.9
1930	8,973,888	55,201,221	16.3	1943	20,117,685	98,817,470	20.4
1931	4,676,364	28,516,032	16.4	1944	20,303,422	94,544,635	21.5
1932	407,486	5,331,201	7.6	1945	19,586,782	87,580,942	22.4
1933	3,555,892	24,624,285	14.4	1946	15,588,763	69,494,052	22.4
1934	4,145,590	25,792,606	16.1	1947	21,407,760	92,670,188	23.1
1935	6,066,601	33,426,486	18.2	1948	23,629,265	100,274,965	23.6
1936	9,658,699	51,465,648	18.8	1949	20,658,232	84,174,399	24.5
1937	12,350,136	72,347,785	17.1	1950	26,717,928	97,150,704	27.5
1938	4,836,435	26,430,910	18.3	1951	30,664,648	115,660,775	26.5
1939	9,425,809	54,827,100	17.2	1952	27,023,982	97,375,010	27.8
1940	12,925,741	75,198,084	17.2	1953	35,895,529	117,197,537	30.6
1941	19,376,120	93,053,994	20.8	1954	28,393,705	76,089,865	37.3

TABLE 13.—Iron-ore mines in the United States in 1954, by size of crude output

Name of mine	State	Nearest town	Range or district	Mining method	Production (gross tons)	
					Crude ore	Usable ore
Sherman	Minnesota	Fraser	Mesabi	Open pit	5,977,917	5,977,917
Rouchleau	do	Virginia	do	do	4,824,705	4,780,015
Benson	New York	Star Lake	Adirondack	do	3,922,660	1,333,979
Red Mountain Group	Alabama	Bessemer	Birmingham	Underground	3,030,976	3,031,266
King	Minnesota	Coleraine	Mesabi	Open pit	2,686,238	1,538,461
Hull Rust	do	Hibbing	do	do	2,310,670	2,152,379
Patrick A	do	Nashwauk	do	do	2,309,446	865,988
Mississippi	do	Keewatin	do	do	1,901,679	778,744
Lone Star	Texas	Daingerfield	East Texas	do	1,828,527	527,902
Mather	Michigan	Ishpening	Marquette	Underground	1,824,756	1,824,756
Mountain Iron	Minnesota	Mountain Iron	Mesabi	Open pit	1,595,995	1,330,215
Gross Marble	do	Marble	do	do	1,504,361	792,143
Pilotac	do	Mountain Iron	do	do	1,410,296	406,481
Hill-Trumbull	do	Marble	do	do	1,371,703	393,822
MacIntyre	New York	Tahawus	Adirondack	do	1,362,766	579,313
Lebanon	Pennsylvania	Lebanon	Cornwall	Combined	1,337,590	708,109
Harrison	Minnesota	Nashwauk	Mesabi	Open pit	1,310,204	468,571
Eagle Mountain	California	Desert Center	Eagle Mountain	do	1,299,641	1,229,807
Canton	Minnesota	Biwabik	Mesabi	do	1,279,100	1,279,100
New Bed Harmony and Old Bed	New York	Mineville	Adirondack	Underground	1,276,278	737,539
Hill Annex	Minnesota	Calumet	Mesabi	Open pit	1,264,255	532,075
West Hill	do	Coleraine	do	do	1,253,178	616,141
Holman Cliffs	do	Taconite	do	do	1,233,493	558,045
Buckeye	do	Coleraine	do	do	1,231,783	514,055
Canisteo	do	do	do	do	1,220,652	528,658
Pyne	Alabama	Bessemer	Birmingham	Underground	1,203,156	1,110,606
Babbitt	Minnesota	Babbitt	Mesabi	Open pit	1,168,909	316,628
Monroe	do	Chisholm	do	do	1,123,435	1,123,435
Mary Ellen	do	Biwabik	do	do	1,113,074	461,535
Spruce	do	Eveleth	do	do	1,102,239	984,914
Hawkins	do	Nashwauk	do	do	1,089,546	457,864
Groups 3 and 4	do	Hibbing	do	do	1,048,765	1,048,765
Output of 32 mines producing over 1,000,000 tons of crude ore each					58,417,993	38,989,228
Output of 32 mines producing 500,000 to 1,000,000 tons of crude ore each					22,803,202	17,212,203
Output of 91 mines producing 100,000 to 500,000 tons of crude ore each					24,085,079	18,739,218
Output of 110 mines producing under 100,000 tons of crude ore each					3,657,634	2,317,294
Grand total United States (265 mines)					108,963,908	77,257,943

TABLE 14.—Consumption of iron ore in the United States in 1954, by States and uses, in gross tons

(Exclusive of ore containing 5 percent or more manganese)

State	Metallurgical uses				Miscellaneous uses			Total[1]
	Iron blast furnaces	Steel furnaces	Sintering plants	Ferro-alloy furnaces	Cement	Paint	Other	
Alabama	6,593,218	121,908	1,025,937	447	44,996	---	---	7,786,506
California					43,963	(2)	---	---
Colorado	2,325,690	414,431	1,970,283	---	---	---	---	4,754,367
Utah					(2)	---	---	---
Illinois	6,362,071	408,301	384,715	---	(2)	(2)	---	7,155,087
Indiana	10,387,070	795,629	1,082,624	---	---	---	---	12,265,323
Kentucky	831,112	66,688	---	---	---	---	---	897,800
Maryland					(2)	(2)	---	---
Massachusetts	5,578,377	716,018	1,515,865	---	---	---	(2)	7,814,161
Michigan					3,901	---	---	---
Minnesota	891,790	86,114	1,356,606	---	---	---	---	2,334,510
New Jersey	---	---	---	---	---	(2)	---	(2)
New York	3,542,200	452,354	3,900,576	74,364	(2)	(2)	(2)	7,969,494
Ohio	13,234,704	975,899	2,603,332	221,779	5,752	(2)	---	17,041,466
Pennsylvania	15,264,000	1,498,539	4,194,891	8,162	12,870	28,545	---	21,007,007
Tennessee	97,404	---	---	---	(2)	---	---	97,404
Texas	826,265	31,729	114,475	---	43,126	---	---	1,015,595
West Virginia	2,607,811	22,249	---	---	(2)	---	---	2,630,060
Undistributed[3]	---	---	---	---	63,020	58,911	1,338,424	1,460,355
Total	68,541,712	5,589,859	18,149,304	304,752	217,628	87,456	1,338,424	94,229,135

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, Oregon, South Dakota, Virginia, and Washington; for paint, Georgia, Oregon, and Virginia.

TABLE 15.—Production and consumption of sinter in the United States in 1954, by States, in gross tons

State	Sinter produced	Sinter consumed	
		In blast furnaces	In steel furnaces
Alabama	1,239,400	1,571,315	29,544
California			
Colorado	1,919,746	1,922,336	---
Utah			
Delaware	114,085	---	---
Illinois	811,094	884,547	60,221
Indiana	1,961,727	1,763,399	279,864
Maryland			
Kentucky	1,695,654	1,764,996	---
Tennessee			
West Virginia			
Michigan	819,083	850,639	125
Minnesota	1,356,606	---	---
New York	4,060,155	1,801,088	13,699
Ohio	3,163,848	3,523,482	315,681
Pennsylvania	5,578,720	6,449,315	350,786
Texas	103,131	102,895	302
Total	22,823,249	20,634,012	1,050,222

STOCKS

Stocks of usable iron ore at mines on December 31, 1954, were 24 percent more than on December 31, 1953. The Lake Superior district mine stocks comprised most of the increase; Michigan mine stocks (the largest quantity) increased 38 percent, Minnesota 18 percent, and Wisconsin 61 percent. Stocks in Alabama, California, Nevada, Utah, and Wyoming decreased.

Consuming-plant inventories of iron ore and sinter totaled 43,138,787 gross tons on December 31, 1954, compared with 45,242,000 tons a year earlier. Ore on Lake Erie docks totaled 6,591,000 gross tons compared with 7,671,000 tons at the end of 1953, according to the Lake Superior Iron Ore Association. Thus total stocks at mines, mills, and docks totaled 49,730,000 gross tons, a 15-percent decrease during the year.

TABLE 16.—Stocks of usable iron ore at mines, Dec. 31, 1953–54, by States, in gross tons

State	1953	1954	State	1953	1954
Alabama	68,113	57,972	Pennsylvania	6,696	6,696
California	90,383	50,121	Tennessee		[1] 1,929
Georgia			Texas	113,857	115,016
Michigan	2,516,994	3,460,801	Utah	426,098	304,535
Minnesota	1,880,869	2,218,889	Virginia		(1)
Nevada	5,347	3,687	Wisconsin	247,083	396,936
New Jersey	82,567	115,915	Wyoming	812	
New York	267,611	346,155	Total	5,706,430	[1] 7,078,652

[1] Virginia included with Tennessee.

PRICES

The average value per long ton of iron ore f. o. b. mines was $6.99 in 1954 compared with $6.76 in 1953, $6.09 in 1952, and $5.46 in 1951. The increase (28 percent in 4 years) reflects increased wages and material costs at the mines. During this same period, 1951–54, the average value of pig iron at blast furnaces increased only 7 percent from $46.75 to $49.93 per net ton.

Table 17 gives the average value at mines of the different products and variety of ore for each State, except where there are fewer than 3 shippers of 1 class of ore in a State and permission has not been given to publish the value. These data are from producers' statements and therefore probably represent only the approximate commercial selling price. In the Lake Superior district the mine value is reported as the Lake Erie price, less freight from mines to lower Lake ports; this value apparently is also applied to ore not sold on the open market.

E&MJ Metals and Mineral Markets quoted Lake Superior iron ore, 51.5 percent iron, per long ton, at lower Lake ports throughout 1954, as follows: Mesabi non-Bessemer, $9.90; Old Range non-Bessemer, $10.15; Mesabi Bessemer, $10.05; and Old Range Bessemer $10.30.

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, at 56 and 62 percent iron per long-ton unit, at 17 and 18 cents.

TABLE 17.—Average value per gross ton of iron ore at mines in the United States, 1953–54

(Exclusive of ore containing 5 percent or more manganese)

State	1953							1954						
	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	$7.31	-----	-----	$7.22	$5.35	-----	(1)	$5.38	$6.15	-----	$7.20	$5.11	-----	(1)
Colorado	-----	$4.27	-----	-----	-----	-----	-----	-----	8.11	-----	-----	-----	-----	-----
Georgia	(1)	2.49	-----	-----	4.45	-----	-----	(1)	1.79	-----	-----	4.18	-----	-----
Michigan	7.11	-----	-----	6.94	-----	-----	-----	7.19	-----	-----	8.01	-----	-----	-----
Minnesota	6.34	-----	-----	6.50	-----	(1)	(1)	6.41	-----	-----	6.68	5.82	-----	(1)
Montana	-----	-----	$6.72	-----	-----	-----	-----	-----	-----	$6.00	-----	-----	-----	-----
New Jersey	-----	-----	(1)	-----	-----	$12.23	-----	-----	-----	(1)	-----	-----	$13.92	-----
New York	-----	-----	(1)	(1)	-----	7.13	$11.28	-----	-----	(1)	(1)	-----	7.09	$11.90
Pennsylvania	-----	-----	-----	-----	-----	(1)	(1)	-----	-----	-----	-----	-----	(1)	(1)
South Dakota	(1)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Utah	-----	-----	5.74	-----	-----	-----	-----	-----	-----	6.34	-----	-----	-----	-----
Other States [2]	6.05	13.16	6.85	8.04	3.79	-----	(1)	7.10	3.64	7.52	9.86	6.47	8.47	(1)
Average, all States	6.53	6.05	6.26	6.57	4.48	10.27	12.56	6.52	3.76	6.67	6.75	5.58	10.29	10.58
Byproduct ore: [3]														
Colorado, Delaware, Michigan, Pennsylvania, Tennessee, Virginia	-----	-----	-----	-----	-----	-----	10.00	-----	-----	-----	-----	-----	-----	14.94

[1] Included with average for all States.
[2] Includes Arkansas, California, Missouri, Nevada, New Mexico, Tennessee, Texas, Virginia, Wisconsin, and Wyoming.
[3] Cinder and sinter obtained from pyrites treated in, but not necessarily mined in, States indicated.

TRANSPORTATION

Domestic iron ore is transported by rail the year around to consuming plants in Alabama, California, Colorado, Minnesota, Tennessee, Texas, and Utah. Consumers in the lower Great Lakes area, however, depend on an 8-month navigation season on the Great Lakes for transportation of their supply of domestic and Canadian Lake Superior district ores.

Increased foreign ore consumption in the United States in 1954 has emphasized more than ever the need for adequate ocean shipping and modern up-to-date port facilities. The St. Lawrence Seaway, when completed, will be invaluable for moving Canadian ores from New Quebec and Newfoundland to lower Great Lakes furnaces.

Freight Rates.—Rail and water freight rates for transportation of iron ore from the Lake Superior district in 1954 were the same as in 1953. Exclusive of a 3-percent Federal transportation tax, the rail and the rail (plus) water freight rates were $7.3104 and $5.1306 per gross ton, respectively, between Minnesota ranges and the Pittsburgh-Wheeling district. Component charges for rail plus water freight were as follows:

From mines to upper Lake ports, $1.1799 per gross ton, including $0.1495 for dock handling; from upper Lake ports to lower Lake ports, $1.83 per gross ton, including $0.23 for unloading; and from lower Lake ports to the Pittsburgh-Wheeling district, $2.1207 per gross ton, including $0.1495 for dock handling.

Freight rates on imported iron ore moving through Philadelphia to the Pittsburgh-Youngstown district were reduced by an Interstate Commerce Commission ruling on February 5, 1954, as follows: Imported ore moving through Philadelphia to the Pittsburgh-Youngstown district must have the same transportation rate as ore moved through the port of Baltimore. Freight rates from either port will be $2.71 per ton to Youngstown and $2.66 per ton to Wheeling and Weirton, W. Va., and $2.61 to Midland, Pa.

At the same time the Commission refused to apply the $2.71 rate to the Youngstown area for shipments of imported ore moving through New York and Boston. New York and Boston harbors do not have modern facilities for unloading large iron-ore cargoes, and in view of the freight-rate advantage of shipping through Philadelphia and Baltimore, it is now doubtful that new facilities will be constructed.

Great Lakes Shipping.—Great Lakes iron-ore transportation companies in 1954 experienced the poorest shipping season tonnagewise since 1946. The shipping season opened the week of April 19 and closed the week of November 29. Shipments from the Lake Superior district (United States ranges and Canadian districts) totaled 62.4 million gross tons, including 1.6 million tons shipped by rail.

The United States Great Lakes ore fleet on December 31, 1954, consisted of 271 self-propelled vessels and 5 barges, with a total trip capacity of 2,924,350 gross tons. The Canadian fleet consisted of 50 self-propelled vessels and 4 barges, with a total trip capacity of 570,000 gross tons. On July 15, 1954, slightly more than 80 percent of the total tonnage was in commission, but by August 15 the percentage had dropped to about 77 percent.

A new ship, the *George M. Humphrey,* was added to National Steel's Great Lakes fleet late in the season; it has the largest iron-ore capacity (total displacement of 31,650 gross tons) of any carrier in the fleet.

Ocean Shipping.—United States iron-ore imports were reflected in increased activity at world shipbuilding centers by an expansion program to enlarge the fleet of bulk carriers, designed especially for transporting ore.

Before 1954 a large part of the ore moving in international trade was carried in chartered tramp ships rather than ships designed to transport ore. It has not been possible to separate the tonnage of iron-ore ships built in 1954 from the total tonnage of the world's seagoing dry bulk carriers built, but the current trend apparently is toward more specially designed ore carriers that will lower the cost of shipping, loading, and discharging. According to reports on Merchant Fleets of the World for 1953 and 1954, bulk carriers increased by 21 during 1954 and in deadweight tonnage by 348,000 tons. This category includes colliers and a small number of other specialized vessels, in addition to those built especially for the ore trade.[2]

[2] Letter to Bureau of Mines, Allman, D. W., chief, Division of Ports and Facilities, U. S. Department of Commerce, June 10, 1955.

United States Ocean Ports.—In 1954 bulk ore-handling facilities[3] were expanded in the Mobile and Philadelphia customs districts. The Tennessee Coal & Iron Division, United States Steel Corp., opened a new terminal dock at Mobile, Ala., in April, which with the State docks bulk-handling plant, increased Mobile facilities to an estimated capacity of 6.3 million gross tons of ore per year. In past years bauxite has comprised approximately 60 percent of the ore handled at the State docks and iron ore about 35 percent.

In the Philadelphia customs district ore-unloading capacity was tripled with opening of the Pennsylvania Railroad's ore terminal at Greenwich Point, Pa. The combined capacity of 3 terminals at Philadelphia is between 4.5 and 5 million gross tons a year. The first ore was unloaded in January 1954 at the Fairless Works, Morrisville, Pa., dock, which is also in the Philadelphia customs district. The capacity of this dock is 3 to 3.5 million gross tons per year.

There was no significant expansion in ore-handling capacity in other United States ports during the year. Ore-unloading capacity of the Maryland customs district (Baltimore) remained between 12 and 15 million gross tons a year.

St. Lawrence Seaway.—The St. Lawrence Seaway Development Corp., which, by Executive order, is under the direct supervision of the Secretary of Defense, was established by the Congress May 13, 1954. The corporation is to construct that part of the seaway lying in United States territory; to complete arrangements with the St. Lawrence Seaway Authority of Canada for construction and operation of the seaway; to finance the United States share of the cost on self-liquidating basis; to cooperate with Canada in the control and operation; and to negotiate with Canada on tolls.[4]

The corporation began to function on July 2, 1954, with a small engineering and administrative staff to supervise the activities of the Army Corps of Engineers (employed as design agent) and private contractors, who are awarded work under competitive bidding. First bids were advertised November 27 and opened December 16, 1954. Four contracts for earth excavation, representing 22 million cubic yards of excavation at a cost of approximately $11 million were awarded. The entire project will be under contract by September 1955, and work is expected to be completed by the fall of 1958. Nearly all port cities on the Great Lakes and St. Lawrence River planned development of adequate port facilities to meet the expected increase in inland shipping import and export trade.[5] [6]

FOREIGN TRADE[7]

Iron ore imported for consumption in the United States in 1954 totaled 15.8 million gross tons, valued at $119 million—alltime highs in quantity and in value. Owing to U. S. Department of Commerce

[3] Work cited in footnote 7.
[4] Federal Register Division, National Archives and Records Service, United States Government Organization Manual, 1954–55: General Services Administration, Washington, D. C., p. 450.
[5] Message from the President of the United States, Status and Progress of the St. Lawrence Seaway: 84th Congress, 1st Session, House of Representatives, Document No. 71, pp. 1–3.
[6] Castle, Lewis G., Administrator, St. Lawrence Seaway Development Corp.: Letter to Bureau of Mines, May 24, 1955.
[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 18.—Iron ore imported for consumption in the United States, 1945–49 (average) and 1950–54, by countries, in gross tons

[U. S. Department of Commerce]

Country	1945–49 (average)		1950		1951		1952		1953		1954	
	Gross tons	Value	Gross tons	Value	Gross tons	Value	Gross tons	Value	Gross tons	Value	Gross tons	Value
North America:												
Canada	1,184,793	$6,351,137	1,852,508	$12,728,135	1,961,990	$14,399,135	1,822,038	$13,884,030	1,840,983	[1]$16,050,131	3,522,863	$28,493,716
Newfoundland - Labrador	3,100	12,400										
Costa Rica							449	1,005	3,076	4,588		
Cuba	71,510	330,193	29,000	61,770	4,223	29,926	87,536	882,684	196,676	[1]1,853,187	32,165	313,563
Dominican Republic							18,408	197,943	80,401	947,442	89,160	1,066,861
Mexico	85,302	160,787	190,958	475,299	169,563	506,482	114,309	356,845	241,636	1,048,617	140,863	417,539
Total	1,344,705	6,854,517	2,072,466	13,265,204	2,135,776	14,935,543	2,042,740	15,322,507	2,362,772	19,903,965	3,785,051	30,291,679
South America:												
Argentina	8	4,989										
Brazil	146,519	845,596	701,329	4,732,136	1,037,828	8,921,991	1,010,919	14,938,163	458,282	6,386,308	595,907	7,016,488
Chile	1,646,308	4,397,444	2,606,557	6,821,829	2,767,207	8,587,746	1,861,575	8,240,661	2,363,401	12,347,510	1,664,300	7,865,692
Peru	3	12							844,481	5,955,545	1,931,929	15,594,978
Venezuela					635,416	3,780,692	1,845,776	14,610,871	1,949,618	17,026,862	5,209,812	36,034,782
Total	1,792,838	5,248,041	3,307,886	11,553,965	4,440,451	21,290,429	4,718,270	37,789,695	5,615,782	41,716,225	9,401,948	66,511,940
Europe:												
Belgium-Luxembourg	244	820										
Denmark									123	4,408		
France	2,602	14,863	500	1,550								
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	[1]124,779	235	5,291
Sweden	981,180	6,070,431	2,047,250	13,511,874	2,522,011	16,920,468	2,111,100	24,504,292	2,097,522	27,207,210	1,543,753	14,241,188
United Kingdom	459	28,485	751	27,050	446	28,837	690	23,369	444	24,011	354	30,129
Total	1,023,496	6,360,275	2,048,501	13,540,474	2,596,763	17,548,655	2,116,390	24,561,143	2,108,779	27,360,408	1,544,342	14,276,608
Asia:												
Iran	1,200	58,800	3,000	180,000	1,500	60,000	2,972	165,755	2,953	205,053	2,953	200,858
Philippines	1,882	16,139	3,600	36,000								
Total	3,082	74,939	6,600	216,000	1,500	60,000	2,972	165,755	2,953	205,053	2,953	200,858

Africa:												
Algeria	232, 057	1, 163, 161	494, 342	2, 917, 910	446, 273	2, 919, 490	66, 008	518, 994	21, 150	273, 888	29, 100	339, 550
British West Africa	20, 209	151, 590	192, 669	1, 615, 728	255, 817	1, 586, 940	217, 760	1, 108, 055	231, 600	1, 305, 910	250, 820	1, 404, 547
Egypt	1, 500	17, 730										
French Morocco	3, 088	16, 886										
Liberia	7	38	(2)	51	110, 123	552, 694	572, 485	3, 156, 561	710, 290	5, 764, 548	763, 610	6, 304, 832
Spanish Africa	1, 700	9, 775	39, 680	250, 717	8, 750	62, 335						
Tunisia	36, 486	186, 055	119, 093	608, 377	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	296, 834	1, 555, 146	845, 784	5, 392, 783	965, 188	5, 685, 419	880, 253	5, 015, 406	983, 749	7, 602, 567	1, 043, 530	8, 048, 929
Grand total	4, 460, 955	20, 092, 918	8, 281, 237	43, 968, 426	10, 139, 678	59, 520, 046	9, 760, 625	82, 854, 506	11, 074, 035	[1] 96, 788, 218	15, 777, 824	[3] 119, 330, 014

[1] Revised figure.
[2] Less than 1 ton.
[3] Due to changes in tabulating procedures by the U. S. Department of Commerce data known not to be comparable to earlier years.

TABLE 19.—Pyrites cinder [1] imported for consumption in the United States, 1945–49 (average) and 1950–54, by countries, in gross tons

[U. S. Department of Commerce]

Country	1945–49 (average)		1950		1951		1952		1953		1954	
	Gross tons	Value	Gross tons	Value	Gross tons	Value	Gross tons	Value	Gross tons	Value	Gross tons	Value
North America: Canada	9, 990	$31, 457	15, 735	$58, 260	8, 675	$34, 758	11, 149	$48, 028	12, 053	$54, 172	898	$3, 556
Europe:												
Belgium-Luxembourg	(2)	17										
France	140	148										
Italy	(2)	2										
Total	140	167										
Grand total	10, 130	31, 624	15, 735	58, 260	8, 675	34, 758	11, 149	48, 028	12, 053	54, 172	898	3, 556

[1] Byproduct iron ore.
[2] Less than 1 ton.

TABLE 20.—Iron ore exported from the United States, 1945–49 (average) and 1950–54, by countries of destination, in gross tons

[U. S. Department of Commerce]

Destination	1945–49 (average)		1950		1951		1952		1953		1954	
	Gross tons	Value	Gross tons	Value	Gross tons	Value	Gross tons	Value	Gross tons	Value	Gross tons	Value
North America:												
Canada	2,313,636	$9,537,769	2,550,712	$15,709,693	3,340,170	$21,734,997	3,790,253	$24,507,789	[1] 3,853,580	$28,094,069	2,812,367	$21,669,146
Canal Zone	4	86			4	138	7	212				
Mexico	13	156			46	127					88	2,379
Other North America	45	1,233										
Total	2,313,698	9,539,244	2,550,712	15,709,693	3,340,220	21,735,262	3,790,260	24,508,001	3,853,580	28,094,069	2,812,455	21,671,525
South America:												
Brazil					4	326						
Colombia	(2)	2									46	1,700
Other South America	(2)	15										
Total	(2)	17			4	326					46	1,700
Europe:												
Netherlands	20	1,503										
Norway	15	158			854	11,129						
United Kingdom	1	258	11	2,966	9	2,200						
Other Europe	4	237										
Total	40	2,156	11	2,966	863	13,329						
Asia:												
Japan	62,532	567,930			987,814	9,245,943	1,332,379	12,893,934	[1] 398,374	[1] 4,327,448	332,231	3,065,285
Philippines	809	7,361	7	639	5	485	1	120	1	120		
Total	63,341	575,291	7	639	987,819	9,246,428	1,332,380	12,894,054	398,375	4,327,568	332,231	3,065,285
Africa:												
French Morocco	20	990										
Gold Coast			1	463								
Union of South Africa											978	43,808
Total	20	990	1	463							978	43,808
Oceania: Australia	3	713	7	2,748	4	1,439	4	1,918			4	1,679
Grand total	2,377,102	10,118,411	2,550,738	15,716,509	4,328,910	30,996,784	5,122,644	37,403,973	[1] 4,251,955	[1] 32,421,637	3,145,714	24,783,997

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

TABLE 21.—World trade of iron ore, in thousand long tons, in 1952

(Compiled by John E. McDaniel)

Exports by countries of origin	Per cent Fe	Production	Exports	Exports by countries of destination: North America: Canada	North America: United States	Europe: Austria	Europe: Belgium-Luxembourg	Europe: Czechoslovakia	Europe: France	Europe: Germany, West	Europe: Italy	Europe: Netherlands	Europe: Poland	Europe: Saar	Europe: Spain	Europe: United Kingdom	Asia: Japan	Other countries
North America:																		
Canada	55	4,707	3,436		1,795					301						630	710	
Cuba	63	99	96	2	94													
Mexico	60	515	112	(1)	112					(1)								
United States	50	97,918	5,123	3,790													1,333	(1)
South America:																		
Brazil	67	2,996	1,537	114	1,038	30	66		28	119		52				90		
Chile	60	2,174	1,798		1,798													
Venezuela	75	1,939	1,859		1,859													
Europe:																		
Austria	32	2,611	273				59			214								
Belgium-Luxembourg	27	7,264	441						10	428								3
France	33	40,073	15,685				8,262			373		130	19	6,460		441		(1)
Germany, West	27	15,161	144			92			11		1			39				1
Greece	50	135	110							71						9		30
Italy	50	778	7							7								
Norway	59	757	700			13	24	20		401		18	147			61		16
Portugal	50	88	119		26		8		4		26	2				53		
Spain	45	2,818	1,778			65	26		3	681	51	228				650		74
Sweden	60	16,681	15,416		2,122	87	2,170	430	64	5,484	49	342	948			3,613		107
Switzerland	40	105	109			49			(1)	60								
Yugoslavia	45	665	153			81				31	2					39		
Asia:																		
Hong Kong	47	128	114														106	8
India	64	3,926	669			10	91	69		57	14	36	4				363	25
Malaya	56	1,055	1,008							60		26				72	850	(1)
Philippines	58	1,152	1,203														1,203	
Portuguese India	55	478	464							100							364	
Africa:																		
Algeria	52	3,047	3,074		44	21	271		166	271	325	213	43			1,720		
French Morocco	44	641	612				4		5	75		246				282		
Liberia	68	890	877		566					45		33				233		
Sierra Leone	60	1,164	1,379		237					339		17				786		
Spanish Morocco	60	919	954			22	10		71	190	20	74			291	276		
Tunisia	54	962	977		20	15			30	53	176	93	25			565		
Oceania: Australia	65	2,684																
Other countries	(2)	[3, 4] 78,470	(2)															
Total		293,000	60,227	3,906	9,711	485	10,991	519	392	9,360	664	1,510	1,186	6,499	291	9,520	4,929	264

[1] Less than 500 tons.
[2] Data not available.
[3] Includes 50,000,000 tons produced in U. S. S. R. and 16,232,000 tons produced in the United Kingdom.
[4] Estimate.

changes in tabulating procedures, the 1954 average value of $7.56 per gross ton of iron-ore imports cannot be compared precisely with data for previous years. However, the Department's new procedures[8] are believed to be accurate enough to allow a general comparison with 1953, indicating an approximate 13.5-percent decrease per gross ton. The quantity of imports in 1954 was 42 percent more than in 1953.

In 1954 Venezuela displaced Chile as the principal supplier of iron ore to the United States, increasing shipments 167 percent above those of 1953 and furnishing 33 percent of total United States iron-ore imports. Canada ranked second with 22 percent and Peru third with 12 percent, and Chile dropped from first to fourth with 11 percent. Sweden furnished 10, Liberia 5, and Brazil 4 percent and 8 countries the remaining 3 percent. Compared with 1953 iron-ore imports from Peru increased 129 percent and from Canada 91 percent. An expected increase in imports of Canadian iron sinter derived from pyrite did not materialize in 1954. Imports from Chile decreased 30 percent and from Sweden 26 percent.

International Trade.—The Bureau of Mines in 1952 began presenting in the Minerals Yearbook a table dated 2 years behind the current issue and showing exports of iron ore by countries of origin with countries of designation. As explained with the first presentation, the time lag is occasioned by the fact that the statistical pattern does not emerge with acceptable accuracy for at least 2 years. Table 21 in this volume—the third such table published—accordingly lists world export-import statistics for 1952.

Portugal entered the trade pattern in 1952 for the first time, exporting ore to the United States, Belgium-Luxembourg, France, Italy, Netherlands, and United Kingdom. Liberia, exporting a record iron-ore production of Bomi Hills, supplied the United States with over 500,000 tons of high-grade ore and the United Kingdom with almost 250,000 tons and also furnished small quantities to West Germany and the Netherlands.

Indian iron-ore exports increased 241 percent in 1952 compared with 1951 as the result of Japanese willingness to invest in long-term iron supplies for their furnaces. Venezuelan exports increased 192 percent, all derived from the Powell iron-ore deposit on the south bank of the Orinoco River. Declining reserves and transfer of shipping facilities to the Venezuelan trade resulted in a 32-percent decrease in Chilean iron-ore exports.

TECHNOLOGY

Numerous articles reporting research work on possible methods for treating low-grade iron ores, including magnetic separation, flotation, differential grinding, and agglomeration, were published in 1954. The success of this work was demonstrated by successful operation of 2 plants to treat the magnetic Minnesota taconite and 1 plant to treat nonmagnetic Michigan jaspillite.

Reserve Mining Co. Babbit plant, which was first put in operation

[8] U. S. Department of Commerce, United States Imports of Merchandise for Consumption, Commodity by Country of Origin: Rept. FT110, 1954, 175 pp.

in August 1952, was described.[9] The West Hill plant of the Western Mining Co. operated by Pickands Mather & Co., also treating Mesabi lean ores, was also described.[10]

The Humble plant of the Humble Mining Co., 13 miles southwest of Ishpeming, began operating in 1954, successfully floating specular hematite from Michigan jasper.[11] The shape of specular hematite grains permits the use of red oil, high in oleic acid, as the only flotation reagent. About 0.65 pound of reagent is used per ton of crude ore.

In the course of batch cyclone test work in the Hanna beneficiation laboratory, it was observed that some sized fractions of iron ore used for testing were higher in grade after the tests were run than before they started, indicating a differential grinding effect in the cyclone.[12]

Work on the flotation of iron ore included an investigation of substitute starches in amine reagents.[13] The value of cornstarch as a selective iron oxide depressant is impaired by the substitute derivatives.

Papers presented at a special meeting in Sweden of the Iron and Steel Institute (Great Britain)[14] outlined the development of methods of agglomerating iron-ore concentrate in Sweden and England and present current conditions that influence this work.[15]

In the broad sense, development of beneficiation processes in both Sweden and England was forced by the same factors as in the United States.

The solid-state reaction responsible for the development of the hard shell in conventionally fired pellets and the high strength and uniform internal structure in laboratory pellets preoxidized before final firing was studied.[16] These studies indicated that bonding occurs between magnetite cubes fired in air at temperatures as low as 500° C. and that the degree of bonding increases with both temperature and time. The experimental kiln of the Oliver Iron Mining Division of the United States Steel Corp. at the Extaca plant provided data on agglomeration of high-grade ore fines and taconite concentrate.[17] Magnetite pelletizing and the production of sponge ore at the Sanvicks Steel Co., Ltd., at Sanvicking, Sweden, was described.[18]

[9] Lee, Oscar, Taconite Beneficiation Comes of Age at Reserves' Babbitt Plant: Min. Eng., vol. 155, No. 5, May 1954, pp. 482–488.

[10] Herkinhoff, E. C., Modern Plant Will Treat Mesabi Lean Ore: Eng. and Min. Jour., vol. 155, No. 3, March 1954, pp. 78–83.

[11] Cocren, R., New Plant Successfully Floats Michigan Jasper: Eng. and Min. Jour., vol. 155, No. 8, August 1954, pp. 100–104, 114.

[12] Erickson, S. E., Differential Grinding in Cyclone Shown by Screen Tests: Eng. and Min. Jour., vol. 155, No. 1, January 1954, pp. 95, 168.

[13] Chang, C. S., Substitute Starches in Amine Flotations of Iron Ore: Min. Eng., vol. 6, No. 9, September 1954, pp. 922–924.

[14] Tigerschiold, Magnus, Aspects on Pelletizing of Iron-Ore Concentrates: Jour. Iron and Steel Inst. (London), vol. 177, May 1954, pp. 13–24.

Stirling, A., The Pelletizing of Northampton Sand Ironstones by Vacuum Extrusion: Jour. Iron and Steel Inst. (London), vol. 177, May 1954, pp. 25–42.

Ridgion, J. M., and Cohen, E., The Development of a Pelletizing Process for Fine Iron Ores: Jour. Iron and Steel Inst. (London), vol. 177, May 1954, pp. 43–63.

Kihlstedt, P. G., Aspects of Swedish Iron-Ore Concentration: Jour. Iron and Steel Inst. (London), vol. 177, May 1954, pp. 63–84.

[15] McLeod, J. M., Preparation of Ores; Methods of Improvement of Blast-Furnace Burdens: Iron and Steel (London), vol. 27, No. 1, February 1954, pp. 49–54. Preparation of Ores—the Sintering of Iron Ores: Iron and Steel (London), vol. 27, No. 2, March 1954, pp. 103–109. Preparation of Ores—Theory of Sintering and Testing of Materials: Iron and Steel (London), vol. 27, No. 3, April 1954, pp. 145–151. Preparation of Ores—Other Methods of Agglomerating Fines and Direct-Smelting Processes: Iron and Steel (London) vol. 27, No. 4, May 1954, pp. 185–191.

[16] Cook, S. R. B., and Brant, R. E., Solid-State Bonding in Iron-Ore Pellets: Min. Eng., vol. 6, No. 4, April 1954, pp. 411–415.

[17] Bennet, R. L., and Hagen R. E., Nodulizing Iron Ores and Concentrates at Extaca: Min. Eng., vol. 6, No. 1, January 1954, pp. 32–38.

[18] Mining Magazine (London), Magnetite Pelletizing and the Production of Sponge Iron: Vol. 90, No. 2, February 1954, pp. 75–78.

Segments of the domestic iron and steel industry strongly oppose giving further consideration to a sponge-iron process for supplementing the existing iron industry. However, in areas where coking coal is costly, sponge or other forms of direct iron may be the basis for an economical iron and steel industry. The Bureau of Mines published a summary of its work,[19] a review of processes developed by others, and descriptions of commercial sponge and other direct-iron processes currently in use, including a selected bibliography and a list of United States patents through April 17, 1951.

Researchers reported that a surprisingly large proportion of fine-ore particles (about 60 percent) was retained in using unpelletized powders in a blast-furnace charge.[20] Radioactive concentrate made by blending 76 tons of iron ore with a 5-pound block of powdered ore that had been bombarded in a nuclear reaction pile for 8 days with neutron rays were used in following material through the blast furnace.

RESERVES

Data in tables 22 and 23 represent taxable and State-owned reserves. Eventual production will doubtless exceed the totals.

TABLE 22.—Iron-ore reserves in Michigan, Jan. 1, 1946-50 (average) and 1951–55, in gross tons

[Michigan Department of Conservation]

Range	1946–50 (average)	1951	1952	1953	1954	1955
Gogebic	30, 941, 545	33, 466, 792	34, 162, 005	31, 467, 972	28, 606, 915	31, 325, 522
Marquette	62, 545, 071	68, 323, 382	65, 119, 690	64, 943, 858	65, 364, 095	69, 549, 132
Monominee	52, 106, 099	60, 136, 726	62, 940, 226	62, 188, 665	60, 086, 244	59, 322, 347
Total, Michigan	145, 592, 715	161, 926, 900	162, 221, 921	158, 600, 495	154, 057, 254	160, 197, 001

TABLE 23.—Unmined iron-ore reserves in Minnesota, May 1, 1945–49 (average) and 1950–54, in gross tons

[Minnesota Department of Taxation]

	1945–49 (average)	1950	1951	1952	1953	1954
Mesabi	925, 155, 022	912, 226, 039	893, 007, 833	854, 280, 596	839, 732, 761	825, 291, 618
Vermilion	11, 440, 927	12, 498, 639	11, 660, 302	12, 390, 557	12, 989, 074	12, 062, 931
Cuyuna	49, 965, 043	42, 977, 068	41, 415, 581	43, 472, 578	43, 983, 246	58, 903, 347
Total, Lake Superior district (taxable)	986, 560, 992	967, 701, 746	946, 083, 716	910, 143, 731	896, 705, 081	896, 257, 896
Fillmore County	225, 738	582, 820	908, 996	574, 908	607, 500	573, 492
Morrison County		88, 286	[1] 43, 986	15, 000		
Aitkin County				850, 000	850, 000	869, 571
Mower County						118, 160
State ore (not taxable)	11, 473, 461	[1] 4, 118, 266	2, 643, 033	2, 486, 297	117, 197	117, 197
Total Minnesota	998, 260, 191	972, 491, 118	949, 679, 731	914, 069, 936	898, 279, 778	897, 936, 316

[1] Revised figure.

EMPLOYMENT

Employment at iron-ore mines and beneficiating plants, the quantity and tenor of ore produced, and the average output per man are listed in table 24 by districts and States. The average number of men em-

[19] Barret, E. P., Sponge-Iron and Direct-Iron Processes: Bureau of Mines Bull. 519, 1954, pp. 143.
[20] Iron Age, Iron Ore: Vol. 173, No. 10, Mar. 11, 1954, pp. 79–80.

ployed decreased from 31,800 in 1952 to 30,762 in 1953, but the average output per manshift rose from 16 tons of crude ore to 19 tons, an increase of over 18 percent.

WORLD REVIEW

NORTH AMERICA

Canada.[21]—Iron-ore production (shipments including only ore tonnage actually shipped from mines) in Newfoundland, Ontario, and British Columbia declined during the year, but the decline was more than offset by production from new mines in Labrador–New Quebec. Shipments rose from 5,812,337 gross tons in 1953 to 6,500,229 gross tons in 1954, a 12-percent increase and a record high. Shipments beginning in July 1954 from properties of the Iron Ore Co. of Canada in Labrador–New Quebec accounted for 27 percent of the total. Development of the known Canadian iron-ore deposits and further successful exploration in Ontario, in the Ungava Bay area of New Quebec, along the Labrador Trough in New Quebec and Labrador, and on the west coast of British Columbia will, within a decade, make Canada one of the major iron-ore producers of the world.

Alberta.—In the Peace River area a bed of oolitic siderite was discovered during drilling of an oil well. The bed is 10 to 20 feet thick and is covered with 50 to 400 feet of overburden. Drill cores assayed about 35 percent iron, with high phosphorus and silica. Preliminary mineral-dressing tests indicated that it was not commercially amenable to concentration.

British Columbia.—The Argonaut Mining Co., Ltd., a subsidiary of the Utah Construction Co. of San Francisco, Calif., operated the Iron Hill open-pit mine near upper Quinsam Lake over 8 months in 1954. Mine production of crude magnetite ore totaled 460,971 gross tons, averaging about 38.4 percent iron. Magnetite concentrate for export to Japan averaged approximately 57.5 percent iron. The mine was closed in mid-November owing to lack of a market. Exploration work with magnetometer surveys and diamond drilling was continued by the company at nearby Iron River and Iron Valley.

Texada Mines, Ltd., mined 516,492 gross tons of magnetite iron ore from the Prescott Lake and North and South Paxton open-pit mines during the year. The crude ore averaged about 42 percent iron, and concentrate averaged 57 percent iron, 1.23 percent sulfur, and 0.22 percent copper. Concentrate was exported to Japan. The company explored the "Yellow Kid" anomaly, where a body of commercial ore had been indicated.

Western Canada Steel Co. explored for iron ore on islands off the west coast of British Columbia. Canadian Collieries (Dunsmuir), Ltd., and Waddington Mining Corp., Ltd., conducted a restricted exploration program on Vancouver Island.

Newfoundland.—Dominion Wabana Ore, Ltd., produced 2,526,131 gross tons of iron ore from its mines under Conception Bay. Shaftheads and surface facilities of these mines are on Bell Island, but most production is from workings 3 miles out to sea. Hematite ore, averaging 50.21 percent iron, 13.42 percent silica, 0.88 percent phosphorus,

[21] Buck, W. Keith, A Survey of the Iron-Ore Industry in Canada During 1954: Canada Dept. of Mines and Tech. Surveys, Mines Branch, Mineral Resources Inf. Circulars, Ottawa, M. R. 13, Apr. 14, 1955, 38 pp.

TABLE 24.—Employment at iron-ore mines and beneficiating plants, quantity and tenor of ore produced, and average output per man in 1953, by districts and States [1]

District and State	Employment: Average number of men employed	Employment: Time employed: Average number of days	Employment: Time employed: Total manshifts	Employment: Time employed: Man-hours: Average per shift	Employment: Time employed: Man-hours: Total	Production: Crude ore (gross tons)	Production: Usable ore: Gross tons	Production: Usable ore: Iron contained: Gross tons	Production: Usable ore: Iron contained: Natural (percent)	Average per man (gross tons): Crude ore: Per shift	Average per man (gross tons): Crude ore: Per hour	Average per man (gross tons): Usable ore: Per shift	Average per man (gross tons): Usable ore: Per hour	Average per man (gross tons): Usable ore: Iron contained: Per shift	Average per man (gross tons): Usable ore: Iron contained: Per hour
Lake Superior: [1]															
Michigan	9,095	259	2,353,702	8.00	18,839,910	16,150,305	15,637,572	7,998,388	51.14	6.862	0.857	6.644	0.830	3.398	0.425
Wisconsin															
Minnesota	13,828	286	3,956,037	8.00	31,665,615	105,531,885	81,030,146	40,646,246	50.16	26.676	3.333	20.483	2.559	10.274	1.284
Total	22,923	275	6,309,739	8.00	50,505,525	121,682,190	96,667,718	48,644,634	50.32	19.285	2.409	15.320	1.914	7.709	.963
Southeastern States:															
Alabama	3,718	245	911,427	8.10	7,386,983	10,970,315	7,462,379	2,833,225	37.97	12.036	1.485	8.188	1.010	3.109	.384
Georgia	88	173	15,264	9.56	146,045	937,531	210,664	91,603	43.48	61.421	6.419	13.801	1.442	6.001	.627
Tennessee															
Virginia	23	268	6,172	8.09	49,945	70,281	18,702	8,144	43.55	11.387	1.407	3.030	.374	1.320	.163
Total	3,829	244	932,863	8.13	7,582,973	11,978,127	7,691,745	2,932,972	38.13	12.840	1.580	8.245	1.014	3.144	.387
Northeastern States:															
New Jersey	721	279	201,269	8.01	1,611,991	1,558,384	876,168	541,636	61.82	7.742	.967	4.353	.544	2.691	.336
New York															
Pennsylvania	1,942	275	533,433	8.00	4,267,464	10,466,919	4,285,645	2,635,892	61.51	19.622	2.453	8.034	1.004	4.941	.618
Total	2,663	276	734,702	8.00	5,879,455	12,025,303	5,161,813	3,177,528	61.56	16.368	2.045	7.026	.878	4.325	.540

Western States.															
California [2]	371	216	79,969	8.09	647,032	2,055,010	2,055,010	1,141,336	55.54	25.698	3.176	25.698	3.176	14.272	1.764
Nevada	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Arkansas	156	217	33,803	8.00	270,420	656,377	274,947	147,369	53.60	19.418	2.427	8.134	1.017	4.360	.545
Missouri	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
New Mexico	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Texas	180	244	43,926	8.00	351,409	3,971,054	1,036,852	495,017	47.74	90.403	11.300	23.605	2.951	11.269	1.409
Utah	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Wyoming [3]	640	313	200,341	8.00	1,602,724	5,501,849	5,501,849	2,951,451	53.64	27.462	3.433	27.462	3.433	14.732	1.842
Total	1,347	266	358,039	8.02	2,871,585	12,184,290	8,868,658	4,735,173	53.39	34.031	4.243	24.770	3.088	13.225	1.649
Total 1953	30,762	271	8,335,343	8.02	66,839,538	157,869,910	118,389,934	59,490,307	50.25	18.940	2.362	14.203	1.771	7.137	.890

[1] Includes manganese-bearing ore in the Lake Superior district.
[2] Colorado included with California and Nevada.
[3] Man-hour data for Montana and South Dakota are not available and are therefore excluded from all totals; however, production data for both States are included with Utah and Wyoming.

TABLE 25.—World production of iron ore, by countries,[1] 1945–49 (average) and 1950–54, in thousand long tons [2]

(Compiled by Pearl J. Thompson)

Country [1]	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Canada	2,011	3,219	4,179	4,707	5,813	6,501
Cuba	58	12	17	99	225	25
Mexico	312	413	453	515	538	514
United States	87,651	98,045	116,505	97,918	117,995	78,094
Total	90,000	102,000	121,000	103,000	124,600	85,000
South America:						
Argentina	[3] 45	40	54	66	72	60
Brazil	1,044	1,956	2,369	2,996	3,095	[3] 3,300
Chile [4]	1,781	2,929	3,201	2,174	2,131	1,958
Peru	----	----	----	----	985	1,394
Venezuela	----	195	1,250	1,939	2,260	5,304
Total	2,900	5,100	6,900	7,200	8,500	[3] 12,000
Europe:						
Austria	857	1,830	2,333	2,611	2,713	2,678
Belgium	51	45	78	133	97	80
Bulgaria [3]	7	27	42	59	66	76
Czechoslovakia [3]	1,139	1,756	1,931	2,278	2,264	2,264
France	19,154	29,542	34,647	40,073	41,705	43,132
Germany:						
East [3]	6,255	380	583	839	1,199	1,457
West		10,711	12,719	15,161	14,388	12,830
Greece	17	5	52	135	85	76
Hungary	213	362	[3] 400	[3] 450	[3] 500	[3] 550
Italy	314	468	544	778	918	1,048
Luxembourg	2,594	3,784	5,536	7,131	7,057	5,814
Norway	146	293	327	757	1,279	1,191
Poland	466	778	887	1,011	1,324	[3] 1,601
Portugal	----	----	21	88	120	82
Rumania [3]	178	389	470	644	679	684
Spain	1,533	2,055	2,351	2,818	2,976	3,352
Sweden	9,193	13,396	15,140	16,681	16,715	15,173
Switzerland	44	54	85	105	103	100
U. S. S. R. [3] [5]	25,500	43,000	47,000	49,000	59,000	64,000
United Kingdom	12,785	12,963	14,777	16,233	15,817	15,557
Yugoslavia	568	719	573	665	782	1,093
Total [3]	81,000	123,000	141,000	158,000	170,000	173,000
Asia:						
China [3]	976	2,000	3,000	4,000	5,000	6,000
Hong Kong	12	169	161	128	123	91
India	2,453	2,965	3,657	3,926	3,560	3,726
Indochina	2	----	----	----	----	----
Japan [6]	788	912	1,150	1,372	1,517	1,605
Korea:						
Republic of	164	----	49	21	19	31
North	93	(7)	(7)	(7)	(7)	(7)
Malaya	5	499	846	1,055	1,063	1,213
Philippines	96	590	889	1,152	1,199	1,402
Portuguese India	31	129	429	478	929	1,359
Thailand (Siam)	----	3	6	3	8	3
Turkey	156	230	222	474	489	577
Total [3] [5]	4,800	7,500	10,400	12,700	13,900	16,000
Africa:						
Algeria	1,740	2,532	2,778	3,047	3,335	2,881
French Guinea	----	----	----	----	393	583
French Morocco	206	318	525	641	498	330
Liberia	----	----	168	890	[8] 1,295	[8] 1,171
Rhodesia and Nyasaland, Fed. of:						
Northern Rhodesia	----	----	----	6	2	1
Southern Rhodesia	16	56	51	64	62	63
Sierra Leone	888	1,166	1,141	1,164	1,368	[8] 877
Spanish Morocco	827	936	922	919	970	916
Tunisia	419	746	908	962	1,040	935
Union of South Africa	1,041	1,170	1,399	1,731	1,940	1,863
Total	5,100	6,900	7,900	9,400	10,900	9,600

See footnotes at end of table.

TABLE 25.—World production of iron ore, by countries,[1] 1945–49 (average) and 1950–54, in thousand long tons [2]—Continued

Country [1]	1945–49 (average)	1950	1951	1952	1953	1954
Oceania:						
Australia	1,806	2,365	2,436	2,684	3,299	3,519
New Caledonia		15				
Total	1,806	2,400	2,400	2,700	3,300	3,500
World total (estimate) [1]	185,606	247,000	290,000	293,000	331,000	299,000

[1] In addition to countries listed, Egypt and Madagascar report production of iron ore in past years, but the quantity produced is believed insufficient to affect estimate of world total.
[2] This table incorporates a number of revisions of data published in previous Iron-Ore chapters.
[3] Estimate.
[4] Production of Tofo mines.
[5] U. S. S. R. in Asia included with U. S. S. R. in Europe.
[6] Includes iron sand production as follows: 1950, 101,544 tons; 1951, 255,984 tons; 1952, 322,008 tons; 1953, 437,868 tons; and 1954, 509,484 tons.
[7] Data not available; estimate by author of chapter included in total.
[8] Exports.

and 1.70 percent moisture was shipped to the company steel plant at Sydney, Nova Scotia, to the United Kingdom, and to West Germany.

The Newfoundland & Labrador Corp. (NALCO) conducted limited exploration work in southeast Labrador. Canadian Javelin, Ltd., holds a subconcession from the corporation on 2,300 square miles in southwest Labrador near Wabush Lake. The Javelin Co. explored this area in 1954, mapping, diamond drilling, and surveying with a magnetometer. The ore in the area is reportedly hematite, averaging about 38 percent iron, which can be concentrated by simple gravity methods to a better than 60-percent iron concentrate. Development of the property will require approximately 45 miles of spur line to the Quebec North Shore & Labrador Railway.

Northwest Territories.—Belcher Iron Ores, Ltd., conducted a small diamond-drilling exploration program on the iron deposits on the Belcher Islands in Hudson Bay. A major anomaly near Atzinging Lake north of the Saskatchewan boundary was indicated by an aeromagnetic survey made in August by the Geology Survey of Canada.

Saskatchewan.—An aeromagnetic survey of the Frobisher, Vermillion, and Black Birch Lakes area by the Saskatchewan Government in 1953 indicated several anomalies. As a result of the survey, three deposits of magnetite were found: 1, On the southeastern shore of Frobisher Lake; 2, 25 miles north of Spear Lake; and 3, immediately southwest of Ithingo Lake. Crude ore assaying 27 percent iron from the Spear Lake deposit was tested by the Mines Branch, Ottawa. Magnetic separation following a 100-mesh grind yielded a concentrate containing 66 percent iron, 7.35 percent silica, and low sulfur and phosphorus.

Mexico.—Production of iron ore in Mexico in 1954 was 514,000 long tons, containing 313,000 tons of iron, compared with 538,000 tons, containing 331,000 tons of iron, in 1953. In accordance with its industrialization program, the Mexican Government continued to maintain strict control over export of iron ore. Export permits have been granted only to Cia. Minera de Piscilla, Cerro de Mercado, and Fierro de Durango. Fierro de Durango acquired an export permit for trial shipment of 25,000 tons of ore from its deposits near Durango. Exports, all to the United States, decreased 18 percent and totaled

87,086 tons in 1954. In 1953 exports were 106,808 tons. An estimated 394,000 tons was delivered to domestic consumers in 1954 compared with 404,000 tons in 1953.[22]

SOUTH AMERICA

Brazil.—Brazil's unfavorable balance in international trade stimulated the present government to encourage further exportation of Brazilian products for hard currency. This policy did not have much effect on iron-ore production in 1954, but production did increase to an estimated 3.3 million long tons from 3 million tons in 1953. Exports in 1954 totaled 1,651,942 tons containing 66 to 68 percent iron.

Chile.—Iron-ore production in Chile's mines decreased 8 percent to 1,958,000 long tons in 1954 compared with 2,131,000 tons in 1953. United States imports of Chilean iron ore decreased from 2,363,000 tons in 1953 to 1,664,000 in 1954. A new company formed by the Cia. Acero del Pacifico and the Bethlehem (Chile) Iron Mines Co. developing a new iron-ore mine, the El Romeral, made arrangements to start production the latter part of the year.[23]

Venezuela.—The first shipment of iron ore from Cerro Bolivar on January 9, 1954, through Puerto Ordaz, Venezuela, marked the beginning of a new iron-ore-mining operation that more than doubled Venezuelan production in the first year. The steamship *Tosca* carried 10,400 tons of iron ore to United States Steel's Fairless Works near Philadelphia, thus beginning iron-ore trade that is expected to affect the economics of both Venezuela and the United States.

Successful exploitation of Venezuelan iron-ore deposits by United States Steel Corp. and the Bethlehem Steel Corp. has interested others in the area. New deposits were reported some 40 miles west of Cerro Bolivar in the Venezuelan Guayana by geologists and engineers of the Cleveland-Cliffs Mining Co.[24]

Iron-ore production in 1954 totaled 5,304,000 long tons, a 135-percent increase over the quantity produced in 1953. Exports totaled 5,419,428 tons, of which 5,401,525 tons was shipped to the United States, 9,512 tons to Germany, and 8,391 tons to England. Iron-ore stocks totaled 893,748 tons at the end of the year.

EUROPE

Austria.—Austrian iron-ore production of 2,678,035 long tons in 1954 was slightly below the quantity produced in 1953. Iron-ore imports totaled 588,960 tons—23 percent less than the quantity imported in 1953.

France.—French iron ore production in 1954 totaled 43,132,000 long tons compared with 41,705,000 tons in 1953. The domestic market and the Saar received 29,499,000 and 6,141,000 tons, respectively. Exports totaled 11,038,000 tons, including 10,216,000 tons to the Belgium-Luxembourg Economic Union.[25] The outstanding position France occupies is due to its proximity to the European market, inasmuch as 94 percent of the iron ore produced in metropolitan France comes from the low-grade, high-phosphorus Lorraine deposits.

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[22] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 5, May 1955, p. 17.
[23] Metal Bulletin (London), No. 3933, Oct. 8, 1954, p. 28.
[24] Engineering and Mining Journal, vol. 155, No. 1, January 1954, p. 114.
[25] Metal Bulletin (London), No. 3965, Feb. 1, 1955, p. 23.

Germany, West.—The iron-ore-mining industry of West Germany experienced a sales crisis in 1954, resulting in some instances in complete closure of the mines and causing considerable hardship to both workers and employers. In the latter half of the year, however, a strong tendency prevailed within the iron and steel industry to use local ores, and contracts were made between West Germany steel plants and German iron-ore mines. By the end of the year the sales crisis had passed, and all mines were operating at normal capacity. Iron-ore production totaled 12,830,000 long tons in 1954—11 percent less than in 1953 and 15 percent less than in 1952. It was announced that iron-ore mines applied for expansion loans from the European Coal and Steel Community totaling $26.5 million.[26]

ASIA

India.—Iron-ore deposits of India are believed to be extensive but largely unexplored, and mining and development have been confined to only a few in the most accessible localities. Production in 1954 totaled 3,726,000 long tons.

Iron-ore reserves estimated at 30 million tons containing a minimum of 25 percent magnetite to a depth of 100 feet were reported in Salem and Trichinopoly district deposits by the Geological Survey of India.[27] Large deposits of iron ore were reported in the Godavari Hills, 10 miles from Katmandu.[28]

Philippines.—Philippine iron-ore production increased 17 percent in 1954 compared with 1953. Exports, all to Japan, totaled 1,435,056 long tons.

An airborne magnetometer search, partly financed by the Foreign Operations Administration, indicated new sources of iron ore in six island areas in the Philippines in 1954.

Philippine Iron Mines Co. installed a 400-ton heavy-medium plant for treating old iron-ore dumps.[29]

AFRICA

Algeria.—Iron ore was the most important mineral product and export of Algeria. Production in 1954 totaling 2,881,000 long tons was 13 percent less than in 1953. Quenza-Bou-Khadra group of mines near the Tunisian border produced 75 percent of the 1954 output. Exports in 1954 totaled 2,812,218 tons.

Sierra Leone.—The principal iron-ore deposits of Sierra Leone, comprising the largest known favorably situated reserves of high-grade iron ore in British West Africa, are in the Tonkolili Hills in the Northern Province and at Marampa, southeast of Port Lokko. In 1954, 817,000 long tons of iron ore was mined and 877,000 tons exported.

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[26] American Metal Market, vol. 61, No. 229, Dec. 2, 1954, p. 11.
[27] Mining Journal (London), vol. 242, No. 6197, May 28, 1954, p. 636.
[28] American Metal Market, vol. 61, No. 69, Apr. 10, 1954, p. 1.
[29] Engineering and Mining Journal, vol. 155, No. 2, February 1954, p. 204.

Iron and Steel

By James C. O. Harris[1]

THE DOMESTIC iron and steel industry suffered a sharp setback in production in 1954 from the alltime record year 1953. High inventories in warehouses at the end of 1953—estimated at 7 million tons above normal by some members of the industry—plus lack of demand during the year caused intense competition in the industry, and emphasis shifted from production to sales. As a result of these factors steel and pig iron output was the lowest since 1949 and 21 and 23 percent, respectively, below the 1953 level. However, during the last 2 months of the year business began to improve, and some steel executives predicted a minimum steel output for 1955 of 100 million tons or 12 million more than in 1954. Steelmaking capacity in 1954 increased 1.5 million tons compared with an average annual increase of 5.6 million tons for the 5 previous years. Blast-furnace capacity attained a new high of 84 million net tons, with an increase of nearly 2 million tons.

TABLE 1.—Salient statistics of iron and steel in the United States, 1945–49 (average) and 1950–54, in net tons

	1945–49 (average)	1950	1951	1952	1953	1954
Pig iron:						
Production	53, 957, 950	64, 499, 983	70, 277, 938	61, 308, 424	74, 853, 319	57, 947, 551
Shipments	53, 935, 824	64, 626, 146	70, 250, 379	61, 234, 790	74, 162, 829	57, 782, 686
Imports	77, 384	804, 799	1, 066, 513	380, 200	589, 825	290, 716
Exports	57, 162	6, 813	6, 555	14, 085	18, 837	10, 247
Steel: [1]						
Production of ingots and castings:						
Open-hearth:						
Basic	71, 169, 681	85, 661, 651	92, 387, 447	82, 143, 400	99, 827, 729	80, 019, 628
Acid	653, 182	600, 858	779, 071	703, 039	646, 094	307, 866
Bessemer	4, 011, 085	4, 534, 558	4, 890, 946	3, 523, 677	3, 855, 705	2, 548, 104
Electric	3, 729, 469	6, 039, 008	7, 142, 384	6, 797, 923	7, 280, 191	5, 436, 054
Total	79, 563, 417	96, 836, 075	105, 199, 848	93, 168, 039	111, 609, 719	88, 311, 652
Capacity, annual, as of Jan. 1	93, 798, 296	99, 392, 800	104, 229, 650	108, 587, 670	117, 547, 470	124, 330, 410
Percent of capacity	84. 8	97. 4	100. 9	85. 8	94. 9	71. 0
Production of alloy steel:						
Stainless	537, 081	832, 309	933, 730	930, 164	1, 049, 077	852, 021
Other than stainless	6, 769, 283	7, 737, 796	9, 190, 857	8, 204, 587	9, 279, 117	6, 340, 842
Total	7, 306, 364	8, 570, 105	10, 124, 587	9, 134, 751	10, 328, 194	7, 192, 863
Shipments of steel products:						
For domestic consumption	55, 075, 481	69, 665, 819	76, 164, 539	64, 732, 412	77, 472, 162	60, 618, 843
For export	3, 554, 933	2, 566, 473	2, 764, 411	3, 271, 200	2, 679, 731	2, 533, 883
Total	58, 630, 414	72, 232, 292	78, 928, 950	68, 003, 612	80, 151, 893	63, 152, 726

[1] American Iron and Steel Institute.

[1] Commodity-industry analyst.

Shipments of steel products for the year were 21 percent below the 80 million tons shipped in 1953. The average value f. o. b. mill of all steel products, computed from figures supplied by the Bureau of the Census, was 6.964 cents per pound in 1954, compared with 6.789 cents per pound in 1953. The average price of pig iron at furnaces increased 10 cents per net ton to $49.93. Steel exports for 1954 were 2,534,000 net tons, a 5-percent decrease from the 1953 total (2,680,000 net tons).

The average hours worked weekly per employee in blast-furnace and steel plants during 1954 totaled 37.9, compared with 40.5 in 1953. The average number of employees was 493,000, compared with

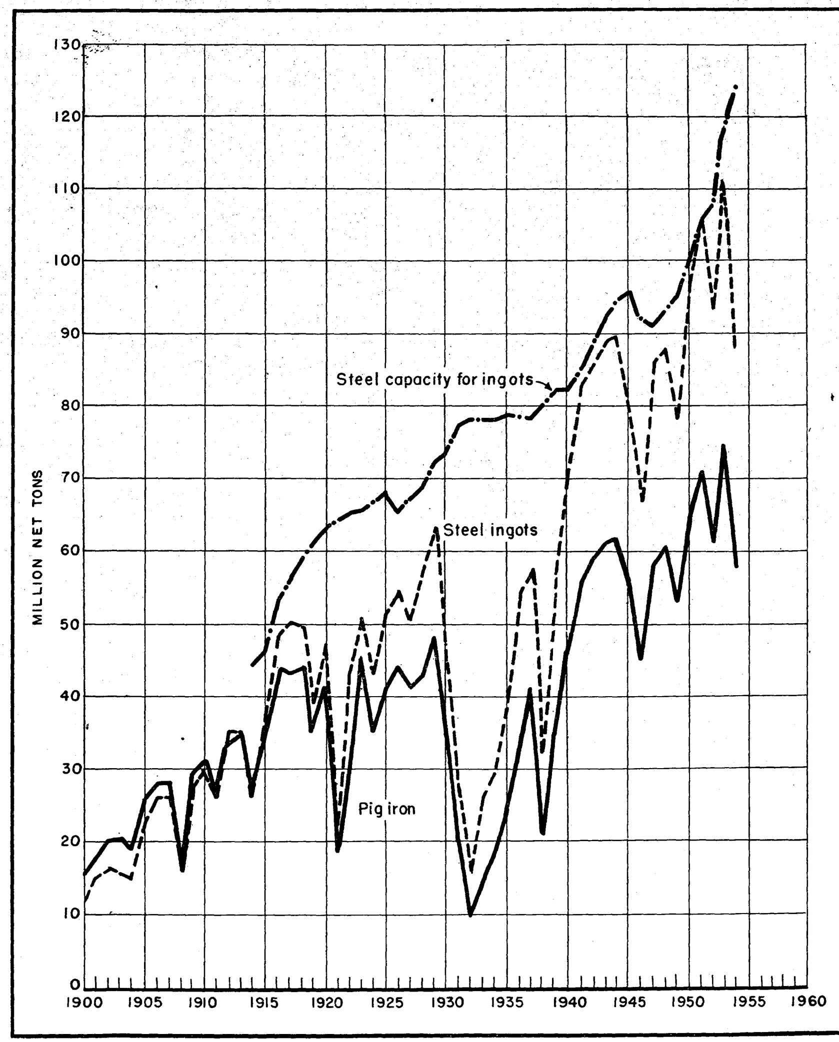

FIGURE 1.—Production of pig iron and steel ingots (1900–54) and steel-ingot capacity (1914–54) in the United States.

560,000 in 1953, and the average hourly wage was $2.20, compared with $2.16 in 1953 and $1.98 in 1952.

PRODUCTION AND SHIPMENTS OF PIG IRON

Domestic production of pig iron, exclusive of ferroalloys, in 1954 was 57.9 million net tons, a 23-percent decrease from 1953. Pennsylvania and Ohio, which ranked first and second in pig-iron production, produced proportionately less pig iron than in 1953. Pennsylvania produced 25 percent of the total in 1954, and Ohio produced 19 percent compared with 28 and 20 percent, respectively, in 1953.

New furnaces built during the year included 1 for McLouth Steel at Trenton, Mich.; 1 for American Steel & Wire at Cleveland, Ohio; and 1 for Bethlehem Steel at Bethlehem, Pa. The world's largest blast furnace (hearth diameter, 30 feet, 3 inches) was under construction at Ecorse, Mich., for Great Lakes Steel Corp. Operation of this furnace is expected to begin in May 1955. Bethlehem Steel's J furnace at Sparrows Point set what might be the world record in May 1954 with the production of 61,424 tons of pig iron—a daily average of 1,981 tons.

Pig-iron production in 1954 consumed 69,304,000 net tons of domestic iron and manganiferous ores and 8,769,000 tons of foreign ores; 58 percent of the imports came from Chile and Venezuela. Consumption of Venezuelan iron ore in blast furnaces increased 197 percent, compared with 1953. Blast furnaces consumed 23,110,000 tons of sinter and 8,784,000 tons of miscellaneous iron-bearing materials. In addition to the above raw materials, 1,832,000 tons of home scrap and 100,700 tons of flue dust were used.

Shipments of pig iron decreased 22 percent in both quantity and value from 1953. The figures in table 4 cover total shipments, which

TABLE 2.—Pig iron produced and shipped in the United States, 1953–54, by States

State	Produced		Shipped from furnaces			
	1953 (net tons)	1954 (net tons)	1953		1954	
			Net tons	Value	Net tons	Value
Alabama	4,663,278	4,064,921	4,669,388	$217,756,777	3,986,336	$187,256,826
California	1,095,118	860,162	1,085,223		872,301	
Colorado, Texas, Utah	3,514,837	2,606,604	3,408,758	222,456,852	2,680,394	173,372,870
Illinois	6,582,114	4,516,872	6,531,839	325,582,535	4,534,969	227,159,687
Indiana	8,349,930	7,489,911	8,372,193	412,683,336	7,485,520	375,496,935
Kentucky	790,206	592,083	790,206	(1)	592,083	(1)
Maryland	3,760,809	3,792,487	3,753,407	(1)	3,786,897	(1)
Massachusetts	151,215	134,986	126,763	(1)	107,594	(1)
Michigan	2,501,953	2,010,733	2,471,789	(1)	2,033,965	(1)
Minnesota	667,074	539,293	643,513	(1)	521,811	(1)
New York	4,807,157	3,658,099	4,697,782	237,030,016	3,589,079	181,610,385
Ohio	15,147,940	11,184,567	15,025,152	742,881,582	11,160,022	545,901,439
Pennsylvania	20,718,641	14,717,549	20,503,705	1,039,285,525	14,652,426	740,221,256
Tennessee, West Virginia	2,103,047	1,779,284	2,083,111	(1)	1,779,289	(1)
Undistributed [1]				497,770,509		454,220,339
Total	74,853,319	57,947,551	74,162,829	3,695,447,132	57,782,686	2,885,239,737

[1] Figure withheld to avoid disclosure of individual company operations included with "Undistributed."

consisted predominantly of molten pig iron transferred to steel furnaces on the site. Values for merchant pig iron are included; however, the average value per ton of pig iron was lower than market prices published in trade journals because handling charges, selling commissions, freight costs, and other related items were not considered. The term "shipped" as distinguished from "production" refers, 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 ore and manganiferous iron ore consumed in manufacturing pig iron in the United States, 1953–54, by sources of ore, in net tons

Source	1953	1954	Source	1953	1954
Africa	306,733	181,086	Peru	392,321	977,189
Brazil	166,345	42,295	Sweden	449,964	596,104
Canada	1,091,020	1,573,786	Venezuela	1,255,097	3,725,336
Chile	2,007,143	1,375,297	Unclassified	96,333	60,548
Cuba	54,173	31,926	Total	5,975,728	8,769,033
India		2,326			
Mexico	156,599	203,140			

Metalliferous Materials Used.—The production of pig iron in 1954 required 101,183,000 net tons of iron ore, sinter, and manganiferous iron ore; 3,135,000 tons of mill cinder and roll scale; 3,713,000 tons of open-hearth and Bessemer slags; 1,768,000 tons of purchased scrap; and 169,200 tons of other materials—an average of 1.898 tons of metalliferous materials (exclusive of home scrap and flue dust) per ton of pig iron made, table 6.

TABLE 4.—Pig iron shipped from blast furnaces in the United States, 1953–54, by grades [1]

Grade	1953			1954		
	Net tons	Value		Net tons	Value	
		Total	Average		Total	Average
Foundry	2,401,634	$115,285,076	$48.00	4,795,471	$228,570,455	$47.66
Basic	60,494,864	3,019,648,231	49.92	45,285,844	2,269,324,903	50.11
Bessemer	7,291,289	365,522,455	50.30	4,812,890	240,682,526	50.01
Low-phosphorus	282,896	15,926,537	56.30	188,283	10,810,762	57.42
Malleable	3,505,160	169,624,571	48.39	2,573,054	129,520,499	50.34
All other (not ferroalloys)	186,986	9,440,262	50.49	127,144	6,330,592	49.79
Total	74,162,829	3,695,447,132	49.83	57,782,686	2,885,239,737	49.93

[1] Includes pig iron transferred directly to steel furnaces at same site.

Alabama furnaces used hematite from the Birmingham district and Missouri, brown ores from Alabama and Georgia, and byproduct ore from Tennessee. Imported ores used were from Venezuela, Brazil, Peru, Liberia, and Sweden and a small quantity of manganiferous ore from Brazil.

Blast furnaces at Fontana, Calif., used iron ore from Eagle Mountain, Calif.

Pueblo, Colo., furnaces (Colorado Fuel & Iron Corp.) used iron ore from Wyoming and Utah and manganiferous ore from New Mexico, Africa, Cuba, and India was used.

Ninety percent of the iron ore used at Sparrows Point, Md., came from foreign sources, mainly Venezuela, Chile, and Sweden; other foreign sources were Cuba and Puerto Rico. Manganiferous ores came from Labrador, Egypt, and Greece.

At Pennsylvania blast furnaces the Lake Superior region of the United States was the principal source of ore; other sources were Venezuela, Canada, Liberia, Sweden, Dominican Republic, Cuba, Peru, Brazil, Norway, and San Domingo. Africa supplied a small quantity of manganiferous ore.

Blast furnaces in Illinois, Indiana, Ohio, and West Virginia used iron and manganiferous ores mostly from the Lake Superior region of the United States and Canada. Some ore from Africa, Labrador, and Peru was also used.

TABLE 5.—Number of blast furnaces (including ferroalloy blast furnaces) in the United States, December 31, 1953–54

[American Iron and Steel Institute]

State	Dec. 31, 1953			Dec. 31, 1954		
	In blast	Out of blast	Total	In blast	Out of blast	Total
Alabama	17	4	21	16	5	21
California	2	1	3	2	1	3
Colorado	3	1	4	4		4
Illinois	17	5	22	17	5	22
Indiana	20	3	23	21	2	23
Kentucky	3		3	3		3
Maryland	9		9	9		9
Massachusetts	1		1	1		1
Michigan	6	1	7	6	2	8
Minnesota	3		3	3		3
New York	14	3	17	14	3	17
Ohio	41	12	53	41	12	53
Pennsylvania	62	16	78	56	22	78
Tennessee	2	1	3	2	1	3
Texas	2		2	2		2
Utah	3	2	5	4	1	5
Virginia	1		1	1		1
West Virginia	4	1	5	4	1	5
Total	210	50	260	206	55	261

The Everett, Mass., blast furnace used iron ore from Africa, Canada, Europe, and Central and South America, 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 and hematite from Canadian and domestic mines in the Lake Superior region. Ore from Africa and Labrador was also used. The Troy furnace consumed iron ore from eastern New York and manganiferous ore from Africa and India. Texas furnaces used brown ores from east Texas, foreign iron ore from Brazil, Chile, and Mexico, and manganiferous ore from Mexico. Utah furnaces used iron ore from Iron County, Utah, and manganiferous ore from Nevada and Utah.

TABLE 6.—Iron ore and other metallic materials consumed and pig iron produced in the United States, 1953–54, by States, in net tons

State	Metalliferous materials consumed: Iron and manganiferous ores: Domestic	Metalliferous materials consumed: Iron and manganiferous ores: Foreign	Metalliferous materials consumed: Sinter	Metalliferous materials consumed: Miscellaneous [1]	Metalliferous materials consumed: Total	Pig iron produced	Materials consumed per ton of pig iron made: Ores	Materials consumed per ton of pig iron made: Sinter	Materials consumed per ton of pig iron made: Miscellaneous	Materials consumed per ton of pig iron made: Total
1953										
Alabama	8,615,911	35,797	1,910,021	225,421	10,787,150	4,663,278	1.855	0.410	0.048	2.313
California	987,471		805,938	150,504	1,943,913	1,095,118	.902	.736	.137	1.775
Colorado, Texas, Utah	3,832,338	157,225	2,109,926	210,747	6,310,236	3,514,837	1.135	.600	.060	1.795
Illinois	11,111,286		1,083,052	920,835	13,115,173	6,582,114	1.688	.165	.140	1.993
Indiana	13,078,334	38,690	2,286,180	1,272,653	16,675,857	8,349,930	1.571	.274	.152	1.997
Kentucky	1,168,652		121,627	191,777	1,482,056	790,206	1.479	.154	.243	1.876
Maryland	356,689	3,784,061	1,405,333	804,488	6,350,571	3,760,809	1.101	.374	.214	1.689
Massachusetts	196,859	73,738		6,629	277,226	151,215	1.789		.044	1.833
Michigan	3,514,344		847,813	312,803	4,674,960	2,501,953	1.405	.339	.125	1.869
Minnesota	1,216,718			138,934	1,355,652	667,074	1.824		.208	2.032
New York	5,941,630	25,719	2,222,339	899,041	9,088,729	4,807,157	1.241	.462	.187	1.890
Ohio	21,339,091	883,713	4,934,045	2,451,220	29,608,069	15,147,940	1.467	.326	.162	1.955
Pennsylvania	25,796,941	833,015	9,022,055	3,636,834	39,288,845	20,718,641	1.285	.435	.176	1.896
Tennessee, West Virginia	3,167,919	143,770	143,599	161,985	3,617,273	2,103,047	1.575	.068	.077	1.720
Total	100,324,183	5,975,728	26,891,928	11,383,871	144,575,710	74,853,319	1.420	.359	.152	1.931
1954										
Alabama	6,392,211	1,004,069	1,759,873	151,161	9,307,314	4,064,921	1.820	.433	.037	2.290
California	752,766		650,609	134,768	1,538,143	860,162	.875	.756	.157	1.788
Colorado, Texas, Utah	2,607,147	220,557	1,617,649	202,412	4,647,765	2,606,604	1.085	.620	.078	1.783
Illinois	7,198,512	32,168	990,692	796,973	9,018,345	4,516,872	1.601	.219	.177	1.997
Indiana	11,653,838	50,925	1,975,007	1,076,705	14,756,475	7,489,911	1.563	.263	.144	1.970
Kentucky	922,615	10,341	82,776	161,924	1,177,656	592,083	1.576	.140	.273	1.989
Maryland	348,618	3,759,193	1,781,397	642,480	6,531,688	3,792,487	1.083	.470	.169	1.722
Massachusetts	161,186	85,202		3,807	250,195	134,986	1.825		.028	1.853
Michigan	2,411,633	7,999	952,716	228,019	3,600,367	2,010,733	1.203	.474	.114	1.791
Minnesota	1,004,995			103,614	1,108,609	539,293	1.864		.192	2.056
New York	4,080,036	56,068	2,017,219	645,665	6,798,988	3,658,099	1.131	.551	.177	1.859
Ohio	14,303,658	750,750	3,946,300	2,014,921	21,015,629	11,184,567	1.346	.353	.180	1.879
Pennsylvania	14,662,762	2,565,932	7,223,233	2,505,717	26,957,644	14,717,549	1.171	.491	.170	1.832
Tennessee, West Virginia	2,804,012	225,829	112,623	116,180	3,258,644	1,779,284	1.703	.063	.065	1.831
Total	69,303,989	8,769,033	23,110,094	8,784,346	109,967,462	57,947,551	1.347	.399	.152	1.898

[1] Does not include recycled material.

PRODUCTION AND SHIPMENTS OF STEEL

Steel production in 1954 in the United States was 88.3 million net tons, or 71 percent of capacity, with an AISI index of 105.4 (1947–49=100). The corresponding figures for 1953 were 111.6, 94.9, and 133.2, respectively. Of the total tonnage of steel ingots produced in the United States in 1954, 91 percent was made in open-hearth furnaces, compared with 90 percent in 1953 and 89 percent in 1951 and 1952; 6 percent in electric furnaces, compared with 7 percent for 1951–53; and 3 percent in Bessemer converters, the same as 1953 and compared with 4 percent in 1952.

In 1954, 35 percent of the domestic steel was produced in the Pittsburgh-Youngstown district, 23 percent in the Chicago district, 20 percent in the Eastern district, 10 percent in the Cleveland-Detroit district, 6 percent in the Western district, and 6 percent in the Southern district, compared with 37, 22, 20, 10, 6, and 5 percent, respectively, in 1953.

TABLE 7.—Steel capacity, production, and percentage of operations, in the United States, 1945–49 (average) and 1950–54, in net tons [1]

[American Iron and Steel Institute]

Year	Annual capacity as of Jan. 1	Production				
		Open hearth	Bessemer	Electric [2]	Total	Percent of capacity
1945–49 (average)	93, 798, 296	71, 822, 863	4, 011, 085	3, 729, 469	79, 563, 417	84. 8
1950	99, 392, 800	86, 262, 509	4, 534, 558	6, 039, 008	96, 836, 075	97. 4
1951	104, 229, 650	93, 166, 518	4, 890, 946	7, 142, 384	105, 199, 848	100. 9
1952	108, 587, 670	82, 846, 439	3, 523, 677	6, 797, 923	93, 168, 039	85. 8
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

[1] The figures include only that portion of the capacity and production of steel for castings used by foundries operated by companies producing steel ingots. Omitted portion is about 2 percent of total steel production.
[2] Includes a small quantity of crucible.

Open-hearth capacity increased 1,139,000 net tons to 110,234,160 tons, electric-furnace capacity increased 358,000 to 10,807,150 net tons, and Bessemer capacity remained unchanged. Most of the increased capacity (the smallest since 1947) was accomplished by enlarging existing furnaces, improving designs, employing better equipment and techniques, and the wider use of oxygen.

Steel production and capacity data used by the Bureau of Mines were furnished by the American Iron and Steel Institute. The output from steel foundries that do not produce steel ingots was not included in the production data.

Shipments of steel for 1954 decreased 21 percent from 1953. The automotive industry was the largest consumer of steel in 1954, receiving 11,792,989 net tons (19.5 percent) of the total domestic shipments compared with 18.9 percent in 1953.

The construction and container industries were the second and third largest consumers, receiving 8,634,987 tons and 5,870,618 net tons, respectively. These two industries showed a marked increase over 1953 in percentage of total domestic consumption. The 1953 figures were 12.8 and 7.8 percent, respectively, compared with 14.2 and 9.7 percent in 1954.

TABLE 8.—Open-hearth steel ingots and castings manufactured in the United States, 1945–49 (average) and 1950–54, by States, in net tons [1]

[American Iron and Steel Institute]

State	1945–49 (average)	1950	1951	1952	1953	1954
New England States	413,081	485,007	535,014	436,993	489,967	327,108
New York and New Jersey	3,913,318	4,820,177	5,271,387	[2] 4,521,685	[2] 5,771,684	[2] 4,596,359
Pennsylvania	21,002,044	24,610,259	26,977,599	24,224,361	28,805,249	20,549,346
Ohio	13,027,391	15,200,938	16,842,144	14,759,616	17,570,814	13,661,994
Indiana	9,655,762	11,055,043	11,888,961	10,414,109	13,818,187	12,330,815
Ilinois	5,805,363	6,831,337	7,271,633	6,508,525	7,735,397	5,963,127
Other States	18,005,904	23,259,748	24,379,780	21,981,150	26,282,525	22,898,745
Total	71,822,863	86,262,509	93,166,518	82,846,439	100,473,823	80,327,494

[1] Includes only that portion of steel for castings produced in foundries operated by companies manufacturing steel ingots. See table 7.
[2] New York only, New Jersey included with "Other States."

Rail transportation and ordnance and other military receipts showed the greatest decrease in percentage of total domestic shipments.

Alloy Steel.—The Bureau of Mines uses the American Iron and Steel Institute specifications for alloy steels, which are steels in which the minimum of the range specified for one or more of the elements named exceeds the following percentages: Manganese, 1.65 percent; silicon, 0.60 percent; copper, 0.60 percent; and aluminum, boron, chromium, cobalt, columbium, molybdenum, nickel, titanium, tungsten, vanadium, zirconium, and other alloying elements, in any added percentage.

The 1954 steel production includes 7,192,863 net tons of alloy steel, a decrease of 30 percent from 1953, representing 8 percent of the total steel output compared with 9 percent in 1953 and 10 percent in 1952.

Stainless steel production represented 12 percent of the alloy-steel output; it decreased 19 percent from the record year 1953. The

TABLE 9.—Bessemer-steel ingots and castings manufactured in the United States, 1945–49 (average) and 1950–54, by States, in net tons [1]

[American Iron and Steel Institute]

State	1945–49 (average)	1950	1951	1952	1953	1954
Ohio	1,811,418	2,000,294	2,208,456	1,922,776	2,326,983	1,658,176
Pennsylvania	1,281,576	1,293,746	1,345,297	751,297	689,814	451,845
Other States	918,091	1,240,518	1,337,193	849,604	838,908	438,083
Total	4,011,085	4,534,558	4,890,946	3,523,677	3,855,705	2,548,104

[1] Includes only that portion of steel for castings produced in foundries by companies manufacturing steel ingots. See table 7.

production of austenitic stainless steel, AISI 300 series, representing 56 percent of the total stainless production, increased 7 percent, while ferritic and martensitic, AISI 400 series, decreased 39 percent. The increased nickel supply accounted for the increase in austenitic stainless output—during the acute nickel shortage in prior years some of the 400 series were used as substitutes for the nickel-bearing

TABLE 10.—Steel electrically manufactured in the United States, 1945–49 (average) and 1950–54, in net tons [1]

[American Iron and Steel Institute]

Year	Ingots	Castings	Total [2]	Year	Ingots	Castings	Total [2]
1945–49 (average)	3,640,394	89,075	3,729,469	1952	6,703,734	94,189	6,797,923
1950	5,927,509	111,499	6,039,008	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

[1] Includes only that portion of steel for castings produced in foundries operated by companies manufacturing steel ingots. See table 7.
[2] Includes a very small quantity of crucible steel.

stainless steels. The output of type 501, 502, and other high-chromium, heat-resisting steels, included in the stainless steel production figure, decreased 39 percent from 1953. Production of all grades of alloy steel other than stainless decreased, except molybdenum manganese-molybdenum, and nickel-molybdenum. Boron-steel production decreased 51 percent from 1953. The percentages of alloy

TABLE 11.—Alloy-steel ingots and castings manufactured in the United States, 1945–49 (average) and 1950–54, by processes, in net tons [1]

[American Iron and Steel Institute]

Process	1945–49 (average)	1950	1951	1952	1953	1954
Open-hearth:						
Basic	5,179,189	5,738,067	6,585,635	5,807,191	6,599,038	4,528,336
Acid	150,764	123,253	238,034	218,867	185,341	130,559
Electric [2]	1,976,411	2,708,785	3,300,918	3,108,693	3,543,815	2,533,968
Total	7,306,364	8,570,105	10,124,587	9,134,751	10,328,194	7,192,863

[1] Includes only that portion of steel for castings produced in foundries operated by companies manufacturing steel ingots. See table 7.
[2] Includes a very small quantity of crucible steel.

steel produced in basic open-hearth, acid open-hearth, and electric furnaces were 63, 2, and 35 percent, respectively, compared with 64, 2, and 34 in 1953.

Metalliferous Materials Used.—Scrap and pig iron used in steel furnaces in 1954 totaled 97.7 million net tons. The percentage of each used was 47 and 53, respectively, unchanged from 1953, compared with 49 and 51 percent in 1952. In addition, steel furnaces used 2,620,000 tons of domestic ores and 3,641,000 tons of foreign ores. For the first time in the steel industry more foreign ores than domestic were consumed in steelmaking furnaces. Sources of the foreign ores used were Africa, Brazil, Canada, Chile, Cuba, Dominican Republic, Mexico, Peru, Sweden, and Venezuela. Also used was 1,143,000 tons of sinter made from both domestic and foreign ores.

Iron ore was employed both as a part of the charge and as a source of oxygen in the refining process. The ore for the first use is termed "charge ore" and for the second "feed ore." The characteristics required of charge and feed ore are similar—hard lump structure, high iron content, and freedom from fines.

TABLE 12.—Metalliferous materials consumed in steel furnaces in the United States, 1945–49 (average) and 1950–54, in net tons

Year	Iron ore		Sinter	Pig iron	Ferro-alloys	Iron and steel scrap
	Domestic	Foreign				
1945–49 (average)	3, 533, 635	690, 481	1, 072, 378	46, 779, 691	1, 186, 400	42, 466, 446
1950	3, 495, 862	1, 799, 089	1, 310, 471	56, 269, 610	1, 320, 000	51, 091, 581
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	1, 700, 000	59, 100, 900
1954	2, 619, 871	3, 640, 771	1, 143, 160	51, 658, 482	1, 270, 000	46, 064, 651

CONSUMPTION OF PIG IRON

Consumption of pig iron decreased 21 percent from 1953. Pig iron, a product of the blast furnace, is a semiraw material; except for a small quantity used in direct casting, it moves to steelmaking or iron-melting furnaces for refining, alone or mixed with other ingredients. In 1954, 88 percent went to steelmaking furnaces (open-hearth, Bessemer, and electric) to be processed into steel, 3 percent was used to make direct castings, and 9 percent was consumed in ironmaking furnaces. Plants in all 48 States and the District of Columbia used pig iron, but consumption was concentrated largely in the steelmaking centers of the East North Central, Middle Atlantic, South Atlantic, and East South Central States. These areas in 1954 consumed 92 percent of the pig iron. Pennsylvania (the leading consumer) used 25 percent of the total and Ohio (the second-largest consumer) 19 percent.

TABLE 13.—Consumption of pig iron in the United States, 1951–54, by types of furnace

Type of furnace or equipment	1951		1952		1953		1954	
	Net tons	Percent of total	Net tons	Percent of total	Net tons	Percent of total	Net tons	Percent of total
Open hearth	56, 055, 103	78. 5	49, 374, 315	80. 2	61, 306, 565	82. 1	48, 632, 261	82. 9
Bessemer	5, 551, 149	7. 8	3, 998, 751	6. 5	4, 351, 117	5. 8	2, 848, 691	4. 9
Electric	144, 131	. 2	118, 668	. 2	181, 336	. 3	177, 530	. 3
Cupola	6, 559, 800	9. 2	5, 438, 294	8. 8	5, 549, 522	7. 4	4, 896, 703	8. 3
Air, Brackelsberg	400, 267	. 5	317, 500	. 5	313, 054	. 4	232, 422	. 4
Crucible	243	(1)	152	(1)	268	(1)	42	(1)
Direct castings	2, 703, 624	3. 8	2, 303, 281	3. 8	3, 005, 882	4. 0	1, 874, 400	3. 2
Total	71, 414, 317	100. 0	61, 550, 961	100. 0	74, 707, 744	100. 0	58, 662, 049	100. 0

[1] Less than 0.05 percent.

TABLE 14.—Consumption of pig iron in the United States, 1946–50 (average) and 1951–54 by States and districts, in net tons

District and State	1946–50 (average) Consumers	1946–50 (average) Net tons	1951[1]	1952[1]	1953[1]	1954[1]
New England:						
Connecticut	56	77,259	83,101	60,598	63,436	48,981
Maine	14	11,844	9,647	4,072	5,928	3,057
Massachusetts	98	193,339	231,897	165,324	174,513	140,194
New Hampshire	16	4,677	4,762	4,607	3,503	3,731
Rhode Island	12	31,267	57,792	46,842	49,432	38,583
Vermont	13	8,443	17,331	14,643	8,974	9,033
Total	209	326,829	404,530	296,086	305,786	243,579
Middle Atlantic:						
New Jersey [2]	77	[3] 332,645	295,182	244,320	200,572	207,610
New York	172	2,766,022	3,416,408	3,128,013	3,689,763	2,984,809
Pennsylvania [2]	368	16,244,986	20,314,328	17,026,406	20,608,854	14,601,423
Total	617	19,343,653	24,025,918	20,398,739	24,499,189	17,793,842
East North Central:						
Illinois [2]	209	4,654,631	5,948,201	4,893,725	6,055,031	4,320,164
Indiana [2]	132	6,605,156	8,339,759	7,044,738	8,928,835	7,713,815
Michigan	169	[4] 2,981,924	3,605,019	3,294,753	3,811,411	3,140,805
Ohio [2]	305	10,854,408	13,230,964	11,650,525	14,641,399	11,117,854
Wisconsin	120	(4)	341,120	278,670	258,786	206,221
Total	935	25,096,119	31,465,063	27,162,411	33,695,462	26,498,859
West North Central:						
Iowa	54	100,641	152,275	101,833	89,467	71,868
Kansas } Nebraska	23 11	17,773	10,395	6,682	12,378	6,559
Minnesota	58	454,554	} 620,166	506,084	518,930	486,718
North Dakota } South Dakota	1 1	329				
Missouri	49	82,468	103,115	80,995	77,075	36,002
Total	197	655,765	885,951	695,594	697,850	601,147
South Atlantic:						
Delaware	7	(3)	} 3,871,880	3,144,907	3,919,420	3,877,686
District of Columbia } Maryland [2]	2 20	[5] 3,472,139				
Florida } Georgia	15 50	59,223	79,929	60,528	65,111	24,600
North Carolina	47	25,597	29,946	27,194	22,644	17,886
South Carolina	15	8,941	21,521	12,911	10,501	13,107
Virginia	51	[6] 242,600	} 1,929,435	1,862,646	1,933,541	1,706,519
West Virginia	24	1,510,028				
Total	231	5,318,528	5,932,711	5,108,186	5,951,217	5,639,798
East South Central:						
Alabama	72	3,271,062	3,902,199	3,527,809	4,163,931	3,554,765
Kentucky [2]	23	(5)	} 1,041,910	845,718	1,055,604	764,232
Mississippi	8	1,916				
Tennessee	52	(6)				
Total	155	3,272,978	4,944,109	4,373,527	5,219,535	4,318,997
West South Central:						
Arkansas } Louisiana } Oklahoma	4 12 11	6,341	13,981	11,961	12,464	8,673
Texas	39	192,044	578,593	418,964	568,161	661,821
Total	66	198,385	592,574	430,925	580,625	670,494

See footnotes at end of table.

TABLE 14.—Consumption of pig iron in the United States, 1946–50 (average) and 1951–54 by States and districts, in net tons—Continued

District and State	1946–50 (average)		1951 [1]	1952 [1]	1953 [1]	1954 [1]
	Consumers	Net tons				
Mountain:						
Arizona, Nevada, New Mexico	4	1,240	866	144	195	266
Colorado, Utah	28	1,397,516	1,864,848	1,776,397	2,506,885	1,889,089
Montana, Idaho, Wyoming	6	1,222				
Montana			276	181	243	99
Idaho						
Wyoming			689	504	235	225
Total	38	1,399,978	1,866,679	1,777,226	2,507,558	1,889,679
Pacific:						
California [2]	113	678,407	1,271,574	1,288,561	1,233,898	1,000,576
Oregon	26	21,852	25,208	19,706	15,357	5,078
Washington	31					
Total	170	700,259	1,296,782	1,308,267	1,249,255	1,005,654
Undistributed [2]	1	43,240			1,267	
Total United States	2,619	56,355,734	71,414,317	61,550,961	74,707,744	58,662,049

[1] Consumption for 1951–54 from sample canvasses; therefore, exact number of consumers by States is not available.
[2] Small tonnages of pig iron, not separable, shown as "Undistributed."
[3] Delaware included with New Jersey.
[4] Wisconsin included with Michigan.
[5] Kentucky included with District of Columbia and Maryland.
[6] Tennessee included with Virginia.

PRICES

The average value of all grades of pig iron listed in table 4 was compiled from producers' reports to the Federal Bureau of Mines. The figures represent value f. o. b. blast furnaces and do not include the value of ferroalloys. The average value for all grades of pig iron at furnaces was $49.93 in 1954, compared with $49.83 in 1953.

According to Metal Statistics, the average value of pig iron at selected locations was as follows:

	1953	*1954*
Foundry pig iron at Birmingham	$46.54	$47.22
Foundry pig iron at Valley	49.78	50.44
Bessemer pig iron at Valley	50.22	50.90
Basic pig iron at Valley	49.33	50.00

There were no price changes at these locations during 1954.

Weighted averages f. o. b. value of all grades of steel as computed from statistics supplied by the Bureau of the Census are given in table 16. The 1954 average composite price, as published by Iron Age, was 4.716 cents per pound compared with 4.518 cents per pound in 1953. Price increases occurred in July and August and slight decreases in September and October.

TABLE 15.—Average value of pig iron at blast furnaces in the United States, 1945–49 (average) and 1950–54, by States, per net ton

State	1945–49 (average)	1950	1951	1952	1953	1954
Alabama	$28.37	$39.00	$43.87	$45.10	$46.63	$46.97
California, Colorado, and Utah	32.61	44.52	48.50	50.83	51.14	51.08
Illinois	31.48	42.77	46.53	48.31	49.85	50.09
Indiana	32.00	42.43	46.59	48.16	49.29	50.16
New York	30.18	42.68	48.01	49.31	50.46	50.60
Ohio	31.71	42.38	45.67	47.65	49.44	48.92
Pennsylvania	31.54	43.09	47.08	49.16	50.69	50.52
Other States [1]	32.96	44.73	47.98	48.70	[2] 49.66	50.61
Average	31.54	42.85	46.75	48.43	49.83	49.93

[1] Comprises Kentucky, Maryland, Massachusetts, Michigan, Minnesota, Tennessee, Texas, Virginia, and West Virginia.
[2] Revised.

TABLE 16.—F. o. b. value of steel-mill products in the United States, 1953–54, in cents per pound [1]

Product	1953				1954			
	Carbon	Alloy	Stainless	Average	Carbon	Alloy	Stainless	Average
Ingots	3.881	7.577	21.889	4.383	3.410	11.013	18.702	[2] 8.382
Semifinished shapes and forms	4.550	7.647	21.595	5.138	4.463	7.571	22.988	5.226
Plates	4.893	11.787	56.437	5.405	4.993	12.015	46.408	5.484
Sheets and strips	5.790	11.646	43.585	6.675	5.830	11.864	45.953	6.654
Tin-mill products	7.849			7.849	7.699			7.699
Structural shapes and piling	4.672	5.585		4.683	4.835	6.097		4.843
Bars	5.794	10.721	50.133	7.164	5.940	10.802	52.971	7.204
Rails and railway track material	5.024			5.024	5.415			5.415
Pipes and tubes	7.966	15.831	124.170	8.790	8.165	14.883	148.687	8.918
Wire and wire products	9.367	25.725	62.485	10.072	9.679	30.478	61.577	10.230
Other rolled and drawn products	6.481	17.573	47.510	8.459	7.770	22.002	55.404	9.135
Average total steel	6.058	11.223	44.881	6.789	6.302	11.394	45.430	6.964

[1] Computed from figures supplied by the U. S. Department of Commerce, Bureau of the Census.
[2] The large increase in the value of all ingots was almost entirely due to an increase in shipments of higher cost stainless from 2 percent of the total in 1953 to about 20 percent in 1954.

FOREIGN TRADE [2]

Pig-iron imports decreased 51 percent and exports 46 percent from the 1953 totals of 589,825 and 18,837, respectively. Canada, West Germany, and Australia supplied 87 percent of the pig-iron imports. Exports of pig iron totaled 10,247 net tons ($761,547) of which Canada and Colombia received 90 percent.

Exports of steel decreased 5 percent from 1953. Imports of semifinished-steel products decreased 70 percent and finished steel products decreased 29 percent. Although imports as a whole decreased greatly, imports of wire and wire products increased 58 percent.

[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.

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TABLE 17.—Pig iron imported for consumption in the United States, 1945–49 (average) and 1950–54, by countries, in net tons

[U. S. Department of Commerce]

Country	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Canada	8,493	195,807	220,094	288,722	305,256	203,303
Mexico	2,451	--	--	--	--	--
Total	10,944	195,807	220,094	288,722	305,256	203,303
South America:						
Argentina	(1)	--	--	--	--	--
Brazil	110	--	33,936	--	--	--
Chile	--	7,583	57,241	2,577	--	--
Total	110	7,583	91,177	2,577	--	--
Europe:						
Austria	4,914	56,635	82,628	11,071	--	--
Belgium-Luxembourg	9,767	8,086	16,605	3,045	--	--
Finland	--	--	--	--	168	--
France	3,643	37,640	37,323	343	--	--
Germany	5,388	225,132	331,244	[2] 16,203	[2] 3,539	[2] 31,854
Italy	1,000	--	123	1	--	--
Netherlands	13,652	243,434	99,189	12,735	18,475	7,914
Norway	6,710	5,364	15,352	6,369	2,692	3,482
Poland-Danzig	1,493	--	--	--	--	--
Spain	--	--	34,048	25,224	4,665	11,704
Sweden	353	14,798	43,822	2,096	56,633	1,203
Turkey	--	--	36,587	622	--	--
U. S. S. R.	271	--	--	--	--	--
United Kingdom	2,060	2,816	3,957	--	--	--
Total	49,251	593,905	700,878	77,709	86,172	56,157
Asia: India	7,836	7,168	34,158	--	12,659	7,470
Africa:						
Federation of Rhodesia and Nyasaland	--	--	--	--	[3] 6,606	[4] 1,944
Union of South Africa	--	336	20,206	--	--	5,517
Total	--	336	20,206	--	6,606	7,461
Oceania: Australia	9,300	--	--	11,192	179,132	16,325
Grand total: Net tons	77,441	804,799	1,066,513	380,200	589,825	290,716
Value	$3,814,849	$26,237,334	$49,169,985	$19,846,695	$25,967,435	$13,315,255

[1] Less than 1 ton.
[2] West Germany.
[3] Southern Rhodesia.
[4] Southern Rhodesia not separately classified after July 1, 1955; 1,562 net tons, January–June.

TABLE 18.—Major iron and steel products imported for consumption in the United States, 1952–54

[U. S. Department of Commerce]

Products	1952		1953		1954	
	Net tons	Value	Net tons	Value	Net tons	Value
Semimanufactures:						
Steel bars:						
Concrete reinforcement bars	130,477	$13,850,685	[1] 108,913	[1] $8,204,340	164,198	[2] $11,684,226
Solid or hollow, n. e. s	103,431	13,954,601	[1] 98,115	10,170,334	40,964	[2] 3,861,663
Hollow and hollow drill steel	588	241,121	539	182,154	378	144,307
Iron slabs, blooms, or other forms	110	12,488			} 219	49,554
Bar iron	208	45,187	174	42,614		
Wire rods, nail rods, and flat rods up to 6 inches in width	44,404	5,636,629	65,418	6,939,265	39,848	4,047,003
Boiler and other plate iron and steel, n. e. s	143,837	17,466,883	[1] 133,221	[1] 15,943,332	2,242	240,682
Steel ingots, blooms, and slabs	8,195	1,500,626	48,536	4,167,762	} 8,788	[2] 1,216,010
Billets, solid or hollow	53,266	6,284,020	[1] 85,145	[1] 9,991,676		
Die blocks or blanks, shafting, etc	827	486,591	421	118,851	310	[2] 80,743
Circular saw plates	14	11,672	17	16,362	13	[2] 21,904
Sheets of iron or steel, common or black and boiler or other plate iron or steel	29,699	3,768,689	[1] 325,658	[1] 43,798,269	789	107,121
Sheets and plates and steel, n. s. p. f.	11,068	1,106,692	[1] 1,005	[1] 151,436	197	262,272
Tinplate, terneplate, and taggers' tin	2,550	530,076	419	[1] 68,441	143	[2] 31,305
Total semimanufactures	528,674	64,895,960	[1] 867,581	[1] 99,794,836	258,089	[2] 21,746,790
Manufactures:						
Structural iron and steel	319,455	35,957,687	[1] 458,239	[1] 39,925,169	276,337	[2] 27,948,987
Rails for railways	3,687	236,444	2,005	137,393	3,511	191,847
Rail braces, bars, fishplates, or splice bars and tie plates	641	40,264	1,041	83,925	267	25,029
Pipes and tubes:						
Cast-iron pipe and fittings	5,308	675,862	3,818	454,307	6,868	[2] 876,427
Other pipes and tubes	274,066	64,506,357	237,804	53,305,392	66,268	[2] 10,815,643
Wire:						
Barbed	26,252	3,981,349	[1] 15,658	[1] 1,818,301	52,948	[2] 6,079,100
Round wire, n. e. s	9,217	1,535,857	17,494	2,383,102	40,794	[2] 4,771,604
Telegraph, telephone, etc., except copper, covered with cotton jute, etc	217	262,266	171	190,297	422	[2] 295,870
Flat wire and iron or steel strips	7,194	3,708,208	[1] 35,072	[1] 7,559,378	17,438	[2] 4,894,411
Rope and strand	3,377	1,316,523	[1] 4,333	[1] 1,602,936	3,939	[2] 1,619,444
Galvanized fencing wire and wire fencing	1,697	247,195	3,442	365,695	10,435	[2] 1,191,220
Iron and steel used in card clothing	(3)	421,796	(3)	356,590	(3)	308,945
Hoop and band iron and steel, for baling	7,324	1,049,706	13,703	1,452,575	17,500	1,819,972
Hoop, band and strips, or scroll iron or steel, n. s. p. f.	20,288	2,232,007	32,543	[1] 3,005,587	21,007	1,669,431
Nails	18,520	3,030,927	40,244	5,385,895	92,829	[2] 11,559,148
Castings and forgings, n. e. s	4,693	1,362,923	6,325	1,835,340	5,459	1,855,545
Total manufactures	701,936	[4] 120,565,371	[1] 871,892	[4] 119,861,882	616,022	[2] 75,922,623
Advanced manufactures:						
Bolts, nuts, and rivets	8,401	2,339,871	12,017	3,436,911	15,568	[2] 3,964,850
Chains and parts	964	545,062	1,027	693,875	1,139	[2] 754,590
Hardware, builders'		153,433		113,869		[2] 235,736
Hinges and hinge blanks		275,005		531,351		[2] 1,328,068
Screws (wholly or chiefly of iron or steel)		892,933		1,040,932		[2] 708,291
Tools		4,438,174		5,308,867		5,255,219
Other advanced manufactures		28,994		32,830		27,297
Total advanced manufactures		8,673,472		11,158,635		12,274,051
Grand total		[4] 194,134,803		[4] 230,815,353		109,943,464

[1] Revised figure.
[2] Due to changes in tabulating procedures by the U. S. Department of Commerce data known not to be comparable to earlier years.
[3] Weight not recorded.
[4] Not comparable to earlier years because of additional classes.

TABLE 19.—Major iron and steel products exported from the United States, 1952–54

[U. S. Department of Commerce]

Products	1952		1953		1954	
	Net tons	Value	Net tons	Value	Net tons	Value
Semimanufactures:						
Steel ingots, blooms, billets, slabs, and sheet bars	732, 185	$66, 321, 638	89, 620	$8, 140, 371	29, 465	$2, 618, 317
Iron and steel bars and rods:						
Iron bars	1, 479	216, 940	519	166, 770	1, 142	333, 021
Concrete reinforcement bars	93, 186	10, 382, 546	53, 354	5, 574, 688	29, 856	3, 078, 997
Other steel bars	164, 960	26, 091, 506	122, 828	18, 767, 586	59, 760	10, 407, 627
Wire rods	29, 681	3, 312, 103	9, 489	1, 232, 367	8, 601	921, 180
Iron and steel plates, sheets, skelp, and strips:						
Plates, including boiler plate, not fabricated	232, 075	27, 025, 828	[1] 201, 673	[1] 24, 861, 106	154, 149	19, 548, 635
Skelp iron and steel	124, 497	11, 407, 272	98, 717	8, 672, 578	56, 793	5, 214, 634
Iron and steel sheets, galvanized	64, 045	12, 389, 082	110, 590	20, 423, 943	142, 972	25, 450, 179
Steel sheets, black, ungalvanized	601, 003	92, 271, 322	[1] 517, 893	[1] 79, 872, 271	616, 227	97, 964, 635
Strip, hoop, band, and scroll iron and steel:						
Cold-rolled	59, 862	15, 308, 477	42, 527	12, 185, 977	31, 042	11, 264, 852
Hot-rolled	69, 765	9, 094, 492	51, 535	6, 725, 892	25, 355	4, 148, 970
Tinplate and terneplate	599, 160	116, 325, 825	514, 797	[1] 94, 720, 263	712, 349	122, 839, 659
Total semimanufactures	2, 771, 898	390, 147, 031	[1] 1,813, 542	[1] 281,343, 812	1, 867, 711	303, 790, 706
Manufactures—steel-mill products:						
Structural iron and steel:						
Water, oil, gas, and other storage tanks complete and knocked-down material	38, 067	10, 227, 578	69, 508	16, 359, 762	60, 187	14, 238, 340
Structural shapes:						
Not fabricated	192, 202	19, 117, 977	234, 600	24, 533, 010	267, 259	28, 452, 461
Fabricated	83, 281	21, 226, 028	[1] 61, 579	[1] 19, 306, 021	48, 179	15, 467, 765
Plates, sheets, fabricated, punched, or shaped	16, 081	4, 265, 933	16, 606	4, 684, 843	14, 023	4, 040, 272
Metal lath	2, 693	788, 648	1, 936	691, 173	2, 634	783, 574
Frames, sashes, and sheet piling	8, 780	1, 671, 974	12, 241	2, 362, 973	23, 013	3, 444, 699
Railway-track material:						
Rails for railways	168, 101	14, 906, 465	[1] 190, 867	[1] 18, 987, 548	96, 914	9, 778, 837
Rail joints, splice bars, fishplates, and tieplates	50, 265	7, 099, 749	51, 557	6, 945, 446	18, 006	3, 194, 633
Switches, frogs, and crossings	6, 622	2, 079, 720	2, 552	959, 837	2, 704	939, 349
Railroad spikes	8, 955	1, 376, 618	4, 935	808, 372	2, 414	395, 871
Railroad bolts, nuts, washers, and nut locks	2, 064	584, 415	1, 741	481, 086	917	342, 513
Tubular products:						
Boiler tubes	36, 798	9, 946, 893	[1] 40, 695	[1] 10, 248, 268	19, 899	7, 364, 461
Casing and line pipe	502, 611	81, 275, 642	416, 534	72, 331, 971	305, 963	54, 710, 196
Seamless black and galvanized pipe and tubes, except casing, line and boiler, and other pipes and tubes	27, 339	5, 900, 410	32, 207	6, 176, 106	32, 007	6, 291, 517
Welded black pipe and tubes	51, 406	8, 853, 874	36, 701	6, 326, 737	56, 232	8, 254, 480
Welded galvanized pipe and tubes	45, 426	8, 919, 059	38, 861	7, 287, 613	11, 273	2, 252, 681
Malleable-iron screwed pipe fittings	3, 805	3, 156, 293	2, 854	2, 217, 071	2, 013	1, 685, 040
Cast-iron pressure pipe and fittings	43, 387	6, 172, 820	26, 554	3, 913, 996	21, 489	3, 360, 190
Cast-iron soil pipe and fittings	9, 874	1, 722, 738	8, 458	1, 479, 446	10, 770	1, 830, 344
Iron and steel pipe and fittings, n. e. c	49, 609	28, 622, 886	49, 616	26, 568, 565	43, 573	23, 363, 902
Wire and manufactures:						
Barbed wire	6, 663	1, 018, 347	3, 519	564, 137	3, 695	630, 744
Galvanized wire	19, 578	4, 349, 990	10, 159	2, 393, 379	5, 056	1, 343, 608
Iron and steel wire, uncoated	58, 262	9, 735, 093	25, 639	4, 854, 034	23, 441	4, 757, 463
Spring wire	4, 006	1, 840, 909	4, 890	2, 545, 172	4, 242	2, 088, 331
Wire rope and strand	15, 564	7, 284, 225	13, 224	6, 208, 285	13, 228	6, 755, 653
Woven-wire fencing and screen cloth	6, 512	[2] 3, 277, 644	4, 006	[2] 2, 096, 509	3, 244	[2] 1, 831, 168
All other	33, 141	10, 322, 111	[1] 29, 312	[1] 9, 198, 870	26, 700	8, 977, 445

See footnotes at end of table.

TABLE 19.—Major iron and steel products exported from the United States, 1952–54—Continued

[U. S. Department of Commerce]

Products	1952		1953		1954	
	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	6,990	$1,960,237	3,960	$1,641,394	3,235	$1,705,901
All other nails, including tacks and staples	3,316	1,634,850	2,277	1,151,451	2,489	1,277,073
Bolts, machine screws, nuts, rivets, and washers, n. e. c.	25,672	17,383,888	17,326	13,499,554	13,752	11,254,985
Castings and forgings: Iron and steel, including car wheels, tires, and axles	118,269	24,153,477	[1] 100,793	22,800,403	66,128	16,657,267
Total manufactures	[3] 1,645,339	[3] 320,876,491	[3] 1,515,707	[3] 299,623,032	1,204,679	247,470,763
Advanced manufactures:						
Buildings (prefabricated and knockdown)		12,880,780		9,377,647		4,985,801
Chains and parts	10,537	9,321,073	14,519	10,195,052	9,505	7,693,658
Construction material	9,416	3,871,649	6,371	3,346,785	6,762	4,000,865
Hardware and parts		10,349,225		12,707,947		14,342,712
House-heating boilers and radiators		3,581,725		5,614,357		6,644,674
Oil burners and parts		7,364,653		8,252,306		8,244,712
Plumbing fixtures and fittings		4,659,119		5,746,459		6,203,291
Tools		47,086,743		41,916,336		43,238,299
Utensils and parts (cooking, kitchen, and hospital)	1,123	3,076,228	1,294	3,785,707	1,272	3,783,383
Other advanced manufactures		21,416,778		22,138,247		23,595,543
Total advanced manufactures		[3] 123,607,973		[3] 123,080,843		122,732,938

[1] Revised figure.
[2] Includes wire cloth as follows—1952: $1,542,736 (12,667,342 square feet); 1953: $1,060,693 (7,394,124 square feet); 1954: $952,431 (5,529,215 square feet).
[3] Not comparable to earlier years because of additional classes.

TECHNOLOGY

The use of high-top-pressure blast furnaces received further recognition when the United States Steel Corp. signed a license agreement to use this process. Some 13 pressurized furnaces were operated in the United States during the year. Previous results of this type of operation had shown up to a 15-percent increase in pig-iron production, 70 pounds less coke required per ton of pig iron produced, and a 30-percent lower flue-dust rate.

The gas-cleaning equipment installed on the ferromanganese blast furnace at U. S. Steel's Dusquesne works, Pittsburgh, Pa., in July 1953 did an excellent job of recovering the extremely fine ferromanganese dust. The collected fines have been briquetted for future use. The equipment included gas-conditioning towers, electrostatic precipitators, and dust-handling equipment. One hundred and five tons of dust is collected daily by cleaning 135,000 c. f. m. of gas.

Carbon brick was used more widely in blast furnaces; approximately 120 United States furnaces were using these brick, primarily in the bottom and on the walls up as high as the bosh. One lining has exceeded the 2.5-million-ton mark, 12 have exceeded the 2-million-ton mark, and 19 range between the 1.5- to 2-million mark.

Electrostatic precipitators for dust removal in steel plants have been extended to sintering plants, open-hearth furnaces, and rolling mills. U. S. Steel Corp. has installed these units at various plants.

At one of its eastern plants they are employed on hot scarfing machines in the blooming and slab mills. A southern plant has installed three units for iron-ore sintering machines. Units have also been installed at western plants for various installations.

The first installation in the United States to employ the Linz-Donawitz steelmaking process was put into operation by McLouth Steel Corp. at Trenton, Mich., during 1954.[3] McLouth also constructed 2 of the world's largest electric furnaces; they have a shell diameter of 24 feet 6 inches, and a 200-ton capacity. These two furnaces were to use blown metal of the Linz-Donawitz process and were expected to lead all other electric furnaces in the United States in rate of output.

Vacuum Melting.—During the year the field of vacuum melting was extended to the production of high-temperature alloys and constructional alloy steels on a commercial scale.

Special steels and alloys, superior in quality to other methods of manufacture, may be produced in induction furnaces by melting in a vacuum or under pressure in an inert-gas atmosphere. In such an operation the furnace and mold are enclosed in an airtight container, which can be evacuated or put under pressure. When the melting is complete the entire assembly is tilted to pour the molten metal into the mold. The container is not opened for recharging until the metal has solidified, to prevent oxidation and the absorption of atmospheric gases. However, units under construction will operate continuously without breaking the vacuum—while one charge is being melted and poured in a vacuum chamber another is introduced through an airlock.

Lubatti Process.—A new method that uses fine unagglomerated raw materials is the Lubatti electric furnace process developed in Italy. The furnace is an open-top submerged-arc electric affair with six water-cooled metal pipes with carbon-block attachments for electrodes. It is shaped like a bowl with a top diameter of 12–15 feet. The carbon lining varies from 2 feet on the sides to 3½ feet at the bottom and has 1 taphole each for metal and slag. The raw materials include lime, coke breeze, pyrite cinder, sand, and enough manganese ore to meet the desired analysis. Power requirements run about 3,200 kw.-hr. per ton of pig iron produced. Three of these furnaces, including an experimental furnace at Turin, were operating in Italy and two in Germany. The manufacturer claims that this furnace can be used for ferromanganese production and the recovery of iron from the fines of the L–D process.[4]

Hot Extrusion.—A great deal of work was being done in the field of hot extrusion. Allegheny Ludlum was making a number of different cross sections for jet-engine use. Stainless steel grades of the 300 and 400 series and a variety of tool steels were being extruded by this company. This process reduces the amount of scrap and in many instances results in a reduction in machining time. It is particularly valuable for small quantity orders, eliminating lost production for roll changes, and expensive cutting of special rolls. Another manufacturer

[3] Process described in Iron and Steel chapter, Minerals Yearbook, vol. 1, 1953, p. 594.
[4] United Nations, Recent Advances in Steel Technology and Market Development, 1954: Geneva February 1955, pp. 14–16.

reported a 70-percent cost saving by using an extrusion press for a bracket that was formerly fabricated.

Rare Earths.—Numerous experiments have been conducted during the past few years dealing with the addition of rare earths (metals and oxides) to iron and steel. The rare earths are the elements of atomic numbers 57 to 71, beginning with lanthanum and cerium and ending with lutetium. Morrogh (research manager, British Cast Iron Research Association) has shown that small additions of cerium (0.005 percent) can neutralize the harmful effects of titanium, lead, bismuth, antimony, aluminum, and copper in the production of nodular irons by the magnesium process, thus permitting the use of a much wider range of raw materials. In the United States it has been demonstrated that rare earths (1 to 2 pounds per ton of steel) improve the hot-working characteristics and corrosion resistance of certain stainless steels and the surface qualities and mechanical properties of carbon steels. One ferroalloy manufacturer claims that the use of rare earths in steel could result in saving 100,000 tons of manganese per year in the United States. It is a well-known fact that the surface quality of carbon steel depends to a great extent on the manganese-sulfur ratio—the higher the ratio the better the quality. The rare-earth metals form relatively stable sulfides in liquid steel, which rise through the molten metal to form a slag, thereby eliminating sulfur. Normally, almost all of the sulfur stays in the metal as iron and manganese sulfide. Of particular interest were the improved hot-working properties of Cr-Mn austenitic stainless steel, which is normally difficult to hot-roll. Investigation of the effect of rare earths in carbon steels was being conducted by the Bureau of Mines.

Other Developments.—Another interesting development during the year was the new use of steel for virtually all artillery cartridge cases for the United States Army. Steel companies cooperated in developing steel cases during World War II. Conversion was reportedly almost complete as of the end of 1954.

During the year A. J. Boynton & Co. introduced a new mechanism called the ladle-addition feeder for adding ferromanganese and other alloys to open-hearth ladles. Provisions in the design were made for controlling the rate of addition at the right location in the ladle. Some reported advantages of this feeder were as follows: (1) Manganese consumption is reduced because of the increased recovery of added manganese; (2) manganese additions can be calculated lower without resulting in more misheats on the low or high side; and (3) manganese spreads from ladle tests at first, middle, and last ingot are reduced. In terms of economy, this company claimed that the feeder saves 10 to 30 cents per ton of ingots, depending on the grade of steel produced.[5]

WORLD REVIEW

World production of pig iron was 175 million net tons, a decrease of 6 percent from 1953. World steel production decreased 5 percent to 246.2 million tons.

[5] Iron Age, vol. 174, No. 16, Oct. 14, 1954, p. 145.

TABLE 20.—World production of pig iron (including ferroalloys), by countries,[1] 1945–49 (average) and 1950–54, in thousand short tons [2]

(Compiled by Pearl J. Thompson)

Country [1]	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Canada	2,081	2,498	2,819	2,914	3,166	2,323
Mexico [3]	300	250	280	336	288	297
United States	55,651	66,371	72,472	63,391	77,201	59,752
Total	58,000	69,100	75,600	66,600	80,700	62,400
South America:						
Argentina	[4] 19	22	31	30	39	43
Brazil	480	804	855	906	984	1,218
Chile	15	120	265	298	315	336
Total	[4] 500	950	1,200	1,200	1,300	1,600
Europe:						
Austria	417	977	1,159	1,295	1,456	1,492
Belgium	2,952	4,073	5,366	5,280	4,648	5,092
Czechoslovakia [4]	1,432	2,180	2,290	2,570	3,075	3,100
Denmark	24	56	36	40	40	44
Finland	83	69	112	119	88	83
France	5,429	8,641	9,753	10,886	9,655	9,855
Germany:						
East	197	369	375	718	1,177	1,436
West	3,917	10,442	11,791	14,194	12,846	13,792
Hungary	290	531	[4] 558	[4] 634	838	929
Italy [5]	365	703	1,200	1,425	1,536	1,484
Luxembourg	1,873	2,755	3,480	3,391	3,000	3,086
Netherlands	303	500	579	594	654	672
Norway	176	250	270	301	305	271
Poland	969	[4] 1,640	[4] 1,738	[4] 1,964	[4] 2,534	[4] 2,864
Rumania [4]	150	370	390	430	500	480
Saar	799	1,856	2,606	2,804	2,626	2,755
Spain	592	750	748	866	911	998
Sweden	859	923	999	1,228	1,165	1,025
Switzerland	21	37	44	44	45	39
U. S. S. R. [4] [6]	13,400	21,500	24,800	27,600	30,900	33,000
United Kingdom	9,280	10,822	10,868	12,015	12,516	13,309
Yugoslavia	144	249	289	317	310	406
Total [4] [6]	43,700	69,700	79,500	88,700	90,800	96,200
Asia:						
China [4]	270	1,120	1,400	2,200	2,600	3,360
India	1,674	1,860	2,043	2,076	1,990	2,169
Japan	882	2,534	3,557	3,952	5,129	5,237
Korea, North [4]	55	25	22	22	110	220
Taiwan (Formosa)	3	7	6	7	8	10
Thailand	----------	9	10	[4] 2	6	2
Turkey	103	128	183	216	237	216
Total [4] [6]	3,000	5,700	7,300	8,500	10,100	11,200
Africa:						
Rhodesia and Nyasaland, Federation of: Southern Rhodesia	[7] 25	37	35	43	40	15
Union of South Africa	685	808	887	1,245	1,348	1,319
Total	700	800	900	1,300	1,400	1,300
Oceania: Australia	1,195	1,472	1,484	1,735	2,064	2,082
World total (estimate)	107,100	148,000	166,000	168,000	186,000	175,000

[1] Pig iron is also produced in Belgian Congo and Indonesia, 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 and Steel chapters.
[3] Excluding ferroalloy production, for which data are not yet available, but estimate has been 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 1948–49.

The United States, the European Coal and Steel Community, and Russia ranked first, second, and third in both pig iron and steel production. United States steel production was 36 percent of world production, compared with 43 percent in 1953, and 40 percent in 1952.

Argentina.—In 1954 Argentina consumed 1.6 million tons of steel, or 3 times as much as it produced. Japan and France supplied 50 percent of the 1.1 million tons imported during the year. Sociedad Mixta Siderurgica of Buenos Aires was building a large steel mill at San Nicolas. An American concern, Arthur G. McKee & Co., received the order for constructing a blast furnace with a capacity of 500,000 tons per year. A German firm was building a battery of coke ovens. Contract for six 200-ton open hearths were to be placed in Europe. The Czechoslovak strip mill, impounded by the United States Treasury and later sold to Argentina for $9 million, was to be installed at this plant. Soaking pits, blooming mill, and a combination structural and rail mill will probably come from the United States.[6]

Brazil.—Brazil planned to increase its steel production from the 1954 level of 1.2 million tons to 2.5 million tons in 1956 and 6 million tons by 1960. The plans included a 900,000-ton-a-year increase at Vitoria and 450,000 tons a year at Laguna. Brazil's National Steel Co. planned to add two open hearths, a battery of coke ovens, and additional rolling mills. A new 1,200-ton-per-day blast furnace was blown in at Volta Redonda in February. The steel capacity of this company was to be increased from 780,000 to 1.2 million tons.[7]

According to information supplied by the United States State Department, Cia. Acos Especiais Itabira of Acesita planned shortly to increase its production to 125,000 tons of high-grade steel yearly. Cia. Siderurgica Belgo-Mineira has been producing 170,000 tons yearly and had planned an output expansion to 250,000 tons; and Cia. Siderurgica Mannesmann anticipated production at the rate of 100,000 tons per year in the near future. Cia. Ferroe Aco de Vitoria was being reequipped for an initial production rate of 40,000 tons annually, and the Cia. Mineracao Geral do Brasil was expected to increase output to 125,000 tons a year.

During the year 1 steel plant in Brazil ordered two 100-ton-per-day electric blast furnaces for pig-iron production. One reason for their use was the shortage of metallurgical coal in Brazil. Units were 90 feet long and 22 feet wide, with porthole side charging of raw materials, similar to the nickel-reduction furnaces built before the war.[8]

Colombia.—Empresa Siderurgica Nacional de Paz de Rio, S. A., Colombia's first fully integrated steel mill, was formally inaugurated in Belencito on October 13, 1954. The $70 million plant, with an annual capacity of about 150,000 tons, will produce plates, rails, and rail accessories, wire and wire products, rounds, reinforcing bars, and small angles.[9]

Iron- and steel-making equipment at this plant included 1 blast furnace, 3 basic converters, and 1 electric furnace for alloy-steel production. Plans were underway to increase the plant capacity to

[6] United Nations, Survey of World Iron-Ore Resources; Geneva, 1955.
Steel, vol. 156, No. 11, Mar. 14, 1955, p. 57.
British Iron and Steel Institute, Statistical Yearbook for 1954; June 1956, pp. 30–31.
[7] Steel, vol. 134, No. 19, May 10, 1954, p. 82. Steel, vol. 135, No. 5, Aug. 2, 1954, p. 58.
[8] Iron and Steel Engineer, vol. 32, No. 1, January 1955, p. 124.
[9] Steel, vol. 135, No. 17, Oct. 25, 1955, p. 101.

TABLE 21.—World production of steel ingots and castings, by countries, 1945–49 (average) and 1950–54, in thousand short tons [1]

(Compiled by Pearl J. Thompson)

Country	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Canada	2,908	3,384	3,569	3,703	4,115	3,194
Mexico	319	430	515	592	509	540
United States [2]	79,563	96,836	105,200	93,168	111,610	88,312
Total	82,790	100,650	109,284	97,463	116,234	92,046
South America:						
Argentina [3]	163	220	275	330	385	505
Brazil	449	870	929	984	1,105	1,291
Chile	31	62	196	271	345	354
Colombia [3]	6	11	11	11		
Total [3]	649	1,163	1,411	1,596	1,835	2,150
Europe:						
Austria	485	1,044	1,133	1,166	1,415	1,822
Belgium	3,019	4,163	5,571	5,585	4,900	5,431
Czechoslovakia [3]	2,275	3,186	3,504	3,784	4,850	4,883
Denmark	63	136	177	194	198	219
Finland	106	112	140	162	162	195
France	6,215	9,528	10,828	11,980	11,019	11,714
Germany:						
East	[3] 328	1,097	1,711	2,087	2,400	[3] 2,486
West	4,546	13,361	14,888	17,423	16,998	19,218
Greece [3]	11	25	33	37	45	62
Hungary	593	1,155	1,422	1,608	1,701	1,644
Ireland [3]	11	18	18	22	22	22
Italy [4]	1,636	2,604	3,376	3,897	3,856	4,637
Luxembourg	1,763	2,702	3,392	3,309	2,931	3,117
Netherlands	245	540	611	755	948	1,023
Norway	68	89	97	108	121	133
Poland	1,666	2,772	3,078	3,509	3,973	4,370
Rumania [3]	277	615	712	769	793	693
Saar	880	2,092	2,869	3,112	2,959	3,094
Spain	714	890	916	1,111	985	1,209
Sweden	1,372	1,584	1,658	1,836	1,939	2,027
Switzerland	105	143	159	172	173	152
U. S. S. R. [3] [5]	17,700	29,800	34,700	38,600	42,400	45,000
United Kingdom	15,159	18,248	17,515	18,389	19,723	20,742
Yugoslavia	299	481	488	499	580	692
Total [3] [5]	59,500	96,400	109,000	120,100	125,100	134,600
Asia:						
China [3]	80	600	1,100	1,650	2,160	2,390
India	[6] 1,461	1,610	1,680	1,768	1,688	1,887
Japan	1,829	5,333	7,167	7,703	8,446	8,543
Korea:						
Korea, Republic of	40	4	1	1	1	1
North Korea [3]		44	44	33	83	165
Pakistan	(6)	3	3	9	12	11
Thailand		9	10	[3] 4	1	2
Turkey	97	99	149	179	187	187
Total [3] [5]	3,507	7,702	10,154	11,347	12,578	13,186
Africa:						
Belgian Congo			(7)	1	4	3
Egypt [3]	8	11	11	11	22	78
Rhodesia and Nyasaland, Federation of: Southern Rhodesia	10	25	31	40	28	50
Union of South Africa	633	832	1,045	1,326	1,368	1,577
Total	651	868	1,087	1,378	1,422	1,708
Oceania: Australia	1,420	1,597	1,606	1,839	2,295	2,490
World total (estimate)	148,500	208,500	232,500	233,700	259,500	246,200

[1] This table incorporates a number of revisions of data published in previous Iron and Steel chapters.
[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] U. S. S. R. in Asia included with U. S. S. R. in Europe.
[6] Pakistan included with India.
[7] Less than 500 tons.

250,000 tons, with the addition of 1 blast furnace, and rolling mills for flat rolled products.[10]

India.—India has had a steel requirement of approximately 4 million tons a year, exceeding its average annual production of about 1.5 million tons. Because of these requirements, the Indian steel industry, consisting primarily of the Tata Iron & Steel Co. at Jamshedpur, the Indian Iron & Steel Co., Ltd., at Burnpur and Kulti, and the Mysore Iron & Steel Works at Bhadravati, was planning to increase its capacity. In addition, the Hindustan Steel Works, with a capacity of 500,000 tons, was expected to come into production by 1958. This plant will be built in Orissa by Krupp of Germany. At the end of 1954 discussions were underway with England and Russia concerning the building of a fifth steel plant, to have a capacity of 1 million tons. Japan, France, and Austria were also interested in building steel plants in India. The major problem in any of these schemes was expected to be financial.[11]

Peru.—Peru was building a steel plant with an annual capacity of 60,000 tons. The plant equipment was to consist of two electric pig-iron furnaces, two 30 ton-heat electric steel furnaces, and rolling mills for producing reinforcing bars, wire rods, and hot-rolled sheets. Electric power was to be supplied by the Canon del Pato hydroelectric plant. The Utah Construction Co. agreed to supply iron ore up to 300,000 tons a year at 28 percent under the world market price. This agreement was made when the Utah Construction Co. signed a 30-year contract with the Peruvian Santa Corp. to mine the Marcona deposit.[12]

United Kingdom.—The year 1954 was one of mounting activity in the British iron and steel industry, as steel production reached an all-time high of 20.7 million short tons. Progress in denationalization of the steel industry was generally slow until the last quarter, but with the high production and profitable operations steel stocks were selling at a premium. Up to the present the British Government has received $300,000,000 of its $670,000,000 investment made when the industry was nationalized.

On July 29 the new Queen Victoria blast furnace at the Appleby-Frodingham Steel Co. was blown in. This furnace, now the largest in Europe, has a hearth diameter of 28 feet, 6 inches and a bosh diameter of 31 feet, 9 inches. At the same plant the Queen Anne furnace, with a hearth diameter of 27 feet, was blown in March 1, 1954. These 2 furnaces were expected to raise pig-iron production at this plant from 970,000 tons to 1,300,000. A blast furnace with a diameter of 29 feet was under construction at Margan, Port Talbot, Wales.[13] With completion of this furnace and extension of the melting shop, pig-iron and steel production in 1956 was expected to be 1,450,000 and 2,400,000 tons per year, respectively. The above is included in the 1953–58 development program, which calls for a British pig-iron and crude-steel output of 15,150,000 and 22,200,000 tons, respectively, by 1958.

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[10] American Metal Market, vol. 41, No. 203, Oct. 22, 1954, pp. 1, 3.
[11] Mining Journal (London), vol. 244, No. 6231, Jan. 21, 1955, pp. 63–64.
Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 1, Jan. 1, 1955, pp. 10–12.
[12] Commercial News Letter, INCA Features: Vol. 3, No. 4, Aug. 15, 1954, 4 pp.
[13] Iron and Steel Engineer, vol. 32, No. 1, January 1955, pp. 107–152.

Additional rolling mills and finishing mills also were under construction or planned.[14]

Venezuela.—The Venezuelan Government plans to have its own steel mill by late 1957 or early 1958. Development of the industry was to be divided into 3 phases; (1) Construction of a new town for 2,000 workers and their families, (2) construction of a hydroelectric power plant utilizing the lower Caroni Falls, and (3) development of the Naricual coal and limestone deposits in the State of Anzoategui. Cerro Bolivar iron ore will be used. The plant is to be between Puerto Ordaz and San Felix at the junction of the Orinoco and Caroni Rivers, only 6 miles from the Cerro Bolivar (U. S. Steel's iron-ore) rail line Puerto Ordaz. The plant is to be controlled by the Government, which will hold 51 percent of the stock, and private investors will own the balance. Estimated costs range from $60 to $100 million and capacities from 100 to 150 thousand metric tons. The Venezuelan Government sponsored engineering scholarships in engineering for the steel project in the United States, Europe, and South America. Nineteen students were sent to the United States during 1954 to 11 different American institutions. In addition, eight graduate industrial-trainee scholarships were awarded in the United States through collaboration of the Venezuelan Government and the United States Steel Corp.

The European Coal and Steel Community.—The European Coal and Steel Community celebrated its second anniversary on July 23, 1954, commemorating its accomplishment in rebuilding the iron and steel industry of western Europe. The Community was engaged in a two-part program—expanding and balancing facilities (pig iron, steelmaking, and rolling) and lowering unit production cost. However, the problems in each country were different. In West Germany modernization was proceeding rapidly, with the building of large furnaces and the construction of modern continuous strip mills.

In France new methods of benefication of Lorraine ores and development of coking technique for the Lorraine coals were underway. The size of blast furnaces, mixers, converters, and electric furnaces was growing, and the use of oxygen in converters was increasing. In Belgium the emphasis was on improvement of ore-handling facilities, modernization of blast furnaces and steel furnaces, installation of duplexing facilities, improved quality of steel through oxygen blowing, and expansion of finishing facilities of the wide strip mill. Some old mills were taken out of service but held in reserve for periods of high demand. The position of Luxembourg was similar to that of Belgium. The Netherlands has completed its current expansion program and was not pressing for additional capacity in 1954.

Italy was still deficient in iron- and steel-making capacity, although capacity increased 30 percent in the period 1950–54. During 1952–54 it was the Community's largest importer and smallest exporter of iron and steel products. About half of the total investment in recent years was used for constructing the new integrated plant at Cornigliano which produced 380,000 metric tons of steel in 1954. In addition, there had been substantial investment at Ilva, Falck, Fait, Dalmine, and Cogne. Plans were underway to build additional iron and steel

[14] Iron and Steel Board, Development of the Iron and Steel Industry, 1953–58: London, Feb. 22, 1955, 42 pp.

capacity to balance expanding finishing facilities and place Italy in a better position to compete with other members in the Community market.

During 1954 the United States granted a $100 million loan to the Community. This loan was being used for modernization, mechanization and development of coal- and iron-mine production, ore dressing, modernization and extension of coke-plant capacities, construction of pithead power stations with the object of increasing the consumption of low-grade products, and the construction of workers' houses.

Trade between member nations of the Community rose to 4,200,000 metric tons for 1954—1,400,000 tons more than 1953 and 2,100,000 more than 1952. Exports increased slightly—6,670,000 tons in 1954 compared with 6,610,000 tons in 1953 and 6,645,000 tons in 1952. Imports for 1954 were 960,000 metric tons compared with 920,000 tons in 1953 and 780,000 tons in 1952.[15]

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[15] United Nations, ECE, The European Steel Market in 1954: Geneva, June 1955, pp. 64, 67, 68. Third General Report on the Activities of the Community: Apr. 10, 1955, pp. 65, 68, 73, 74, 132.

Iron and Steel Scrap

By James E. Larkin [1]

FERROUS MATERIALS (scrap and pig iron) consumed in 1954 totaled 120,016,000 short tons, or 21 percent less than the record year 1953 and the lowest since 1949. The decrease resulted from lower demand for steel. There were no major labor problems in the iron and steel industry. Scrap consumption fluctuated during the first 7 months of the year between a high of 5,350,000 tons in May and 4,378,000 tons in July, the lowest month (exclusive of strike months) since November 1949. Consumption of scrap increased in August and continued upward to a high of 5,685,000 tons in December. July was the lowest nonstrike month since February 1950 in the use of pig iron, totaling 4,469,000 short tons. Stocks of ferrous scrap held by consumers reached an alltime high on December 31, 1954—3 percent greater than at the beginning of the year. These record stocks were equivalent to a 44-day supply at the 1954 average daily consumption rate of 168,000 short tons.

During 1954 a proposal for trading iron and steel scrap on a commodity exchange was made by the Chicago Mercantile Exchange. Such a proposal had been made on two separate occasions, in 1940 and 1944, by the New York Commodity Exchange, each one failing due to opposition by both the scrap supplying and consuming industries. The Chicago Mercantile Exchange continued with its plans to carry No. 1 and No. 2 Heavy-Melting scrap grades that would be bought and sold on the cash and futures exchange market at Chicago. On September 7, 1954, trading was opened for contracts to be delivered in January and March.

GOVERNMENT REGULATIONS

On January 19, 1954, the United States Department of Commerce announced that first quarter exports of iron and steel scrap would continue under the export policy established for the fourth quarter in 1953.

Export controls in effect for short supply reasons were removed April 1, 1954. As of this date, exports of iron and steel scrap were to be controlled only to protect the national security. Under the new policy exporters are not required to submit evidence of availability or inspection certificates in connection with their export license applications. Also, licenses issued after April 1, 1954, were valid for 6 months instead of 60 days. However, exporters were required to have received orders from their foreign buyers before filing applications, and applications for exports to countries outside

[1] Commodity-industry analyst.

the Western Hemisphere were to be accompanied by an import certificate issued by the importing country, or a consignee end-use statement.

On November 15, 1954, the Bureau of Foreign Commerce, United States Department of Commerce, began issuing scrap-export licenses valid for 3 months rather than for 6 months (except offshore and to Mexico); this was done to conform to the life of end-use certificates and was a matter of procedure, having no bearing on the general export matter.

The increased exports of iron and steel scrap from the United States during the latter part of the year caused consumers some concern. After conferences with a task group comprised of representatives from industry and Government agencies, the United States Department of Commerce announced on December 1, 1954, that it was taking steps to safeguard against undue drain on supplies for domestic consumption. Among the steps taken was the requirement that export-license applicants supply certification that the scrap was available for export; submit other appropriate documentation, such as an order from the foreign purchaser; and file a fourth copy of the shippers' export declaration with customs officials on all shipments.

H. R. 8155 suspending import duties on all metal scrap except lead and zinc was renewed on July 6, 1954, by the Senate Finance Committee, to be in effect until June 30, 1955.

During 1954 some scrap-processing operations at Government military installations were discontinued.

The increase in ferrous scrap stocks during 1954 brought forth a proposal that scrap be stockpiled the same as critical raw materials that have been stockpiled as part of the national defense program.

It was suggested the Army buy metallics from dealers and deliver them to steel mills for melting and pouring into ingots, which could be stockpiled for defense in the vicinity of the mills. Thus, a supply of steel would be readily available in case of war, assuring the mills some protection for obtaining metallics if there is any disruption in transportation from their sources of supply.

The Office of Defense Mobilization decided against stockpiling scrap, but the stockpiling of some steel products, such as heavy plate, continued under consideration. This would reduce the time required in an emergency to obtain quantity production of steel products. provided fabricating facilities were available.

CONSUMPTION

Of the 1954 consumption of ferrous scrap and pig iron for all purposes, 61,354,000 tons or 51 percent was scrap. Scrap was consumed at an average monthly rate of 5,113,000 short tons, 20 percent lower than in 1953. The decreased use of ferrous scrap was accompanied by a 22-percent decrease in demand for pig iron. The average monthly consumption rate of pig iron was 4,889,000 short tons, compared with 6,226,000 short tons in 1953.

A 21-percent decrease from 1953 in the output of steel ingots and castings required melting 22 percent less ferrous materials. The quantities used in steelmaking furnaces (open-hearth, Bessemer, and

TABLE 1.—Salient statistics of ferrous scrap and pig iron in the United States, 1953–54

	1953 (short tons)	1954 (short tons)	Change from 1953 (percent)
Stocks, December 31: Ferrous scrap and pig iron at consumers' plants:			
Total scrap	7,148,766	7,348,896	+3
Pig iron	2,797,555	2,536,220	−9
Total	9,946,321	9,885,116	−1
Consumption: Ferrous scrap and pig iron charged to—			
Steel furnaces: [1]			
Total scrap	59,100,900	46,064,651	−22
Pig iron	65,839,018	51,658,482	−22
Total	124,939,918	97,723,133	−22
Iron furnaces: [2]			
Total scrap	16,779,591	14,153,375	−16
Pig iron	8,868,726	7,003,567	−42
Total	25,648,317	21,156,942	−25
Miscellaneous uses [3] and ferroalloy production: Total scrap	1,250,011	1,136,423	−9
All uses:			
Total ferrous scrap	77,130,502	61,354,449	−20
Pig iron	74,707,744	58,662,049	−22
Grand total	151,838,246	120,016,498	−21
Imports of scrap (including tinplate scrap)	[4] 173,660	238,987	+38
Exports of scrap:			
Iron and steel	[5] 297,905	[5] 1,668,860	+460
Tinplate, circles, strips, cobbles, etc	18,637	14,243	−24
Average prices per gross ton:			
Scrap:			
No. 1 Heavy-Melting Pittsburgh [6]	$40.99	$29.90	−27
No. 1 Cast Cupola, Chicago [6]	$42.73	$39.74	−7
For export	$39.70	$34.11	−14
Pig iron, f. o. b. Valley furnaces: [6]			
Basic	$55.25	$56.00	+1
No. 2 Foundry	$55.75	$56.50	+1

[1] Includes open-hearth, Bessemer, and electric furnaces.
[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.

electric) were 46,065,000 short tons of scrap and 51,658,000 short tons of pig iron, a decrease of 22 percent each from the quantity of these materials used during 1953. December was the highest month during the year for consumption of ferrous materials in these furnaces.

The proportions of scrap and pig iron used in steel furnaces in 1954 were 47 and 53 percent, respectively, the same as during the previous year. The charge of scrap and pig iron used in iron foundries, mainly cupola furnaces, comprised 67 percent scrap and 33 percent pig iron, unchanged from 1953.

Consumption of scrap and pig iron decreased 20 and 22 percent, respectively, in 1954, compared with 1953. Scrap use decreased in all but the West South Central district. There was a noticeably greater quantity of scrap than pig iron used in the New England, West North Central, West South Central, and Pacific Coast districts.

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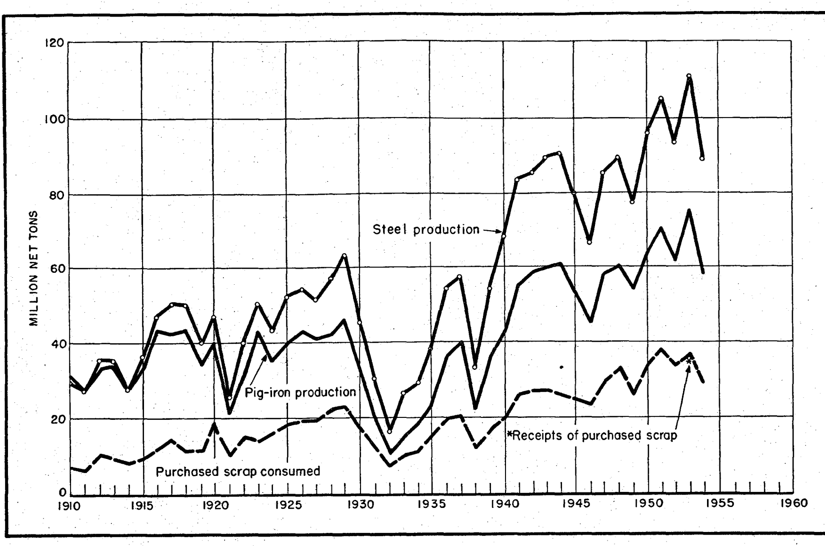

FIGURE 1.—Consumption of purchased scrap in the United States, 1910–52, and output of pig iron and steel, 1910–54. Figures on consumption of purchased scrap for 1910–32 are from State of Minnesota vs. Oliver Iron Mining Co., et al., Exhibits, vol. 5, 1935, p. 328; those for 1933–34 are estimated by authors; and those for 1935–52 are based on Bureau of Mines records. Data for 1953–54 represent receipts of purchased scrap by consumers, based on Bureau of Mines records. Data on steel output from the American Iron and Steel Institute.

These districts together used 11 percent of the total scrap and 4 percent of the pig iron consumed in 1954, the same percentages as during 1953. The average ratio of scrap to pig iron in these 4 districts was 2.7:1, whereas the United States average was 1.05:1, compared with 1.03:1 in 1953.

Open-hearth furnaces continued to be the largest consumers of ferrous scrap and pig iron during 1954; however, their consumption decreased from that of 1953 by 10,640,000 tons of scrap and 12,674,000 tons of pig iron. Open-hearth furnaces consumed 64 percent of the total scrap used in 1954, the same percentage as in 1953. Pig-iron consumption in open-hearth used 83 percent of the total pig iron compared with 82 percent in 1953.

Scrap consumption in cupola furnaces was 16 percent of the total scrap used compared with 14 percent in 1953; pig iron was 8 percent compared with 7 percent in 1953.

Bessemer converters consumed 5 percent of the pig iron and 0.3 percent of the scrap compared with 6 percent pig iron and 0.4 percent scrap, respectively, during the previous year.

Electric furnaces consumed 11 percent of the total scrap or 1 percent less than in 1953 and 0.3 percent of the pig iron compared with 0.2 percent in 1953.

TABLE 2.—Ferrous scrap and pig iron consumed in the United States and percentage of total derived from scrap and pig iron, 1953–54, by districts

District	1953			1954		
	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, 248, 012	75. 5	24. 5	1, 001, 065	75. 7	24. 3
Middle Atlantic [1]	47, 769, 843	48. 7	51. 3	34, 051, 471	47. 7	52. 3
East North Central [1]	69, 161, 210	51. 3	48. 7	55, 767, 880	52. 5	47. 5
West North Central	2, 885, 376	75. 8	24. 2	2, 420, 643	75. 2	24. 8
South Atlantic [1]	11, 030, 021	46. 0	54. 0	9, 861, 381	42. 8	57. 2
East South Central [1]	9, 179, 200	43. 1	56. 9	7, 642, 209	43. 5	56. 5
West South Central	1, 958, 372	70. 4	29. 6	2, 179, 106	69. 2	30. 8
Rocky Mountain	4, 103, 534	38. 9	61. 1	3, 373, 275	44. 0	56. 0
Pacific Coast [1]	4, 417, 201	71. 7	28. 3	3, 648, 760	72. 4	27. 6
Undistributed [1]	85, 477	98. 5	1. 5	70, 708	100. 0	----------
Total	151, 838, 246	50. 8	49. 2	120, 016, 498	51. 1	48. 9

[1] Some scrap consumed in the Middle Atlantic, East North Central, South Atlantic, East South Central, and Pacific Coast districts and some pig iron consumed in the East North Central district—not separable—are included with "Undistributed."

TABLE 3.—Consumption of ferrous scrap and pig iron in the United States, 1953–54, by type of furnace, in short tons

Type of furnace or equipment	Total scrap	Pig iron	Total scrap and pig iron
1953			
Open-hearth	49, 668, 274	61, 306, 565	110, 974, 839
Bessemer	276, 020	4, 351, 117	4, 627, 137
Electric	9, 156, 606	181, 336	9, 337, 942
Cupola	10, 634, 168	5, 549, 522	16, 183, 690
Air	1, 197, 047	313, 054	1, 510, 101
Crucible	134	268	402
Blast	4, 948, 242	----------	4, 948, 242
Direct castings	----------	3, 005, 882	3, 005, 882
Ferroalloy	373, 172	----------	373, 172
Miscellaneous	876, 839	----------	876, 839
Total	77, 130, 502	74, 707, 744	151, 838, 246
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

TABLE 4.—Proportion of scrap and pig iron used in furnaces in the United States, 1953–54, in percent

Type of furnace	1953		1954	
	Scrap	Pig iron	Scrap	Pig iron
Open-hearth	44.8	55.2	44.5	55.5
Bessemer	6.0	94.0	6.7	93.3
Electric	98.1	1.9	97.5	2.5
Cupola	65.7	34.3	66.1	33.9
Air	79.3	20.7	80.5	19.5
Crucible	33.3	66.7	64.1	35.9
Blast	100.0		100.0	

CONSUMPTION BY DISTRICTS AND STATES

Iron and steel scrap was consumed in all 48 States and the District of Columbia during 1954, showing decreases in all areas except the West South Central district. In all but the West South Central district less pig iron was used than during 1953. As in 1953, the largest consuming districts were East North Central, Middle Atlantic, and South Atlantic. The States having the largest consumption of scrap, with the percentages consumed, were: Pennsylvania 21, the lowest percentage on record; Ohio 17, the same as during 1953; Indiana 11 and Illinois 10 compared with 10 and 9, respectively, during 1953.

TABLE 5.—Consumption of ferrous scrap and pig iron in the United States in 1954, by types of consumer and types of furnace, in short tons

Type of furnace or equipment	Type of consumer									Total		
	Manufacturers of steel ingots and castings [1]			Manufacturers of steel castings [2]			Iron foundries and miscellaneous users					
	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	38,466,427	48,543,836	87,010,263	561,752	88,425	650,177				39,028,179	48,632,261	87,660,440
Bessemer	182,356	2,847,556	3,029,912	17,266	954	18,220	4,428	181	4,609	204,050	2,848,691	3,052,741
Electric	5,496,888	136,745	5,633,633	1,170,051	20,396	1,190,447	165,483	20,389	185,872	6,832,422	177,530	7,009,952
Total steelmaking furnaces	44,145,671	51,528,137	95,673,808	1,749,069	109,775	1,858,844	169,911	20,570	190,481	46,064,651	51,658,482	97,723,133
Cupola	702,140	647,115	1,349,255	553,853	170,087	723,940	8,307,870	4,079,501	12,387,371	9,563,863	4,896,703	14,460,566
Air	30,606	12,050	42,656	241,033	56,652	297,685	690,020	163,720	853,740	961,659	232,422	1,194,081
Crucible	10	11	21				65	31	96	75	42	117
Blast [3]	3,627,778		3,627,778							3,627,778		3,627,778
Direct castings		1,126,817	1,126,817					747,583	747,583		1,874,400	1,874,400
Ferroalloy							305,607		305,607	305,607		305,607
Miscellaneous	272,122		272,122				558,694		558,694	830,816		830,816
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
1953	62,187,847	67,993,589	130,181,436	3,585,795	485,511	4,071,306	11,356,860	6,228,644	17,585,504	77,130,502	74,707,744	151,838,246

[1] Includes only those castings made by companies producing steel ingots.
[2] Excludes companies that produce both steel castings and steel ingots.
[3] Includes consumption in blast furnaces by both integrated and nonintegrated mills.

TABLE 6.—Consumption of ferrous scrap and pig iron in the United States, 1950–54, 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:				
1950	968,971	+26.6	358,652	+26.6
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
Middle Atlantic:				
1950	20,357,707	+26.9	21,649,125	+22.1
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
East North Central:				
1950	32,058,680	+29.0	28,597,252	+19.8
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
West North Central:				
1950	2,111,712	+20.5	747,629	+30.8
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
South Atlantic:				
1950	4,390,510	+13.8	5,747,111	+19.3
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
East South Central:				
1950	3,798,475	+29.9	4,751,371	+21.4
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
West South Central:				
1950	1,003,466	+46.5	364,004	+78.1
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
Rocky Mountain:				
1950	1,540,778	+25.8	1,768,772	+29.5
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
Pacific Coast:				
1950	2,670,976	+20.2	959,202	+39.2
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
Undistributed:				
1951 [1]	81,397			
1952 [1]	75,411			
1953 [1]	84,210		1,267	
1954 [1]	70,708			
United States 1945–49 (average)	57,168,331		54,004,546	
1950	68,901,275	+26.8	64,943,118	+21.5
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

[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 1954, by districts and States

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
Connecticut	222,043	0.4	48,981	0.1	271,024	0.2
Maine	7,990	(2)	3,057	(2)	11,047	(2)
Massachusetts	413,816	.7	140,194	.2	554,010	.5
New Hampshire	17,257	(2)	3,731	(2)	20,988	(2)
Rhode Island	72,657	.1	38,583	.1	111,240	.1
Vermont	23,723	(2)	9,033	(2)	32,756	(2)
Total New England	757,486	1.2	243,579	.4	1,001,065	.8
New Jersey [1]	612,598	1.0	207,610	.3	820,208	.7
New York [1]	3,005,283	4.9	2,984,809	5.1	5,990,092	5.0
Pennsylvania	12,639,748	20.6	14,601,423	24.9	27,241,171	22.7
Total Middle Atlantic	16,257,629	26.5	17,793,842	30.3	34,051,471	28.4
Illinois	5,976,283	9.7	4,320,164	7.4	10,296,447	8.6
Indiana [1]	6,927,565	11.3	7,713,815	13.1	14,641,380	12.3
Michigan	5,291,299	8.6	3,140,805	5.4	8,432,104	7.0
Ohio [1]	10,362,041	16.9	11,117,854	19.0	21,479,895	17.9
Wisconsin	711,833	1.2	206,221	.3	918,054	.7
Total East North Central	29,269,021	47.7	26,498,859	45.2	55,767,880	46.5
Iowa	379,521	.6	71,868	.1	451,389	.4
Kansas and Nebraska	67,770	.1	6,559	(2)	74,329	.1
Minnesota, North Dakota, and South Dakota	544,307	.9	486,718	.8	1,031,025	.8
Missouri [1]	827,898	1.4	36,002	.1	863,900	.7
Total West North Central	1,819,496	3.0	601,147	1.0	2,420,643	2.0
Delaware, District of Columbia, and Maryland	2,502,350	4.1	3,877,686	6.6	6,380,036	5.3
Florida and Georgia	215,771	.4	24,600	.1	240,371	.2
North Carolina	58,614	.1	17,886	(2)	76,500	.1
South Carolina	24,329	(2)	13,107	(2)	37,436	(2)
Virginia and West Virginia [1]	1,420,519	2.3	1,706,519	2.9	3,127,038	2.6
Total South Atlantic	4,221,583	6.9	5,639,798	9.6	9,861,381	8.2
Alabama [1]	2,217,457	3.6	3,554,765	6.1	5,772,222	4.8
Kentucky, Mississippi, and Tennessee	1,105,755	1.8	764,232	1.3	1,869,987	1.6
Total East South Central	3,323,212	5.4	4,318,997	7.4	7,642,209	6.4
Arkansas, Louisiana, and Oklahoma	160,927	.3	8,673	(2)	169,600	.1
Texas	1,347,685	2.2	661,821	1.2	2,009,506	1.7
Total West South Central	1,508,612	2.5	670,494	1.2	2,179,106	1.8
Arizona, Nevada, and New Mexico	57,266	.1	266	(2)	57,532	.1
Colorado and Utah	1,401,901	2.3	1,889,089	3.2	3,290,990	2.7
Montana	14,564	(2)	99	(2)	14,663	(2)
Idaho and Wyoming	9,865	(2)	225	(2)	10,090	(2)
Total Rocky Mountain	1,483,596	2.4	1,889,679	3.2	3,373,275	2.8
California	2,185,451	3.6	1,000,576	1.7	3,186,027	2.6
Oregon [1] and Washington	457,655	.7	5,078	(2)	462,733	.4
Total Pacific Coast	2,643,106	4.3	1,005,654	1.7	3,648,760	3.0
Undistributed [1]	70,708	.1			70,708	.1
Total United States:						
1954	61,354,449	100.0	58,662,049	100.0	120,016,498	100.0
1953	77,130,502	100.0	74,707,744	100.0	151,838,246	100.0

[1] Some scrap consumption in Alabama, Indiana, Missouri, New Jersey, New York, Ohio, Oregon, and West Virginia and some pig iron in Indiana and Ohio—not separable—are included with "Undistributed."
[2] Less than 0.05 percent.

CONSUMPTION BY TYPES OF FURNACE

Open-Hearth Furnaces.—Ferrous scrap and pig iron consumption in open-hearth furnaces in 1954 totaled 87.7 million short tons, a 21-percent decrease from 1953, and the lowest consumption since 1949. Consumption of ferrous materials (scrap and pig iron) and the production of ingots and castings in open-hearth furnaces during 1954, decreased 21 and 20 percent, respectively, from 1953. The use of pig iron in furnaces of this type was the lowest since 1949, decreasing 21 percent from the record year 1953. The open-hearth furnace melt in 1954 consisted of 45 percent scrap and 55 percent pig iron, the same as during the previous year.

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.

TABLE 8.—Consumption of ferrous scrap and pig iron in open-hearth furnaces in the United States in 1954, 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	278, 780	81, 565	360, 345
Total: 1954	278, 780	81, 565	360, 345
1953	405, 360	115, 477	520, 837
Middle Atlantic:			
New Jersey and New York	2, 221, 598	2, 811, 928	5, 033, 526
Pennsylvania	9, 430, 661	12, 925, 526	22, 356, 187
Total: 1954	11, 652, 259	15, 737, 454	27, 389, 713
1953	17, 071, 350	21, 381, 269	38, 452, 619
East North Central:			
Illinois	3, 423, 557	3, 165, 713	6, 589, 270
Indiana	6, 089, 340	7, 454, 643	13, 543, 983
Michigan and Wisconsin	1, 949, 715	2, 102, 305	4, 052, 020
Ohio	6, 472, 463	8, 418, 853	14, 891, 316
Total: 1954	17, 935, 075	21, 141, 514	39, 076, 589
1953	21, 572, 313	26, 497, 520	48, 069, 833
West North Central: Minnesota and Missouri	770, 343	454, 421	1, 224, 764
Total: 1954	770, 343	454, 421	1, 224, 764
1953	930, 037	514, 136	1, 444, 173
South Atlantic:			
Delaware and Maryland	2, 174, 169	3, 519, 789	5, 693, 958
Georgia and West Virginia	1, 107, 710	1, 609, 890	2, 717, 600
Total: 1954	3, 281, 879	5, 129, 679	8, 411, 558
1953	3, 857, 168	5, 054, 760	8, 911, 928
East South Central: Alabama and Kentucky	1, 516, 845	3, 014, 264	4, 531, 109
Total: 1954	1, 516, 845	3, 014, 264	4, 531, 109
1953	1, 932, 153	3, 918, 799	5, 850, 952
West South Central: Oklahoma and Texas	900, 383	504, 138	1, 404, 521
Total: 1954	900, 383	504, 138	1, 404, 521
1953	762, 614	454, 643	1, 217, 257
Rocky Mountain: Colorado and Utah	1, 218, 127	1, 723, 578	2, 941, 705
Total: 1954	1, 218, 127	1, 723, 578	2, 941, 705
1953	1, 280, 034	2, 293, 945	3, 573, 979

TABLE 8.—Consumption of ferrous scrap and pig iron in open-hearth furnaces in the United States in 1954, by districts and States, in short tons—Continued

District and State	Total scrap	Pig iron	Total scrap and pig iron
Pacific Coast: California and Washington	1, 474, 488	845, 648	2, 320, 136
Total: 1954	1, 474, 488	845, 648	2, 320, 136
1953	1, 857, 245	1, 076, 016	2, 933, 261
Total United States: 1954	39, 028, 179	48, 632, 261	87, 660, 440
1953	49, 668, 274	61, 306, 565	110, 974, 839

Bessemer Converters.—The 3.1 million short tons of ferrous raw materials used in Bessemer converters in 1954 represents a decrease of 34 percent from 1953, with the production of ingots in these furnaces also showing a decrease of 34 percent. The greatest decrease in the metallic charge in the Bessemer furnace was in pig iron, which decreased 35 percent. The ratio of scrap to total charge was 1:15 compared with 1:17 during 1953. Ohio followed the pattern of 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.

During late December a new steelmaking process, the Linz-Donawitz or oxygen steel process, was put into operation. For statistical reporting purposes the use of iron and steel scrap and pig iron in this process will be included with statistics for Bessemer converters.

TABLE 9.—Consumption of ferrous scrap and pig iron in Bessemer converters in the United States in 1954, 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, 623	47	1, 670
Pennsylvania	84, 721	529, 889	614, 610
Total: 1954	86, 344	529, 936	616, 280
1953	102, 340	804, 562	906, 902
East North Central and West North Central:			
Illinois	1, 178	217, 084	218, 262
Minnesota and Missouri	5, 805	----------	5, 805
Ohio	102, 844	1, 815, 506	1, 918, 350
Total: 1954	109, 827	2, 032, 590	2, 142, 417
1953	144, 633	2, 893, 528	3, 038, 161
South Atlantic: Delaware, Maryland, and West Virginia	4, 072	286, 125	290, 197
Total: 1954	4, 072	286, 125	290, 197
1953	24, 451	652, 858	677, 309
East South Central and West South Central: Alabama, Louisiana, and Texas	3, 540	27	3, 567
Total: 1954	3, 540	27	3, 567
1953	4, 193	157	4, 350
Rocky Mountain and Pacific Coast: Colorado and Washington	267	13	280
Total: 1954	267	13	280
1953	403	12	415
Total United States: 1954	204, 050	2, 848, 691	3, 052, 741
1953	276, 020	4, 351, 117	4, 627, 137

Electric Steel Furnaces.—The melt of ferrous scrap and pig iron used in electric furnaces in 1954 totaled 7,010,000 short tons, a 25-percent decrease from 1953, with the production of ingots and castings in these furnaces also showing a decrease of 25 percent. The ratio of scrap to pig iron used in the electric furnace was 38:1, compared with 50:1 in 1953. Consumption of scrap in the electric furnaces decreased in 8 of the 9 districts, with the largest decrease 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 71 percent of the total.

TABLE 10.—Consumption of ferrous scrap and pig iron in electric steel furnaces in the United States in 1954, 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	13,300	440	13,740
Massachusetts	28,662	2,911	31,573
Total: 1954	41,962	3,351	45,313
1953	48,501	1,714	50,215
Middle Atlantic:			
New Jersey	28,210	1,631	29,841
New York	155,164	1,912	157,076
Pennsylvania	1,218,634	13,299	1,231,933
Total: 1954	1,402,008	16,842	1,418,850
1953	2,040,460	24,091	2,064,551
East North Central:			
Illinois	1,093,814	90,926	1,184,740
Indiana	83,697	1,483	85,180
Michigan	720,254	13,878	734,132
Ohio	1,397,306	25,545	1,422,851
Wisconsin	132,268	2,848	135,116
Total: 1954	3,427,339	134,680	3,562,019
1953	4,912,642	142,555	5,055,197
West North Central:			
Iowa, Kansas, and Nebraska	58,337	640	58,977
Minnesota	10,679	182	10,861
Missouri	185,824	255	186,079
Total: 1954	254,840	1,077	255,917
1953	238,019	2,650	240,669
South Atlantic:			
Delaware, District of Columbia, and Maryland	86,021	4,684	90,705
Florida and Georgia	152,025	84	152,109
North Carolina, Virginia, and West Virginia	55,036	1,018	56,054
Total: 1954	293,082	5,786	298,868
1953	314,814	2,228	317,042
East South Central:			
Alabama	94,211	181	94,392
Kentucky	312,284	19	312,303
Tennessee	23,716	285	24,001
Total: 1954	430,211	485	430,696
1953	438,669	637	439,306
West South Central:			
Arkansas, Louisiana, and Oklahoma	40,629	979	41,608
Texas	234,005	11,715	245,720
Total: 1954	274,634	12,694	287,328
1953	288,296	3,872	292,168
Rocky Mountain: Arizona, Colorado, Nevada, and Utah	29,042	343	29,385
Total: 1954	29,042	343	29,385
1953	30,520	273	30,793

TABLE 10.—Consumption of ferrous scrap and pig iron in electric steel furnaces in the United States in 1954, by districts and States, in short tons—Continued

District and State	Total scrap	Pig iron	Total scrap and pig iron
Pacific Coast:			
California	459, 424	1, 741	461, 165
Oregon	145, 313	263	145, 576
Washington	74, 567	268	74, 835
Total: 1954	679, 304	2, 272	681, 576
1953	844, 685	3, 316	848, 001
Total United States: 1954	6, 832, 422	177, 530	7, 009, 952
1953	9, 156, 606	181, 336	9, 337, 942

Cupolas.—Consumption of scrap and pig iron for cupolas decreased 11 percent from 1953; scrap decreased 10 percent and pig iron 12 percent. The charge to cupolas consisted of 66 percent scrap and 34 percent pig iron, the same as in 1953. Shipments of gray-iron castings in 1954 decreased 16 percent from 1953, according to the Bureau of the Census, United States Department of Commerce.

Michigan continued to be the leading State in consumption of scrap in cupola furnaces, using 24 percent of the total.

TABLE 11.—Consumption of ferrous scrap and pig iron in cupola furnaces in the United States in 1954, by districts and States, in short tons

District and State	Total scrap	Pig iron	Total scrap and pig iron
New England:			
Connecticut	83, 026	41, 805	124, 831
Maine	7, 990	3, 056	11, 046
Massachusetts	212, 523	73, 971	286, 494
New Hampshire	11, 748	2, 258	14, 006
Rhode Island	29, 560	19, 228	48, 788
Vermont	23, 723	9, 033	32, 756
Total: 1954	368, 570	149, 351	517, 921
1953	407, 301	174, 256	581, 557
Middle Atlantic:			
New Jersey	355, 470	178, 564	534, 034
New York	310, 157	162, 294	472, 451
Pennsylvania	642, 935	286, 471	929, 406
Total: 1954	1, 308, 562	627, 329	1, 935, 891
1953	1, 505, 853	710, 617	2, 216, 470
East North Central:			
Illinois	855, 404	287, 988	1, 143, 392
Indiana	461, 988	223, 595	685, 583
Michigan	2, 273, 083	1, 016, 482	3, 289, 565
Ohio	1, 093, 311	449, 538	1, 542, 849
Wisconsin	459, 075	178, 736	637, 811
Total: 1954	5, 142, 861	2, 156, 339	7, 299, 200
1953	5, 841, 473	2, 652, 544	8, 494, 017
West North Central:			
Iowa	192, 045	68, 401	260, 446
Kansas	28, 327	6, 094	34, 421
Nebraska	16, 518	313	16, 831
Minnesota, North Dakota, and South Dakota	151, 654	37, 810	189, 464
Missouri	141, 079	25, 507	166, 586
Total: 1954	529, 623	138, 125	667, 748
1953	626, 759	171, 776	798, 535

TABLE 11.—Consumption of ferrous scrap and pig iron in cupola furnaces in the United States in 1954, by districts and States, in short tons—Continued

District and State	Total scrap	Pig iron	Total scrap and pig iron
South Atlantic:			
Delaware and Maryland	74,152	64,908	139,060
Florida	5,776	2,551	8,327
Georgia	29,618	11,719	41,337
North Carolina	51,566	17,007	68,573
South Carolina	22,179	13,107	35,286
Virginia	188,533	65,635	254,168
West Virginia	14,973	36,519	51,492
Total: 1954	386,797	211,446	598,243
1953	407,894	231,991	639,885
East South Central:			
Alabama	685,232	971,265	1,656,497
Kentucky and Mississippi	100,222	150,603	250,825
Tennessee	243,682	181,751	425,433
Total: 1954	1,029,136	1,303,619	2,332,755
1953	1,052,870	1,300,099	2,352,969
West South Central:			
Arkansas		151	151
Louisiana	8,694	293	8,987
Oklahoma	34,655	7,252	41,907
Texas	175,960	122,920	298,880
Total: 1954	219,309	130,616	349,925
1953	200,141	113,791	313,932
Rocky Mountain:			
Arizona and New Mexico	17,413		17,413
Colorado	70,134	29,459	99,593
Utah	63,003	43,489	106,492
Idaho and Wyoming	7,469	225	7,694
Montana	8,845	98	8,943
Total: 1954	166,864	73,271	240,135
1953	197,806	93,850	291,656
Pacific Coast:			
California	348,372	103,487	451,859
Oregon	30,875	1,280	32,155
Washington	32,894	1,840	34,734
Total: 1954	412,141	106,607	518,748
1953	391,179	99,331	490,510
Undistributed: [1] 1953	2,892	1,267	4,159
Total United States: 1954	9,563,863	4,896,703	14,460,566
1953	10,634,168	5,549,522	16,183,690

[1] Some scrap and pig iron consumed in cupola furnaces in 1953 in Indiana and Ohio—not separable—are included with "Undistributed."

Air Furnace.—Scrap and pig iron consumed in air furnaces decreased 21 percent, scrap decreasing 20 percent and pig iron 26 percent. No Brackelsberg furnaces were used in the United States during the year. Owing to continued large consumption of scrap in air furnaces in Ohio, the East North Central district was the largest consuming area for these furnaces, using 75 percent of the total scrap consumed.

TABLE 12.—Consumption of ferrous scrap and pig iron in air furnaces in the United States in 1954, by districts and States, in short tons

District and State	Total scrap	Pig iron	Total scrap and pig iron
New England:			
Connecticut	27,309	6,297	33,606
Massachusetts and New Hampshire	10,184	2,965	13,149
Rhode Island			
Total: 1954	37,493	9,262	46,755
1953	50,808	14,133	64,941
Middle Atlantic:			
New Jersey	3,357	2,561	5,918
New York	34,528	10,960	45,488
Pennsylvania	109,261	40,456	149,717
Total: 1954	147,146	53,977	201,123
1953	204,740	74,930	279,670
East North Central:			
Illinois	139,155	33,469	172,624
Indiana	127,699	33,919	161,618
Michigan	96,675	12,661	109,336
Ohio	284,012	50,309	334,321
Wisconsin	70,808	20,116	90,924
Total: 1954	718,349	150,474	868,823
1953	876,502	200,974	1,077,476
West North Central: Iowa, Minnesota, and Missouri	11,636	7,508	19,144
Total: 1954	11,636	7,508	19,144
1953	13,062	7,750	20,812
South Atlantic and West South Central:			
Delaware, North Carolina, and West Virginia	14,296	6,762	21,058
Texas	18,135	1,735	19,870
Total: 1954	32,431	8,497	40,928
1953	38,228	11,742	49,970
Pacific Coast: California	14,604	2,704	17,308
Total: 1954	14,604	2,704	17,308
1953	13,707	3,525	17,232
Total United States: 1954	961,659	232,422	1,194,081
1953	1,197,047	313,054	1,510,101

Crucible and Puddling Furnaces.—The consumption of scrap and pig iron in crucible furnaces was negligible during 1954, 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 6.3 percent compared with 6.6 percent in 1953, and total scrap consumption was 27 percent lower in 1954. Other materials consisted of 99,974,000 short tons of iron ore, sinter, and manganiferous ore; 3,135,000 tons of mill cinder and roll scale; 3,713,000 tons of open-hearth and Bessemer slag; and 169,000 tons of miscellaneous materials.

TABLE 13.—Consumption of ferrous scrap in blast furnaces in the United States in 1954, by districts and States, in short tons

District and State	Total scrap	District and State	Total scrap
New England and Middle Atlantic:		South Atlantic and East and West South Central:	
Massachusetts and New York	318,409	Alabama	229,293
Pennsylvania	1,099,013	Kentucky, Maryland, Tennessee, Texas, and West Virginia	307,148
Total: 1954	1,417,422	Total: 1954	536,441
1953	2,060,764	1953	932,774
East North Central and West North Central:		Rocky Mountain and Pacific Coast:	
Illinois	262,414	California, Colorado, and Utah	38,187
Indiana	157,920	Total: 1954	38,187
Michigan and Minnesota	299,669	1953	41,754
Ohio	915,725		
Total: 1954	1,635,728	Total United States: 1954	3,627,778
1953	1,912,950	1953	4,948,242

USE OF SCRAP IN FERROALLOY PRODUCTION

The ferroalloy plants operating electric furnaces or aluminothermic units during 1954 used 18 percent less scrap than in 1953.

Scrap used in blast furnaces in manufacturing ferroalloys is included with blast furnaces in this chapter.

TABLE 14.—Consumption of ferrous scrap by ferroalloy producers in the United States, in 1954, by districts, in short tons

District and State	Total scrap	District and State	Total scrap
Middle Atlantic: [1]		East South Central:	
Total: 1954	29,436	Total: 1954	38,261
1953	32,438	1953	55,485
East North Central: [1]		Pacific Coast:	
Total: 1954	13,003	Total: 1954	2,979
1953	19,278	1953	4,173
West North Central:		Undistributed: [1]	
Total: 1954	149,071	Total: 1954	70,708
1953	178,587	1953	80,968
South Atlantic:		Total United States: 1954	305,607
Total: 1954	2,149	1953	373,172
1953	2,243		

[1] Some scrap consumption in the Middle Atlantic and East North Central districts—not separable—is included with "Undistributed."

MISCELLANEOUS USES

Scrap consumed in 1954 for miscellaneous purposes, such as rerolling, nonferrous metallurgy, and as a chemical agent was 1.4 percent of the total consumption compared with 1.1 percent during the previous year. The quantity so used decreased 5 percent from that used for similar purposes in 1953.

TABLE 15.—Consumption of ferrous scrap in miscellaneous uses in the United States in 1954, by districts and States, in short tons

District and State	Total scrap	District and State	Total scrap
New England: Connecticut and Massachusetts	15,882	South Atlantic:	
		Georgia	618
		Virginia and West Virginia	46,430
Total: 1954	15,882		
1953	16,033	Total: 1954	47,048
		1953	42,946
Middle Atlantic:			
New Jersey	106,286	East and West South Central: Alabama and Texas	57,185
New York	68,628		
Pennsylvania	54,328		
		Total: 1954	57,185
Total: 1954	229,242	1953	61,278
1953	266,878		
		Rocky Mountain:	
East North Central:		Arizona	26,509
Illinois	200,761	Colorado, Idaho, and Montana	9,512
Indiana	6,922	Utah	5,339
Michigan and Wisconsin	15,783		
Ohio	83,311	Total: 1954	41,360
		1953	52,681
Total: 1954	306,777		
1953	312,007	Pacific Coast:	
		California	48,215
West North Central:		Washington	1,129
Minnesota	600		
Missouri	83,378	Total: 1954	49,344
		1953	49,735
Total: 1954	83,978		
1953	74,930	Undistributed: [1] 1953	351
		Total United States: 1954	830,816
		1953	876,839

[1] Some scrap consumed in miscellaneous uses during 1953, included with "Undistributed."

STOCKS

Complete iron- and steel-scrap stock figures covering 1954 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.

Consumers' Stocks.—Consumers' total scrap stocks on December 31, 1954, increased 3 percent over those held at the beginning of the year. Stocks of pig iron on December 31, 1954, decreased 9 percent from the stocks on hand December 31, 1953.

Suppliers' Stocks.—Stocks of iron and steel scrap in the hands of a combined total of 425 dealers, automobile wreckers, and shipbreakers, as reported voluntarily to the Bureau of Mines, totaled 1,044,000 short tons on December 31, 1954.

TABLE 16.—Consumers' stocks of ferrous scrap and pig iron on hand in the United States on December 31, 1953, and December 31, 1954, by district and States, in short tons

District and State	December 31, 1953		December 31, 1954	
	Total scrap	Pig iron	Total scrap	Pig iron
Connecticut	34,850	9,671	19,099	8,356
Maine	3,099	1,366	1,576	651
Massachusetts	87,638	101,864	65,873	82,448
New Hampshire	2,363	663	1,193	304
Rhode Island	9,002	5,383	8,948	5,253
Vermont	4,876	1,150	3,177	1,214
Total New England	141,828	120,097	99,866	98,226
New Jersey [1]	68,017	38,098	75,795	39,641
New York [1]	428,527	225,388	532,797	289,014
Pennsylvania	1,705,062	511,654	1,478,802	528,845
Total Middle Atlantic	2,201,606	775,140	2,087,394	857,500
Illinois	798,279	188,220	914,415	129,339
Indiana [1]	672,823	128,603	708,418	116,563
Michigan	378,094	509,722	407,780	237,537
Ohio [1]	1,176,841	376,148	1,198,178	367,463
Wisconsin	66,350	33,797	70,586	27,308
Total East North Central	3,092,387	1,236,490	3,299,377	878,210
Iowa	37,328	18,199	32,295	37,694
Kansas and Nebraska	16,654	1,758	12,132	753
Minnesota, North Dakota, and South Dakota	158,123	41,411	137,788	59,426
Missouri [1]	158,959	18,153	176,766	14,218
Total West North Central	371,064	79,521	358,981	112,091
Delaware, District of Columbia, and Maryland	136,991	46,639	171,338	34,538
Florida and Georgia	14,092	3,184	16,352	3,062
North Carolina	2,594	2,296	6,834	3,364
South Carolina	1,515	1,675	1,940	2,659
Virginia and West Virginia [1]	131,417	11,541	166,640	16,470
Total South Atlantic	286,609	65,335	363,104	60,093
Alabama [1]	117,618	203,396	159,778	269,413
Kentucky, Mississippi, and Tennessee	90,864	102,044	139,335	113,857
Total East South Central	208,482	305,440	299,113	383,270
Arkansas, Louisiana, and Oklahoma	20,566	1,728	17,983	1,792
Texas	169,914	66,422	191,227	61,193
Total West South Central	190,480	68,150	209,210	62,985
Arizona, Nevada, and New Mexico	21,404	188	23,460	152
Colorado and Utah	134,500	83,612	145,940	51,484
Montana	8,211	56	6,325	66
Idaho and Wyoming	2,245	72	2,540	81
Total Rocky Mountain	166,360	83,928	178,265	51,783
Alaska, Washington, and Oregon [1]	87,162	4,165	108,026	3,476
California	386,162	59,098	313,544	28,586
Total Pacific Coast	473,324	63,263	421,570	32,062
Undistributed [1]	16,626	191	32,016	----------
Total United States	7,148,766	2,797,555	7,348,896	2,536,220

[1] Some scrap stocks in 1954 in Alabama, New Jersey, New York, Missouri, Ohio, Oregon, West Virginia, and also some scrap stocks and pig iron stocks in 1953 in Ohio and Indiana—not separable— are included with "Undistributed."

PRICES

The price of No. 1 Heavy-Melting scrap at Pittsburgh, as reported in the Iron Age Annual Review, January 6, 1955, was $30.25 per gross ton in January, $12.75 less than in January 1953. Prices for this grade of scrap fluctuated from a low of $24.90 per ton in March to a high of $34.20 in November but dropped to $33.00 at the end of December.

According to Iron Age magazine the upward trend in scrap buying and prices was due to at least three major factors: (1) A realization that prices had dropped so far as to dry up supplies; (2) a slight pickup in the steel ingot rate in May and June; and (3) easing by the Commerce Department of curbs on scrap exports.

Cast-iron scrap at Cincinnati averaged $37.77 per gross ton for the year. The lowest price, $34.50 per ton, for this grade of scrap was during March; the highest price, $39.50 per ton, was firm during the last 3 months of the year.

The average composite price of iron and steel scrap, as reported by Iron Age, was $28.67 per gross ton in January, $13.33 less than in January 1953; the price decreased to $23.83 per ton in March and rose to a high of $33.40 in November, but dropped to $32.46 per ton at the end of December. The average composite price for the year was $28.59 per ton. The price of No. 1 Cast scrap at Chicago varied from month to month with a low of $35.75 per gross ton during January, and a high of $43.63 per ton during December. The average for the year was $39.74 per ton. No. 1 Heavy Melting at Chicago was quoted at $28.13 per ton in January, ranging from a low of $24.50 per ton during March to a high of $33.75 per ton in October but dropped to $33.00 at the end of December. The average price for this grade of scrap for the year was $29.71 per ton.

FOREIGN TRADE [2]

Imports.—Imports of iron and steel scrap, including tinplate, increased 38 percent in quantity over the previous year, but the value increased only 1 percent. Of the scrap imported, the largest quantity was received from Canada-Newfoundland-Labrador (93 percent of the total imports), followed by Netherlands Antilles (1 percent) and Venezuela (1 percent); 5 percent was imported from other countries. Of the total imports, 14 percent was tinplate scrap, mostly from Canada, compared with 24 percent during the previous year.

Exports.—An exceptionally large quantity of ferrous scrap, including rerolling material, was exported during 1954, the first year since the Korean War in which there were no export-quota limitations. Exports can be best evaluated by comparing exports in 1954 with the 5-year prewar average (1935–39) of 3,298,000 tons a year; the percentage in 1954 was 51 compared with 10 in 1953 and 11 in 1952. Tinplate scrap, tinplate circles, strips, cobbles and terneplate clippings and scrap exported during 1954 were 1 percent of the total exports, with a value of $1,117,000. The same materials in 1953 were 6 percent of the 1953 exports, with a value of $1,253,000.

[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.

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TABLE 17.—Ferrous scrap imported for consumption in the United States, 1945–49 (average) and 1950–54, by countries, in short tons

[U. S. Department of Commerce]

Country	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Canada-Newfoundland-Labrador	45,504	87,981	69,799	55,101	131,371	222,982
Canal Zone	2,023	1,163	10,525	1,141	2,180	511
Cuba	15,220	21,242	43,870	22,800	3,012	2,893
French West Indies	939	-----	-----	1,596	1,381	1,215
Netherlands Antilles	4,499	3,609	4,328	951	7,104	3,360
Panama	184	-----	65	1,913	1,410	-----
Other North America	3,693	7,442	11,806	6,875	3,007	511
Total	72,062	121,437	140,393	90,377	149,465	231,472
South America:						
Venezuela	1,672	-----	554	8,385	2,240	2,912
Other South America	1,169	119	4,796	5,417	-----	-----
Total	2,841	119	5,350	13,802	2,240	2,912
Europe:						
Belgium-Luxembourg	2,674	39,527	1,676	328	-----	-----
Denmark	1,191	5,006	475	128	-----	-----
France	266	162,090	27,844	258	373	46
Germany	152,131	185,839	63,912	-----	[1] 253	[1] 1
Netherlands	42,082	70,001	19,402	12	77	13
Norway	84	18	35	2,576	3	-----
Switzerland	-----	28	6,709	-----	-----	-----
United Kingdom	1,190	8,529	6,225	23	[2] 5,686	591
Other Europe	1,609	1,706	2,965	545	247	177
Total	201,227	472,744	129,243	3,870	6,639	828
Asia:						
India	976	325	21,519	13,251	-----	-----
Japan	55,076	113,436	31,648	1,259	1,751	400
Korea	179	-----	8,516	5,741	-----	-----
Philippines	20,272	14,253	26,336	-----	51	-----
Other Asia	2,254	17,966	217	-----	-----	-----
Total	78,757	145,980	88,236	20,251	1,802	400
Africa:						
Algeria	206	15,401	22,863	799	790	688
French Morocco	1,013	6,586	3,042	2,187	3,778	906
Union of South Africa	1,907	5,893	6,930	5,617	2,167	1,399
Other Africa	71	260	364	820	316	224
Total	3,197	28,140	33,199	9,423	7,051	3,217
Oceania:						
Australia	6,820	16,635	12,512	8,755	6,145	56
New Zealand	459	175	7,477	431	318	102
Western Pacific Islands	20	-----	-----	6,720	-----	-----
Other Oceania	-----	-----	448	45	-----	-----
Total	7,299	16,810	20,437	15,951	6,463	158
Grand total: Short tons	365,383	785,230	416,858	153,674	[2] 173,660	238,987
Value	$8,888,472	$18,718,895	$15,013,148	$5,398,570	[2] $5,870,215	[3] $5,947,731

[1] West Germany.
[2] Revised figure.
[3] Due to changes in tabulating procedures by the U. S. Department of Commerce data known not to be comparable with earlier years.

TABLE 18.—Ferrous scrap exported from the United States, 1945–49 (average) and 1950–54, by countries of destination, in short tons [1]

[U. S. Department of Commerce]

Destination	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Canada-Newfoundland-Labrador	115,548	81,000	89,632	195,370	76,762	48,544
Mexico	53,794	124,537	130,491	135,054	156,394	224,411
Other North America	146	34	49	26	----------	----------
Total	169,488	205,571	220,172	330,450	233,156	272,955
South America:						
Argentina	1,948	1,112	2,597	741	----------	75,425
Brazil	415	3,225	1,018	296	----------	928
Chile	2,833	----------	6	----------	----------	----------
Other South America	448	283	279	3	9	191
Total	5,644	4,620	3,900	1,040	9	76,544
Europe:						
Belgium-Luxembourg	12	----------	316	55	15	23,324
France	94	----------	1	----------	----------	31,427
Germany	----------	25	----------	[2] 131	----------	[2] 332,801
Italy	52	115	473	1,300	171	253,748
Netherlands	71	355	1,212	34	27	20,906
Turkey	133	95	420	846	624	459
United Kingdom	123	----------	----------	9,634	9,055	181,342
Other Europe	1,358	27	1,375	398	126	142,036
Total	1,843	617	3,797	12,398	10,018	986,043
Asia:						
British Malaya	----------	863	2,487	1,044	361	73
China	2,026	230	----------	----------	----------	----------
Hong Kong	1,004	2,547	14	----------	121	939
India	346	160	797	1,763	3,205	1,929
Japan	----------	1,605	3,105	4,362	62,471	316,626
Philippines	6	186	81	----------	287	439
Other Asia	19	329	465	306	84	10,741
Total	3,401	5,920	6,949	7,475	66,529	330,747
Africa:						
Union of South Africa	225	236	709	28	91	----------
Other Africa	111	----------	----------	33	11	130
Total	336	236	709	61	102	130
Grand total: Short tons	180,712	216,964	235,527	351,424	309,814	1,666,419
Value	$4,730,060	$6,013,719	$8,736,327	$12,423,002	$10,827,452	$50,390,994

[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). Not separately classified before 1949.

[2] West Germany.

TABLE 19.—Ferrous scrap imported into and exported from the United States, 1945–49 (average) and 1950–54, 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.	Terne-plate clippings and scrap	Total
SHORT TONS								
1945–49 (average)	330,549	34,834	365,383	176,359	141	3,880	332	180,712
1950	737,749	47,481	785,230	208,355	629	7,819	161	216,964
1951	359,099	57,759	416,858	[2] 219,905	907	14,554	161	[2] 235,527
1952	105,896	47,778	153,674	[2] 336,287	3,998	11,139		[2] 351,424
1953	[2] 131,568	42,092	[2] 173,660	[2] 291,177	5,818	12,819		[2] 309,814
1954	206,316	32,671	238,987	1,652,176	1,057	13,186		1,666,419
VALUE								
1945–49 (average)	$8,306,121	$582,351	$8,888,472	$4,295,394	$12,490	$398,842	$23,334	$4,730,060
1950	17,834,543	884,352	18,718,895	5,254,747	39,237	697,755	21,980	6,013,719
1951	13,181,093	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	[2] 4,754,939	1,115,276	[2] 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	49,274,157	22,651	1,094,186		50,390,994

[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). Not separately classified before 1949.
[2] Revised figure.
[3] Due to changes in tabulating procedures by the U. S. Department of Commerce data known not to be comparable with earlier years.

TECHNOLOGY

A new baler for bundling steel scrap has introduced automation into the scrap-baling department of the new stamping plant at Pontiac Division of General Motors Corp. It was designed and built, and wherever possible U. S. standard threads were used by the manufacturer, Maschinenfabrik Lindemann, Pressenbaugh, G. m. b. H., Dusseldorf, Germany.[3]

The new Pontiac equipment shears the scrap and compresses it into dense bales, which are ejected into a chute that empties onto a belt conveyor. Size of bales may be varied, but Pontiac selected 11-inch by 11-inch by 6-inch bales to facilitate weighing and charging in the cupola. As a result of the higher pressure that can be exerted, the density of the small bales is greater and more uniform than that of larger ones. Some automatic baling equipment of this type is available for making bales ranging from 60 to 950 pounds.

Advantages of the automatic shear baler may be summarized as follows:

1. Oxygen cutting and manual raking of scrap is eliminated.
2. Scrap is handled continuously and automatically.
3. Number of valves and rams is reduced.
4. Opening of the press box can be varied to suit the application.

[3] Patton, W. G., Scrap Handling Speeded With Automatic Shear-Baler: Iron Age, vol. 173, No. 11, Mar. 18, 1954, pp. 143, 144, 145.

5. Bales are ejected automatically by the high-pressure ram.
6. Cylinders are horizontal and easily accessible at floor level.
7. Output per square foot of floor space is increased.
8. Operating rate for the smaller bales ranges up to 100 bales per hour; for the largest, 45 bales per hour.

There are some other advantages, such as reducing the ram travel to a minimum and eliminating or minimizing vibration and chatter by reinforcement of the hydraulic lines.

Scrap briquets, which are formed from steel turnings and compare favorably with No. 1 Heavy-Melting steel scrap, have been used intermittently for several years in open-hearth furnaces by the Pittsburgh Steel Co.[4]

Although briquets made from cast-iron borings have been used for some time by foundries, widespread use of steel-scrap briquets is still in the development stage. The main obstacle that has retarded the mills using them is the control of analysis in the briquet. Few dealers have anything in the way of testing equipment, and in addition the majority of turnings shipped to dealers is in mixed lots.

In the belief that the market for briquets will develop in the near future, the Pennsteel Corp., Pittsburgh, Pa., endeavored to obtain carloads of turnings of uniform analysis. Samples of these turnings were taken to a testing laboratory for further analysis, and the cars found to be low in residual content were used for briquetting. These briquets offer several advantages over much of the scrap now being used in open-hearth furnaces; density is higher than in most of the scrap used, better recovery results, charging operations are speeded and handling time is substantially lowered.

Economies in cupola charge and improved castings were obtained by successful remelting of machine-shop swarf and small foundry scrap. Successful use of very fine particles of scrap depends on correct handling of small pieces in the cupola.[5]

Other than coke, fluxes, and special ferroalloys, cupola charges comprise proportions of pig iron, cast-iron scrap, and often some steel scrap. Finely broken cuttings or small press punchings of steel scrap, as well as cast iron or steel borings, grindings, small-size cuttings, or chips, are undesirable for cupola charges unless they can be compressed economically by briquetting or loading into a container. However, there are several problems to be overcome before either method could be successful. If fine borings are loaded loosely into the cupola, the air blast blowing up the furnace forces out many small poɹticles and results in very high losses of material. When these bairngs are distributed through the cupola mix by the air blast, oxidation is heavily increased, resulting in considerable loss of carbon, silicon, and manganese.

If these small sized materials are to be successfully remelted, a method must be available to permit easy handling and overcome other disadvantages. Briquetting requires an investment in press equipment, and in addition pressure-compacted briquets expand when heated and tend to disintegrate the block, allowing particles to disperse

[4] Iron Age, vol. 175, No. 15, Apr. 14, 1955, p. 57.
[5] Halliday, W. M., Cut Cupola Charge Cost: Iron Age, vol. 174, No. 9, Aug. 26, 1954, p. 106.

widely into coke layers before reaching the melting region. Therefore, the most economical and satisfactory method of handling these small metal particles is to pack them in a container that gives protection against the air blast and can arrest oxidation.

WORLD REVIEW

A proposal for reorganizing the scrap market, effective April 1, 1954, was examined by the Coal and Steel Community Council of Ministers at its meeting on March 11 and 12, 1954.[6]

The proposals for reorganization are listed below:

1. Elimination of all price controls on scrap.
2. Obligatory perequation of imported scrap.
3. Establishment of a perequation price.
4. Maintenance of the Community's three bureaus in Brussels.
5. Negotiation in common of scrap import program.
6. Administration of the Perequation Fund under the authority and responsibility of the High Authority.
7. Maintenance of restrictions on exports of scrap to third countries.

The Council agreed upon eliminating maximum prices for scrap and further proposed seeking agreement of consumers for the continued voluntary perequation of scrap imported from third countries. They also concurred with the principle of obligatory perequation of scrap imports if consumers in all six countries do not agree voluntarily to continue the present perequation arrangements.

The Brussels office of the European Steel and Coal Community planned to import approximately 250,000 tons of scrap from the United States, to be allocated to member countries, with initial shipments to be sent to Germany.[7]

Austria, a nonmember of the Community, needed scrap during July but, due to the needs of member nations, was unable to secure the desired tonnages and had to request imports from the United States. Arrangements were made to ship the scrap to Austria by way of Trieste, with purchases scheduled for the balance of the year.

Australia.—Large stocks of scrap, particularly steel and cast iron, were being held by dealers on November 1, owing in part to the decrease of consumers' purchases in preceding months.[8]

The Australian Government had rigid controls on scrap exports; only 20,000 metric tons was permitted to be exported during the 6 months ended December 31, 1954. This tonnage was negligible compared with actual surplus stocks.

The dealers were collecting scrap at a rate in excess of local usage, and coupled with the ban on export this would tend to increase stocks to such a level that the dealers would cease buying steel and cast-iron scrap and depend on nonferrous scrap. If such a situation should arise, a shortage of scrap for the local market could result. The Government imposed its export ban to prevent a local shortage.

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[6] United States Representative to the European Coal and Steel Community, U. S. Embassy, Luxembourg, State Department, Dispatch D-94, Mar. 16, 1954.

[7] Waste Trade Journal, vol. 97, No. 16, July 10, 1954, p. 49.

[8] Waste Trade Journal, vol. 98, No. 8, Nov. 13, 1954, p. 81.

Germany, West.—The fluctuation in iron and steel output in West Germany during the early months of 1954 resulted in an unstable scrap situation.[9]

The main reason given for this situation was that consumers did not build up stocks at the beginning of the year when steel and iron production was at a low ebb and when scrap was being offered at low prices, but instead reduced their scrap purchases. As a result of the poor domestic market, dealers exported large quantities. Thus, when scrap demand increased during the third and fourth quarter of the year, there was an inadequate supply. The scrap trade can supply about 415,000 metric tons annually, of which 50,000 tons is reserved for export to E. C. S. C. countries, mainly Italy. Although West Germany had received a large share of scrap that had been bought at an earlier date by the High Authority from the United States and other countries, it was necessary to import scrap because stocks at iron and steel plants had been reduced to a critical stage.

However, increased imports of scrap from countries not in the Coal and Steel Community, especially Canada and the United States, plus increased domestic sources during the second half of 1954, enabled the iron and steel industry to operate at record levels for the remainder of the year.[10]

The Brussels Scrap Association contracted for 900,000 tons of third country scrap for import into the Coal and Steel Community, of which Germany was allocated 310,000 tons for delivery by the end of 1954. These imports were essential to meet rising demand and to improve stocks.

By the end of the year the situation had improved, and scrap stocks held by consumers and in dealers' yards had increased, regardless of the record production of iron and steel. Scrap stocks at the mills amounted to 531,000 metric tons in December 1954 compared with 674,000 tons at the close of 1953, while foundry stocks amounted to 210,000 tons. These stocks, at the current rate of production, were equivalent to a 17-day supply at the mills and 19 days at the foundries.[11]

Japan.—During the early part of 1954 a number of Japanese steel manufacturers, including the three major steel mills, sought authorization from the Fair Trade Commission to organize a cartel for joint purchases of scrap iron and steel at home and abroad.[12]

The plan was to be organized under the revised Japanese Antitrust Law, which permitted industrial companies and trading firms to form cartels for specific purposes such as industrial rationalization and combatting a business recession.

This cartel was to provide for concerted action in determining prices, specifications, transport conditions in purchasing scrap, and for the imposition of penalties on violators of the agreement.

During 1954 the Japanese steel industry was concerned over: (1) The possibility of not being able to import a substantial quantity of scrap

[9] Metal Bulletin, No. 3948, Nov. 30, 1954, p. 11.
[10] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 2, February 1955, p. 18.
[11] United States Consulate General, Dusseldorf, Germany, State Department Dispatch 242, Jan. 14, 1955.
[12] Waste Trade Journal, vol. 96, No. 16, Jan. 9, 1954, p.33.

from the United States, (2) decreased Government investment in industry, and (3) a reduction in development projects for which steel was required.

Regardless of these circumstances, Japan was the second largest importer of scrap from the United States, importing 316,626 short tons of scrap in 1954 compared with 68,344 short tons during 1953. Although there was a decline in industrial demand during the last 6 months of 1954, the Japanese iron and steel industry had an exceptionally good year.

Jewel Bearings

By Henry P. Chandler[1] and Eleanor V. Blankenbaker[2]

DOMESTIC PRODUCTION and consumption of jewel bearings continued to decline in 1954. This recession in the industry was paralleled by a drop in imports and by a reduction in the manufacture of articles requiring jewel bearings.

The annual survey of the jewel-bearings industry in the United States, conducted by the Federal Bureau of Mines in cooperation with the Business and Defense Services Administration, was revised and expanded in 1954 to include information from 78 active respondents in 16 States, compared with 41 active respondents in 12 States in 1953. Fifteen of the larger respondents, representing 87 percent of the jewel-bearings industry in 1954, reported in both years. The canvass of semifinished jewels was discontinued in 1954.

DOMESTIC PRODUCTION

During 1954 the reported production of finished jewel bearings in the United States declined 33 percent, and the production of blanks declined 87 percent from the previous year. Firms at South Pasadena, Calif.; Waltham and West Lynn, Mass.; Newark, Perth Amboy, and Trenton, N. J.; Rochester, N. Y.; and Rolla, N. Dak., reported manufacture of finished jewel bearings. The Turtle Mountain Ordnance Plant, Rolla, N. Dak., continued to produce jewel bearings under the management of the Bulova Watch Co. This plant was established in 1953 to provide for training personnel in making jewel bearings and to develop necessary techniques and machinery.

TABLE 1.—Salient statistics of the jewel-bearings industry in the United States, 1950–54

[Number of jewel bearings]

	1950	1951	1952	1953	1954
Production:					
Blanks	795, 400	1, 200, 503	1, 907, 301	6, 043, 886	802, 098
Finished jewels [1]	3, 327, 206	9, 876, 654	10, 637, 206	15, 666, 908	10, 465, 978
Consumption:					
Blanks	7, 008, 289	11, 415, 514	9, 062, 893	7, 939, 130	2, 803, 030
Semifabricated jewels	3, 331, 500	7, 884, 500	1, 892, 000	1, 900, 000	(2)
Finished jewels [1]	71, 126, 700	85, 030, 037	77, 311, 999	70, 936, 923	66, 233, 973
Shipments:					
Blanks	85, 400	75, 503	5, 391	8, 189, 821	33
Semifabricated jewels	2, 414	561	1, 439	30, 000	(2)
Finished jewels [1]	6, 976, 608	14, 031, 386	28, 795, 001	36, 772, 885	29, 368, 633
Stocks on hand Dec. 31:					
Blanks	5, 796, 014	2, 618, 650	4, 327, 957	1, 413, 951	702, 571
Semifabricated jewels	529, 540	710, 479	1, 054, 886	2, 134, 040	(2)
Finished jewels [1]	107, 432, 348	97, 390, 081	104, 169, 041	97, 545, 593	95, 378, 696

[1] Includes finished jewels made from glass.
[2] Canvass discontinued.

[1] Commodity-industry analyst.
[2] Literature-research clerk.

CONSUMPTION AND USES

Since 1951 the consumption of finished jewels and blanks in the United States has declined steadily. The 1954 consumption of finished jewels being 7 percent below 1953 and 22 percent below 1951. Consumption of blanks showed an even greater reduction. Because of increased canvass coverage in 1954 the decline was even more marked than reported figures indicate.

Consumption and sales of finished jewel bearings in the United States, by uses, are shown in table 2. Synthetic sapphire and ruby bearings amounted to 91 percent; glass, 8 percent; and other types, 1 percent of the total consumed. The data on distribution by uses are not entirely comparable with previous years because a revised method of reporting the various types of jewel bearings used or sold was begun in 1954 and all questions regarding values were discontinued.

A diagram illustrating the more widely used types of jewel bearings is shown in figure 1.

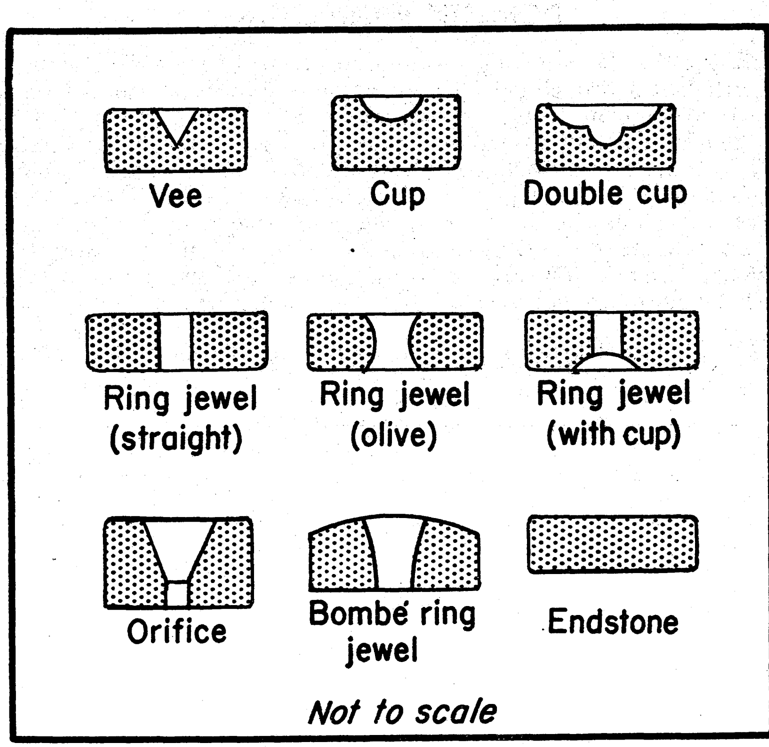

FIGURE 1.—Typical shapes of jewel bearings.

Of the 16 States reporting consumption of jewel bearings in 1954, New York had the largest number of firms reporting, consuming 33 percent of the national total, followed, in order of quantity used, by Illinois, Pennsylvania, and New Jersey (table 3).

TABLE 2.—Consumption and sales of finished jewels in the United States, 1954, by uses

Use	Consumption (number of jewels)	Sales (number of jewels)
Synthetic sapphire and ruby:		
Watch holes:		
Olive	20, 647, 647	966, 704
Straight	7, 578, 193	295, 679
Pallet stones	6, 122, 540	4, 056
Roller (jewel) pins	2, 294, 603	53, 043
End stones or caps:		
Watch	7, 872, 132	1, 314, 237
Instrument	1, 686, 053	5, 578, 185
Vees	5, 807, 717	5, 678, 420
Instrument rings	1, 267, 985	5, 192, 711
Cups or double cups	5, 209, 045	3, 801, 068
Orifice jewel	212, 428	151, 153
Dies (wire drawing)		(1)
Other	1, 468, 006	2, 597, 162
Total number of finished synthetic sapphire and ruby jewel bearings	60, 166, 349	25, 632, 418
Glass:		
Vees	5, 394, 069	3, 712, 641
Instrument rings (including hole jewels)	242, 013	23, 574
Total number of glass bearings	5, 636, 082	3, 736, 215
Other jewel bearings	431, 542	
Total finished jewel bearings	66, 233, 973	29, 368, 633

[1] Included with "Other."

In 1954 the following firms consumed 87 percent of the jewel bearings used in the United States:

Bulova Watch Co., Woodside, L. I., N. Y.
Duncan Electric Mfg. Co., Lafayette, Ind.
Elgin National Watch Co., Elgin, Ill.
Federal Products Co., Providence, R. I.
General Electric Co., West Lynn, Mass.
General Electric Co., Somersworth, N. H.
Gruen Watch Co., Cincinnati, Ohio.
Hamilton Watch Co., Lancaster, Pa.
Kollsman Instrument Co., Elmhurst, N. Y.
Moser Jewel Co., Perth Amboy, N. J.
New Haven Clock & Watch Co., New Haven, Conn.
Sangamo Electric Co., Springfield, Ill.
Waltham Watch Co., Waltham, Mass.
Westinghouse Electric Corp., Newark, N. J.
Weston Electric Instrument Co., Newark, N. J.

TABLE 3.—Consumption of finished jewel bearings in the United States, 1954, by States

State	Number of consumers	Quantity (Number of jewels)
California	5	137, 442
Connecticut	8	2, 960, 551
Illinois	11	18, 761, 147
Indiana	2	997, 800
Massachusetts	8	2, 297, 869
Michigan	3	126, 828
New Hampshire	4	2, 356, 749
New Jersey	8	6, 702, 511
New York	12	21, 790, 691
Ohio	5	1, 850, 553
Pennsylvania	5	6, 773, 403
Other States [1]	7	1, 478, 429
Total	78	66, 233, 973

[1] Includes Maryland, Minnesota, Missouri, Rhode Island, and Wisconsin.

FOREIGN TRADE [3]

Imports of jewel bearings into the United States during 1954, as shown in table 4, were lower by 43 percent in quantity and 40 percent in value from 1953. Jewel bearings in loose form (not assembled in units) were dutiable at 10 percent ad valorem.

TABLE 4.—Jewel bearings imported for consumption in the United States, 1945–49 (average) and 1950–54

[U. S. Department of Commerce]

Year	Number	Value	Year	Number	Value
1945–49 (average)	97, 659, 704	$3, 658, 328	1952	98, 021, 914	$4, 226, 948
1950	87, 939, 766	3, 737, 979	1953	86, 892, 637	3, 708, 027
1951	92, 396, 053	3, 965, 983	1954	49, 262, 027	2, 219, 001

TABLE 5.—Imports [1] of jewel bearings in 1954, by uses

Use	Quantity (number of jewels)	Use	Quantity (number of jewels)
Watch holes:		Vees	5, 316, 673
Olive	10, 652, 624	Instrument rings	3, 192, 390
Straight	7, 194, 916	Cups or double cups	3, 031, 779
Pallet stones	2, 467, 502	Other [2]	4, 564, 063
Roller pins	1, 597, 682		
End stones or caps:		Total	49, 167, 420
Watch	5, 985, 358		
Instrument	5, 164, 433		

[1] As reported to the Bureau of Mines.
[2] Includes orifice, rough pins, finished stylii, phonograph blanks, and guide jewels.

TECHNOLOGY

The various processes, equipment, and operations used in manufacturing jewel bearings were reviewed.[4] Types of bearing systems, V-jewel design, shock-resistant mountings, and ringstone and endstone bearing systems were described.[5] The processes of manufacture and utilization of jewel bearings were described in English in a Swiss publication.[6] Investigation of the types of jewels formerly used in watches made an interesting study in connection with the history of the jewel-bearings industry.[7] Synthetic sapphire, both as a jewel bearing and in other forms, is finding many new applications in industry.[8]

An importing firm issued a folder giving specifications for jewel bearings (tolerances within 0.00005 inch on inner diameter if required) and a hardness comparison chart (Mohs and Knoop). Bearing qualities and applications were described.[9]

[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.
[4] Houston, H. H., Synthetic Sapphire Production and Fabrication for Instrument Bearings: Bull., Am. Ceram. Soc., vol. 33, No. 4, April 1954, p. 27.
[5] Lawson, A. C., Design Factors for Jewel-Bearing Systems: Machine Design, vol. 26, No. 4, April 1954, pp. 132–137.
[6] Berner, G. A., Jour. Suisse d'Horlog, January-February 1954, pp. 83–86.
[7] Kleeb, A. A., Watch Jewels of the Past: Gems and Gemology, vol. 8, No. 1, Spring 1954, pp. 3–15.
[8] Materials and Methods, Synthetic Sapphire Parts Resist Wear and Heat Corrosion: Vol. 9, No. 24, Dec. 15, 1954, p. 119.
[9] Design News, Swiss-American Jewel Bearings Co. Folder: Vol. 9, No. 24, Dec. 15, 1954, p. 119.

Kyanite and Related Minerals

By Brooke L. Gunsallus [1] and Frances P. Uswald [2]

KYANITE, sillimanite, andalusite, dumortierite, topaz, and synthetic mullite are discussed under the heading "Kyanite and Related Minerals," because of similarities in properties and end use. These minerals are aluminum silicates that may be used to produce mullite-containing refractories. The first three minerals in their pure form have the formula $Al_2O_3 \cdot SiO_2$ but differ in crystal structure; the formula for dumortierite is $8Al_2O_3 \cdot 6SiO_2 \cdot B_2O_3 \cdot H_2O$; the formula for topaz is $2Al_2O_3 \cdot 2Al(F,OH)_3 \cdot 3SiO_2$. All of these minerals, when heated to the proper temperatures, transform to mullite ($3Al_2O_3 \cdot 2SiO_2$) and silica (SiO_2). The mineral mullite rarely occurs in nature. As with all refractories, chemical composition of the raw material is not the only criterion of quality; mineralogical constitution and grain structure also are essential factors.

Domestic production of crude kyanite decreased 6 percent in 1954 from 1953. For several years no domestic production of other minerals in this group was reported.

As has been the case for several years, uncertainty of obtaining high-grade material from India influenced kyanite imports. Kyanite imports for consumption decreased 27 percent in 1954 from 1953 and 47 percent from 1952. The consumption of synthetic mullite in 1954 was estimated to be slightly less than in 1953.

Kyanite was removed from the list of critical and strategic minerals in 1954. The commercial development of synthetic mullite assures the United States of self-sufficiency in raw materials for mullite refractories.

DOMESTIC PRODUCTION

Kyanite was the only natural mullite-forming mineral produced in the United States in 1954.

In 1954 the kyanite production picture was similar to that in 1952 and 1953. All kyanite produced was recovered from disseminated ores. Demand for domestic kyanite concentrate is limited, as mullite produced from it is not suitable for the highest grades of refractories because of small grain size and low density. Domestic kyanite concentrate has been satisfactory for use in refractory cements and for purposes that require a relatively fine grained material.

For many years only two companies have produced kyanite in the United States: Commercialores, Inc., 39 Cortlandt St., New York, N. Y., from deposits at Henry Knob, near Clover, S. C.; and Kyanite Mining Corp., Cullen, Va., from a property on Baker Moun-

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

tain near Farmville, Prince Edward County, Va. The Bureau of Mines withholds production figures to prevent disclosure of individual operations.

CONSUMPTION AND USES

Domestic consumption of foreign and domestic kyanite and synthetic mullite during 1950–54 was about 30,000, 38,000, 40,000, 45,000, and 42,000 short tons, respectively.

Mullite was produced by calcining natural ores and by synthesis. Output was used almost entirely in the manufacture of superduty refractories. Mullite refractories represent only a small percentage of the total tonnage of refractories used in the United States, but they occupy an important position in that field because of their relatively high softening points and low coefficients of expansion and their resistance to loads at high temperatures, thermal shock, and corrosive action of certain fluxing agents. Although mullite refractories are relatively expensive, industry has found them profitable for certain superduty applications.

Mullite refractories are 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 is 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.

For a number of years about 50 percent of all mullite refracto ies have been 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 1954 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.

STOCKS

Stocks of imported kyanite at the end of 1954 were estimated to be 3,000 short tons, compared with 2,900 short tons in 1953.

PRICES

As reported by industry in December 1954, quotations on kyanite were as follows: Per short ton, f. o. b. point of shipment, Virginia and South Carolina, 35-mesh, carlots, in bulk, $35, in bags, $38; 200-mesh, in bags, carlots, $46. Quotations on imported kyanite (55- to 59-percent grade) in bags were $75 to $85 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 dobbies, in bulk, $140 per short ton; ground, in bags, minus 4- or minus 7-mesh, $160 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 1954, with 69 percent of the total compared with 63 percent in 1953 and 53 percent in 1952; Union of South Africa supplied 20 percent in

TABLE 1.—Kyanite and allied minerals imported (for consumption) into and exported from the United States, 1945–49 (average) and 1950–54

[U. S. Department of Commerce]

Imports

Year and origin	Short tons	Value
1945–49 (average)	13,568	$209,413
1950	17,417	587,819
1951	19,570	812,434
1952	9,057	390,557
1953		
Asia: India	4,155	184,293
Africa:		
Southern British Africa	858	22,477
Union of South Africa	1,607	80,919
Total	2,465	103,396
Grand total 1953	6,620	287,689
1954		
North America: Canada	7	360
Asia: India	3,322	151,371
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	196,609

Exports

Year and destination	Short tons	Value
1945–49 (average)	484	$25,435
1950	941	35,750
1951	990	43,762
1952	1,129	44,497
1953		
North America:		
Canada	586	24,036
Mexico	446	17,365
Total	1,032	41,401
Grand total 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

[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.

1954 compared with 24 percent in 1953 and 16 percent in 1952; and Southern British Africa supplied 9 percent in 1954 compared with 13 percent in 1953 and none in 1952. Total imports for 1954 decreased 27 percent compared with 1953. As in 1953, competition from synthetic mullite produced in the United States was partly responsible for the decline. Contributing to the decline was the continued uncertainty of obtaining supplies of high-grade massive kyanite from India.

TECHNOLOGY

During the last few years research by the Bureau of Mines and private industry, utilizing Western Hemisphere raw materials, has resulted in the development of synthetic mullite products equal or superior to those derived from high-grade Indian kyanite. Synthetic mullite is manufactured by sintering or fusing intimate mixtures of siliceous and aluminous materials to form products consisting principally of mullite.

The highest quality of synthetic mullite is produced by using Bayer-process alumina made from Caribbean bauxite and siliceous materials either by the fusing process or by sintering at high temperatures.

The suitability for refractories of all these raw materials, whether obtained from natural ores or from synthetic processing, depends on grain size and density, and can only be determined by the performance of the finished refractories under operating conditions.

Sintered synthetic mullite, a microcrystalline, granular product, is produced by sintering properly proportioned mixtures of aluminous and siliceous raw materials, such as bauxite, alumina, kaolin, kyanite concentrates, and flint or other forms of silica, in periodic or rotary kilns. The cost of sintered synthetic mullite has been comparable to that of mullite produced from imported kyanite. Most of the sintered synthetic mullite was produced from low-iron siliceous bauxite occurring in the southeastern United States.

A description of one of the accepted methods of producing sintered synthetic mullite follows: Domestic low-iron siliceous bauxite is ground, screened, pugged with water, and extruded through a die to form a column. The extruded column is cut into dobbies or slugs, which are calcined in periodic or rotary kilns. The calcined material is crushed, ground, and screened to specifications based on desired end products. The prepared material is bonded and formed into brick and shapes by power pressing. In most operations a few brick and shapes are formed by hand. After drying, the mullite brick and shapes can be fired in several types of kilns.

Sintered synthetic mullite was produced in the midwestern United States in a plant formerly used to manufacture high-grade fire-clay refractories. Any plant of this type can be converted at low cost to produce sintered synthetic mullite refractories. Some sintered synthetic mullite was produced as an additional product and on a small scale in other plants that formerly produced only high-grade refractory firebrick.

A completely fused material has been produced from exceptionally high quality raw materials in an electric-arc furnace. When crushed and sized, mullite produced by this process is a superior product because of its crystalline structure, uniform composition, and small content of impurities. The cost of fused synthetic mullite is much higher than the cost of sintered mullite or mullite produced by calcining imported lump kyanite, but for certain applications its superior properties have proved it to be economical.

A company in the eastern United States reported that it is producing a very good grade of sintered synthetic mullite, using mixtures of siliceous and aluminous materials. The dobbies are produced in the conventional way and fired in a pebble-type heat-exchange kiln with a capacity of 120 tons. The time required to set, fire, cool, and draw this kiln is about 1 month. The minimum temperature used in sintering is 3,200° F., using fuel oil. According to the chemical analysis reported and pyrometric-cone equivalent, this material approaches the range of Government specifications for electrically fused synthetic mullite.

The commercial development of synthetic mullite assures the United States of self-sufficiency in raw materials for mullite-refractories manufacture, and in 1954 kyanite was removed from the list of critical and strategic materials for stockpiling. The stockpile objective for kyanite was reached in 1952.

RESERVES

A small deposit of high-grade fibrous kyanite occurs on Willis Mountain in western Virginia. Reserves of high-grade lump kyanite were estimated at 5,000 tons. This represented about 1 month's supply for the United States at the 1954 rate of consumption. No other deposits of massive kyanite are known in the United States.

Reserves of massive Indian kyanite, 55 to 59 percent grade (Al_2O_3), were believed to be adequate for export requirements in the foreseeable future, but detailed information was not available.

In the opinion of the Federal Geological Survey, the reserves of disseminated kyanite ores in Virginia, North Carolina, South Carolina, and Georgia are of the order of tens of millions of tons of ore containing 20 to 30 percent kyanite.

Another potential source of fine-grained kyanite is the tailings from the concentration of monazite, zircon, rutile, and ilmenite from Florida beach sands, which are known to contain 20 to 30 percent of a mixture of kyanite and sillimanite associated with staurolite and small quantities of other minerals. Accumulation of these tailings from operations preceding 1954 was of the order of 40,000 tons of kyanite-sillimanite content, and the average rate of accumulation of tailings in 1954 was several hundred tons a month.

Industry and Government reports indicate that reserves of low-iron siliceous bauxite for producing synthetic mullite are sufficient to meet short-range requirements, provided that in an emergency production is allocated principally for production of mullite refractories. However, the adequacy of reserves to supply all potential refractory purposes may be questioned.

Deposits of sillimanite occur in Montana, Idaho, and elsewhere, but very little is known of the character and grade of the ore as a refractory raw material.

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WORLD REVIEW

Africa.—The history of the kyanite industry in Kenya was discussed.[4] In Union of South Africa, Pella Refractory Ores, Ltd., began regular production of massive corundum-sillimanite at Pella, near Kakamas, in Namaqualand. Production was about 400 to 600 long tons per month. A small quantity was sold locally, and the remainder was exported. Ore reserves of this operation were estimated to be approximately 400,000 long tons.[5]

Canada.—Investigation of a recently discovered Canadian occurrence of kyanite was continued in 1954 by the Industrial Minerals Division of the Department of Mines and Technical Surveys. The deposit is near Mattawa, Antoine, and Butler townships, Nipissing district, northern Ontario.[6]

India.—Although occurrences of natural sillimanite have been known in the States of Assam and Rewa for the past 30 years, mining was not begun on a commercial scale until 1948. According to the press, the sillimanite reserves in the Khasi Hills of Assam are around 250,000 short tons. In 1952 exports totaled 3,193 short tons; most of the sillimanite was shipped to the United Kingdom and West Germany. About 25 percent of the production comprised pieces large enough to yield fault-free sawn blocks of 1 cubic foot or more. These blocks were said to have a pyrometric-cone equivalent of about 36 (3,290° F.) and were used mostly to line glass tanks and high-temperature metallurgical furnaces. Sillimanite fragments not large enough for sawing into blocks were crushed at the quarry and graded into 3 sizes; 1-inch to 5-mesh, 5-mesh to 10-mesh, and 10-mesh to flour; all were used in the manufacture of high-temperature refractories.[7]

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[4] The Refractories Journal (London), vol. 30, No. 7, July 1954, pp. 288–291.

[5] Mining World, vol. 16, No. 10, September 1954, p. 89.
South African Mining and Engineering Journal, Johannesburg, S. A., vol. 64, No. 3184, February 1954, p. 890.

[6] Canadian Mining and Metallurgical Bulletin, Montreal, vol. 47, No. 509, September 1954, pp. 582–583.
Canadian Mining Journal, Quebec, vol. 75, No. 6, pp. 93–94.

[7] Dunbar, U. B. H., Sillimanite: Its Extraction and Use in India: Supplement to Capital, June 25, 1953 (daily newspaper), Calcutta, India.

Lead

By O. M. Bishop [1] and Edith E. den Hartog [2]

LEAD SUPPLIES in the United States continued well in excess of demand in 1954, and again this feature highlighted the domestic industry. Supplies from all sources—domestic mine production, secondary recovery, and imports—totaled 1,244,000 tons, a decrease of 133,000 tons from 1953, but still 149,000 tons more than the reported domestic consumption, excluding purchases for the National Strategic Stockpile. Domestic mine production and imports decreased 5 and 20 percent, respectively, but secondary lead output was nearly as large as in 1953. Domestic consumption of lead was fairly steady throughout 1954. Smelter stocks of refined lead, however, increased 50 percent from January 1 to May 31 and thereafter through December 31 declined 19 percent from the May 31 figure, owing largely to resumption of Strategic Stockpile purchases by the United States Government.

The quoted price of lead in New York at the beginning of 1954 was 13.50 cents per pound, but it dropped to 13.00 cents on January 18 and to 12.50 cents on February 18. Between March 9 and October 5 price movements of 0.25 and 0.125 cent, all upward except one, raised the price to 15.00 cents, which held through December. The average weighted yearly price was 13.70 cents compared with 13.10 cents in 1953.

Lead supply in 1954 consisted of 325,400 tons of recoverable lead from domestic mine production, 480,900 tons of secondary lead recovered from scrap, and 437,700 tons of imports (exclusive of imported scrap which normally goes to secondary smelting plants and is thus included in the scrap total). The total—1,244,000 tons—was 10 percent under the 1953 supply. Consumption of lead, including that in pigments and chemicals, totaled 1,095,000 tons compared with 1,202,000 tons in 1953. Producers' stocks of primary refined lead increased from 65,000 tons on December 31, 1953, to 78,900 tons on December 31, 1954, and primary antimonial lead stocks decreased from 14,400 tons to 13,300. Smelter stocks of ores and concentrates and base bullion decreased 28 percent, and consumers' stocks of metal increased from 113,800 tons to 124,600.

Domestic mine production of recoverable lead was 17,000 tons less than in 1953 and the lowest since 1934. Although some lead-zinc

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[2] Statistical assistant.

mines curtailed production early in 1954, the low output was mainly the outgrowth of production cutbacks and mine closings effected in 1952 and 1953, following material reductions in the prices of lead and zinc, which in most mines are coproducts. The average monthly mine production in 1954 (27,100 tons) was slightly higher than the average monthly rate in the latter half of 1953 (26,700 tons). Missouri, supplying 125,300 tons, or 38 percent of the total domestic mine output, was again much the largest lead-producing State. Idaho, with 69,300 tons (21 percent), and Utah, with 45,000 tons (14 percent), ranked second and third in quantity of output. Production in 12 of the 16 important producing States was lower than in 1953. The largest decreases, on a tonnage basis, were in California, Idaho, Montana, and Colorado. Kansas, Oklahoma, Utah, and Virginia were the only States producing more than 100 tons annually in which lead output increased.

Despite declines in domestic mine production and imports and no increase in secondary lead output, the total supply of lead in 1954 exceeded consumption by 12 percent. Although imports declined 20 percent from 1953, they still represented 35 percent of the total supply. The sustained high level of imports, with the depressed state of the domestic lead- (and zinc-) mining industry since the drop in metal prices in 1952, stimulated much study of various protective tariff proposals and other plans to aid the industry. The general investigation of all phases of the lead and zinc industries by the Tariff Commission begun in 1953, pursuant to resolutions adopted by congressional committees, was completed, and a report was submitted in April 1954.[3] Certain data abstracted from the report were published in the 1953 report of this series (Lead chapter, Minerals Yearbook 1953, volume I). Another report of the Tariff Commission, dated May 21, 1954, recommended that import duties on most lead and zinc materials be increased 50 percent above the rates in effect on January 1, 1945. The President did not accept the recommendations of the Tariff Commission but instead outlined, in a statement dated August 23, 1945, an expanded stockpiling program for strengthening the lead and zinc industry as an integral part of the Nation's defense-mobilization base. The resumption of Government purchases of lead and zinc for the long-range Strategic Stockpile in June had already been a factor in sustaining the price of lead and in halting the upward trend in smelter stocks.

[3] United States Tariff Commission, Lead and Zinc—Report on Investigation Conducted Under Section 332 of the Tariff Act of 1930 Pursuant to a Resolution by the Committee on Finance of the United States Senate, Dated July 27, 1953, and a Resolution by the Committee on Ways and Means, House of Representatives, dated July 29, 1953: April 1954, pts. I, II, III, IV, and V.

TABLE 1.—Salient statistics of the lead industry in the United States, 1945–49 (average) and the 1950–54, in short tons

	1945–49 (average)	1950	1951	1952	1953	1954
Production of refined primary lead:						
From domestic ores and base bullion	354, 963	418, 809	342, 644	383, 358	328, 012	322, 271
From foreign ores and base bullion	66, 402	89, 505	75, 049	89, 494	139, 879	164, 441
Total	421, 365	508, 314	417. 693	472, 852	467, 891	486, 712
Recovery of secondary lead	436, 010	482, 275	518, 110	471, 294	486, 737	480, 925
Imports (general):						
Lead in pigs, bars, and old	217, 959	461, 827	[2] 188, 175	523, 059	390, 510	281, 941
Lead in base bullion	2, 254	3, 488	2, 281	389	869	41
Lead in ores and matte	67, 246	76, 520	[2] 67, 471	104, 515	[2] 160, 899	161, 413
Exports of refined pig lead	979	2, 735	1, 281	1, 762	803	596
Consumption of primary and secondary lead	1, 054, 329	1, 237, 981	1, 184, 793	1, 130, 795	1, 201, 604	1, 094, 871
Prices (cents per pound):						
New York:						
Average for period	9. 14	13. 30	17. 49	16. 47	13. 48	14. 05
Quotation at end of period	13. 51	17. 00	19. 00	14. 12	13. 50	15. 00
London average for period	12. 60	13. 29	20. 25	17. 09	11. 48	12. 08
Mine production of recoverable lead [1]	382, 182	430, 827	388, 164	390, 162	342, 644	325, 419
World smelter production of lead	1, 400, 000	[2] 1,810, 000	[2] 1,770, 000	[2] 1,940, 000	[2] 2,010, 000	2, 120, 000

[1] Includes Alaska.
[2] Revised figure.

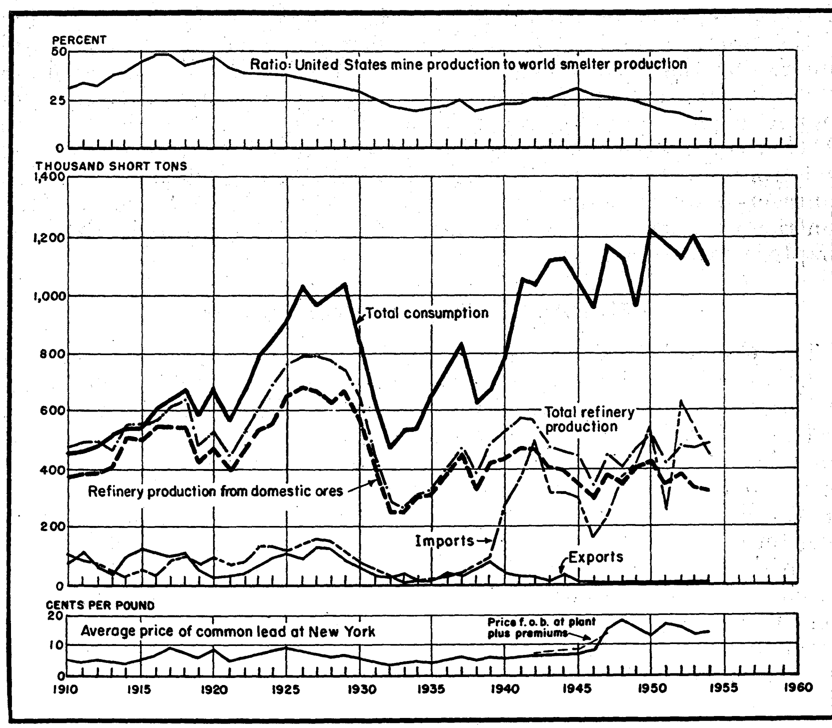

FIGURE 1.—Trends in the lead industry in the United States, 1910–54. Consumption includes primary refined, antimonial, and secondary lead and lead in pigments made directly from ore. Imports are factored to include 95 percent of lead content of ores, mattes, and concentrates and 100 percent of pigs, bars, base bullion, and scrap. Exports include lead that entered the United States under bond.

GOVERNMENT REGULATIONS

Export licenses continued to be required for exports of lead to all countries except Canada.

GOVERNMENT PROGRAMS UNDER THE DEFENSE PRODUCTION ACT OF 1950

Provisions of the Defense Production Act of 1950 with respect to exploration continued to be carried out by the Defense Minerals Exploration Administration (DMEA) and those with respect to procurement by the General Services Administration.

DEFENSE MINERALS EXPLORATION ADMINISTRATION

The DMEA program to encourage exploration and increase domestic reserves of strategic and critical minerals and metals was continued throughout 1954; but, inasmuch as lead and zinc were not on the list of metals eligible for the program from May 15, 1953, to March 23, 1954, the Government executed only four new exploration contracts for lead and zinc. These provided 50 percent of the approved cost of such programs for a maximum of $1,114,693. From the beginning of the program in 1951 through December 31, 1954, 197 lead- and zinc-exploration contracts were executed; these authorized a maximum Government participation of $8,729,329.[4] Lead-zinc and lead-zinc-copper exploration contracts in 1954 comprised 4 percent of all DMEA contracts executed and 36 percent of all the funds obligated and from the beginning through 1954 represented 28 percent of all contracts and 42 percent of the funds obligated. A list of DMEA contracts for lead and zinc exploration in 1954 is given in the Zinc chapter of this volume.

GENERAL SERVICES ADMINISTRATION

The General Services Administration (GSA) was responsible for developing expansion programs for metals, minerals, and certain other materials designed to meet objectives established by the Office of Defense Mobilization under the Defense Production Act of 1950, as amended, and for the negotiation and execution of all contracts under such programs. The scope of the stockpiling program was expanded in March 1954 when the President authorized establishment of new long-term metal and mineral stockpile objectives. The additional quantities of materials needed to meet the new objectives were to be purchased, wherever possible, from domestic producers, and purchases were to be spread over a considerable period. Preference was to be given to newly mined metals and minerals of domestic origin. The purchases would be timed to reactivate productive capacity and to

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[4] Includes sums provided through amendments to contracts and also funds for participation in exploration contracts that were subsequently canceled or terminated upon completion.

alleviate distressed economic conditions in domestic minerals industries. Stockpile objectives, which are the subject of a periodic review, were being studied by the Office of Defense Mobilization (ODM) in accordance with the new policy. After long-term objectives are established, ODM forwards purchase directives to GSA. Pursuant to this new program, GSA purchased lead and zinc each month from June through December 1954, in accordance with the purchase objectives.

No new contracts with foreign producers for obtaining lead under the Defense Production Act of 1950 were executed in 1954; some lead produced under contracts negotiated in preceding years was delivered.

DOMESTIC PRODUCTION [5]

Statistics on lead output may be prepared on a mine or a 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.

Comprehensive economic data on domestic production and the competitive position of the domestic lead and zinc industry with reference to foreign producers in 1952 and 1953, as well as on important changes that have taken place in the domestic industry since 1939, are provided in the report on the Tariff Commission covering its investigation of the lead and zinc industry made in 1953–54 in compliance with instructions from congressional committees. Considerable data abstracted from the report were published in the 1953 volume of this series (see Lead chapter, Minerals Yearbook 1953, volume I).

MINE PRODUCTION

Mine production of recoverable lead in the United States in 1954 decreased 5 percent from 1953 and followed a decline of 12 percent in 1953 from 1952. The 1954 output of 325,400 tons was the lowest since 1934. The decline was due mainly to cutbacks and mine closings in 1952 and 1953 caused by the sharp decline in the prices of lead and zinc in 1952 and the continuance of lower prices through 1953 and the first part of 1954. There was no significant upward or downward trend in the monthly lead-production rate during 1954; output in the last quarter was 3 percent less than in the first quarter but was almost the same as in the last quarter of 1953. Missouri, with 125,300 tons, Idaho, with 69,300 tons, and Utah, with 45,000 tons, together contributed 74 percent of the United States total mine output of lead in 1954. Production in Missouri was nearly the same as in 1953, that in Idaho decreased 7 percent, and that in Utah increased 8

[5] Data for 1954 were collected jointly with the Bureau of the Census (U. S. Department of Commerce). Production totals will be compared with the Census when they are available and differences adjusted or explained.

percent. Decreases were recorded in all other principal producing States except Oklahoma, Kansas, and Virginia. A brief review of domestic mine production by areas and major producing States and mines follows. Information in greater detail can be found in the State chapters of Minerals Yearbook, volume III.

Mines in the West Central States yielded 143,500 tons of recoverable lead in 1954, a 4-percent increase over 1953. The producing areas comprised the southeastern Missouri region and the Tri-State district (southwestern Missouri, northeastern Oklahoma, and southeastern Kansas); there was no lead production in Arkansas in either of the 2 years.

For the 47th consecutive year the southeastern Missouri lead belt was the major lead-producing district in the United States, and its output of 125,200 tons of recoverable lead in 1954 constituted 38 percent of the total domestic mine production. The St. Joseph Lead Co., largest producer of lead in the United States, operated its Bonne Terre, Desloge, Federal, and Leadwood mine-mill units and Doe Run and Hayden Creek mines in St. Francois County and its new Indian Creek unit in Washington County. The company also operated the Mine La Motte mine-mill unit in Madison County. The National Lead Co. continued to operate the Madison mine-mill unit at Fredericktown, also in Madison County.

TABLE 2.—Mine production of recoverable lead in the United States, 1945–49 (average) and 1950–54, by States, in short tons

State	1945–49 (average)	1950	1951	1952	1953	1954
Western States and Alaska:						
Alaska	154	149	21	1	9	
Arizona	27,766	26,383	17,394	16,520	9,428	8,385
California	9,331	15,831	13,967	11,199	8,664	2,671
Colorado	20,954	27,007	30,336	30,066	21,754	17,823
Idaho	75,044	100,025	76,713	73,719	74,610	69,302
Montana	14,159	19,617	21,302	21,279	19,949	14,820
Nevada	8,203	9,408	7,148	6,790	4,371	3,041
New Mexico	6,250	4,150	5,846	7,021	2,943	887
Oregon	7	17	2	1	5	5
South Dakota	6		2	2	10	
Texas	85	129	43	56		
Utah	46,049	44,753	50,451	50,210	41,522	44,972
Washington	5,142	10,334	8,002	11,744	11,064	9,938
Wyoming	1					
Total	213,151	257,803	231,227	228,608	194,329	171,844
West Central States:						
Arkansas	9	9	33	4		
Kansas	7,851	9,487	8,947	5,916	3,347	4,033
Missouri	135,549	134,626	123,702	129,245	125,895	125,250
Oklahoma	15,485	20,724	16,575	15,137	9,304	14,204
Total	158,894	164,846	149,257	150,302	138,546	143,487
States east of the Mississippi River:						
Illinois	3,343	2,729	3,160	4,262	3,391	3,232
Kentucky	168	66	107	60	52	80
New York	1,196	1,484	1,500	1,120	1,435	1,187
Tennessee	92	113	14	18	9	
Virginia	4,089	3,254	1,508	3,792	2,788	[1] 4,324
Wisconsin	1,249	532	1,391	2,000	2,094	[2] 1,265
Total	10,137	8,178	7,680	11,252	9,769	10,088
Grand total	382,182	430,827	388,164	390,162	342,644	325,419

[1] Includes 4 tons from North Carolina.
[2] Includes 4 tons from Iowa.

The Tri-State district mines yielded 18,300 tons of recoverable lead in 1954 compared with 13,300 tons in 1953. Nearly all the lead came from mines that produced zinc as the chief metal. There were 9 mills operating in the district in January 1954 and 7 at the end of the year. The mines and Central mill of the Eagle-Picher Co. (largest producer of lead and zinc in the district) resumed operations early in January after being idle since mid-June 1953 owing to a strike. The National Lead Co. reopened its Ballard mine-mill unit in May following a 6-month shutdown. The Quick Seven mine-mill operation of Brown & Root and the America Zinc, Lead & Smelting Co. was permanently closed in June because of depletion of ore reserves. About 60 mines were active in the district at the end of 1954 compared with about 20 at the beginning of the year.

The Western States together produced 171,800 tons of recoverable lead in 1954 compared with 194,300 tons in 1953. The decline was attributed chiefly to production-curtailment policies adopted in 1952–53 and apparently continued into 1954, as even in the last quarter of the year output was low despite an advance in price to 15 cents a pound. Usually lead is only one of several commercial metals in the western lead-bearing ores; and absence of an appreciable rise in the price of zinc, coupled with no change in the prices of gold and silver, was a factor in the continued lower rate of lead production.

Idaho and Utah together produced almost two-thirds of the total Western States output of lead in 1954. Idaho production decreased 7 percent from 1953 and was the smallest since 1946. The greatest drop took place at the Morning mine, Shoshone County, where large-scale production was terminated late in 1953 because of low metal prices, high operating costs, and ore depletion. There were few reports of additional mine closures. The work week at base-metal mines in the Coeur d'Alene region (which produced 94 percent of the Idaho lead), was reduced from 48 hours to 40 in February. Despite this curtailment, the output of lead for the year from the Bunker Hill, Star, and Frisco mines was about the same as in 1953. Because the market price of lead was higher than that of zinc throughout 1954, lead-zinc producers mined ores higher in lead content in preference to zinc, and zinc output decreased more than lead. The Bunker Hill mine was by far the largest lead-producing property, and the Star mine ranked second. Outside the Coeur d'Alene region the Triumph mine in Blaine County and the Clayton in Custer County were the principal producers. Idaho led other States in the number of lead-zinc exploration projects and amount of capital invested in such projects under DMEA contracts executed in 1953 and 1954. Utah was the only Western State where mine production of lead increased in 1954; the total was 45,000 tons or 8 percent above the 1953 output. The increase was due largely to greater output at the Chief No. 1 mine in the Tintic district and the resumption of operations in September at the United Park City Mines Co. group of mines in the Park City region. The United States & Lark mine in the West Mountain (Bingham) district was much the largest producer of lead in Utah. Other important producers included the Mayflower-Galena

(New Park) group in the Park City region and the West Calumet and Ophir mines in Tooele County.

Colorado ranked third among the Western States in lead production, but its output decreased 18 percent from 1953. The Idarado group of mines in San Miguel County was the largest producer; it was followed by the Eagle mine in Eagle County, Rico-Argentine property in Dolores County, Resurrection holdings in Lake County, and Emperius group of mines in Mineral County. The Smuggler Union-Montana group of mines near Telluride, formerly a substantial lead producer, was closed at the end of February 1954. Montana and Washington, ranking fourth and fifth, respectively, reported decreases of 26 and 10 percent. The prinicpal factors in Montana's decrease were the closing of two Anaconda Copper Mining Co. Butte mines before August and a strike which closed the rest of the company Butte mines from August 23 to October 15. Among the important producers outside the Butte district were the Jack Waite mine in Sanders County, Maulden (Hand) in Beaverhead County, Algonquin and Scratch Awl in Granite County, and January in Broadwater County. Washington's drop in lead production resulted from the idleness of the Deep Creek mine in Stevens County from January to May because of low metal prices and the closing of the Grandview mine, Pend Oreille County, by a strike from August through December. Production increased at the Pend Oreille (Pend Oreille County) and Van Stone (Stevens County) mines, the State's other large producers.

Lead production in Arizona dropped for the fifth consecutive year and was 11 percent less than in 1953. The Iron King mine in Yavapai County continued to be the largest producer. The only other steady producers were the Flux mine in Santa Cruz County and Athletic in Graham County. In California the 69-percent decrease resulted from closing of the Darwin group of mines (Inyo County) at the end of February. Nevada's 30-percent decrease resulted from diversion of more of the Combined Metals Reduction Co. Caselton mill capacity to manganese-lead-zinc ores at the expense of lead-zinc ores owing to the continued low prices of zinc and lead. The output of lead in New Mexico in 1954 was only 900 tons, the smallest since 1921 and a 70-percent decrease from 1953. Most of the 1954 output came from the Portales and Mex-Tex lead mines in Socorro County. All the zinc-lead mines in the State were idle throughout 1954.

Six States east of the Mississippi River contributed to the mine output of lead in 1954; their combined production was 10,100 tons, nearly all recovered from ores yielding chiefly zinc or fluorspar and zinc. Output in Virginia, the principal producer during the year, increased 55 percent over 1953 owing mainly to higher lead content in the ore mined at the Austinville mine in Wythe County. This increase more than offset declines in the other important producing States and led to a 3-percent overall increase for the 6 States. Producers of substantial quantities of lead, besides the Austinville mine, were the Vinegar Hill Zinc Co., Tri-State Zinc, Inc., Calumet & Hecla, Inc., and Eagle-Picher Co. in the northern Illinois-southwestern Wisconsin region and the Balmat mine of the St. Joseph Lead Co. in New York. Output was reduced in the Illinois-Kentucky fluorspar-zinc district as a result of a decline in fluorspar mining, from which the lead is recovered as a byproduct. The Ozark-Mahoning Co. suspended operations at its mines for several months, the Rosiclare Fluorspar & Lead Mining Co. ceased operation March 1, and Minerva Oil Co. reduced its work schedule to half-time early in the year.

TABLE 3.—Mine production of recoverable lead in the United States, 1945–49 (average) and 1950–54, by districts that produced 1,000 tons or more during any year, 1950–54, in short tons

District	State	1945–49 (average)	1950	1951	1952	1953	1954
Southeastern Missouri region	Missouri	133,048	133,680	122,318	122,942	125,273	125,173
Coeur d'Alene region	Idaho	69,955	94,697	70,570	67,330	69,885	64,812
West Mountain (Bingham)	Utah	24,900	27,472	29,120	34,328	29,311	29,671
Tri-State (Joplin region)	Kansas, southwestern Missouri, Oklahoma.	25,788	31,157	26,906	27,356	13,273	18,314
Summit Valley (Butte)	Montana	8,113	15,679	16,630	16,153	16,767	11,516
Metaline	Washington	3,501	7,445	5,234	(1)	8,694	(1)
Tintic	Utah	5,596	6,520	5,553	4,279	3,590	5,926
Upper San Miguel	Colorado	3,202	7,780	8,008	7,657	7,440	5,574
Park City region	Utah	9,906	7,538	11,719	7,494	4,735	5,432
Big Bug	Arizona	2,493	4,357	4,035	4,135	4,339	4,336
Austinville	Virginia	4,084	3,254	1,508	3,792	2,788	4,320
Upper Mississippi Valley	Iowa, northern Illinois, Wisconsin.	1,958	1,801	1,923	3,532	3,688	3,229
Red Cliff	Colorado	981	2,110	4,274	3,980	2,500	2,588
Rush Valley & Smelter (Tooele County).	Utah	3,519	1,393	2,674	2,595	2,753	2,454
Warm Springs	Idaho	1,904	2,648	3,086	3,455	2,583	2,415
Creede	Colorado	498	1,422	1,167	1,513	1,696	2,178
Pioneer (Rico)	do	2,095	1,138	2,231	2,230	1,871	2,177
Harshaw	Arizona	1,339	1,931	1,668	1,921	2,104	2,135
California (Leadville)	Colorado	4,717	6,392	5,996	5,624	3,072	1,935
Coso (Darwin)	California	6,096	8,479	7,191	(1)	8,269	(1)
Bayhorse	Idaho	1,369	1,679	1,732	1,091	1,484	1,372
Kentucky-southern Illinois	Kentucky-southern Illinois.	2,802	1,526	2,516	2,790	1,849	1,348
Northport (Aladdin)	Washington	469	237	937	(1)	2,165	1,275
Ophir	Utah	624	948	712	999	1,157	1,159
Sneffels	Colorado	816	866	1,094	1,044	1,307	1,113
Breckenridge	do	153	347	246	499	1,056	1,000
Pioche	Nevada	4,442	6,761	4,751	4,632	3,306	(1)
Aravaipa	Arizona	793	1,498	1,294	865	-------	812
Hansonberg	New Mexico	29	451	753	847	1,031	800
Magdalena	do	1,698	926	1,004	1,046	-------	47
Central	do	3,649	2,315	3,133	4,486	1,460	5
Warren (Bisbee)	Arizona	11,766	7,790	1,606	1,828	-------	4
Old Hat	do	5,361	5,980	4,241	3,913	-------	3
Pima (Sierritas, Papago, Twin Buttes).	do	3,083	2,996	2,834	1,864	-------	1
St. Lawrence County	New York	1,196	1,484	1,497	1,120	1,435	------
Animas	Colorado	2,576	3,069	3,963	3,464	1,212	------
Eagle	Montana	617	1,013	(1)	733	1,179	------
Bossburg	Washington	1,000	2,640	1,768	(1)	168	------
Heddleston	Montana	2,438	930	1,398	1,251	-------	------
Tomichi	Colorado	1,033	645	761	739	-------	------
Ten Mile	do	2,101	910	6	8	-------	------
Resting Springs	California	(1)	(1)	(1)	(1)	-------	------

1 Figure not shown to avoid disclosure of individual company operations.

TABLE 4.—Twenty-five leading lead-producing mines in the United States in 1954, 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	Bunker Hill & Sullivan Mining & Concentrating 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	Anaconda Copper Mining Co	Lead-zinc.
6	Mine La Motte	Southeastern Missouri	Missouri	St. Joseph Lead Co	Lead.
7	Pend Oreille	Metaline	Washington	Pend Oreille Mines & Metals Co	Lead-zinc.
8	Star	Hunter	Idaho	Sullivan Mining Co	Do.
9	Bonne Terre	Southeastern Missouri	Missouri	St. Joseph Lead Co	Lead.
10	Desloge	do	do	do	Do.
11	Page	Yreka	Idaho	American Smelting & Refining Co	Lead-zinc.
12	Treasury Tunnel-Black Bear	Upper San Miguel	Colorado	Idarado Mining Co	Do.
13	Madison	Southeastern Missouri	Missouri	National Lead Co	Lead-copper.
14	Chief	Tintic	Utah	Chief Consolidated Mining Co	Lead-zinc.
15	Iron King	Big Bug	Arizona	Shattuck-Denn Mining Co	Do.
16	Austinville	Austinville	Virginia	New Jersey Zinc Co	Zinc-lead.
17	Indian Creek	Southeastern Missouri	Missouri	St. Joseph Lead Co	Lead.
18	Mayflower-Galena	Blue Ledge	Utah	New Park Mining Co	Lead-zinc.
19	Frisco	Lelande	Idaho	American Smelting & Refining Co	Do.
20	Sunshine	Evolution	do	Sunshine Mining Co	Silver.
21	Morning	Hunter	do	American Smelting & Refining Co	Lead-zinc.
22	Bunker Hill smelter	Yreka	do	Bunker Hill & Sullivan Mining & Concentrating Co	Slag.
23	Eagle	Redcliff (Battle Mountain)	Colorado	The New Jersey Zinc Co	Zinc-silver.
24	Dayrock	Placer Center	Idaho	Day Mines, Inc	Lead.
25	Triumph	Warm Springs	do	Triumph Mining Co	Lead-zinc.

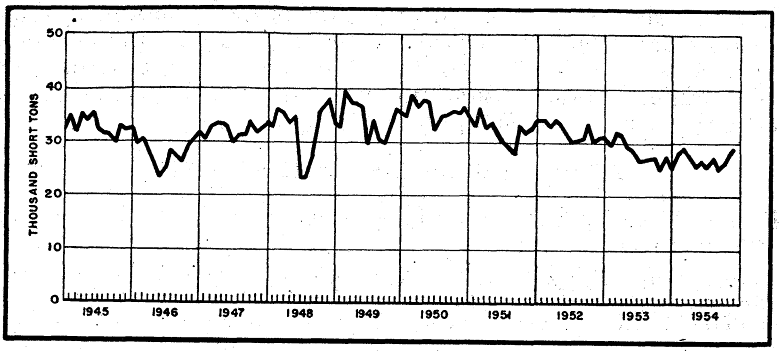

FIGURE 2.—Mine production of recoverable lead in the United States, 1945–54, by months.

TABLE 5.—Mine production of recoverable lead in the United States,[1] 1953–54, by months, in short tons

Month	1953	1954	Month	1953	1954
January	31,073	25,289	August	26,531	27,480
February	29,861	28,002	September	26,934	25,370
March	31,780	29,908	October	27,225	26,135
April	31,490	27,259	November	25,154	28,314
May	29,507	25,793	December	27,455	29,449
June	28,797	26,658			
July	26,837	25,762	Total	342,644	325,419

[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 ores and base bullion, and scrap materials (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. Of the 13 primary lead plants in the United States, 6 combined smelting and refining operations, 5 produced only base bullion (containing approximately 98 percent lead plus gold and silver and small quantities of other impurities recovered from the ores smelted), and 2 confined their activities to refining. 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.

The 11 primary smelters in operation in 1954 consumed 485,500 short tons (lead content) of primary materials in the form of ores and concentrates, of which 66 percent was of domestic and 34 percent of foreign origin. Total consumption was 2 percent higher than in 1953 but 3 percent under consumption in 1952.

ACTIVE LEAD SMELTERS AND REFINERIES

Primary lead smelters and refineries operating in the United States in 1954 were as follows:

California: Selby—Selby plant, American Smelting & Refining Co. (smelter and refinery).
Colorado: Leadville—Arkansas Valley plant, American Smelting & Refining Co. (smelter).
Idaho: Bradley—Bunker Hill Smelter, Bunker Hill & Sullivan Mining & Concentrating Co. (smelter and refinery).
Illinois: Alton—Federal plant, American Smelting & Refining Co. (smelter and refinery).
Indiana: East Chicago—U. S. S. Lead Refinery, Inc. (refinery).
Kansas: Galena—Galena plant, Eagle-Picher Co. (smelter and refinery).
Missouri: Herculaneum—Herculaneum plant, St. Joseph Lead Co. (smelter and refinery).
Montana: East Helena—East Helena plant, American Smelting & Refining Co. (smelter).
Nebraska: Omaha—Omaha plant, American Smelting & Refining Co. (refinery).
New Jersey: Barber—Perth Amboy plant, American Smelting & Refining Co. (smelter and refinery).
Texas: El Paso—El Paso plant, American Smelting & Refining Co. (smelter).
Utah:
- Midvale—Midvale plant, United States Smelting, Refining & Mining Co. (smelter).
- Tooele—Tooele plant, International Smelting & Refining Co. (smelter).

Slag-fuming plants, to recover zinc and some lead from both hot slag from current smelting activity and cold slag from slag dumps, were operated at the following smelters:

California: Selby—American Smelting & Refining Co.
Idaho: Kellogg—Bunker Hill & Sullivan Mining & Concentrating Co.
Montana: East Helena—Anaconda Copper Mining Co.
Texas: El Paso—American Smelting & Refining Co.
Utah: Tooele—International Smelting & Refining Co.

Work undertaken by the St. Joseph Lead Co. to expand the capacity of its Herculaneum (Mo.) smelter to 100,000 tons of pig lead annually was completed in 1954. According to the company annual report for 1954, output during the year rose to 91,736 tons from 65,899 tons in 1953. The new electrothermic zinc slag furnace at the Herculaneum lead smelter was nearing completion in 1954 and was expected to be put in operation in March 1955.

REFINED LEAD

Primary refineries in the United States produced 491,800 short tons of refined lead in 1954, an increase of 4 percent over 1953 production.

Of the 486,700 tons of refined lead that came from primary sources, 66 percent was from domestic ores and base bullion and 34 percent from imported ores and bullion (70 and 30 percent, respectively, in 1953 and 81 and 19 percent in 1952). 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, 1945–49 (average) and 1950–54, by source material, in short tons

Source	1945–49 (average)	1950	1951	1952	1953	1954
Refined lead:						
From domestic ores and base bullion	354, 964	418, 809	342, 644	383, 358	328, 012	322, 271
From foreign ores	64, 760	86, 241	71, 984	89, 092	139, 711	164, 353
From foreign base bullion	1, 641	3, 264	3, 065	402	168	88
Total from primary sources	421, 365	508, 314	417, 693	472, 852	467, 891	486, 712
From scrap	14, 076	5, 455	3, 893	3, 070	4, 211	5, 066
Total refined lead	435, 441	513, 769	421, 586	475, 922	472, 102	491, 778
Average sales price per pound	$0. 126	$0. 135	$0. 173	$0. 161	$0. 131	$0. 137
Total calculated value of primary refined lead [1]	$107, 232, 000	$137, 245, 000	$144, 522, 000	$153, 247, 000	$122, 587, 000	$133, 359, 000

[1] Excludes value of refined lead produced from scrap at primary refineries.

TABLE 7.—Refined primary lead produced in the United States, 1945–49 (average) and 1950–54, by source material and country of origin, in short tons

Source	1945–49 (average)	1950	1951	1952	1953	1954
Domestic ore and base bullion	354, 963	418, 809	342, 644	383, 358	328, 012	322, 271
Foreign ore:						
Australia	9, 753	6, 984	9, 056	5, 888	19, 886	17, 311
Canada	5, 330	7, 892	7, 986	7, 113	26, 673	47, 150
Europe	15		17	454	199	865
Mexico	4, 716	5, 992	3, 620	2, 344	5, 876	16, 790
South America	21, 579	38, 770	36, 849	48, 625	50, 828	58, 341
Other foreign	23, 368	26, 603	14, 456	24, 668	36, 249	23, 896
Total	64, 761	86, 241	71, 984	89, 092	139, 711	164, 353
Foreign base bullion:						
Australia	370	2, 427	2, 815			
Mexico	1, 155	435	27	70	42	
South America	57	402	75	177	126	88
Other foreign	59		148	155		
Total	1, 641	3, 264	3, 065	402	168	88
Total foreign	66, 402	89, 505	75, 049	89, 494	139, 879	164, 441
Grand total	421, 365	508, 314	417, 693	472, 852	467, 891	486, 712

ANTIMONIAL LEAD

Primary lead refiners produced 59,900 tons of antimonial lead in 1954, a 4-percent decrease from 1953 production. Two of the five producing plants increased production, but output from the other three was considerably lower.

Although antimonial lead is an important byproduct of the refining of base bullion, the quantity derived from this source was only a small part of the total domestic output. The major production was recovered from the smelting of antimonial lead scrap at secondary smelters. Production data from lead-smelting plants treating scrap materials exclusively are summarized in the following section.

TABLE 8.—Antimonial lead produced at primary lead refineries in the United States, 1945–49 (average) and 1950–54

Year	Production (short tons)	Antimony content		Lead content by difference (short tons)			
		Short tons	Percent	From domestic ore	From foreign ore	From scrap	Total
1945–49 (average)	67,043	4,302	6.4	12,714	7,046	42,981	62,741
1950	57,959	4,504	7.8	10,728	4,344	38,383	53,455
1951	65,309	4,416	6.7	17,372	9,218	34,303	60,893
1952	58,203	4,392	7.5	12,993	5,673	35,145	53,811
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

SECONDARY LEAD

Some scrap lead is treated at primary smelters, but the greater part is processed at a large number of plants that specialize in treating secondary materials. Secondary lead is recovered in the form of refined lead, antimonial lead, and other alloys.

Recovery of secondary lead in 1954 totaled 480,900 tons, a 1-percent decrease from the 486,700 tons recovered in 1953, and was the largest single source of supply. Lead reclaimed as metal and in alloys exceeded domestic mine production for the ninth successive year and was also greater than imports of lead. Data on lead recovered in 1950–54, by type of plant, are shown in table 9. Detailed information on secondary lead appears in the Secondary Metals—Nonferrous chapter of this volume.

TABLE 9.—Secondary lead recovered in the United States, 1945–49 (average) and 1950–54, in short tons

	1945–49 (average)	1950	1951	1952	1953	1954
As refined metal:						
At primary plants	14,076	5,455	3,893	3,070	4,211	5,066
At other plants	92,096	123,858	165,023	137,032	122,363	114,941
Total	106,172	129,313	168,916	140,102	126,574	120,007
In antimonial lead:						
At primary plants	42,980	38,383	34,303	35,145	36,749	43,555
At other plants	171,018	187,257	195,660	187,806	199,806	195,284
Total	213,998	225,640	229,963	222,951	236,555	238,839
In other alloys	115,840	127,322	119,231	108,241	123,608	122,079
Grand total:						
Short tons	436,010	482,275	518,110	471,294	486,737	480,925
Value	$113,631,175	$130,214,250	$179,266,060	$151,756,668	$127,525,094	$131,773,450

LEAD PIGMENTS

The principal lead pigments were litharge, white lead, red lead, sublimed lead, leaded zinc oxide, and orange mineral. These products were manufactured for the most part from metal, but some ore and concentrate were converted directly into pigments. Details of the production of lead pigments are given in the Lead and Zinc Pigments and Zinc Salts chapter of this volume.

CONSUMPTION AND USES

Domestic lead consumption (including lead in lead ore consumed directly in manufacturing lead pigments and salts) totaled 1,095,000 tons in 1954, a 9-percent decrease from 1953. Of the total consumed, 712,900 tons was refined soft lead (including both primary and secondary refined lead); 263,300 tons was contained in antimonial lead (the greater part of which was secondary), 23,400 tons in unmelted white scrap, 41,800 tons in percentage metals, 20,600 tons in copper-base scrap, and 25,000 tons in drosses and residues; and 8,000 tons was recovered from ore in leaded zinc oxide. About 41 percent of all lead consumed was used in metal products (excluding storage batteries), 31 percent in storage batteries, 10 percent in pigments, 15 percent in chemicals (including tetraethyl lead), and 3 percent in miscellaneous uses. Production of the three largest lead-consuming items—batteries, tetraethyl fluid, and cable coverings—took 31, 15, and 12 percent, respectively, a total of 58 percent of all lead consumed in 1954. Lead used for cable covering decreased 13 percent, in batteries 8 percent, and in tetraethyl lead 1 percent.

Shipments of automotive replacement batteries during 1954 were down slightly to 23,147,000 units from 23,613,000 units in 1953, according to the Association of American Battery Manufacturers, Inc.[6]

TABLE 10.—Consumption of lead in the United States, 1953–54, by products, in short tons

	1953	1954		1953	1954
Metal products:			Pigments:		
Ammunition	45,147	40,206	White lead	17,775	17,704
Bearing metals	38,591	27,166	Red lead and litharge	88,649	76,472
Brass and bronze	26,203	20,147	Pigment colors	12,859	14,062
Cable covering	146,565	127,939	Other [1]	10,307	8,171
Calking lead	48,236	49,854	Total	129,590	116,409
Casting metals	12,906	10,969			
Collapsible tubes	11,583	10,736	Chemicals:		
Foil	4,410	4,448	Tetraethyl lead	162,443	160,436
Pipes, traps, and bends	28,693	26,832	Miscellaneous chemicals	6,976	6,748
Sheet lead	30,476	26,014			
Solder	78,743	71,122	Total	169,419	167,184
Terne metal	3,200	1,286			
Type metal	26,729	25,665	Miscellaneous uses:		
			Annealing	5,280	4,653
Total	501,482	442,384	Galvanizing	2,029	2,732
			Lead plating	987	872
			Weights and ballast	8,244	7,393
Storage batteries:					
Antimonial lead	191,753	174,447	Total	16,540	15,650
Lead oxides	175,822	162,825	Other, unclassified uses	16,998	15,972
Total	367,575	337,272	Grand total	1,201,604	1,094,871

[1] Includes lead content of leaded zinc oxide production.

[6] American Metal Market, vol. 62, No. 23, Feb. 2, 1955, p. 6.

TABLE 11.—Consumption of lead in the United States 1953–54, by months, in short tons [1]

Month	1953	1954	Month	1953	1954
January	96,377	90,815	August	109,943	96,763
February	92,121	83,345	September	105,565	95,348
March	103,336	93,323	October	104,716	91,002
April	104,816	93,844	November	89,944	90,433
May	101,282	91,804	December	85,474	90,222
June	108,534	96,027			
July	99,496	81,945	Total	1,201,604	1,094,871

[1] Includes lead content of leaded zinc oxide production.

TABLE 12.—Consumption of lead in the United States in 1954, by classes of product and types of material, in short tons

	Soft and antimonial lead	Scrap, percentage metal, drosses, etc.	Total
Metal products	335,439	106,945	442,384
Storage batteries	335,533	1,739	337,272
Pigments	108,168	272	108,440
Chemicals	167,184		167,184
Miscellaneous	15,506	144	15,650
Unclassified	14,348	1,624	15,972
Total	976,178	110,724	[1] 1,086,902

[1] Excludes 7,969 tons of lead contained in leaded zinc oxide.

TABLE 13.—Lead consumption, distributed by States, in 1954, in short tons [1]

State	Refined soft lead	Antimonial lead	Unmelted white scrap	Percentage metals	Copper-base scrap	Drosses, residues, etc.	Total
Alabama	221				489		710
California	40,308	21,227	2,291	548	1,093	1,793	67,260
Colorado	1,240	584	961	217	212	288	3,502
Connecticut	15,257	9,635	194	5	1,051		26,142
District of Columbia	92	24					116
Florida	343	1,109					1,452
Georgia	13,686	5,728	175	2,166	100	2,748	24,603
Illinois	85,843	25,094	3,787	15,690	2,988	3,789	137,191
Indiana	49,120	32,494	2,739	2,091	969	2,197	89,610
Iowa	36	218					254
Kansas	1,883	3,538	9	209	509		6,148
Kentucky	199	100					299
Maryland	27,569	9,453	636	2,655	115	42	40,470
Massachusetts	7,272	2,458	1,405	1,539	678		13,352
Michigan	10,987	9,616	9	1,672	784	12	23,080
Minnesota	1,012	7,455		1,008	263	1,252	10,990
Missouri	45,306	2,906	332	1,756	1,433	28	51,761
Nebraska	12,266	1,087			123		13,476
New Jersey	123,371	40,805	1,042	569	635	8,040	174,462
New York	46,148	7,597	1,358	2,241	1,232	19	58,595
Ohio	22,165	15,006	3,018	3,073	1,989	603	45,854
Pennsylvania	41,156	25,085	3,529	1,672	2,667	4,013	78,122
Rhode Island	4,484	76		105			4,665
Tennessee	698	4,398		355	386	14	5,851
Virginia	1,106	1,621		1,011	1,187	4	4,929
Washington	8,452	968		20		3	9,443
West Virginia	15,711	2,127		355			18,193
Wisconsin	584	21,034	34	263	413		22,328
Louisiana and Texas	125,831	7,213	421	1,135	407	102	135,109
Montana and Idaho	5,575	3					5,578
Oregon and Hawaii	719	1,840	9	209	253		3,030
Utah and Nevada	85	50					135
Arkansas and Oklahoma	2,359	2,687			53		5,099
North and South Carolina	173					2	175
New Hampshire, Maine, and Delaware	1,662	23	1,425	1,254	507	47	4,918
Total	712,919	263,259	23,374	41,818	20,536	24,996	1,086,902

[1] Excludes lead content of leaded zinc oxide production.

Table 13 shows consumption of lead by States and by types of lead consumed. In consumption of all grades, New Jersey used 16 percent of the total, Illinois 13 percent, Indiana 8 percent, Pennsylvania 7 percent, and California 6 percent—a total of 50 percent consumed in 5 of the leading lead-consuming States.

STOCKS

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 of the refiners of secondary metal who produce soft lead. Supply (1,244,000 tons) continued to exceed consumption (1,095,000 tons), and stocks continued to rise. Stocks of lead in process and in finished lead increased from 196,300 tons in 1953 to 201,900 tons in 1954, or 3 percent.

TABLE 14.—Stocks of lead at smelters and refineries in the United States at end of year, 1945–49 (average) and 1950–54, in short tons

[American Bureau of Metal Statistics]

	1945–49 (average)	1950	1951	1952	1953	1954
Refined pig lead	36,493	28,894	18,518	31,405	65,036	77,930
Antimonial lead	8,077	6,725	6,821	12,155	16,116	14,789
Total	44,570	35,619	25,339	43,560	81,152	92,719
Lead in base bullion:						
At smelters and refineries	10,157	11,993	11,315	17,583	17,920	18,170
In transit to refineries	4,609	4,959	3,909	3,105	2,867	1,723
In process at refineries	16,193	15,341	15,700	19,759	26,713	27,164
Total	30,959	32,293	30,924	40,447	47,500	47,057
Lead in ore and matte and in process at smelters	90,070	69,757	67,817	65,771	67,688	62,074
Grand total	165,599	137,669	124,080	149,778	196,340	201,850

Figures reported to the Bureau of Mines in its annual survey of smelters and refiners 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 with the figures in table 14. Bureau reports indicated stocks of 78,900 tons of refined lead on December 31, 1954, compared with 65,000 tons on January 1. Stocks of antimonial lead at primary plants decreased from 14,400 tons to 13,300 during the year. Stocks of lead in ore and concentrates also decreased, dropping from 43,700 tons (lead content) to 29,900 tons, and stocks of base bullion at refineries that receive bullion and smelters that produce bullion for shipment to refineries decreased from 18,200 tons to 15,900 tons.

Consumers' Stocks.—In 1954, consumers' stocks of lead increased 10 percent over 1953—from 113,800 tons to 124,600 tons. Stocks of refined lead, antimonial lead, percentage metals and the drosses increased 8, 18, 18, and 10 percent, respectively, with stocks of unmelted white scrap down 11 percent and lead in copper-base scrap down 4 percent.

TABLE 15.—Consumers' stocks of lead in the United States at end of year, 1950–54, 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
1950	87,285	27,737	5,406	6,446	1,558	11,452	139,884
1951	56,731	28,221	3,140	7,054	1,429	6,185	102,760
1952	80,888	20,309	3,877	6,191	2,282	8,983	122,530
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

PRICES

Prices.—The two major markets for lead in the United States were New York and St. Louis. The bulk of the lead produced domestically was sold at prices normally based upon quotation in these markets. The differential between St. Louis and New York prices was about 0.2 cent a pound, an amount approximating the freight charges between the two cities, the St. Louis price being the lower.

The market quotation for common lead, New York, was 13.50 cents a pound at the beginning of the year, but subsequent price cuts on January 18 and February 18 brought it to 12.50 cents. Thereafter, however, in a series of ¼- and ⅛-cent increases, the price advanced to 15.00 cents on October 5 and remained there for the balance of the year. Price increases were attributed chiefly to Government purchases of lead for the new long-term stockpile and the anticipation of such purchases.

The London free lead market operated throughout the year. Quotations on the Metal Exchange ranged from a low of £80¾ per long ton (equivalent to 10.14 cents per pound computed on the 281.29 cents per £ base) on February 19 to a high of £111¼ per long ton (13.89 cents per pound) on October 6. The year ended with the bid price quoted at £106½.

TABLE 16.—Average monthly and yearly quoted prices of lead at St. Louis, New York, and London, 1952–54, in cents per pound [1]

Month	1952			1953			1954		
	St. Louis	New York	London [2]	St. Louis	New York	London [2] [3]	St. Louis	New York	London [2] [3]
January	18.80	19.00	21.73	13.99	14.19	12.51	13.05	13.25	10.85
February	18.80	19.00	21.10	13.30	13.50	11.86	12.62	12.82	10.39
March	18.80	19.00	20.82	13.20	13.40	11.46	12.73	12.93	10.85
April	18.72	18.92	20.43	12.44	12.64	10.34	13.71	13.91	11.77
May	15.53	15.73	17.18	12.55	12.75	10.32	13.80	14.00	11.88
June	15.06	15.26	16.26	13.21	13.41	11.14	13.91	14.11	12.26
July	15.80	16.00	16.53	13.48	13.68	11.71	13.80	14.00	12.04
August	15.80	16.00	16.30	13.80	14.00	11.98	13.86	14.06	12.17
September	15.80	16.00	16.27	13.54	13.74	11.68	14.40	14.60	12.67
October	14.20	14.40	[3] 11.28	13.30	13.50	11.59	14.77	14.97	13.57
November	13.98	14.18	[3] 11.69	13.30	13.50	11.82	14.80	15.00	13.48
December	13.92	14.12	[3] 12.20	13.30	13.50	11.34	14.80	15.00	12.97
Average	16.27	16.47	16.82	13.28	13.48	11.48	13.85	14.05	12.08

[1] St. Louis: Metal Statistics, 1955, p. 533. New York: Metal Statistics, 1955, p. 527. London: E&MJ Metal and Mineral Markets.

[2] Conversion of English quotations into American money based on average rates of exchange recorded by Federal Reserve Board.

[3] Average of daily mean of bid-and-asked quotations, at morning session of London Metal Exchange.

FOREIGN TRADE [7]

Imports.—General imports of lead decreased to 443,400 tons in 1954 compared with 552,300 tons in 1953 and the record high of 628,100 tons in 1952. Despite the decreased imports, the surplus of lead over commercial demand in the United States continued but was reduced materially by deliveries to the Government for the new long-range stockpile. The quantity of lead imported in ores, flue dust, and matte was virtually the same as in 1953 (totaling 161,400 short tons), but that in pigs and bars (276,300 tons) decreased 28 percent; the overall decrease was 20 percent. Of the lead contained in ores, flue dust, and matte, Canada supplied 25, Peru 24, Union of South Africa 22, Australia 13, Bolivia 9, and other countries (mainly Guatemala, Mexico, Philippines, and Honduras) 7 percent. Of the pigs and bars, Mexico furnished 25, Canada 22, Australia (Oceania) 21, Yugoslavia 14, Peru 7, French Morocco 6, and others 5 percent.

TABLE 17.—Total lead imported into the United States in ore, matte, base bullion, pigs, bars, and reclaimed, by countries, 1945–49 (average) and 1950–54, in short tons, in terms of lead content [1]

[U. S. Department of Commerce]

Country	1945–49 (average)	1950	1951	1952	1953	1954
Ore, flue dust or fume, and matte:						
North America:						
Canada	4,658	9,452	7,252	12,048	39,242	40,617
Newfoundland and Labrador	11,963					
El Salvador	117	417	286	126	----------	----------
Guatemala	570	325	3,169	4,721	5,391	2,703
Honduras	105	412	381	595	1,090	1,636
Mexico	3,040	2,846	2,525	2,497	3,443	2,167
Other North America	69	72	28	(2)	----------	(2)
Total	20,522	13,524	13,641	19,987	49,166	47,123
South America:						
Bolivia	10,649	13,336	15,989	18,473	18,984	14,946
Chile	2,979	2,605	1,945	3,197	3,341	173
Peru	10,742	16,010	16,946	28,213	32,842	38,734
Other South America	1,733	453	36	92	345	466
Total	26,103	32,404	34,916	49,975	55,512	54,319
Europe	27	83	12	425	----------	696
Asia:						
Korea, Republic of	153	1	----------	58	----------	----------
Philippines	64	949	789	2,446	2,980	2,160
Other Asia	123	54	30	160	92	----------
Total	340	1,004	819	2,664	3,072	2,160
Africa:						
French Morocco	1,837	----------	----------	----------	2,633	----------
Union of South Africa	7,500	19,713	10,663	22,543	29,777	35,507
Other Africa	637	----------	10	113	63	19
Total	9,974	19,713	10,673	22,656	32,473	35,526
Oceania:						
Australia	10,247	9,792	7,423	8,954	[3] 20,676	21,589
Other Oceania	33	----------	----------	----------	----------	----------
Total	10,280	9,792	7,423	8,954	20,676	21,589
Total ore and matte	67,246	76,520	67,484	104,661	[3] 160,899	161,413

See footnotes at end of table.

[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 17.—Total lead imported into the United States in ore, matte, base bullion, pigs, bars, and reclaimed, by countries, 1945–49 (average) and 1950–54, in short tons, in terms of lead content [1]—Continued

[U. S. Department of Commerce]

Country	1945–49 (average)	1950	1951	1952	1953	1954
Base bullion:						
North America:						
Guatemala		232		266	736	
Mexico	1,549					
Total	1,549	232		266	736	
South America:						
Peru	177	72	47	123	133	41
Other South America	(2)					
Total	177	72	47	123	133	41
Europe: Yugoslavia				(2)		
Asia:						
Japan		921				
Korea, Republic of	73					
Total	73	921				
Africa: Union of South Africa	6					
Oceania: Australia	449	2,263	2,234			
Total base bullion	2,254	3,488	2,281	389	869	41
Pigs and bars:						
North America:						
Canada	42,379	} 107,673	56,959	104,531	49,000	59,887
Newfoundland and Labrador	2					
Mexico	104,871	220,767	36,987	198,872	140,751	68,695
Other North America	14	2		18	209	20
Total	147,266	328,442	93,946	303,421	189,960	128,602
South America:						
Bolivia				635	220	
Peru	21,811	31,988	31,528	42,169	52,216	20,047
Other South America			2	2	9	
Total	21,811	31,988	31,530	42,806	52,445	20,047
Europe:						
Belgium-Luxembourg	1,825	166	331	1,785	2,017	339
Germany	1,667	8,643	738	[4] 6,052	[4] 4,006	[4] 799
Italy	4,954					
Netherlands	409	484		2,747	1,981	156
Spain	331	440		5,509		5,580
United Kingdom	153	49	299	4,216	1,148	2,386
Yugoslavia	5,489	43,855	36,311	53,997	51,826	38,465
Other Europe	59			717	1,496	3,902
Total	14,887	53,637	37,679	75,023	62,474	51,627
Asia:						
Burma	751					
Japan	3,454	5,712				10
Other Asia	631				138	
Total	4,836	5,712			138	10
Africa:						
French Morocco			2,279	6,670	9,258	17,555
Other Africa	117				448	
Total	117		2,279	6,670	9,706	17,555
Oceania: Australia	16,051	22,009	13,598	82,800	70,348	58,445
Total pigs and bars	204,968	441,788	179,032	510,720	385,071	276,286

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, 1945–49 (average) and 1950–54, in short tons, in terms of lead content [1]—Continued

[U. S. Department of Commerce]

Country	1945–49 (average)	1950	1951	1952	1953	1954
Reclaimed, scrap, etc.:						
North America:						
Canada	4,798	} 1,317	1,730	6,047	371	3,023
Newfoundland and Labrador	16					
Canal Zone	208	319	228	858	205	35
Jamaica	25	51	252	101	28	----------
Mexico	505	934	2,089	872	98	1,298
Panama	74	80	234	300	138	180
Other North America	185	283	625	622	476	617
Total	5,811	2,984	5,158	8,800	1,316	5,153
South America:						
Chile	12	----------	84	----------	----------	----------
Peru	----------	----------	159	297	59	173
Venezuela	2	106	668	196	----------	----------
Other South America	----------	----------	113	20	----------	----------
Total	14	106	1,024	513	59	173
Europe:						
Belgium-Luxembourg	263	13	----------	----------	202	----------
France	58	----------	88	----------	----------	----------
Germany	133	290	----------	----------	----------	[4] 56
Italy	544	----------	----------	----------	----------	----------
Netherlands	612	4	18	454	502	----------
Yugoslavia	131	----------	----------	345	103	110
Other Europe	307	74	7	276	456	103
Total	2,048	381	113	1,075	1,263	269
Asia:						
Burma	41	----------	----------	203	----------	----------
Japan	1,620	14,769	470	345	21	13
Other Asia	1,066	723	122	141	----------	47
Total	2,727	15,492	592	689	21	60
Africa	260	----------	----------	----------	17	----------
Oceania:						
Australia	2,131	1,061	2,175	924	2,666	----------
Other Oceania	----------	15	81	338	97	----------
Total	2,131	1,076	2,256	1,262	2,763	----------
Total reclaimed, scrap, etc	12,991	20,039	9,143	12,339	5,439	5,655
Grand total	287,459	541,835	257,940	628,109	[3] 552,278	443,395

[1] Data are "general imports," that is, they include lead imported for immediate consumption plus material entering the country under bond.
[2] Less than 1 ton.
[3] Revised figure.
[4] West Germany.

TABLE 18.—Lead imported for consumption in the United States, 1945–49 (average) and 1950–54, 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		
1945–49 (average)	60,921	$12,022,033	2,771	$807,055	201,446	$47,835,379	93	$51,413	$25,974	$63,907,559
1950	95,068	21,045,414	1,148	193,356	434,410	104,340,645	207	78,111	78,690	129,613,215
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	[2] 294,068	379,119	95,285,223	178	58,291	242,925	[2] 111,919,588
1954	196,054	47,967,269	41	10,149	274,286	[3] 68,419,607	397	[3] 128,812	[3] 149,208	[3] 118,125,081

[1] In addition to quantities shown (value included in total values), "reclaimed, scrap, etc.," imported as follows—1945–49 (average): 12,865 tons, $3,165,705; 1950: 22,524 tons, $3,876,999; 1951: 8,020 tons, $2,183,240; 1952: 11,358 tons, $3,198,844; 1953: 3,660 tons, $824,997; 1954: 7,217 tons, [3] $1,450,036. Figures include lead received by the Government and held in stockpiles but exclude imports for manufacture in bond and export, which are classified as "imports for consumption" by the U. S. Department of Commerce.

[2] Revised figure.

[3] Due to changes in tabulating procedures by the U. S. Department of Commerce data known not to be comparable to earlier years.

TABLE 19.—Miscellaneous products containing lead, imported for consumption in the United States, 1945–49 (average) and 1950–54

[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
1945–49 (average)	221	128	$238,658	10,170	9,363	$2,350,207
1950	4,345	2,744	2,814,264	12,518	10,582	3,431,650
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

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

Exports.—Exports of pigs and bars totaled only 596 tons, lead scrap less than 4,000 tons, and ore, matte, and base bullion only 102 tons in 1954. Export restrictions imposed under the Export Control Act of 1940 remained in effect throughout 1954.

Expansion in trade between countries in Eastern and Western Europe was indicated. European press reports stated that under trade agreements executed in 1954 U. S. S. R. was to receive 3,000 metric tons of lead from France and 4,000 tons from Belgium-Luxembourg. Also, in a quota agreement running to March 31, 1955, Iran was reported to have agreed to provide U. S. S. R. with 50,000 tons of lead ore and 12,000 tons of zinc ore.

TABLE 20.—Total lead exported from the United States in ores, matte, base bullion, pigs, bars, anodes, and scrap, by destinations, 1945–49 (average) and 1950–54, in short tons [1]

[U. S. Department of Commerce]

Destination	1945–49 (average)	1950	1951	1952	1953	1954
Ore, matte, base bullion (lead content):						
North America:						
Canada	325	[2] 132	557	836	1,038	18
Other North America	(3)					
Total	325	132	557	836	1,038	18
Europe: Belgium-Luxembourg	20	[2] 1				
Asia: Japan						84
Total ore, matte, base bullion	345	133	557	836	1,038	102
Pigs, bars, anodes:						
North America:						
Canada	15	306	138	40	32	18
Canal Zone	15	19	24	18	1	
Cuba	72	61	48	52	28	23
El Salvador	10	96	35	23	2	5
Guatemala	1	14	1	1	29	33
Honduras	10	6	14	10	3	5
Mexico	16	3	4	7	8	34
Other North America	28	21	24	26	100	46
Total	167	526	288	177	203	164
South America:						
Argentina	181		55			
Brazil	175	47	62	433	76	44
Chile	70	35	107	193	18	98
Colombia	32	123	42	10	21	20
Ecuador	5	15	[2] 1	84		
Uruguay	22	734	424	231		
Venezuela	70	95	62	67	41	27
Other South America	8	2	3	15	5	13
Total	563	1,051	756	1,033	161	202
Europe:						
Belgium-Luxembourg	15		37			
Denmark	26					
Turkey	18			280		
United Kingdom		67				
Other Europe	95	8	3	22	2	2
Total	154	75	40	302	2	2
Asia:						
India	29		11	4		
Pakistan		569				
Philippines	19	306	17	78	405	192
Other Asia	31	193	169	165	25	34
Total	79	1,068	197	247	430	226
Africa	14	15	(3)	2	6	2
Oceania	(3)			1	1	
Total pigs, bars, anodes	977	2,735	1,281	1,762	803	596
Scrap:						
North America:						
Canada	(4)	41	203	20	27	
Mexico	(4)					370
Total	(4)	41	203	20	27	370
South America	(4)					(3)
Europe:						
Belgium-Luxembourg	(4)		31			103
Denmark	(4)					318
Germany	(4)	264	145		[5] 39	[5] 29
United Kingdom	(4)	1,271	20	55	2,000	1,060
Total	(4)	1,535	196	55	2,039	1,510

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 destinations, 1945–49 (average) and 1950–54, in short tons[1]—Continued

[U. S. Department of Commerce]

Destination	1945–49 (average)	1950	1951	1952	1953	1954
Asia:						
Japan	(4)	--------	195	--------	640	2,014
Lebanon	(4)	--------	--------	--------	--------	--------
Total	(4)	--------	195	--------	640	2,014
Total scrap	(4)	1,576	594	75	2,706	3,894
Grand total	----------	4,444	2,432	2,673	4,547	4,592

[1] In addition foreign lead was reexported as follows: Ore, matte, base bullion 1945–49 (average) 1 ton; 1950: 4 tons; 1951–54: none. Pigs, bars, anodes 1945–49 (average) 134 tons; 1950: 53 tons; 1951: none; 1952: 2 tons; 1953: 799 tons; 1954: none. Scrap 1949–53: none; 1954: 121 tons.
[2] Revised figure.
[3] Less than 1 ton.
[4] Not separately classified 1945–48; 1949: Belgium-Luxembourg 362 tons; Canada 95 tons; Lebanon 11 tons; United Kingdom 279 tons; total scrap 747 tons.
[5] West Germany.

Tariff.—The duty on pig lead remained at 1$\frac{1}{16}$ cents a pound and that on lead in ores and concentrates at $\frac{3}{4}$ cent a pound throughout 1954. Details of changes in tariff rates on these and other lead articles since 1930 were published in the 1953 volume of this series (Lead chapter, Minerals Yearbook, volume I).

Efforts of a segment of the domestic lead and zinc mining industry to bring about an increase in tariff rates under the "escape-clause" provisions of the Trade Agreements Extension Act of 1951 continued during the early part of 1954. The report of the Tariff Commission on its investigation begun in 1953 relating to these provisions was released in May 1954.[8] The report recommended that import duties on most lead and zinc materials be increased 50 percent above the rates existing on January 1, 1945. In lieu of increasing the duties, the President on August 23 outlined an expanded stockpiling program to assist the mining industry. Under the new program domestic purchases of lead and zinc could total up to 200,000 and 300,000 tons, respectively.

TECHNOLOGY

Progress continued to be made in applying new prospecting techniques and in mechanization of development and mining operations, in efficiency of lead smelting, and in research on utilization of lead in new alloys and compounds. Although all the new or improved techniques employed in the industry were of course not covered in the literature released for publication, much valuable information was provided in papers contributed by the technical staffs of individual companies, trade journals, and others engaged in research.

[8] United States Tariff Commission, Lead and Zinc: Report to President on Escape-Clause Investigation 27, Under the Provisions of Section 7 of the Trade Agreements Extension Act of 1951, May 1954, 34 pp. (with statistical appendix).

Publications of the Geological Survey issued in 1954 and relating to lead included the following:

Bulletin 1000–B. Geochemical Prospecting Investigations in the Nyeba Lead-Zinc District, Nigeria.
Bulletin 1004. Geology and Ore Deposits of the Willow Creek Mining District, Alaska.
Bulletin 1010. Geologic Controls of Lead and Zinc Deposits in Goodsprings (Yellow Pine) District, Nevada.

The Bureau of Mines published Bulletin 542,[9] which contains tables of heat and free-energy-of-formation data for inorganic oxides. Such data are used in evaluating heat balances in metallurgical processes, in appraising possible improvements in existing metal extractive methods, and as a guide in the search for better methods of producing metals of recent or possible future commercial interest.

A number of excellent articles appeared in the technical press.

An article [10] described the methods used in sinking a concrete-lined circular shaft 950 feet deep with an inside diameter of 12 feet 7 inches to develop the new Indian Creek property of the St. Joseph Lead Co. in Washington County, Mo. Operations were highly mechanized, and an average advance of 7 feet 4 inches per drill round, without a single misbreak and with no lost-time accidents, was accomplished.

Methods used in a shaft-sinking project for deep exploration at the Atlas mine in the Coeur d'Alene district of Idaho were described.[11] Full use was made of up-to-date methods in sinking. Rock bolting, mucking machine, and attention to details helped to provide a good record despite unfavorable ground.

Borehole photography of critical borings as a means of foundation investigation for high dams and for use in the field of mining was tested.[12]

Recent advances in the metallurgy of lead described by Roll [13] were the following:

(1) The vacuum dezincing process for removing traces of zinc from refined lead, (2) the use of the Venturi scrubber for collecting lead fume and dust in place of baghouses or Cottrells, (3) the use of oxygen-enriched air in the lead blast furnace, (4) an efficient means for bonding lead to steel so that lead's corrosion resistance can be combined with physical strength of steel, and (5) the development of several new lead alloys with enhanced physical characteristics for special applications.

Metallurgical research and new methods of using standard equipment increased production at the lead-zinc-silver mine of the New Broken Hill Consolidated, Ltd., in Australia. An article [14] described the use of three penthouses in the shaft for sinking done in weak ground and mentioned a number of improvements in ore-mining methods. One of the problems on which metallurgical research was carried

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[9] Coughlin, James P., Contributions to the Data on Theoretical Metallurgy. XII. Heats and Free Energies of Formation of Inorganic Oxides: Bureau of Mines Bull. 542, 1954, 80 pp.

[10] Bain, C. Kremer, A Highly Mechanized Shaft Sinking Operation: Min. Cong. Jour., vol. 40, No. 6, June 1954, pp. 38–39.

[11] Love, William H., Facts and Figures on the Atlas Shaft-Sinking Project: Min. Eng., vol. 6, No. 11, November 1954, pp. 1090–1092; and Western Miner and Oil Review, vol. 27, No. 8, August 1954.

[12] Mining World, Would You Like to See the Inside of a Drill Hole: Vol. 16, No. 3, March 1954, p. 53 (also pub. in March 1954 issue of Systems Magazine, issued by Remington-Rand, Inc.).

[13] Roll, Kempton H., Latest Developments in the Metallurgy of Lead: Paper pres. at combined meeting, of Lead Industries Association and American Zinc Institute, Chicago, Ill., Apr. 27, 1955.

[14] Mining Engineering, New Methods Boost Australia's Broken Hill Output: Vol 6, No. 10, October 1954, pp. 966–967.

on was the effect of the lubricant used in rock drills on the recovery of lead and zinc minerals by flotation in the mills. Laboratory tests revealed that one rock-drill lubricant has a detrimental effect on flotation.

An article told how smelter practice at the Midvale lead smelter of the United States Smelting, Refining & Mining Co. was modified for two-shift operation.[15] The Midvale smelter had operated its sintering plant and lead blast furnace on a two-shift basis from 7 a. m. to 11 p. m. since early 1952. These departments had also been operating 5 and 6 days per week, depending on operating schedules. Obviously, continuous operation would be much preferred, but the two-shift operation was quite satisfactory.

A paper was published covering experimental work conducted at the Port Pirie smelter of Broken Hill Associated Smelters Pty., Ltd., at Port Pirie, South Australia.[16] Limited experimental work indicated that, by increasing the surface area of sinter, and possibly that of coke as well, a marked increase in the rate and degree of sinter reduction in the furnace shaft can be achieved. Fusion-point tests have shown that this increased reduction means a much higher sinter fusion point and narrower plastic zone. More efficient utilization of coke in the furnace is inherent in the intensification of reduction by providing a more reactive sinter surface. Investigations aimed at increasing the capability of the blast furnace to operate on a higher lead tenor of sinter thus reducing fuel cost proportionately, and at eliminating the loss in reduction potential in coke entering the furnace, as shown by the presence of appreciable proportions of CO in the top gases, are reported. Several lines for future investigations are proposed that could result in improved smelting methods.

Data on the physical and mechanical properties of hard and soft lead published in 1954 [17] show that the properties may vary considerably depending upon temperature, rate of cooling, and time of aging. The effect of aging treatments on strength and hardness of age-hardenable lead alloys is discussed.

Progress was reported [18] in experimental work by American and British investigators on inverse segregation in lead-antimony alloys. One of the observations made was that examination of hypoeutectic lead-antimony castings revealed a great deal more antimony in the surface layer than would be expected from the composition of the alloy. As the composition of the alloy approaches that of the eutectic (that is, about 13 percent of antimony), the surface layer becomes almost entirely antimony instead of the expected eutectic. Another observation was that inverse segregation can be fully accounted for by interdentritic flow from the interior of the solidifying ingot and that no special forces are necessary.

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[15] Johnson, Hugo L., and Nelson, Casper A., Midvale Smelter Practice Modified for 2-Shift Operation: Jour. Metals, vol. 6, No. 9, September 1954, pp. 949–951. (Pres. at the annual meeting AIME, New York, Feb. 15–18, 1954.)

[16] Haney, L. B., and Hopkins, R. J., Thoughts on Lead Blast-Furnace Smelting (with discussion). Jour. of Metals, vol. 6, No. 11, November 1954, pp. 1208–1213.

[17] Materials and Methods, vol. 40, No. 4, October 1954, pp. 131, 139, 141.

[18] Metal Industry (London), vol. 85, No. 26, Dec. 24, 1954, p. 539.

In another article, it was stated [19] that a lead-tin alloy coating improves workability of strip steel. A lead-tin alloy is deposited electrolytically from a special fluoborate bath to give smooth, porefree surface. Coating acts as a lubricant in reducing wear on dies and forming roll leaving a surface of improved solderability and corrosion resistance.

A small piece of glass coated with lead sulfide may prove invaluable in developing devices for detecting warm objects at great distances.[20] The Ekstron detector is said to have 10,000 times the sensitivity to certain infrared rays as previous laboratory instruments. In addition to heat-detection devices, the sensitive cells may be applied to switching devices.

In 1954 lead was more than holding its own in competition with other chemical construction materials.[21] Chemical lead, acid lead, and copper lead were the grades usually specified for chemical construction, which included equipment for the production, transmission, storage, and use of a variety of corrosive chemicals.

Paint formulation and the conditions for application of paint to metal surfaces were described [22] in relation to the permanence of its attachment. Some pigments like red lead and aluminum powder can have a beneficial effect on adherence either because their reaction products with the binder or metal substrate improve adhesion or because they inhibit the rate of deterioration of the flexibility of the film. Others like TiO_2 have no effect. Some pigments, such as zinc oxide, can accelerate the cure of a film, and some may retard it.

WORLD REVIEW

World mine production of lead in 1954 increased 7 percent over 1953 and established a new record. Output was 2,230,000 short tons compared with the previous high of 2,090,000 tons in 1953. Substantial gains in Europe, Australia, Asia, and Africa accounted for the increase; the output in North America was nearly the same as in 1953, and that in South America declined 4 percent. The United States, which has been the largest lead-producing country since the 1880's, retained first rank in 1954 by a wide margin in smelter production but by a small margin in mine production owing to a 16-percent increase in Australia, the second largest producer in terms of mine output. Lead ores were mined in about 55 countries in 1954, but 6—United States, Australia, Mexico, the U. S. S. R., Canada, and Peru—furnished nearly two-thirds of the total mine output.

World smelter production of lead also attained a new record, increasing 6 percent over 1953 (the former record year) to 2,160,000 short tons. On a smelter basis, the 6 countries that were the principal

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[19] Roehl, E. J., Lead-Tin Alloy Coating Improves Workability of Strip Steel, Iron Age, vol. 173, No. 11, Mar. 18, 1954, pp. 140–142.
[20] Journal of Metals, vol. 6, No. 7, July 1954, p. 803.
[21] Chemical Engineering, Lead More Than Holding Its Own: Vol. 61, No. 11, November 1954, p. 188.
[22] Bobalek, E. G., Adherence of Paint Films: Metal Progress, August 1954, vol. 66, No. 2, pp. 113–119.

producers on a mine basis supplied 67 percent of the total world smelter output, nearly the same percentage as they did of the mine output.

Annual world mine production by countries for 1950–54, and the average of the 5-year period 1945–49, insofar as statistics are available, are given in table 21. World smelter production for the same years is given in table 22. World smelting and refining facilities outside the United States were listed in the 1953 chapter of this series, table 23.

TABLE 21.—World mine production of lead, by countries, 1945–49 (average) and 1950–54, in short tons [1]

(Compiled by Augusta W. Jann)

Country	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Canada	183,633	165,697	158,231	168,842	193,706	219,280
Cuba	[2] 50	13				
Guatemala	1,149	3,307	3,638	4,630	7,789	2,607
Honduras	[3] 326	308	500	593	[4] 1,090	[4] 1,636
Mexico	216,641	262,436	248,536	271,198	244,216	238,788
Salvador [5]	161	580	520	110		
United States [6]	382,182	430,827	388,164	390,162	342,644	325,419
Total	784,142	863,168	799,589	835,535	789,445	787,730
South America:						
Argentina	21,082	21,360	25,100	21,000	17,600	21,000
Bolivia (exports)[6]	17,896	34,366	33,684	33,083	26,222	20,092
Brazil	987	4,400	3,900	3,100	3,300	3,300
Chile	2,800	3,657	8,599	[5] 4,400	[5] 3,500	[5] 3,500
Ecuador	284	252	33	126	126	
Peru	58,839	68,473	90,775	105,571	126,303	121,287
Total	101,888	132,508	162,091	[5] 167,280	[5] 177,050	[5] 169,180
Europe:						
Austria	2,575	4,894	4,985	5,763	5,677	5,432
Bulgaria [5]	5,500	11,000	11,000	11,000	11,000	(7)
Czechoslovakia [5]	1,390	1,100	1,100	1,100	1,100	1,100
Finland	137	157	238	238	239	291
France	8,441	13,702	12,179	13,024	12,710	11,486
Germany:						
East [5]	1,800	2,800	2,900	2,900	3,300	5,500
West	24,038	51,081	55,467	56,510	69,085	74,419
Greece [8]	1,004	6,400	4,200	6,600	6,300	5,900
Hungary	132	330	(7)	(7)	(7)	(7)
Ireland	[9] 168	413	1,330	2,097	1,005	(7)
Italy	23,457	42,200	44,300	44,200	44,600	47,400
Norway	164	258	456	455	579	740
Poland [10]	14,400	20,000	20,000	22,000	23,500	24,000
Portugal	534	1,445	1,787	2,118	1,900	2,200
Rumania [5] [10]	3,771	4,400	4,400	5,500	6,600	6,600
Spain	33,468	43,283	44,580	46,720	59,750	61,000
Sweden	24,190	24,993	21,708	22,700	28,146	33,029
U. S. S. R. [5] [10]	70,000	123,000	141,500	170,000	202,000	228,500
United Kingdom	3,021	3,677	5,429	6,369	7,439	7,598
Yugoslavia	55,957	94,842	86,807	87,047	93,864	92,735
Total [5]	274,150	450,000	464,900	506,900	579,300	632,030

For footnotes, see end of table.

TABLE 21.—World mine production of lead by countries, 1945–49 (average) and 1950–54, in short tons—Continued [1]

Country	1945–49 (average)	1950	1951	1952	1953	1954
Asia:						
Burma [5]	80	1,100	2,200	3,300	8,800	13,200
China [5]	420	1,300	1,700	2,200	(7)	(7)
Hong Kong			197	330	330	220
Iran [11]		2,200	19,300	18,000	8,800	[5] 19,800
Japan	7,028	12,000	14,187	19,271	20,562	25,176
Korea:						
North [5]	3,800	3,300	(7)	(7)	(7)	(7)
Republic	837	44		157	164	128
Philippines	140	969	629	2,535	2,683	2,014
Thailand (Siam)	[9] 202	762	1,456	1,155	4,000	5,500
Turkey	913	290	660	[5] 1,100	1,500	2,200
Total [5]	13,420	22,000	41,400	49,100	60,600	84,800
Africa:						
Algeria	1,039	1,536	3,128	4,652	8,763	11,200
Belgian Congo	625				72	184
Egypt	15	1	159	21	276	143
French Equatorial Africa	2,546	2,000	2,760	3,914	4,877	3,833
French Morocco	24,523	53,748	75,105	92,162	86,928	91,084
Nigeria	87	13	4	30	39	10
Rhodesia and Nyasaland, Federation of:						
Northern Rhodesia [10]	11,775	15,328	15,646	14,112	12,890	16,800
Southern Rhodesia	19				45	1
South-West Africa	18,761	37,126	43,245	[6] 58,248	[6] 65,287	[6] 77,146
Spanish Morocco	185	196	408	807	[5] 660	[5] 440
Tanganyika (exports)	1	719	1,721	2,655	3,085	[5] 3,000
Tunisia	12,872	20,790	23,424	25,650	26,514	28,976
Uganda (exports)	12	49	10	9	18	61
Union of South Africa	175	660	990	634	551	181
Total	72,635	132,166	166,600	202,894	210,000	233,059
Australia	218,545	245,137	251,478	260,693	274,303	319,046
World total (estimate)	1,465,000	1,850,000	1,890,000	2,020,000	2,090,000	2,230,000

[1] This table incorporates a number of revisions of data published in previous Lead chapters.
[2] Average for 1946–49.
[3] Average for 1948–49.
[4] Imports into United States.
[5] Estimate.
[6] Tonnage recoverable from ore.
[7] Data not available; estimate by senior author of chapter included in total.
[8] Includes lead content of zinc-lead concentrate.
[9] Average for one year only, as 1949 was first year of commercial production.
[10] Smelter production.
[11] Year ended March 21 of year following that stated.

TABLE 22.—World smelter production of lead, by countries where smelted, 1945–49 (average) and 1950–54, in short tons [1] [2]

(Compiled by Augusta W. Jann)

Country	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Canada	159,457	170,364	162,712	183,389	166,356	166,379
Guatemala	118	299	66	348	725	[3] 110
Mexico	210,699	254,447	241,524	261,736	236,966	230,567
United States (refined) [4]	419,723	505,050	414,628	472,450	467,723	486,624
Total	789,997	930,160	818,930	917,923	871,770	883,680
South America:						
Argentina	22,589	20,900	26,167	21,815	14,330	[3] 25,300
Brazil	584	4,630	[3] 3,300	2,145	3,250	[3] 3,300
Peru	39,593	34,936	48,774	53,597	65,041	63,648
Total	62,766	60,466	78,241	77,557	82,621	92,248
Europe:						
Austria [5]	6,284	12,026	12,287	11,445	13,113	13,294
Belgium [5]	47,611	68,447	80,271	87,640	84,162	79,208
Czechoslovakia	3,786	(6)	(6)	(6)	(6)	(6)
France	34,553	70,740	53,970	56,811	60,390	67,704
Germany:						
East [3]	} 45,019	{ 13,200	18,500	19,800	24,200	24,200
West		73,435	83,845	102,164	118,801	121,504
Greece	1,396	2,342	4,288	2,712	[3] 2,800	[3] 3,200
Hungary	[3] 44	331	(6)	(6)	(6)	(6)
Italy	19,373	41,302	40,212	37,810	41,881	41,150
Poland	14,400	20,000	20,000	22,000	23,500	24,000
Portugal	302	651	798	1,174	973	[3] 1,100
Rumania [3]	3,771	4,400	4,400	5,500	6,600	6,600
Spain	34,609	44,719	49,285	51,305	56,492	62,475
Sweden	11,010	18,388	10,259	12,555	17,806	22,147
U. S. S. R. [3]	70,000	123,000	141,500	170,000	202,000	228,500
United Kingdom [5]	2,772	3,360	4,583	5,295	7,446	7,598
Yugoslavia	41,737	63,057	66,214	74,053	78,039	73,556
Total [3]	336,700	563,300	594,300	664,200	742,100	780,200
Asia:						
Burma	1,720	12	5,474	2,949	9,641	12,722
China	999	[3] [5] 4,400	[3] [5] 5,500	[3] [5] 6,600	[3] [5] 10,000	[3] [5] 10,000
India	331	701	962	1,268	1,897	2,003
Japan	8,717	11,005	11,839	16,707	19,537	28,916
Korea:						
North [3]	[3] 3,900	[3] 3,300	------	------	[3] 2,200	(6)
Republic	704	(6)	(6)	139	55	[3] 30
Total [3]	16,400	19,800	24,100	27,700	43,300	59,200
Africa:						
French Morocco	2,180	13,335	24,606	33,166	30,240	29,418
Rhodesia and Nyasaland, Federation of:						
Northern Rhodesia	11,775	15,328	15,646	14,112	12,890	16,800
South-West Africa	32	------	------	------	------	------
Tunisia	13,639	25,944	25,250	28,116	30,017	29,972
Total	27,626	54,607	65,502	75,394	73,201	76,190
Australia [7]	193,522	221,252	221,346	217,670	231,301	267,182
World total (estimate)	1,430,000	1,850,000	1,800,000	1,980,000	2,040,000	2,160,000

[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.

[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] Including lead content of lead bullion, figures for which are as follows: 1945–49 average, 23,411 short tons; 1950, 41,463; 1951, 35,697; 1952, 42,234; 1953, 38,137; and 1954, 42,723.

NORTH AMERICA

Canada.—Mine production of lead in Canada in 1954 increased 13 percent over 1953 to 219,300 short tons, the largest output since 1942. A substantial part of the lead concentrate produced was shipped to other countries for smelting. Smelter output of lead in Canada was 166,400 tons, virtually the same as in 1953.

Much the largest producer of lead continued to be the famous Sullivan zinc-lead-silver mine at Kimberley, British Columbia, owned and operated by The Consolidated Mining & Smelting Co., of Canada, Ltd. The ore was treated in the 12,000-ton mill at the mine, and the flotation lead and zinc concentrates produced were shipped to the company reduction works at Trail. The works included a lead smelter and refinery with an annual capacity of 250,000 tons of refined lead and an electrolytic zinc smelter with an annual capacity of 180,000 tons of bar zinc. The Trail lead smelter was the only primary lead smelter operating in Canada.

The second largest lead-producing mine was the Buchans Mining Company, Ltd., zinc-lead-copper property in Newfoundland, equipped with a 1,300-ton flotation mill.

A report [23] by the Canada Department of Mines and Technical Surveys gave detailed information on the lead industry of Canada. Lead output by provinces was shown as follows: British Columbia, 174,300 short tons; Newfoundland, 18,700 tons; Yukon, 16,300 tons; Quebec, 8,500 tons; Nova Scotia, 2,100 tons; and Ontario 1,300 tons. Exports of lead contained in ore and concentrates totaled 59,800 short tons (largely to the United States), and exports of refined lead amounted to 117,300 tons (mostly to the United States and the United Kingdom).

The following information on Canadian mining activities was abstracted from this report.

In British Columbia the Sullivan mine at Kimberley produced 2,681,600 tons of zinc-lead-silver ore in 1954 compared with 2,643,300 tons in 1953. A large part of the ore came from open-pit operations and pillar removal in the upper part of the ore body. The Consolidated Mining & Smelting Co., operator of the Sullivan mine, also operated the Bluebell silver-lead-zinc mine at Riondell on Kootenay Lake. Other producers of lead concentrate included Tulsequah Mines, Ltd., (a Consolidated Mining & Smelting Co. subsidiary) in northwestern British Columbia; Canadian Exploration, Ltd., Jersey mine near Salmo; Sheep Creek Gold Mines, Ltd., Mineral King mine 25 miles southwest of Athalmer (began production in May 1954); Violamac Mines, Ltd., near Sandon; Sunshine Lardeau Mines, Ltd., near Gamborne; Giant Mascot Mines, Ltd., near Spillimacheen; Silver Standard Mines, Ltd., near Hazelton; and Yale Lead & Zinc Mines, Ltd., at Ainsworth. Sil-Van Consolidated Mining & Milling Co., Ltd., discontinued operations in April at its property near Smithers.

Producers in Quebec included the New Calumet Mines, Ltd., Pontiac County; Anacon Lead Mines, Ltd., and United Montauban

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[23] Neelands, R. E., Lead in Canada, 1954 (Prelim.): Canada Dept. of Mines and Tech. Surveys, Ottawa, 1955, 6 pp.

Mines, Ltd. (mine closed in February) both in Portneuf County; Golden Manitou Mines, Ltd., Abitibi East County; Consolidated Candego Mines, Ltd., North Gaspé County (closed in October); and Ascot Metals Corporation, Ltd., Sherbrooke County.

In the Mayo district, Yukon, United Keno Hill Mines, Ltd., produced concentrate containing around 13,800 tons of lead from its Hector and Calumet mines, and the Mackeno Mines, Ltd., produced concentrate containing about 2,500 tons of lead. Prospectors Airways Co., Ltd., found extensive flat-lying deposits of zinc-lead ore by drilling on the Vangorda property near the Pelly River northwest of the Canol Road. Drilling by the American Smelting & Refining Co. 38 miles north of Watson Lake outlined more than a million tons averaging 15 percent combined lead and zinc.

On Cape Breton Island, Nova Scotia, Mindamar Metals Corp., Ltd., mined an average of 600 tons of ore daily and produced zinc concentrate and bulk lead-copper concentrate. In Ontario, Jardun Mines, Ltd., began producing lead and zinc concentrates in a new 300-ton mill on its property 18 miles northeast of Sault Ste. Marie.

Activity in development and exploration for base metals in New Brunswick was featured by the discovery of several extensive zinc-lead-copper-pyrite ore bodies in the Little River property 30 miles northwest of Newcastle, announced in November by the American Metal Co., Ltd. Large-scale development of the property was planned. The Brunswick Mining & Smelting Corp., Ltd., sank a 400-foot exploration shaft on its Anacon deposit and began developing two levels. The ore from this development was to be treated in the 150-ton pilot mill built in 1954 near the large company Austin Brook zinc-lead-pyrite deposit 17 miles southwest of Bathurst, discovered in 1952. Several miles east of the Brunswick Austin Brook property, New Larder "U" Island Mines, Ltd., began sinking a shaft (planned to reach 1,500 feet in depth) on its property where drilling had indicated a deposit containing 1 million tons of ore averaging 8.2 percent combined lead and zinc. The 200-ton mill of Keymet Mines, Ltd., completed in 1953 at its property 15 miles north of Bathurst, was destroyed by fire in April 1954 but was rebuilt and began producing zinc and lead concentrates in October.

In Northwest Territories, Pine Point Mines, Ltd., a subsidiary of Consolidated Mining & Smelting Co. and Ventures, Ltd., resumed exploration at its extensive zinc-lead property near Pine Point south of Great Slave Lake; two prospect shafts were sunk to investigate mining conditions and provide ore for bulk sampling tests.

Greenland.—Exploration and development of the Mestersvig lead-zinc deposit in East Greenland continued in 1954. According to announcements released to the press in Copenhagen by the Nordic Mining Co., Ltd., on August 25, mining was scheduled to begin, and it was hoped that the first shipments of lead and zinc concentrates could be made during the summer season of 1956. It was also stated at a meeting of the board of directors of the company on August 24 that, in terms of metal prices quoted at that time, the deposits of lead and zinc ascertained thus far had a value of about 100 million kroner ($14,500,000) and that they would assure operation over a period of 6 or 7 years. Navigation difficulties presented a problem owing to the lack of enough vessels of sufficient ice-breaking strength to navigate safely in East Greenland waters, and local milling of the ore was being considered.

Guatemala.—The zinc-lead-silver mine and mill of Compania de Guatemala, S. A., near Coban in northern Guatemala continued to operate in 1954.

Mexico.—With the advance in prices of lead and zinc, economic conditions for lead mining and smelting in Mexico improved somewhat during 1954, but there were no significant changes in Government regulations and taxes affecting operations of the large mines. Mine production of lead was 238,800 short tons (2 percent less than in 1953) and smelter production was 230,600 tons (3 percent less). To give further incentive to the industrialization program of Mexico, decrees were published on April 16 and May 22 providing for export tax exemptions of certain alloys of lead and fabricated lead products. This action was equivalent to a Government subsidy to Mexican lead fabricators amounting to about 3.6 cents a pound; the mining company deducted this sum from the sales price of lead to the local fabricators and in turn reduced the amount to be paid on its lead export tax by an equivalent amount.

The San Luis Potosi smelter of the American Smelting & Refining Co. continued operations in 1954. Company producing mines in Mexico, owned or leased in 1954, included the Charcas unit, San Luis Potosi; the Parral, Santa Barbara, Santa Eulalia, Montezuma Lead, and Plomosas units, Chihuahua; the Taxco unit, Guerrero; the Aurora-Xichu unit, Guanajuato; and Cia. Metalurgica Mexicana mine. According to the company annual report for 1954, all operations at the Angangueo unit, Michoacan, ended in April 1954, and the properties were returned to the owner, Michoacan Railway & Mining Co., Ltd., on December 31, 1954. Construction of the 400-ton mill at the Nuestra Senora lead-zinc-silver property in the Cosala district, Sinaloa, was completed, and operations on a part time basis commenced in August. Exploration and development of the Rosario lead-zinc property at Rosario, Sinaloa, continued to yield favorable results. The San Pedro mine, a lead-zinc property 75 miles north of the Charcas unit, San Luis Potosi, was purchased. Although not of major importance, it will be an attractive source of ore for the Charcas mill.

The operating subsidiaries of the American Metal Co., Ltd., in Mexico in 1954 were the Cia. Minera de Penoles, S. A., and the Cia. Metalurgica Penoles, S. A.[24] The first company operated 5 mining units—the Avalos unit at Avalos, Zacatecas, producing lead and zinc concentrates; Ocampo unit, Boquillas, Coahuila, lead concentrates; Calabaza unit, Etzatlan, Jalisco, lead and zinc concentrates; Topia unit, Topia, Durango, lead and zinc concentrates; and Guadalupe unit, Villaldama, Nuevo Leon, lead oxide ore. The second company operated its Torreon, Coahuila, lead smelter and Monterrey, Nuevo Leon, lead refinery. Besides concentrates received from the company mining units, the smelter treated lead ores and concentrates received from a large number of custom shippers throughout Mexico. Partly as a result of improved rail service which permitted the shipment of concentrates theretofore stored at mines, company refined-lead production in Mexico increased from 75,900 tons in 1953 to 90,200 tons

[24] American Metal Co., Ltd., Annual Report for the 67th Year, 1954.

in 1954. Improved metallurgical efficiencies were more than offset by adverse factors, principally the increase in export taxes following the peso devaluation in April 1954. This increase had to be paid even on metal in process at the time of devaluation, on which the company could not adjust its purchase cost correspondingly. Pilot-plant operations for recovering zinc from the Torreon lead blast-furnace slags were carried out successfully, but the construction of a commercial plant was postponed.

Other large producers in Mexico during the year were San Francisco Mines of Mexico, Ltd., El Potosi Mining Co. (subsidiary of Howe Sound Co.), Fresnillo Co., and Minas de Iquala, S. A. (subsidiary of Eagle-Picher Co.). An article [25] described operations of the recently rebuilt 2,000-metric-ton-per-day mill of San Francisco mines in Chihuahua.

SOUTH AMERICA

Argentina.—Most of Argentina's lead production has been from the Aguilar district, and the chief producer in 1954 continued to be the Compania Minera Aguilar, S. A., a subsidiary of the St. Joseph Lead Co. According to the annual report of the St. Joseph Lead Co. for 1954, ore treated in the Aguilar 1,000-ton mill yielded 22,581 metric tons of lead concentrate and 36,240 tons of zinc concentrate compared with 19,768 tons of lead concentrate and 31,797 tons of zinc concentrate in 1953.

Late in 1954 the National Lead Co., S. A., announced [26] that a major expansion was planned at its Mina Castano zinc-lead-silver mining property in the Province of San Juan about 700 miles northwest of Buenos Aires. The expansion will include a concentrator, powerplant, pipeline, and new housing for personnel. Construction was expected to get underway on February 1, 1955. When the new plant begins operations in mid-1956, it will be capable of handling crude ore at the rate of 200 metric tons per day. Concentrate will be shipped to the company lead smelter at Puerto Villelas.

Bolivia.—The nationalized lead and zinc mines in Bolivia were operated by the Corporacion Minera de Bolivia. The mine production of lead in 1954, based on the quantity estimated to be recoverable from concentrate and slag exported, was 20,100 short tons, 6,100 tons less than in 1953.

Brazil.—The lead output of Brazil has come chiefly from deposits in the States of Sao Paulo and Parana. According to a report,[27] ore was also produced in 1954 from another deposit at Alto Garcia, district of Blumenau, State of Santa Catarina, and was processed by Cia. de Mineracao Sul-Brasileira. Total mine production in Brazil in 1954, the same as smelter production, was 3,300 short tons.

Chile.—Mine production of lead was estimated at 3,500 short tons in 1954. It was reported [28] that Cia. Minera Aysen was producing lead concentrate averaging 72 percent lead at the rate of 450 tons per month and zinc concentrate averaging 54.7 percent zinc at the rate of 350 tons.

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[25] Mining World, Tabling and Flexibility Make a Unique New Mill: Vol. 16, No. 6, May 1954, pp. 44–48.
[26] Engineering and Mining Journal, vol. 155, No. 12, December 1954, p. 117.
[27] Mining Journal (London), vol. 244, No. 6231, Jan. 21, 1955, p. 68.
[28] Engineering and Mining Journal, vol. 156, No. 4, April 1955, p. 166.

Peru.—Mine production of lead in Peru in 1954 was 121,287 short tons, a 4-percent decrease from the record high of 126,300 tons in 1953. The Cerro de Pasco Corp. continued to be the largest individual lead producer, operating several copper-silver and copper-lead-zinc-silver mines and mills in the Departments of Pasco, Junin, and Lima and a lead smelter and refinery, copper smelter and refinery, and electrolytic zinc refinery at La Oroya. The annual report of the corporation for 1954 stated that its production of the principal metals, except lead, showed significant gains over 1953. Production of refined lead, nearly as large as in 1953, was 63,485 short tons. The corporation copper-lead-zinc mine at San Cristobal in the vicinity of La Oroya, under development in 1954, was approaching production again at the end of 1954 after a lapse of 6 years, during which known ore reserves were developed and extended. The ores were treated at the Mahr concentrator to which they were transported over 7 miles by aerial tramway.

The Tangana lead-zinc mine in the Province of Castrovirreyna, Department of Huancavelica, made its first shipment to the Banco Minero concentrator at Hauchocolpa. Production was at the rate of about 50 tons of ore daily.[29] About 40 other lead-producing mines shipped ore to one or more of the four operating custom mills of the Banco Minero del Peru. Two of the six Banco Minero mills were not in operation.

EUROPE

Austria.—Bleiberger Bergwerks Union, a nationalized mining company at Bleiberg-Dreuth, Province of Carinthia, was the only producing lead-zinc mine in Austria in 1954. The ore produced totaled 120,192 metric tons, of which 44,529 tons was reclaimed from dumps. The average metal content of the newly mined ore was 4.6 percent lead and 4.3 percent zinc. The ore was treated in a modern flotation plant at Kreuth. The mill produced 6,844 metric tons of lead concentrate (with 4,928 metric tons of extractable metal content) and 9,292 metric tons of zinc concentrate (4,663 metric tons of extractable metal content). Lead extraction was 94.6 percent and zinc 84.5 percent. Lead concentrate and lead scrap were processed by the lead smelter at Gailitz-Arnoldstein, Province of Carinthia, the only producer of primary lead in Austria. Bleiberg lead is completely free of silver, a property valued by storage-battery manufacturers. The annual capacity of the smelter is 11,000 to 12,000 metric tons of lead metal. In 1954 Italy shipped 4,920 metric tons of lead concentrate to Austria for processing. Between 3,500 and 4,000 metric tons of secondary lead metal is annually remelted from domestic scrap by the Bleiberger Bergwerks Union and several other companies.

Finland.—The output of lead concentrate in Finland in 1954 was 478 metric tons, of which 402 tons was from the Orijarvi mine (producing chiefly zinc) and 76 tons from the Vihanti mine.

France.—Mines in France produced 11,486 short tons of lead in 1954 compared with 12,710 tons in 1953. The principal producing mines in 1954 were the La Loubatière at Carcassonne (Aude), La Plagne at Aimè (Savoie), and Les Malines at St. Laurent-de-Minier (Gard). The Sentein mine (Saint-Girons, Department of Ariège), a substantial producer in 1953, was closed in 1954. Imports of lead

[29] Mining World, vol. 16, No. 12, November 1954, p. 76.

concentrates, predominantly from French Morocco, totaled 75,285 metric tons (68,200 metric tons in 1953), and imports of pig lead, largely from French North Africa, totaled 53,640 metric tons (40,000 tons in 1953). Production of primary lead metal increased 12 percent over 1953 to a new record high of 61,420 metric tons. All this metal was produced by the Penarroya Noyelles-Godault smelter (Pas-de-Calais). Consumption of primary lead in Metropolitan France in 1954 was about 102,980 metric tons compared with 90,000 tons in 1953. The price of lead in France (fixed by the Government) rose gradually during 1954, from 104 francs per kilogram at the beginning to 116 francs at the end of the year.

Germany, West (Federal Republic of Germany).—The major lead-zinc producing areas of West Germany are in the Hartz Mountains and the Rhineland. The mine output of lead (metal content) in 1954 increased to 74,419 short tons from 69,085 tons in 1953. Among the more important mines were Mechernich (Gewerkschaft Mechernicher Werke), Rammelsberg (Unterharzer Berg-und Hüttenwerke G. m. b. H.), Ramsbeck and Holzappel (Stolberger Zinc A. G. für Bergbau und Huttenbertrieb), Bad Grund (Preussische Bergwerks und Hütten A. G.), Auguste Victoria (Gewerkschaft Auguste Victoria), and Leuderich (A. G. des Altenbergs für Bergbau and Zinchüttenbetrieb). An important new producer, scheduled to begin open-pit mining in April 1955, is Maubacher Bleiberg mine of Stolberger Zinc A. G., Aachen, at Maubach, Dueren.

The West German lead smelters [30] included the Braubach near Coblenz, Stolberg (Binsfeldhammer) near Aachen, Harz (lead smelter at Clausthal, lead refinery at Lautenthal, and lead-copper smelter at Oker), and Mechernich southwest of Cologne. The Unterweser smelter, mainly a zinc works, smelted some lead concentrates and lead-bearing residues. The Norddeutsche Affinerie (Hamburg), essentially a copper smelter, also produced some lead derived from scrap and concentrates. The combined annual capacity of the smelters, some of which treat imported as well as domestic concentrates, was 200,000 metric tons of metal.

Imports of lead materials into West Germany in 1954 were 81,907 metric tons of lead ores and concentrates and 59,355 metric tons of pig lead and scrap, while exports of pig lead and scrap totaled 31,326 tons. The imports and exports together involved trade with about 40 countries. Lead (primary and secondary) consumption in West Germany increased from 154,000 tons in 1953 to 186,700 tons in 1954.

Ireland.—An article published in 1954 [31] indicated that there were two lead-producing mines in Ireland in 1954. The Abbeytown Mining Co., Ltd., operated its mine at Ballysodare, County Sligo. The ore was mined at the rate of 300 tons per day, mainly by open-pit methods, and was concentrated by differential flotation. The Wicklow Mining Co., Ltd., worked its mine at Glendalough, County Wicklow, through adits, producing about 50 tons of ore daily. The ore was concentrated by tabling and jigging. The Shallee lead mine of Silvermines Lead & Zinc Co., Ltd., about 20 miles northeast of Limerick in County Tipperary, which had been in production since 1950, was closed in April 1953.

[30] Mining Magazine (London), The German Lead Smelters: Vol. 92, No. 5, May 1955.
[31] Engineering and Mining Journal, Special Report on Ireland's Lead: Vol. 155, No. 4, April 1954, p. 86.

Italy.—Italy's mine production of lead in 1954 was 47,400 short tons, an increase of 6 percent from 1953. Smelter production decreased 2 percent to 41,150 short tons. The Island of Sardinia continued to be the most important lead-zinc mining province. A new sink-and-float unit was completed in the west section of the Montevecchio property, largest lead-zinc mine in Sardinia. This was the second unit of its kind to be installed at Montevecchio.[32] The operating units consist of several mines, two mills, and a lead smelter on Sardinia and an electrolytic zinc plant at Port Marghera, Venice.

Spain.—The mine output of lead in Spain was 61,000 short tons in 1954 against 59,750 tons in 1953. The increased production was attributed to better ore-treatment results following expansion and improvement in flotation plants. Smelter production increased to 62,475 short tons compared with 56,492 tons in 1953. Exports totaled about 30,000 tons. The Penarroya smelter of the Sociedad Minera Metalurgica de Penarroya was the largest producer of pig lead in Spain. Other companies operating smelters were the Real Compania Asturiana de Minas, Compania "La Cruz", Compania Minero-Metalurgica "Los Guindoes," Minera Industrial Pirenaica, S. A., Minas del Priorato, S. A., and Industrias Reunidas Minero-Metalurgica, S. A.

U. S. S. R.—Official data on the production of lead in the U. S. S. R. in 1954 are not available. Smelter production was estimated at 228,500 short tons compared with 202,000 tons in 1953.

United Kingdom.—Lead contained in concentrates produced in the United Kingdom in 1954 totaled 7,598 short tons compared with 7,439 tons in 1953. A series of articles, in five parts, on lead mining in the British Isles was published in 1954. The concluding article [33] stated that the Greenside mine at Westmoreland was still going strong after a productive life extending without a serious break for 134 years and that a mine at Llanrwst in North Wales, reopened since World War II, had been producing on an increasing scale during the past few years. In Derbyshire exploration continued on the lead-zinc deposits discovered in 1953 at Riber Hillside near Matlock by the Matlock Lead Mines.

According to information published in London,[34] the lead market was in a sound position at the end of 1954, with consumption of lead in the United Kingdom and on the European Continent running at quite a good rate. Because of the London dock strike in October there was some diversion of cargoes of raw material, and one United Kingdom lead refinery was obliged to suspend operation for a time. The tight position created by the strike affected the price of prompt lead, and the peak for the year was reached in mid-November at £112 10s. per metric ton; the year opened at £89 10s. and closed at £107. Other factors that influenced the lead market during the year were the purchasing program for lead and zinc begun in June by the United States Government for its Strategic Stockpile, and the decision to relax the restrictions on the shipment of pig lead to countries in the Soviet bloc.

[32] Mining World, vol. 16, No. 2, February 1954, p. 71.
[33] Varvill, W. W., Lead Mining in the British Isles, Part Five: Mine and Quarry Eng., vol. 20, No. 12, December 1954, pp. 532–538 (the 4 previous articles in the series were published in Mine & Quarry Eng., p. 352, August 1954; p. 398, September 1954; p. 436, October 1954; and p. 488, November 1954).
[34] Metal Bulletin (London), No. 3956, Dec. 31, 1954, p. 29; Metal Industry (London), vol. 86, No. 1, Jan. 7, 1955, p. 12.

Consumption of lead in the United Kingdom in 1954 totaled 335,471 long tons compared with 303,753 tons in 1953. The principal uses of lead were for cable coverings (85,825 tons), sheet and pipe (78,594 tons), and batteries, including oxides and compounds (57,751 tons). Apparent total stocks of refined lead were 26,887 metric tons at the beginning of 1954 and 31,173 tons at the end of the year.

Imports of lead metal (mostly from Australia, Canada, and Mexico) increased 10 percent from 1953 to 197,517 long tons in 1954 and exports and reexports decreased 54 percent to 11,465 tons.

Yugoslavia.—The output of recoverable lead from mines in Yugoslavia was 92,735 short tons in 1954, a slight decline (1 percent) from 1953. The production of refined lead totaled 73,556 short tons compared with 78,039 tons in 1953. Most of the mine output of lead in 1954, as usual, came from the Trepca mines in the southernmost area of the Kopaonik mountain range in the vicinity of the town of Kosovska Mitrovica. Nine flotation mills treated the ore from these mines. The reduction plants at Trepca, besides handling ore from the Trepca mines, were central collection points for further treatment and processing of ores of other lead-zinc mines in Serbia andMacedonia. A flotation plant, smelters, and refinery are at Zvecan, a few miles north of Kosovska Mitrovica, and another lead smelter was at Mezica. The major producer among the Trepca mines has been the Stari Trg, with an ore reserve (as of 1953) of 10,500,000 tons containing an estimated 660,000 tons of recoverable lead and zinc combined. The ore mined in 1953 averaged 6.2 percent lead and 2.5 percent zinc and also yielded byproducts, such as silver, cobalt, bismuth, iron pyrites, and manganese. The Stari Trg was the largest lead producer in Europe and one of the most important zinc producers. In addition to the Trepca mines, 15 other Yugoslav mines were in production or under development during the year.

ASIA

Burma.—Mine output of lead in Burma in 1954 was 13,200 short tons and smelter output 12,722 short tons compared with 8,800 and 9,641 tons, respectively, in 1953. The Burma Corp., Ltd., continued to operate Bawdwin silver-lead-zinc mine in the Shan States of northern Burma on an expanding scale. Concentrating ore milled from January through June 1954 [35] totaled 46,034 tons; the output of refined lead was 5,108 tons and that of silver 567,828 ounces compared with 37,956 tons of ore, 3,973 tons of refined lead, and 295,257 ounces of silver during the last 6 months of 1953. Assays of ore milled during the quarter ended June 30, 1954, were 12.975 ounces of silver per ton, 15.991 percent lead, and 10.175 percent zinc. It was reported [36] that, to meet the urgent need for more skilled underground labor in 1954, the Burmese Government sanctioned recruitment from India of a further 300 Gurkha miners. At Mansam Falls hydroelectric generating station, No. 4 generator (4,000 kw.) was successfully brought into commission, bringing the total rehabilitated capacity of the station to 8,000 kw. in preparation for the projected increased milling capacity planned. Reserves of ore at the Bawdwin mine

[35] Mining Journal (London), vol. 243, No. 6226, Dec. 17, 1954, p. 722.
[36] Mining World, vol. 16, No. 11, October 1954, p. 68.

were estimated in 1951 to be 2,736,000 long tons containing 12.5 percent zinc, 20 percent lead, and 15.5 ounces of silver per ton.

The lead smelter and refinery of the Burma Corp. at Namtu had an annual capacity of 73,900 metric tons of refined lead, but only a small portion of the capacity has been utilized since World War II.

India.—Data on mine production of lead in India in 1954 are not available. The Metal Corp. of India, Ltd., had a lead smelter at Tundoo; Katrasgarh, Bihar, and lead-zinc mines at Zewar.

Japan.—Mines in Japan produced 25,176 short tons of lead (metal content of ores) in 1954, most of which was mined in conjunction with zinc, the metal of chief value in the ores. Primary smelter production of lead was 28,916 short tons and that of secondary lead 50,948 tons. Imports of lead were 18,325 short tons.

Thailand (Siam).—Mine production of recoverable lead increased to 5,500 short tons in 1954 from 4,000 tons in 1953. The Consolidated Mining Co., only producer in the country, operated the Nong Plai mine in Kanburi.

AFRICA

Algeria.—Production of lead concentrates in Algeria increased to 14,768 metric tons from 11,756 tons in 1953. The larger producers included the Mines de Sidi Kambar (4,005 tons), Compagnie des Mines d'Ouasta de Mesloula (3,494 tons), Société Algerienne du Zinc (3,232 tons), and Société Minière and Mètallurgique de Penarroya (2,532 tons).

Federation of Rhodesia and Nyasaland.—The only producer of lead and zinc in northern Rhodesia was the Rhodesia Broken Hill Development Co., Ltd., which produced 172,115 dry short tons of lead-zinc ore in 1954 compared with 188,393 tons in 1953. The output of lead and zinc concentrates was 21,900 and 42,297 tons, respectively. The company also operated a lead smelter at Broken Hill with an annual capacity of 18,300 tons of refined lead. The output in 1954 was 16,800 tons. After the federation of the two Rhodesias and Nyasaland was effected, certain legislation was put on a federal basis, in particular that relating to income tax.[37] Company profits were taxable under the Federal law, and under this new form of legislation a benefit accrued to the company by reason of the granting of a depletion allowance which had not been available under Northern Rhodesia law.

In Southern Rhodesia 2 tons of lead concentrate was produced in 1954 and 68 tons in 1953.

French Equatorial Africa.—The Compagnie Minière du Congo Français continued work at the M'Fouati mine, producing 6,500 tons of lead concentrates.[38] As the M'Fouati deposit was nearly exhausted, the company planned to equip the neighboring Hapilo deposit, the ore from which will be taken by cable railway to the M'Fouati plants for concentration.

French Morocco.—The output of lead concentrate (which averaged 72 percent lead) increased from 110,393 metric tons in 1953 to 114,419 tons in 1954. The principal producing companies in 1954 were the Société des Mines de Zellidja (Bou Beker mines), 40,458 metric tons;

[37] Economist (London), May 29, 1954, vol. 171, No. 5779, p. 770.
[38] Metal Bulletin (London), No. 4027, Sept. 16, 1955, p. 11.

Société des Mines d'Aouli (Aouli and Mibladen), 27,188; Compagnie Royale Asturienne des Mines (Touissit mine), 25,699; Société Minière de Haut-Guier, 5,715 tons; Société des Mines de l'Atlas Marocain, 1,645; and Société des Mines de Ksiba, 1,035. Fifty mines produced lead in 1954 compared with 38 in 1953. Small mines produced 7 percent of French Morocco's lead-concentrate production in 1954 and 3 percent in 1953.

The Zellidja-Penarroya lead smelter at Oued-El-Heiner processed 42,406 metric tons of lead concentrate during 1954, producing 26,688 tons of lead metal and 12,992 tons of lead slag. Production in 1953 was 27,433 tons of metal and 10,624 tons of slag.

Exports of lead concentrate in 1954 comprised 72,257 metric tons to France, 1,871 metric tons to West Germany, and 907 tons to other countries. France also received the bulk of the zinc concentrate produced from French Morocco lead-zinc ores. Lead-metal exports totaled more than 25,000 tons. Exports of lead ore were temporarily exempted from the 5-percent ad valorem export tax by decree of June 26, 1954. The 0.5-percent ad valorem statistical service tax remained in force.

Exploration work started a few years ago in French Morocco led to the discovery of two lead deposits that merited further attention.[40] The first, Tsili n'Roumi, was being explored by Société Minière de KSIBA. The second, Djebel Khetem, near Khenibra, was owned by the company formed by the Bureau de Récherches et de Participations Minières and Hadj Omar Sebti. Production at the latter will start after the construction of a washing plant.

Nigeria.—Ore reserves in the Ameri and Nyeba areas of Mines Development Syndicate (West Africa), Ltd., were estimated at between 900,000 and 1,000,000 tons, containing 10 percent lead and 7.3 percent zinc.[39] This has been indicated by diamond drilling. The management has decided to mine and treat the ore on the basis of 250 tons daily.

South-West Africa.—Output of lead contained in ores and concentrates from Southwest Africa totaled 77,146 short tons in 1954 compared with 65,287 tons in 1953. Virtually the entire production was exported, mostly to the United States and Belgium. The Tsumeb mine of Tsumeb Corp., Ltd., continued to be much the largest producer; it was a copper-lead-silver-zinc producer and was equipped with a 1,200-ton flotation mill. The South West Africa Co., operating its Abenab West mine, was the other important lead producer in the Territory.

Tanganyika.—Operation of the pilot concentration plant of Uruwira Minerals, Ltd., at the Mpanda lead-copper mine continued in 1954, and exports of lead concentrate from the mill totaled 4,700 tons compared with 6,100 tons in 1953.[41] The company nearly completed construction of the new 1,200-ton-per-day lead-copper heavy-medium separation and flotation plant at Mukwamba, from which full production was planned for July 1955. The new mill was financed mostly through a United States Government loan of $1,640,000. The dollars will be repaid with 5-percent interest by deliveries of copper and lead

[39] Mining World, vol. 17, No. 3, March 1955, p. 73.
[40] Mining and Industrial Magazine, vol. 44, No. 11, November 1954, p. 418.
[41] South African Mining and Engineering Journal, vol. 65, pt. 2, No. 3235, Feb. 12, 1955, p. 1047.

to the United States stockpile until December 31, 1956. The United States also retained a purchase option on up to 50 percent of production for 10 years after the advance and interest have been paid.

Tunisia.—The output of lead concentrate in Tunisia in 1954 was 51,561 metric tons with a metal content of 26,287 tons, compared with 37,937 and 24,053 tons, respectively, in 1953. The principal producing mines in 1954 were Djebel Semene, with 7,415 metric tons of lead concentrate; El Grefa, 5,915; Sidi Bou Aouane, 5,450; Djebel Hallouf, 4,140; Ressas Touireuf, 3,645; Sakiet Sidi Youssef, 2,954; Sidi Amor, 2,681; and Oued Maden (which also produces mercury ore), 1,763.

Imports of lead concentrate totaled 4,415 tons in 1954, all from Algeria. Production of pig lead in Tunisia totaled 27,190 metric tons, almost the same as in 1953. The Megrine smelter produced 22,843 tons in 1954, Djebel Hallouf smelter 1,970 tons, and the Bizerte smelter 2,377 tons. Exports of lead metal totaled 27,326 tons in 1954.

OCEANIA

Australia.—Mine production of recoverable lead increased to 319,046 short tons in 1954 from 274,303 tons in 1953, and smelter output rose to 224,459 tons from 193,164 tons. Australia's consumption of lead amounted to only 16 percent of the total mine output, leaving 84 percent available for export. The producing districts were Broken Hill and Captain's Flat in New South Wales, Cloncurry (Mount Isa field) in Queensland, and Read-Rosebery in Tasmania.

The four large mines in the Broken Hill district, all equipped with mills, continued operations in 1954. Ore mined at the New Broken Hill Consolidated, Ltd., mine totaled 482,058 metric tons averaging 9.4 percent lead, 14.4 percent zinc, and 2.1 ounces of silver to the ton, according to the company annual report for 1954. Ore milled totaled 483,461 metric tons yielding 56,564 tons of lead concentrate containing 73.6 percent lead and 142.9 ounces of silver to the ton and 127,180 tons of zinc concentrate assaying 51.8 percent zinc. Ore reserves fully outlined and developed ready for stoping, or in process of being stoped, were 2,800,000 tons assaying 11.1 percent lead, 2.7 ounces of silver to the ton, and 11.9 percent zinc. At the end of 1954 buildings had been completed for a second section that was being added to the mill to enable it to treat 540,000 tons of ore a year.

The mine of Zinc Corp., Ltd., produced 594,479 tons of ore, of which 593,209 tons were milled during the year, yielding 11,087 tons of lead concentrate containing 73.7 percent lead and 165.1 ounces of silver to the ton and 110,972 tons of zinc concentrate assaying 52.5 percent zinc. The Broken Hill South, Ltd., mine (including Barrier Central) produced ore yielding 43,377 metric tons of lead, 2,599,955 ounces of silver, and 39,242 tons of zinc in the fiscal year ended June 30, 1954. North Broken Hill, Ltd., milled 379,001 tons of ore in the fiscal year ended June 30, 1954, yielding 69,494 tons of lead concentrate and 70,509 tons of zinc concentrate; ore reserves were 4,616,000 metric tons.

The silver-lead concentrates produced in the Broken Hill district were smelted at the large Port Pirie smelter of Broken Hill Associated Smelters Pty., Ltd. Most of the zinc concentrate was exported.

In the Captain Flats district the Lake George Mines (Pty.), Ltd., milled 175,318 long tons of ore during the fiscal year ended June 30, 1954; mill output was 25,469 tons of zinc concentrate, 13,195 tons of lead concentrate, 4,286 tons of copper concentrate, 21,659 tons of pyrite, and 144 tons of gold concentrate. Ore reserves were 1,949,300 tons of ore averaging 1.02 dwt. gold and 1.30 ounces of silver to the ton, 6.0 percent lead, 10.75 percent zinc, and 0.58 percent copper. Owing to unsettled labor conditions, operations were suspended from June 25, 1954, to the end of the year.

In the Cloncurry district, north Queensland, Mount Isa Mines, Ltd., continued to operate its mine, mill, lead smelter, and the new copper smelter that was put in operation in 1953. Output during 1954 was 3,125,952 ounces of silver, 42,724 tons of lead, 22,308 tons of copper (as metal), and 21,970 tons of zinc concentrate, which was exported. Ore reserves at the end of the fiscal year ended June 30, 1954, were 9,900,000 tons of ore averaging 6.3 ounces of silver to the ton, 8.7 percent lead, and 6.1 percent zinc; and 3,700,000 tons of copper ore, of which 3,644,000 tons of sulfides had an average assay of 4.1 percent copper.

In the Read-Rosebery district the Electrolytic Zinc Co. of Australasia, Ltd., operated its Rosebery and Hercules mines and the Rosebery mill. The mill produced zinc concentrate, which was shipped to the company Risdon electrolytic zinc plant, and lead and copper concentrates, which were shipped to the United States.

Lead and Zinc Pigments and Zinc Salts

By Robert L. Mentch[1] and Esther B. Miller[2]

A FURTHER DECLINE in the volume of business in lead and zinc pigments and zinc salts featured the domestic industry in 1954. Production and shipments of all the pigments and salts covered by this report declined (except production of white lead, which increased slightly), some to the lowest level in many years. Shipments of the pigments—white lead, red lead, litharge, zinc oxide, leaded zinc oxide, and lithopone—decreased 2, 13, 9, 6, 14, and 16 percent, respectively, compared with 1953. Shipments of the zinc salts—zinc chloride and zinc sulfate—decreased 16 and 14 percent, respectively.

Decreases in shipments of pigments and salts were attributed largely to decreases in the volume of business in industries that were important consumers of these products. In 1954 the production of passenger automobiles was 9 percent below the 1953 total, and the output of trucks and buses was 14 percent lower than that in 1953. Consumption of natural and synthetic rubber decreased 8 percent compared with 1953. The value of public and private construction increased 5 percent in 1954, but the value of sales of paint, varnish, and lacquer materials decreased 3 percent. Increased use of substitutes and a reduction in the lead- and zinc-pigment content of paint formulations contributed to the decline in shipments of lead and zinc pigments for the manufacture of paints in recent years.

Lead and zinc (metal, ore, and scrap), the chief raw materials of the pigments industry, were in plentiful supply throughout the year, and the production of lead and zinc pigments was more than adequate to meet demands. Lead and zinc prices recovered somewhat from the low levels of late 1952 and 1953 and became relatively stable in stronger positions at the close of 1954. Common lead, New York, opened at 13.50 cents a pound, reached a low of 12.50 cents in February, subsequently increased in a series of ¼-cent advances to 15 cents on October 5, and continued at that price for the remainder of the year. Prime Western grade slab zinc dropped from 10.00 cents a pound at the beginning of the year to 9.25 cents in February and thereafter increased to 11.50 cents on September 7, at which level it remained for the rest of 1954.

As in previous years, the 1954 lead pigment quotations generally followed the major fluctuations in pig-lead prices. Quotations for the zinc pigments, however, remained essentially unchanged throughout the year owing to the narrow range of prices in slab zinc.

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

TABLE 1.—Salient statistics of the lead[1] and zinc pigments industry of the United States, 1945–49 (average) and 1950–54

	1945–49 (average)	1950	1951	1952	1953	1954
Production (shipments) of principal pigments:						
White lead (dry and in oil)..short tons..	50,971	45,176	35,415	26,663	26,217	25,571
Red lead......do....	34,325	35,072	35,352	30,926	31,333	27,163
Litharge.......do....	143,095	177,658	154,753	140,798	154,518	139,877
Zinc oxide.....do....	141,533	160,829	147,716	142,210	148,627	140,285
Leaded zinc oxide short tons..	63,238	63,973	44,341	37,892	39,712	33,972
Lithopone.....do....	133,311	105,650	102,837	61,832	52,439	44,011
Value of products:						
All lead pigments.....	$64,308,400	$79,858,000	$89,273,000	$72,230,000	$64,303,000	$61,756,000
All zinc pigments.....	50,685,800	71,322,000	74,599,000	63,950,000	56,475,000	50,438,000
Total...............	114,994,200	151,180,000	163,872,000	136,180,000	120,778,000	112,194,000
Value per ton received by producers:						
White lead (dry)......	$263	$335	$426	$403	$378	$383
Red lead..............	273	314	397	376	312	323
Litharge..............	273	292	383	348	285	303
Zinc oxide............	181	258	311	307	264	255
Leaded zinc oxide.....	190	262	320	313	259	258
Lithopone.............	97	124	141	137	132	135
Foreign trade:						
Lead pigments:						
Value of exports....	$1,089,200	$950,000	$984,000	$933,000	$799,000	$872,000
Value of imports....	189,400	344,000	1,797,000	451,000	16,000	149,000
Zinc pigments:						
Value of exports.....	4,079,800	2,124,000	6,855,000	4,352,000	1,468,000	1,351,000
Value of imports....	19,800	1,275,000	930,000	90,000	287,000	515,000
Export balance.	4,959,800	1,455,000	5,112,000	4,744,000	1,964,000	1,559,000

[1] Excludes basic lead sulfate, data for which are withheld to avoid disclosure of individual company operations.

Shipments of white lead (dry) in 1954 increased 3 percent while shipments of the "in-oil" variety decreased 12 percent. Total shipments of both varieties declined for the fourth successive year and were the smallest since long before the beginning of the present century, reflecting, to a great extent, the marked increase in utilization of competitive white pigments. Shipments of red lead and litharge decreased 13 and 9 percent, respectively, during the year and were the lowest since 1949. Figure 1 shows trends in shipments of lead pigments for 1910–54.

Lead-free zinc oxide shipments declined 6 percent from the 1953 total and were the smallest since 1949. Producers' deliveries of the leaded grades of zinc oxide dropped 14 percent and were the lowest since 1935. The use of lithopone has declined markedly in recent years; in 1954 shipments were 16 percent lower than in 1953 and 67 percent lower than average annual shipments in 1945–49. The 1954 total was considerably below shipments for all years from 1915 to 1953, inclusive. Figure 2 shows trends in shipments of zinc pigments for 1910–54.

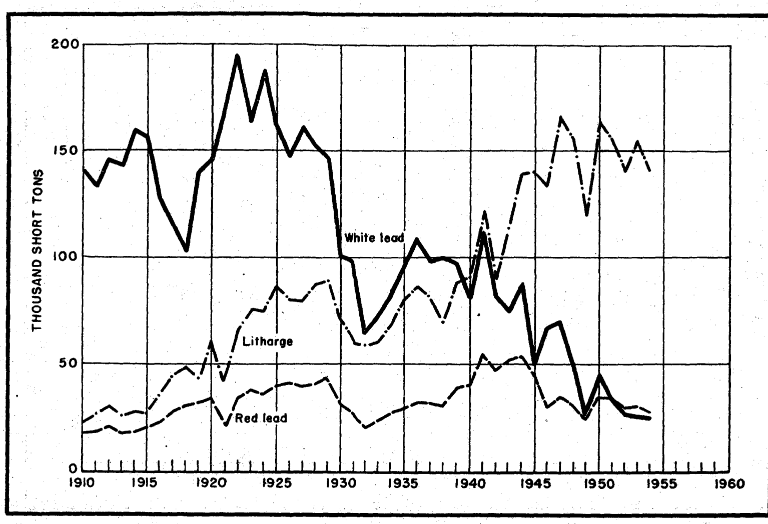

FIGURE 1.—Trends in shipments of lead pigments, 1910–54.

The distribution pattern of shipments of pigments to consumers in 1954 was essentially the same as in previous years. The paint industry continued to be by far the largest user of white lead, leaded zinc oxide, and lithopone, receiving approximately 82, 99, and 73 percent, respectively, of total shipments of these products. The paint industry was also the largest consumer of red lead, taking 46 percent of shipments. In addition, 22 percent of zinc oxide (lead-free) shipments and 6 percent of litharge shipments went into paint manufacture. Storage-battery makers were the chief users of litharge and the second largest users of red lead, receiving 68 and 44 percent, respectively, of producers' shipments. The rubber industry continued as the largest consumer of zinc oxide, receiving 51 percent of total shipments. Relatively small quantities of litharge and lithopone also were used in manufacturing rubber products. The ceramics industry ranks fourth in consumption of lead and zinc pigments, being surpassed only by the paint, storage-battery, and rubber industries. In 1954, 12 percent of litharge shipments, 6 percent of lead-free zinc oxide shipments, 4 percent of red lead shipments, and 2 percent of white lead shipments were used in making ceramics.

Titanium pigments continued to furnish the chief competition to lead and zinc pigments in paintmaking. Production and shipments of titanium pigments established new highs in 1954, increasing slightly over the 1953 totals. The use of titanium pigments has about doubled over the 10 years 1945–54, an indication of the extent to which titanium pigments have displaced lead and zinc pigments, chiefly white lead and lithopone, in paint formulations. At present the Bureau of Mines is not at liberty to publish statistics for titanium pigments. Producers and details of the distribution of shipments are given in the Titanium chapter of Minerals Yearbook 1954.

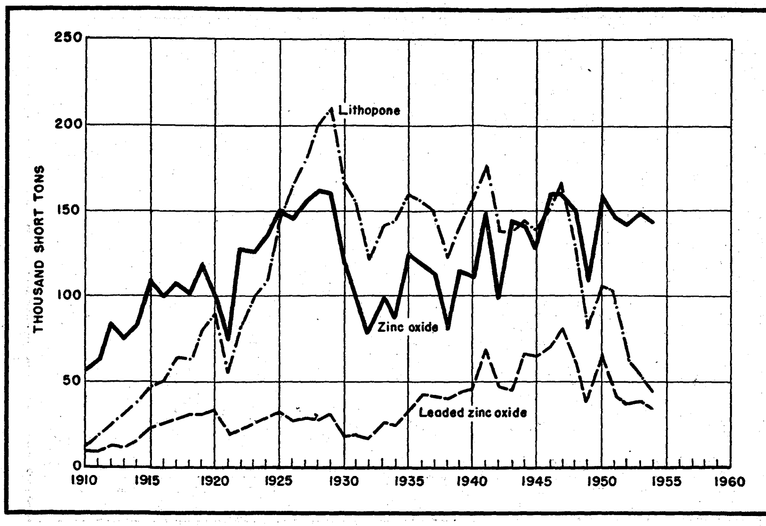

FIGURE 2.—Trends in shipments of zinc pigments, 1910–54.

PRODUCERS AND PLANTS

A list of companies producing lead and zinc pigments and zinc salts, plants, and products manufactured is given in the Lead and Zinc Pigments and Zinc Salts chapter of Minerals Yearbook, vol. I, 1953. In addition to the companies shown, the Esmond Chemical Co. produced zinc oxide in 1954. The Eagle-Picher Co. disposed of its East Chicago, Ill., plant (red lead and litharge) in June 1953.

PRODUCTION

The value of shipments of lead and zinc pigments in 1954 (exclusive of that for basic lead sulfate and zinc sulfide, which cannot be shown) was $112 million, a 7-percent decrease from 1953. Lead pigments comprised 55 percent of the total value and zinc pigments 45 percent compared with 53 and 47 percent, respectively, in 1953.

For many years figures on "sales" were used in this series of reports as a better guide than production to activity in the pigments industry. Beginning with 1945 the base was changed to "shipments" to conform with data compiled on Bureau of Mines lead and zinc schedules. Available information for 1945 (the year of change) indicates little difference between sales and shipments in that year. In reporting tonnages of pigments an attempt is made to avoid all duplication, one of the chief problems being that finished pigments frequently are blended to make another product. Basic lead sulfate and zinc oxide, for example, are blended to make leaded zinc oxide, and in this instance the pigment weights appear in the total for the last-named class only. Pigments consumed by producing companies to make products beyond those covered by this report—that is, paints, storage batteries, and other articles—are considered shipments.

LEAD PIGMENTS

Combined shipments of the lead pigments covered by this report decreased 9 percent in quantity and 4 percent in value in 1954. The average value of white lead (dry) in 1954 was $383 per ton, 1 percent above the 1953 value; red lead sold at an average of $323 per ton, 4 percent higher than the 1953 average; and litharge brought $303 per ton, up 6 percent from 1953.

White Lead.—The downward trend in the use of white lead continued in 1954 but at a reduced rate. Total shipments declined slightly from 1953, and output in recent years has been the lowest by far since long before the beginning of the 20th century. The extent of the decline is revealed by a comparison of statistics for selected years; in 1954 shipments totaled 25,600 tons, a decrease of 69 percent from the 1941–45 average of 81,900 tons and down 83 percent from average yearly shipments of 154,500 tons in 1925–29.

Basic Lead Sulfate.—The Bureau of Mines is not at liberty to publish figures on basic lead sulfate for 1946–54.

Red Lead.—Shipments of red lead decreased 13 percent in 1954 and were 50 percent lower than in 1944, the peak year.

Orange Mineral.—No shipments of orange mineral were reported in 1947–54.

Litharge.—Shipments of litharge declined 9 percent in 1954 and were the lowest since 1949.

Battery makers produced 79,000 tons of black or gray suboxide of lead in 1954 for their own use in place of litharge. This quantity compares with 82,000 tons in 1953 and 76,000 tons in 1952. This suboxide production required 76,000 tons of pig lead in 1954, 78,000 tons in 1953, and 72,000 tons in 1952.

TABLE 2.—Production and shipments of lead pigments[1] in the United States, 1953–54

Pigment	1953				1954			
	Production (short tons)	Shipments			Production (short tons)	Shipments		
		Short tons	Value[2]			Short tons	Value[2]	
			Total	Average			Total	Average
White lead:								
Dry	16,544	16,784	$6,337,051	$378	17,359	17,235	$6,598,680	$383
In oil[3]	9,249	9,433	4,210,823	446	8,479	8,336	3,990,053	479
Red lead	32,009	31,333	9,776,657	312	26,906	27,163	8,765,997	323
Litharge	156,871	154,518	43,978,371	285	140,084	139,877	42,401,256	303

[1] Except for basic lead sulfate, figure for which is withheld to avoid disclosure of individual company operations.
[2] At plant, exclusive of container.
[3] Weight of white lead only, but value of paste.

TABLE 3.—Lead pigments[1] shipped by manufacturers in the United States, 1945–49 (average) and 1950–54, in short tons

Year	White lead			Red lead	Orange mineral	Litharge
	Dry	In oil	Total			
1945–49 (average)	29,118	21,853	50,971	34,325	71	143,095
1950	28,506	16,670	45,176	35,072		177,658
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		139,877

[1] Excludes basic lead sulfate, data for which are withheld to avoid disclosure of individual company operations.

ZINC PIGMENTS AND SALTS

Total shipments of the major zinc pigments decreased 9 percent in quantity and 11 percent in value in 1954. Shipments of lead-free zinc oxide, the most important of the zinc pigments in tonnage and total value, decreased 6 percent. Shipments of leaded zinc oxide declined 14 percent, and shipments of lithopone decreased 16 percent.

Average values of zinc pigments as reported by producers were mixed compared with 1953 prices. The average price for zinc oxide (lead-free) in 1954 declined $9 per ton to $255; leaded zinc oxide was down $1 per ton to $258; lithopone advanced $3 per ton to $135.

Shipments of the zinc salts, zinc chloride and zinc sulfate, decreased 16 and 14 percent, respectively, in 1954. The average value of zinc chloride (50° B. solution) dropped $3 to $90 per ton whereas the average price received for zinc sulfate increased 10 percent to $158 per ton.

TABLE 4.—Production and shipments of zinc pigments and salts in the United States, 1953–54

Pigment or salt	1953				1954			
	Production (short tons)	Shipments			Production (short tons)	Shipments		
		Short tons	Value[1]			Short tons	Value[1]	
			Total	Average			Total	Average
Zinc oxide[2]	155,645	148,627	$39,266,282	$264	135,908	140,285	$35,742,797	$255
Leaded zinc oxide[2]	39,819	39,712	10,284,801	259	34,318	33,972	8,765,719	258
Lithopone	54,593	52,439	6,923,487	132	39,090	44,011	5,929,789	135
Zinc chloride, 50° B	60,234	57,537	5,323,919	93	52,241	48,252	4,357,178	90
Zinc sulfate	22,449	22,220	3,181,411	143	18,496	19,027	3,004,621	158

[1] Value at plant, exclusive of container.
[2] Zinc oxide containing 5 percent or more lead is classed as leaded zinc oxide. In this table data for leaded zinc oxide include a small quantity containing less than 5 percent lead.

TABLE 5.—Zinc pigments and salts shipped by manufacturers in the United States, 1945–49 (average) and 1950–54, in short tons

Year	Zinc oxide	Leaded zinc oxide	Lithopone	Zinc chloride (50° B.)	Zinc sulfate
1945–49 (average)	141,533	63,238	133,311	60,595	21,782
1950	160,829	63,973	105,650	64,564	23,912
1951	147,716	44,341	102,837	60,730	23,524
1952	142,210	37,892	61,832	51,966	19,587
1953	148,627	39,712	52,439	57,537	22,220
1954	140,285	33,972	44,011	48,252	19,027

Zinc Oxide.—Lead-free zinc oxide shipments declined 6 percent from the 1953 total and were the lowest since 1949.

TABLE 6.—Production of zinc oxide (lead-free) by processes, 1945–49 (average) and 1950–54, as percent of total

Process	1945–49 (average)	1950	1951	1952	1953	1954
American process (ore and primary residues)	75	72	75	74	74	68
French process (metal and scrap)	16	18	18	20	20	21
Other	9	10	7	6	6	11
Total	100	100	100	100	100	100

Leaded Zinc Oxide.—Shipments of leaded zinc oxide decreased 14 percent and were the smallest since 1935.

Four grades of leaded zinc oxide, classified according to lead content, are produced in the United States. The bulk of the output falls into the 5- to 35-percent grade, but small quantities are produced as less than 5-percent grade, over 35- to 50-percent grade, and over 50-percent grade. For publication purposes, the under 5-percent and 5- to 35-percent grade are combined. The two higher grades are also combined. Output in 1954 (comparison with 1953 in parentheses) was as follows: 30,343 (35,517) tons of 35 percent lead and under and 3,975 (4,302) tons of over 35 percent lead.

Lithopone.—Lithopone shipments dropped 16 percent from the 1953 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 diminished to very small proportions. The trend has been downward almost continuously since 1937, when 19,400 tons was used in making the titanated variety. The tonnage consumed for this purpose in 1953 was 60 percent below the quantity used in 1952 and was the smallest on record. The Bureau of Mines is not at liberty to divulge statistics on the 1954 production of titanated lithopone (see table 7). However, the quantity is included in the totals for ordinary lithopone in other tables.

Zinc Sulfide.—In 1954 only one company produced zinc sulfide, hence the Bureau of Mines is not at liberty to publish figures for this pigment.

Zinc Chloride.—Shipments of zinc chloride decreased 16 percent in 1954 and were the lowest since the current series of data was begun in 1942.

Zinc Sulfate.—Zinc sulfate shipments (gross weight) fell 14 percent in 1954; the tonnage was the smallest since 1944.

TABLE 7.—Titanated lithopone produced in the United States and ordinary lithopone used in its manufacture, 1945–49 (average) and 1950–54, in short tons

Year	Titanated lithopone produced	Ordinary lithopone used	Year	Titanated lithopone produced	Ordinary lithopone used
1945–49 (average)	4,680	3,950	1952	900	750
1950	3,400	2,900	1953	360	300
1951	1,550	1,300	1954	(1)	(1)

[1] Figure withheld to avoid disclosure of individual company operations.

RAW MATERIALS USED

Figures covering the raw materials used in making pigments and salts in 1954 and 1953 are shown in tables 8 and 9.

Lead pigments and zinc pigments and salts are manufactured from a variety of materials, including ore, refined metal, and such secondary materials as scrap, residues, ashes, drosses, and skimmings. In 1954 approximately 96 percent of the lead in pigments was derived from pig lead and the remainder from ore; in 1952–53 about 95 percent of the contained lead was from metal. Of the lead in ore used to make leaded zinc oxide, about 34 percent (23 in 1953) was from foreign sources. The proportion of zinc from various sources used in zinc pigments was as follows: 72 percent (74 in 1953) from ore and concentrates, 14 (14) percent from slab zinc, and 14 (12) percent from secondary materials; about 30 (33) percent of the ore used was of foreign origin.

Tables 8 and 9 give the source of the metal used in manufacturing each pigment and salt. Pig lead was employed exclusively, either directly or indirectly, in manufacturing white lead, litharge, red lead, and orange mineral and also in manufacturing basic lead sulfate. The lead content of leaded zinc oxide made from basic lead sulfate, which in turn is made from pig lead, was credited to pig lead in the table. In recent years, however, basic lead sulfate has been made almost exclusively from lead ore. Zinc oxide was the only pigment for which considerable slab zinc was used. Ore was employed in manufacturing zinc oxide, leaded zinc oxide, lithopone, zinc sulfide, zinc sulfate, and basic lead sulfate. A large proportion of the zinc contained in lithopone (21 percent in 1954 and 43 in 1953) and virtually all of that in zinc chloride (100 percent in 1954 and 1953) produced in the United States has been derived from secondary material. The proportion of zinc oxide production derived from metal and scrap increased to 33 percent in 1954 compared with 29 percent in 1953.

TABLE 8.—Lead content of lead and zinc pigments[1] produced by domestic manufacturers, by sources, 1953–54, in short tons

Pigment	1953: Lead in pigments produced from— Ore: Domestic	1953: Ore: Foreign	1953: Pig lead	1953: Total lead in pigments	1954: Lead in pigments produced from— Ore: Domestic	1954: Ore: Foreign	1954: Pig lead	1954: Total lead in pigments
White lead			20,634	20,634			20,670	20,670
Red lead			29,016	29,016			24,390	24,390
Litharge			145,890	145,890			131,016	131,016
Leaded zinc oxide	7,367	2,186		9,553	5,240	2,729		7,969
Total	7,367	2,186	195,540	205,093	5,240	2,729	176,076	184,045

[1] Excludes lead in basic lead sulfate, data for which are withheld to avoid disclosure of individual company operations.

TABLE 9.—Zinc content of zinc pigments[1] and salts produced by domestic manufacturers, by sources, 1953–54, in short tons

Pigment or salt	1953: Zinc in pigments and salts produced from— Ore: Domestic	1953: Ore: Foreign	1953: Slab zinc	1953: Secondary material[2]	1953: Total zinc in pigments and salts	1954: Zinc in pigments and salts produced from— Ore: Domestic	1954: Ore: Foreign	1954: Slab zinc	1954: Secondary material[2]	1954: Total zinc in pigments and salts
Zinc oxide	57,315	31,391	21,022	14,548	124,276	53,112	19,969	18,584	17,051	108,716
Leaded zinc oxide	15,107	5,121			20,228	11,207	6,553			17,760
Lithopone	4,378	1,635	9	4,489	10,511	3,061	2,883		1,593	7,537
Total pigments	76,800	38,147	21,031	19,037	155,015	67,380	29,405	18,584	18,644	134,013
Zinc chloride				13,644	13,644				12,271	12,271
Zinc sulfate	2,350	947		4,214	7,511	1,418	1,044		3,907	6,369

[1] Excludes zinc sulfide, data for which are withheld to avoid disclosure of individual company operations.
[2] These figures are higher than those shown in the report on Secondary Metals—Nonferrous because they include zinc recovered from byproduct sludges, residues, etc., not classified as purchased scrap material.

CONSUMPTION AND USES

LEAD PIGMENTS

White Lead.—The principal use of white lead was in paintmaking; shipments to the paint industry usually account for 90 percent or more of the total. In 1954, however, and in some other recent years the customary percentage was not indicated by available statistics. This situation probably was due to the inability of shippers to give complete data on end-use classification. It is known that in the past some white lead sold to the Government was reported under "Other," and it is likely that a substantial part of the entire "Other" classification belongs properly under paint. Shipments to ceramic makers and manufacturers of plasticizers and stabilizers accounted for 2 and 4 percent, respectively, of the total distribution in 1954.

TABLE 10.—Distribution of white lead (dry and in oil) shipments,[1] by industries, 1945–49 (average) and 1950–54, in short tons

Industry	1945–49 (average)	1950	1951	1952	1953	1954
Paints	45,955	38,920	28,718	21,223	21,030	20,929
Ceramics	1,227	1,815	1,548	1,079	785	487
Other	3,789	[2] 4,441	[2] 5,149	[2] 4,361	[2] 4,402	[2] 4,155
Total	50,971	45,176	35,415	26,663	26,217	25,571

[1] Excludes basic lead sulfate, data for which are withheld to avoid disclosing individual company operations.
[2] Includes the following tonnages for plasticizers and stabilizers: 1950—1,257; 1951—1,003; 1952—986; 1953—1,089; 1954—1,133.

Basic Lead Sulfate.—Statistics covering distribution of basic lead sulfate shipments by uses have not been available for publication since 1945, when 3,000 tons went to the paint industry, 200 tons to the rubber industry, and 700 tons to other industries. Substantial quantities of lead sulfate are used as an intermediate product in manufacturing leaded zinc oxide. Such quantities have always been shown in this chapter under leaded zinc oxide rather than basic lead sulfate.

Red Lead.—The paint industry again was the largest consumer of red lead in 1954. Storage-battery makers (the chief users until 1953) received 44 percent of total shipments in 1954 compared with 46 percent for paint manufacturers. In 1953 shipments for storage batteries and paints were 45 and 47 percent, respectively, of the total, whereas in 1952 the percentages were 45 and 43, respectively, and in the period 1929–51 storage-battery makers usually received well over 50 percent of total shipments. Relatively small quantities were used in making ceramics.

TABLE 11.—Distribution of red-lead shipments, by industries, 1945–49 (average) and 1950–54, in short tons

Industry	1945–49 (average)	1950	1951	1952	1953	1954
Paints	11,523	14,103	14,740	13,149	14,570	12,568
Storage batteries	18,748	17,478	16,722	13,796	13,975	12,062
Ceramics	942	981	834	388	1,188	1,207
Other	3,112	2,510	3,056	3,593	1,600	1,326
Total	34,325	35,072	35,352	30,926	31,333	27,163

Orange Mineral.—No shipments of orange mineral have been reported since 1946 when 123 tons went to various industries.

Litharge.—The use of litharge for storage batteries regularly accounts for roughly two-thirds of total shipments; in 1954 the proportion was 68 percent compared with 67 percent in 1953. The ceramics industry was the second largest consumer of litharge; shipments for this purpose comprised 12 percent of the total in 1954. Shipments for chrome pigments declined 49 percent, while shipments for insecticides and varnish increased 9 and 6 percent, respectively; total shipments for all purposes decreased 9 percent.

TABLE 12.—Distribution of litharge shipments, by industries, 1945–49 (average) and 1950–54, in short tons

Industry	1945–49 (average)	1950	1951	1952	1953	1954
Storage batteries	89,093	105,558	94,064	97,656	103,849	94,659
Ceramics	15,263	27,771	22,815	15,906	20,924	17,118
Chrome pigments	9,502	10,017	11,117	8,376	8,821	4,335
Varnish	3,804	4,347	5,584	5,572	3,915	4,162
Oil refining	6,752	6,488	6,068	4,080	4,342	3,775
Insecticides	10,199	10,651	5,691	2,724	2,305	2,501
Rubber	2,087	3,047	2,641	2,109	2,230	1,768
Floor coverings	115	220	1,772	791	603	596
Other	6,280	9,559	5,001	3,584	7,529	10,966
Total	143,095	177,658	154,753	140,798	154,518	139,877

ZINC PIGMENTS AND SALTS

Zinc Oxide.—Shipments of lead-free zinc oxide to consuming industries followed the same distribution pattern in 1954 as in previous years. The rubber industry and paint manufacturers remained by far the leading consumers, accounting for 51 (53 in 1953) and 22 percent (21), respectively, of total shipments. Shipments for ceramics and coated fabrics and textiles (chiefly rayon) comprised 6 and nearly 5 percent, respectively, of the total (each 6 percent in 1953). Shipments to all consuming industries except ceramics decreased in 1954.

TABLE 13.—Distribution of zinc oxide shipments, by industries, 1945–49 (average) and 1950–54, in short tons

Industry	1945–49 (average)	1950	1951	1952	1953	1954
Rubber	74,172	82,944	71,507	72,774	78,439	71,058
Paints	29,730	39,699	32,934	31,424	31,920	31,157
Ceramics	8,960	12,679	10,324	7,760	8,862	8,990
Coated fabrics and textiles [1]	12,232 (with Floor coverings)	6,303	7,265	6,262	8,718	6,322
Floor coverings		3,670	3,114	2,413	2,234	1,749
Chemical warfare	411	(2)	(2)	(2)	(2)	(2)
Other	16,028	15,534	22,572	21,577	18,454	21,009
Total	141,533	160,829	147,716	142,210	148,627	140,285

[1] Includes the following tonnages for rayon: 1950—4,850; 1951—5,275; 1952—5,852; 1953—7,388; 1954—5,603.
[2] Included with "Other."

Leaded Zinc Oxide.—Leaded zinc oxide (all grades) was used almost exclusively as a pigment in paint manufacturing in 1954, 99 percent of total shipments went to paintmakers. Small quantities (less than 1 percent) were used by the rubber industry and for other diverse products.

TABLE 14.—Distribution of leaded zinc oxide shipments, by industries, 1945–49 (average) and 1950–54, in short tons

Industry	1945–49 (average)	1950	1951	1952	1953	1954
Paints	60,502	63,002	43,678	37,607	39,276	33,690
Rubber	168	240	82	9	41	7
Other	2,568	731	581	276	395	275
Total	63,238	63,973	44,341	37,892	39,712	33,972

Lithopone.—Lithopone was used principally in the manufacturing of paints, varnish, and lacquers; approximately three-fourths of total shipments went to these industries. In 1954 shipments for paints, etc., comprised 73 percent (71 in 1953) of the total. Other uses of lithopone were in coated fabrics and textiles, floor coverings, paper, rubber, and printing ink.

TABLE 15.—Distribution of lithopone shipments, by industries, 1945–49 (average) and 1950–54, in short tons

Industry	1945–49 (average)	1950	1951	1952	1953	1954
Paint, varnish, and lacquers [1]	105,619	78,177	76,614	45,267	37,452	32,177
Coated fabrics and textiles	7,247	7,945	4,814	5,698	5,806	3,995
Floor coverings	9,213	5,297	4,620	3,009	2,575	2,351
Paper	3,471	3,821	6,462	3,089	2,096	1,841
Rubber	2,621	4,092	3,295	1,523	1,723	1,701
Printing ink	(2)	838	868	657	716	195
Other	5,140	5,480	6,164	2,589	2,071	1,751
Total	133,311	105,650	102,837	61,832	52,439	44,011

1 Includes a small quantity, not separable, used for printing ink, except in 1950, 1951, and 1952.
2 Included in "Other" before 1950, except for those quantities reported under "Paint, varnish, and lacquers."

Zinc Chloride.—Complete statistics on the end-use distribution of zinc chloride shipments are not available. The principal uses of the salt are in soldering and tinning fluxes, battery manufacturing, galvanizing, vulcanized fiber, wood preserving, oil refining, and fungicides.

Zinc Sulfate.—Agriculture supplanted the textile (rayon) industry as the chief consumer of zinc sulfate in 1954. Shipments for agricultural purposes (fertilizers and fungicides) composed 37 percent (30 in 1953) of the total compared with 35 percent (41) for rayon. Among the smaller uses, shipments for glue, electrogalvanizing, and paint and varnish processing increased, while shipments for chemicals, flotation reagents, and textile dyeing and printing decreased.

TABLE 16.—Distribution of zinc sulfate shipments, by industries, 1945–49 (average) and 1950–54, in short tons

Industry	1945–49 (average)	1950		1951		1952		1953		1954	
	Gross weight	Gross weight	Dry basis	Gross weight	Dry basis	Gross weight	Dry basis	Gross weight	Dry basis	Gross weight	Dry basis
Agriculture	6,985	5,841	4,880	5,588	4,847	5,111	4,446	6,773	5,894	7,067	6,139
Rayon	8,613	11,217	8,322	10,073	7,925	8,181	6,812	9,008	7,612	6,615	5,740
Chemicals	1,984	1,879	1,377	2,871	2,243	1,675	1,489	2,539	2,105	2,300	1,973
Glue	482	579	464	396	337	391	329	601	501	648	545
Flotation reagents	1,196	952	727	858	736	1,070	950	736	648	357	317
Electrogalvanizing	302	324	203	190	129	342	243	337	225	454	301
Paint and varnish processing	322	189	119	32	20	172	130	106	70	130	114
Textile dyeing and printing	256	145	129	1,400	1,163	350	301	155	138	4	4
Other	1,642	2,786	1,820	2,116	1,274	2,295	1,422	1,965	1,219	1,452	1,024
Total	21,782	23,912	18,041	23,524	18,674	19,587	16,122	22,220	18,412	19,027	16,157

PRICES

Total and average values received by producers for lead and zinc pigments and zinc salts are given in the first part of this report. Average values of litharge, red lead, and white lead increased $18, $11, and $5 per ton in 1954 but remained well below the record highs established in 1951. The price of pig lead fluctuated from a low of 12.50 cents a pound in February to a high of 15.00 cents in October; the average quoted price for the year at New York was 14.05 cents compared with 13.48 cents in 1953.

TABLE 17.—Range of quotations on lead pigments, and zinc pigments and salts at New York (or delivered in the East), 1951–54, in cents per pound

[Oil, Paint and Drug Reporter]

Product	1951	1952	1953	1954
White lead (basic lead carbonate), dry, carlots, bags, barrels	18.50–20.10	16.25–20.10	16.25–17.25	16.00–17.50
Basic lead sulfate (sublimed lead), less than carlots, bags, barrels	18.75–20.19	15.75–20.19	15.00–15.75	15.75–16.75
Red lead, dry, 95 percent or less, less than carlots, barrels	20.75–22.57	17.25–22.57	15.75–18.50	15.50–18.00
Orange mineral, American, less than carlots, barrels	23.10–24.92	19.60–24.92	18.10–20.85	17.85–20.60
Litharge, commercial, powdered, less than carlots, barrels	19.75–21.65	16.25–21.65	14.75–17.50	14.50–17.00
Zinc oxide:				
American process, lead-free, bags, carlots	16.00–17.60	14.25–17.60	13.50–14.25	13.50
American process, 5 to 35 percent lead, barrels, bags, carlots	16.88–18.35	14.40–18.35	14.00–14.40	14.00–14.25
French process, red seal, bags, carlots	17.25–18.85	15.25–18.85	14.75–15.50	14.75
French process, green seal, bags, carlots	17.75–19.35	16.00–19.35	15.25–16.00	15.25
French process, white seal, barrels, bags, carlots	18.25–19.85	16.50–19.85	15.75–16.50	15.75
Lithopone, ordinary, less than carlots, bags	8.50– 8.90	8.25– 8.90	8.25– 8.50	8.25– 8.50
Zinc sulfide, less than carlots, bags, barrels	25.00–26.30	26.30	25.30–26.30	25.30
Zinc chloride, works:				
Solution, tanks	4.10– 5.35	4.10– 5.35	4.10– 4.85	4.85
Fused, drums	9.85	9.60– 9.85	9.85–10.85	10.10–10.85
Zinc sulfate, crystals,[1] less than carlots, barrels	10.15–11.20	18.10–11.20	8.10–10.30	7.90– 8.60

[1] Includes granulated.

Average values received for the zinc pigments, zinc oxide, leaded zinc oxide, and lithopone declined $9, $1, and $3 per ton, respectively, in 1954. Quotations for Prime Western grade slab zinc, East St. Louis, ranged from a low of 9.25 cents a pound in February to a high of 11.50 cents in September; the average price for the year was 10.69 cents compared with 10.86 cents in 1953.

FOREIGN TRADE [3]

Foreign trade in lead and zinc pigments and salts has comparatively minor importance in relation to domestic shipments of these commodities. In 1954 the tonnage and value of imports were more than double the 1953 rate, while the quantity and value of exports declined slightly. The value of major classes of exports was $2,223,000 compared with $2,267,000 in 1953. The value of imports of lead and zinc pigments increased from $303,000 to $664,000.

Imports of lead pigments were small in 1954 and consisted chiefly of litharge which totaled 600 tons (60 tons in 1953). Imports of zinc products included 2,300 tons of zinc oxide, by far the chief item in tonnage and value; 400 tons of zinc sulfate; nearly 300 tons of zinc chloride; and 100 tons of zinc sulfide.

The United States exported comparatively small quantities of litharge, white lead, lead arsenate, and red lead in 1954; the totals constituted only a small portion of shipments by domestic producers.

TABLE 18.—Value of foreign trade of the United States in lead and zinc pigments and salts, 1952–54

[U. S. Department of Commerce]

	Imports for consumption			Exports		
	1952	1953	1954	1952	1953	1954
Lead pigments:						
White lead	$139,829	$44		$222,092	$219,514	$289,901
Red lead	623	47	$508	183,649	153,830	124,613
Litharge	273,719	15,281	134,413	527,450	425,848	457,078
Other lead pigments	36,386	678	14,219	(1)	(1)	(1)
Total	450,557	16,050	149,140	(1)	(1)	(1)
Zinc pigments:						
Zinc oxide	88,056	275,122	[2] 475,913	2,720,203	883,821	897,065
Zinc sulfide		6,460	31,858	(1)	(1)	(1)
Lithopone	2,308	5,658	7,029	1,632,106	584,279	454,461
Total	90,364	287,240	[2] 514,800	4,352,309	1,468,100	1,351,526
Lead and zinc salts:						
Lead arsenate	36,879			62,498	83,139	161,607
Other lead compounds	12,550	6,457	[2] 20,337	32,577	10,573	23,555
Zinc arsenate	22	27		(1)	(1)	(1)
Zinc chloride	79,645	25,379	34,075	(1)	(1)	(1)
Zinc sulfate	10,767	3,958	32,957	(1)	(1)	(1)
Total	139,863	35,821	[2] 87,369	(1)	(1)	(1)
Grand total	680,784	339,111	[2] 751,309	(1)	(1)	(1)

[1] Data not available.
[2] Due 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.

Zinc oxide and lithopone were the pigments (of the classes covered by this report) exported in greatest tonnages from the United States. Exports of zinc oxide increased 5 percent in 1954 whereas exports of lithopone decreased 23 percent; the quantities exported comprised 2 and 7 percent, respectively, of total shipments by producers.

TABLE 19.—Lead pigments and salts imported for consumption in the United States, 1945–49 (average) and 1950–54

[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	
1945–49 (average)	73	69	320	22	7	12	(1)	$193,656
1950	944	70	12	57	27	----------	2	344,555
1951	2,575	215	1,855	53	----------	7	180	1,868,034
1952	390	2	621	53	(1)	81	32	499,986
1953	(1)	(1)	60	1	4	----------	18	22,507
1954	----------	2	596	28	----------	----------	86	(2) 169,477

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

TABLE 20.—Zinc pigments and salts imported for consumption in the United States, 1945–49 (average) and 1950–54

[U. S. Department of Commerce]

Year	Short tons							Total value
	Zinc oxide		Lithopone	Zinc sulfide	Zinc chloride	Zinc arsenate	Zinc sulfate	
	Dry	In oil						
1945–49 (average)	85	(1)	2	(1)	4	----------	286	$33,912
1950	5,093	2	1,201	33	210	----------	159	1,317,141
1951	1,772	10	794	----------	714	----------	201	1,140,624
1952	173	(1)	11	----------	275	(1)	66	180,798
1953	1,157	29	30	23	179	(1)	46	316,604
1954	2,348	----------	65	106	260	----------	399	(2) 581,832

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

TABLE 21.—Lead pigments and salts exported from the United States, 1945–49 (average) and 1950–54

[U. S. Department of Commerce]

Year	Short tons					Total value
	White lead	Red lead	Litharge	Lead arsenate	Other lead compounds	
1945–49 (average)	1,443	1,212	1,581	1,514	(1)	$1,545,415
1950	815	549	1,612	520	32	[2] 1,186,232
1951	767	585	1,038	313	70	[2] 1,195,400
1952	675	435	1,233	128	36	[2] 1,028,266
1953	818	417	1,238	152	12	[2] 892,904
1954	951	335	1,284	355	31	1,056,754

[1] Classification established 1949; quantity and value not included in averages.
[2] Revised figure.

TABLE 22.—Zinc pigments exported from the United States, 1945–49 (average) and 1950–54

[U. S. Department of Commerce]

Year	Short tons		Total value	Year	Short tons		Total value
	Zinc oxide	Lithopone			Zinc oxide	Lithopone	
1945–49 (average)	10,164	[1] 14,088	$4,079,902	1952	7,615	9,985	$4,352,309
1950	3,094	9,357	2,124,367	1953	2,971	3,927	1,468,100
1951	8,895	20,473	6,854,600	1954	3,111	3,013	1,351,526

[1] Includes zinc sulfide.

Lime

By John E. Holtzinger,[1] Annie L. Marks,[2] and James M. Foley[2]

LIME output in 1954 declined considerably from the record established in 1953, as distribution to all major consuming groups decreased. Lime sold or used totaled 8,629,000 tons in 1954, compared with 9,674,000 tons in 1953. Open-market sales in 1954 totaled 7,180,000 short tons, a decrease of approximately 12 percent from 1953.

TABLE 1.—Salient statistics of lime sold or used in the United States, 1945–49 (average) and 1950–54

	1945–49 (average)	1950	1951	1952	1953	1954
Active plants	182	168	155	160	156	154
Sold or used by producers:						
By types:						
Quicklime ... short tons	3, 494, 545	3, 833, 872	4, 369, 269	4, 262, 229	5, 337, 268	5, 128, 370
Hydrated lime ... do	1, 655, 566	1, 885, 101	1, 919, 783	1, 882, 824	2, 042, 100	1, 979, 895
Dead-burned dolomite ... do	1, 304, 796	1, 759, 443	1, 966, 460	1, 928, 025	2, 294, 815	1, 520, 854
Total lime:						
Short tons	6, 454, 907	7, 478, 416	8, 255, 512	8, 073, 078	9, 674, 183	8, 629, 119
Value [1]	$61, 051, 925	$83, 247, 990	$96, 934, 611	$95, 231, 221	$112,158,060	$101,723,102
Per ton	$9. 46	$11. 13	$11. 74	$11. 80	$11. 59	$11. 79
Total open-market lime ... short tons	6, 093, 434	7, 022, 225	7, 720, 333	7, 587, 443	8, 114, 396	7, 180, 159
Total captive tonnage lime ... short tons	[2] 361, 473	[2] 456, 191	[2] 535, 179	485, 635	1, 559, 787	1, 448, 960
By uses:						
Agricultural ... short tons	350, 052	332, 687	343, 619	392, 383	329, 455	323, 557
Building ... do	919, 195	1, 248, 989	1, 234, 136	1, 191, 263	1. 166, 240	1, 130, 032
Chemical and industrial ... do	3, 880, 863	4, 137, 297	4, 711, 297	4, 561, 407	5, 883, 673	5, 654, 676
Refractory (dead-burned dolomite) ... short tons	1, 304, 797	1, 759, 443	1, 966, 460	1, 928, 025	2, 294, 815	1, 520, 854
Imports for consumption ... do	28, 692	34, 284	34, 025	24, 008	37, 202	36, 298
Exports ... do	46, 323	50, 491	63, 295	64, 952	79, 934	73, 246

[1] Selling value, f. o. b. plant, excluding cost of containers.
[2] Incomplete figures; prior to 1953 there was only a partial coverage of captive plants.

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

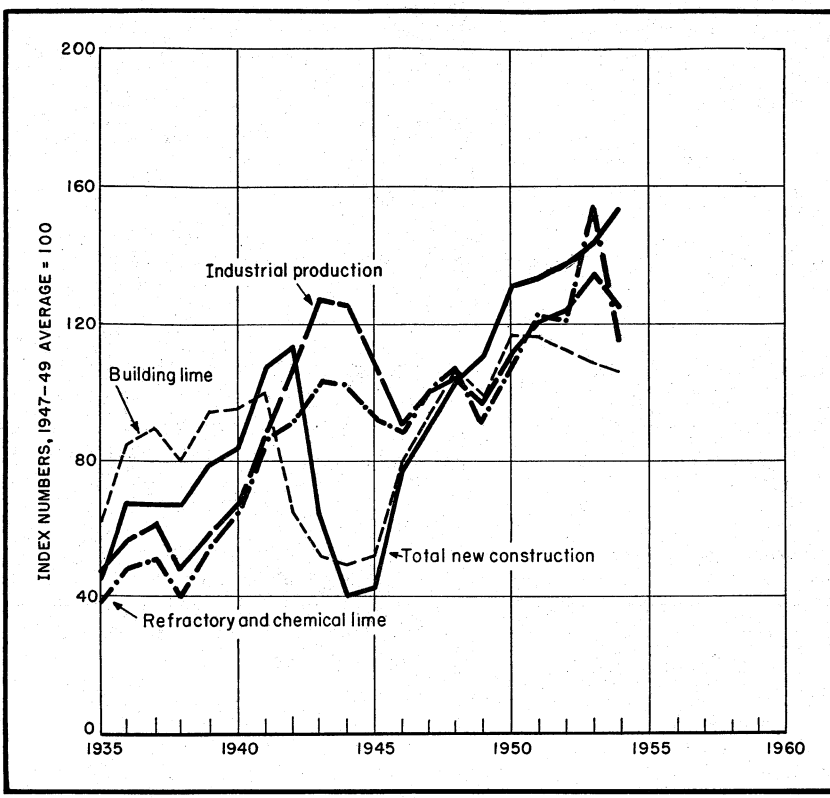

FIGURE 1.—Production of building lime compared with physical volume of total new construction, and output of refractory and chemical lime compared with industrial production, 1935–54. Units are reduced to percentages of the 1947–49 average. Statistics on new construction from Construction and Building Materials, U. S. Department of Commerce, and on industrial production from Federal Reserve Board.

Lime is a basic raw material for the construction industry and for many chemical and other industrial uses. Relationships of lime output to the volume of new construction and to the general trend of industrial production are shown in figure 1. Building-lime production followed new construction rather closely until 1948, but thereafter failed to pace construction activity. This downward trend, which has become marked since 1950, reflects increased use of gypsum wallboard and replacement of lime-cement mortar with masonry cements in the building industry.[3] Because of the rapid growth in construction the total drop in building-lime production has not been great.

[3] Boynton, Robert S., Postwar Research by the National Lime Association: Rock Products, vol. 58, No. 1, January 1955.

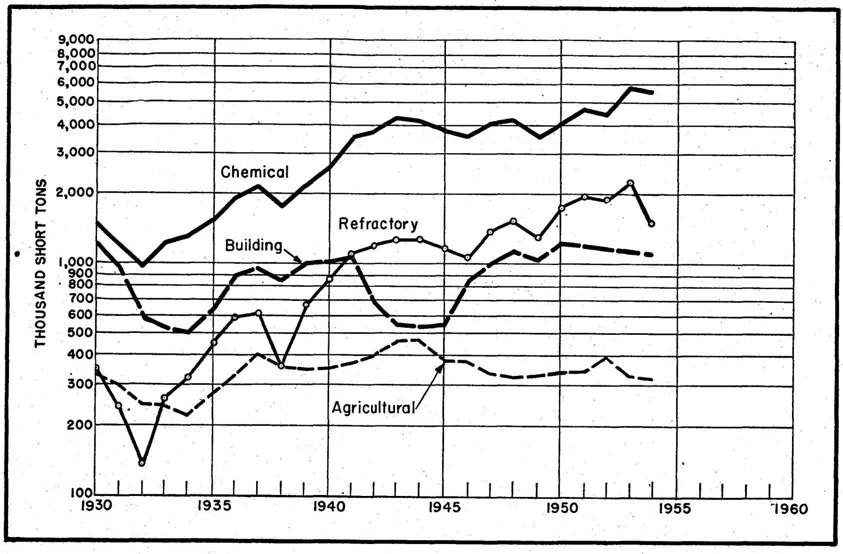

FIGURE 2.—Trends in major uses of lime, 1930–54.

Production of lime by principal uses over a period of years is shown in figure 2.

DOMESTIC PRODUCTION

Lime production in 1954, as measured by the total tonnage sold and used, was about 11 percent below the record reported in 1953. In 1954, 17 percent of the total production was captive, compared with 16 percent in 1953.

The output of open-market lime declined 12 percent in 1954 from the record set in 1953. Production of lime at consumer-operated plants also declined but to a somewhat smaller degree than open-market production. Total captive tonnage reported in 1954 was about 7 percent below 1953, the only year for which comparable data are available.

Lime was produced in 33 States and 2 Territories in 1954. Ohio, Missouri, and Pennsylvania continued to be the largest producing States, furnishing about 55 percent of the total production. Texas, Illinois, Virginia, Alabama, and California, next in order of output, together supplied about 25 percent of the total. Thus eight States produced about four-fifths of the lime output in the United States in 1954.

TABLE 2.—Lime (quick, hydrated, and dead-burned dolomite) sold or used by producers in the United States, 1953–54, by States

State or Territory	1953			1954		
	Active plants	Short tons	Value	Active plants	Short tons	Value
Alabama	8	470,541	$5,018,156	8	421,807	$4,488,167
Arizona	5	96,408	1,238,204	5	88,932	1,131,334
Arkansas	2	(1)	(1)	2	(1)	(1)
California	6	301,422	4,653,303	6	212,381	3,387,981
Connecticut	1	(1)	(1)	1	(1)	(1)
Florida	2	(1)	(1)	2	(1)	(1)
Georgia	1	9,345	95,484	1	(1)	(1)
Hawaii	1	7,431	223,575	1	8,375	251,610
Illinois	6	519,992	6,986,560	6	532,051	7,420,849
Indiana	1	(1)	(1)	1	(1)	(1)
Iowa	2	(1)	(1)	1	(1)	(1)
Louisiana	1	(1)	(1)	1	(1)	(1)
Maine	1	(1)	(1)	1	(1)	(1)
Maryland	6	71,705	707,736	5	67,081	685,427
Massachusetts	3	135,383	2,156,205	3	127,836	1,709,341
Michigan	3	(1)	(1)	3	(1)	(1)
Minnesota	1	(1)	(1)	1	(1)	(1)
Missouri	7	1,212,107	12,084,130	8	1,125,919	11,165,381
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	18	2,945,800	35,310,353	17	2,549,046	31,444,083
Oklahoma	1	(1)	(1)	1	(1)	(1)
Pennsylvania	24	1,335,300	16,010,114	24	1,081,583	13,206,310
Puerto Rico	2	7,338	157,467	2	8,384	198,452
South Dakota	1	(1)	(1)	1	(1)	(1)
Tennessee	3	114,474	1,177,461	3	80,372	968,078
Texas	10	475,569	4,380,831	10	547,436	5,421,732
Utah	2	(1)	(1)	3	(1)	(1)
Vermont	2	(1)	(1)	2	(1)	(1)
Virginia	12	477,384	4,947,418	11	445,158	4,610,645
Washington	2	(1)	(1)	1	(1)	(1)
West Virginia	5	(1)	(1)	5	(1)	(1)
Wisconsin	7	123,997	1,566,085	8	115,397	1,557,579
Undistributed [1]		1,369,987	15,444,978		1,217,361	14,076,133
Total	156	9,674,183	112,158,060	154	8,629,119	101,723,102

[1] Figures that may not be shown separately are combined as "Undistributed" to avoid disclosure of individual company operations.

Size of Plants.—No significant changes in the structure of the lime industry occurred in 1954. The size of plants and industry concentration was about the same as in 1953 and 1952. Of the total lime output in 1954, 26 plants, having an output of more than 100,000 tons each, produced 5,575,000 tons or 65 percent of the total; 22 plants, having an output of more than 50,000 tons each, supplied 1,428,000 tons or 17 percent of the total; and 30 plants, having an annual output of more than 25,000 tons each, supplied 1,043,000 tons or 12 percent of the total. Thus 78 plants—only slightly more than half those reporting output—supplied 93 percent of the lime produced in 1954. The average output per plant in 1954 was 56,000 tons compared with an average of 62,000 tons in 1953.

TABLE 3.—Lime sold or used by producers in the United States,[1] 1953–54, by types and major uses

	1953				1954				Change from 1953, percent
	Sold	Used	Total	Percent of total	Sold	Used	Total	Percent of total	
By type:									
Quicklime	6,242,759	1,389,324	7,632,083	79	5,393,973	1,255,251	6,649,224	77	−13
Hydrated lime	1,871,637	170,463	2,042,100	21	1,786,186	193,709	1,979,895	23	−3
Total lime	8,114,396	1,559,787	9,674,183	100	7,180,159	1,448,960	8,629,119	100	−11
By use:									
Agricultural:									
Quicklime	123,087		123,087	1	123,285	1,361	124,646	1	+1
Hydrated lime	206,368		206,368	2	198,911		198,911	2	−4
Total	329,455		329,455	3	322,196	1,361	323,557	3	−2
Building:									
Quicklime	150,315	52,399	202,714	2	150,550	46,763	197,313	2	−3
Hydrated lime	948,453	15,073	963,526	10	908,198	24,521	932,719	11	−3
Total	1,098,768	67,472	1,166,240	12	1,058,748	71,284	1,130,032	13	−3
Chemical and other industrial:									
Quicklime	3,706,606	1,304,861	5,011,467	52	3,618,942	1,187,469	4,806,411	56	−4
Hydrated lime	716,816	155,390	872,206	9	679,077	169,188	848,265	10	−3
Total	4,423,422	1,460,251	5,883,673	61	4,298,019	1,356,657	5,654,676	66	−4
Refractory (dead-burned dolomite)	2,262,751	32,064	2,294,815	24	1,501,196	19,658	1,520,854	18	−34

[1] Includes Hawaii and Puerto Rico.

TABLE 4.—Distribution of lime (including refractory) plants, 1952–54, according to size of production

Size group (short tons)	1952 [1]			1953 [2]			1954 [2]		
	Plants	Production: Short tons	Production: Percent of total	Plants	Production: Short tons	Production: Percent of total	Plants	Production: Short tons	Production: Percent of total
Less than 1,000	12	4,982	(3)	11	6,507	(3)	10	4,656	(3)
1,000 to less than 5,000	26	76,517	1	17	52,010	1	28	83,319	1
5,000 to less than 10,000	17	116,896	1	21	144,837	1	16	108,563	1
10,000 to less than 25,000	26	443,834	6	23	375,001	4	22	386,135	4
25,000 to less than 50,000	35	1,302,652	16	33	1,190,762	12	30	1,043,448	12
50,000 to less than 100,000	19	1,248,714	16	23	1,551,233	16	22	1,427,969	17
100,000 and over	25	4,879,483	60	28	6,353,833	66	26	5,575,029	65
Total	160	8,073,078	100	156	9,674,183	100	154	8,629,119	100

[1] Includes captive tonnage in part.
[2] Includes captive tonnage.
[3] Less than 1 percent.

Hydrated Lime.—Quicklime (CaO or $CaO.MgO$), which is the kiln product after calcination, has a strong affinity for water, with which it combines to form hydrated lime ($Ca(OH)_2$ or $Ca.Mg.(OH)_2$). As hydrated lime has some advantages over quicklime in handling and transportation and is preferred in certain applications, considerable quantities are hydrated, or slaked, before shipment. In 1954, 23 percent of the lime sold or used was in hydrated form, compared with 21 percent in 1953.

TABLE 5.—Hydrated lime sold or used by producers in the United States, 1953–54, by States, in short tons

State or Territory	1953				1954			
	Active plants	Open-market	Captive	Total	Active plants	Open-market	Captive	Total
Alabama	5	57,538		57,538	6	(1)	(1)	72,645
California	5	33,738		33,738	5	(1)	(1)	32,649
Georgia	1	6,940	2,405	9,345	(2)	(2)		(2)
Hawaii	1	7,388		7,388	1	8,351		8,351
Illinois	4	59,995		59,995	4	64,775		64,775
Maryland	3	18,376		18,376	3	17,727		17,727
Massachusetts	3	(1)	(1)	56,617	3	(1)	(1)	55,458
Missouri	6	205,714		205,714	7	208,235		208,235
Ohio	14	(1)	(1)	655,398	13	(1)	(1)	603,583
Pennsylvania	14	324,306		324,306	14	307,566		307,566
Tennessee	3	22,900		22,900	3	20,567		20,567
Texas	7	69,481	150,088	219,569	7	72,278	168,725	241,003
Virginia	10	56,458		56,458	8	(1)	(1)	55,366
Other States [2]	32	307,471	7,287	314,758	31	285,529	6,441	291,970
Undistributed		701,332	10,683			801,158	18,543	
Total	108	1,871,637	170,463	2,042,100	105	1,786,186	193,709	1,979,895

[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 1954 (1953 same as 1954 unless shown differently in parentheses): Arizona 3, Arkansas 1, Connecticut 1, Florida 1, Georgia 1 (1954 only), Indiana 1 (1953 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 1, Vermont 1, Washington 1 (1953 only), West Virginia 4, and Wisconsin 5.

CONSUMPTION AND USES

Lime was used in three major fields—the chemical and manufacturing industries, the building industry, and agriculture. Chemical and manufacturing uses were by far the most important. One of the most widely used chemical raw materials in the industrial world, lime was utilized in so many different processes that all of its applications cannot be reported. Data on lime sold or used, by major fields of use and districts, are given in table 6. Considerably more detail on chemical and industrial uses, as well as uses for agricultural, construction and refractory purposes, are shown in table 7.

Tonnages in each major use declined, but the largest loss was in refractory lime, with smaller decreases occurring in agricultural and building lime and lime used for chemical and other industrial purposes. Distribution of output, according to the major categories of type and use, was similar to that in 1953, except that more of the 1954 tonnage went to "Chemical and other industrial uses" and less to refractories. About 81 percent of the open-market sales were to chemical, refractory, and other industrial consumers; 15 percent to the building industry; and 4 percent to agricultural uses. Most captive production was for chemical or other industrial uses, with relatively minor quantities for agricultural or building purposes. Consequently, it appears that, of the total lime production in 1954 (open-market plus captive), about 84 percent was used at chemical, refractory, and other industrial installations; 13 percent in the construction industry; and 3 percent for agriculture.

TABLE 6.—Lime (quick, hydrated, and dead-burned dolomite) sold or used by producers in the United States in 1954, 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	15,519	$190,088	46,655	$690,498	122,212	$1,617,409	----------	----------	184,386	$2,497,995
Districts 2 and 3: Maryland, New Jersey, New York, Pennsylvania, and West Virginia	212,017	2,358,530	149,272	2,037,473	986,184	11,760,148	115,217	$1,592,940	1,462,690	17,749,091
District 4: Virginia	14,781	180,802	11,146	91,616	419,231	4,338,227	----------	----------	445,158	4,610,645
District 5: Ohio	68,460	889,070	516,679	8,133,692	1,040,082	9,135,604	923,825	13,285,717	2,549,046	31,444,083
District 7: Illinois, Indiana, and that portion of Missouri east of the 93d meridian	----------	----------	(2)	(2)	1,067,284	10,619,317	(2)	(2)	1,526,333	17,116,146
Districts 6, 8, and 9: Iowa, Michigan, Minnesota, South Dakota, and Wisconsin	(2)	(2)	(2)	(2)	275,361	3,283,057	----------	----------	315,205	3,844,914
Districts 10–11: Alabama, Florida, Georgia, and Tennessee	(2)	(2)	93,072	1,023,321	441,270	4,800,945	(2)	(2)	543,030	5,932,823
District 12: Arkansas, Oklahoma, Louisiana, and that portion of Missouri west of the 93d meridian	(2)	(2)	(2)	(2)	452,603	3,951,443	----------	----------	527,819	4,787,004
District 13: Texas	400	4,176	42,303	489,838	504,733	4,927,718	----------	----------	547,436	5,421,732
Districts 14 and 15: Arizona, California, Montana, Nevada, Oregon, Washington, and Utah	(2)	(2)	105,929	2,023,145	334,780	4,613,007	(2)	(2)	511,257	7,868,607
Noncontiguous Territories:										
Hawaii	----------	----------	(2)	(2)	(2)	(2)	----------	----------	8,375	251,610
Puerto Rico	(2)	(2)	(2)	(2)	(2)	(2)	----------	----------	8,384	198,452
Undistributed[2]	12,380	91,415	164,976	2,206,075	10,936	305,804	481,812	7,082,027	----------	----------
Total	323,557	3,714,081	1,130,032	16,695,658	5,654,676	59,352,679	1,520,854	21,960,684	8,629,119	101,723,102

[1] The districting is the same as that used by the National Lime Association. Non-lime-producing States are omitted.
[2] Figures that may not be shown separately are combined as "Undistributed" to avoid disclosure of individual company operations.

TABLE 7.—Lime (quick, hydrated, and dead-burned dolomite) sold or used by producers in the United States, 1953–54, by uses, in short tons

Use	1953			1954		
	Open-market	Captive	Total	Open-market	Captive	Total
Agriculture	329,455	---------	329,455	322,196	1,361	323,557
Building:						
Finishing lime	522,027	5,506	527,533	474,145	9,861	484,006
Mason's lime	466,704	4,366	471,070	470,702	5,592	476,294
Other (including masonry mortars)	110,037	57,600	167,637	113,901	55,831	169,732
Total	1,098,768	67,472	1,166,240	1,058,748	71,284	1,130,032
Chemical and other industrial:						
Alkalies (ammonium, potassium and sodium compounds)	4,738	906,516	911,254	9,429	911,194	920,623
Asphalts and other bitumens	(1)	---------	(1)	(1)	---------	(1)
Bleach, liquid and powder [2]	4,803	---------	4,803	4,223	---------	4,223
Brick, sand-lime and slag	(1)	(1)	17,038	11,826	---------	11,826
Brick, silica (refractory)	19,704	---------	19,704	16,491	---------	16,491
Calcium carbide and cyanamide	607,196	---------	607,196	562,482	---------	562,482
Calcium carbonate (precipitated)	21,005	---------	21,005	19,512	---------	19,512
Coke and gas (gas purification and plant byproducts)	35,900	---------	35,900	14,250	---------	14,250
Explosives	20,880	---------	20,880	6,102	---------	6,102
Food and food by-products	26,288	---------	26,288	23,656	---------	23,656
Glassworks	245,274	---------	245,274	249,073	---------	249,073
Glue	14,696	---------	14,696	2,554	---------	2,554
Grease, lubricating	6,943	---------	6,943	3,575	---------	3,575
Insecticides, fungicides, and disinfectants	88,965	---------	88,965	69,481	---------	69,481
Medicines and drugs	(1)	---------	(1)	(1)	---------	(1)
Metallurgy:						
Nonferrous smelter flux	(1)	(1)	51,860	(1)	(1)	47,902
Steel (open-hearth and electric furnace flux)	1,132,230	150,564	1,282,794	1,149,019	121,564	1,270,583
Ore concentration [3]	150,270	152,211	302,481	143,768	149,878	293,646
Wire drawing	32,975	---------	32,975	2,159	---------	2,159
Other [4]	(1)	(1)	13,185	(1)	(1)	59,161
Oil drilling	14,260	---------	14,260	12,399	---------	12,399
Paints	(1)	(1)	29,118	(1)	(1)	26,529
Paper mills	(1)	(1)	768,961	(1)	(1)	732,670
Petrochemicals (glycol)	(1)	---------	(1)	91,680	---------	91,680
Petroleum refining	39,995	---------	39,995	43,546	---------	43,546
Rubber manufacture	1,631	---------	1,631	1,555	---------	1,555
Salt refining	9,200	---------	9,200	(1)	---------	(1)
Sewage and trade-wastes treatment	93,677	787	94,464	100,586	1,394	101,980
Soap and fat	(1)	---------	(1)	(1)	---------	(1)
Sugar refining	(1)	(1)	26,930	(1)	(1)	33,685
Tanneries	71,052	---------	71,052	69,185	---------	69,185
Varnish	(1)	---------	(1)	(1)	---------	(1)
Water purification	618,636	19,021	637,657	618,034	19,332	637,366
Wood distillation	2,170	---------	2,170	(1)	---------	(1)
Undistributed [5]	952,688	231,152	276,748	871,483	112,125	83,661
Unspecified	208,246	---------	208,246	201,951	41,170	243,121
Total	4,423,422	1,460,251	5,883,673	4,298,019	1,356,657•	5,654,676
Refractory lime (dead-burned dolomite)	2,262,751	32,064	2,294,815	1,501,196	19,658	1,520,854
Grand total lime	8,114,396	1,559,787	9,674,183	7,180,159	1,448,960	8,629,119
Hydrated lime included in above distribution	1,871,637	170,463	2,042,100	1,786,186	193,709	1,979,895

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, alkalies, asphalt, brick (sand-lime and slag), medicine and drugs, magnesium products, paints, paper mills, petrochemicals (glycol), polishing compounds, retarder, soap and fat, sugar, sulfur, tobacco, varnish, and miscellaneous industrial uses.

Total open-market sales to chemical and other industrial consumers were about 3 percent less in 1954 than in 1953; captive output in this category declined about 7 percent compared with 1953, and the total captive and open market in 1954 was about 4 percent below the record set in 1953. Substantial losses were reported in many smaller uses, and moderate declines occurred in some of the larger classes of use, such as calcium carbide and cyanamide, metallurgy, and water purification. On the other hand, lime sales for sewage and trade-waste treatment in 1954 increased about 8 percent compared with 1953. Small increases also were reported for alkalies, glassworks, and petroleum and sugar refining.

Open-market sales of building lime in 1954 declined about 4 percent from 1953. Captive tonnage of building lime in 1954 was about 6 percent greater than in 1953, but the total output was down 3 percent from 1953. A small decline in agricultural lime also was reported. Sales and captive use of dead-burned dolomite for refractory purposes dropped sharply (34 percent) in 1954.

Both tonnage and value of lime sold or used in 1953 and 1954, according to major uses, are indicated in table 8. The sales distribution of hydrated lime is shown in table 9. To supply a more comprehensive picture of various materials used in liming land, table 10 shows, in addition to agricultural lime, tonnage of oystershells, limestone, and calcareous marl applied to soil improvement.

TABLE 8.—Lime (quick, hydrated, and dead-burned dolomite) sold or used by producers in the United States,[1] 1953–54, by major uses

Use	1953			1954		
	Short tons	Value [2]		Short tons	Value [2]	
		Total	Average		Total	Average
Agricultural	329,455	$3,426,368	$10.40	323,557	$3,714,081	$11.48
Building:						
Finishing lime	527,533	8,067,677	15.29	484,006	7,817,816	16.15
Mason's lime	471,070	6,349,110	13.48	476,294	6,675,040	14.01
Other (including masonry mortars)	167,637	2,095,933	12.50	169,732	2,202,802	12.98
Total building	1,166,240	16,512,720	14.16	1,130,032	16,695,658	14.77
Chemical and industrial uses	5,883,673	60,763,588	10.33	5,654,676	59,352,679	10.50
Refractory (dead-burned dolomite)	2,294,815	31,455,384	13.71	1,520,854	21,960,684	14.44
Grand total lime	9,674,183	112,158,060	11.59	8,629,119	101,723,102	11.79

[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, 1953–54, by uses, in short tons

Use	1953			1954		
	Open market	Captive	Total	Open market	Captive	Total
Agricultural	206, 368		206, 368	198, 911		198, 911
Building	948, 453	15, 073	963, 526	908, 198	24, 521	932, 719
Chemical and industrial:						
Bleach, liquid and powder	2, 358		2, 358	(1)		(1)
Brick, sand-lime and slag	(1)	(1)	7, 122	4, 536		4, 536
Brick, silica	16, 713		16, 713	13, 867		13, 867
Coke and gas	1, 149		1, 149	895		895
Food products	14, 766		14, 766	11, 905		11, 905
Insecticides, fungicides, and disinfectants	74, 774		74, 774	54, 555		54, 555
Metallurgy	29, 453		29, 453	50, 128		50, 128
Paints	(1)	(1)	14, 790	(1)	(1)	14, 908
Paper mills	43, 013		43, 013	44, 281		44, 281
Petroleum	23, 372		23, 372	22, 667		22, 667
Sewage and trade-waste treatment	46, 348		46, 348	(1)	(1)	40, 433
Sugar refining	21, 528		21, 528	21, 527		21, 527
Tanneries	39, 858		39, 858	40, 964		40, 964
Water purification	233, 448		233, 448	225, 439		225, 439
Undistributed [2]	85, 710	155, 390	219, 188	112, 082	169, 188	225, 929
Unspecified	84, 326		84, 326	76, 231		76, 231
Total	716, 816	155, 390	872, 206	679, 077	169, 188	848, 265
Grand total, hydrated lime	1, 871, 637	170, 463	2, 042, 100	1, 786, 186	193, 709	1, 979, 895

[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, 1953–54, by kinds

Kind	1953				1954			
	Short tons		Value		Short tons		Value	
	Gross weight	Effective lime content [1]	Total	Average	Gross weight	Effective lime content [1]	Total	Average
Lime:								
Quicklime	123, 087	104, 620	$3, 426, 368	$10. 40	124, 646	105, 949	$3,714,081	$11. 48
Hydrated lime	206, 368	144, 460			198, 911	139, 238		
Oystershells (crushed) [2]	85, 371	40, 120	358, 330	4. 20	84, 154	39, 552	574, 666	6. 83
Limestone	[3] 18, 427, 513	[3] 8, 660, 931	[3] 30, 103, 864	1. 63	18, 274, 121	8, 588, 837	30, 199, 337	1. 65
Calcareous marl	277, 354	116, 490	173, 347	. 63	206, 257	86, 628	152, 491	. 74
Total		[3] 9, 066, 621	[3] 34, 061, 909			8, 960, 204	34, 640, 575	

[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.

As noted previously, most of the lime produced in the United States has been from relatively few large plants in comparatively few States. Some States produce a surplus, while in others there is a deficit in supply. In addition, limes vary considerably from plant to plant in chemical and physical properties, and shipments from distant points sometimes are required to meet specialized needs of consumers. Accordingly, as table 11 indicates, a large volume of lime output enters interstate commerce each year. The principal States exporting lime beyond their borders in 1954 were Ohio, Missouri, Pennsylvania, and Virginia. Data on the origin and destination of lime shipments, by States and groups of States in 1954, are shown in table 12.

TABLE 11.—Apparent consumption of lime sold and used in continental United States in 1954, by States, in short tons

State	Sales by producers	Shipments from States [1]	Shipments into States	Apparent consumption		Total
				Quicklime	Hydrated lime	
Alabama	421,807	183,937	11,080	222,054	26,896	248,950
Arizona	88,932	6,364	7,740	83,322	6,986	90,308
Arkansas	(2)	(2)	(2)	69,728	8,404	78,132
California	212,381	12,376	91,159	203,449	87,715	291,164
Colorado				16,144	6,216	22,360
Connecticut	(2)	(2)	(2)	27,672	26,169	53,841
Delaware				30,199	14,086	44,285
District of Columbia				260	10,579	10,839
Florida	(2)		(2)	83,210	57,353	140,563
Georgia	6,058		87,786	65,413	28,431	93,844
Idaho				1,854	2,196	4,050
Illinois	532,051	316,891	304,328	368,105	151,383	519,488
Indiana	(2)		(2)	393,942	40,757	434,699
Iowa	(2)	(2)	(2)	87,819	19,509	107,328
Kansas				34,342	15,984	50,326
Kentucky				351,365	22,049	373,414
Louisiana	235,454		123,434	306,984	51,904	358,888
Maine	(2)		(2)	59,602	4,307	63,909
Maryland	67,081	13,910	127,581	143,683	37,069	180,752
Massachusetts	127,836	85,115	46,913	36,212	53,422	89,634
Michigan	(2)	(2)	(2)	241,304	63,530	304,834
Minnesota	(2)	(2)	(2)	80,293	20,639	100,932
Mississippi				38,709	5,414	44,123
Missouri	1,125,919	972,866	22,434	109,449	66,038	175,487
Montana	(2)	(2)	(2)	25,578	3,455	29,033
Nebraska				2,807	9,709	12,516
Nevada	(2)	(2)	(2)	28,300	2,785	31,085
New Hampshire				7,709	4,620	12,329
New Jersey	(2)	(2)	(2)	60,175	89,255	149,430
New Mexico				1,088	2,665	3,753
New York	(2)	(2)	(2)	215,803	140,210	356,013
North Carolina				47,909	28,966	76,875
North Dakota				4,656	1,114	5,770
Ohio	2,549,046	1,396,850	215,101	1,227,572	139,725	1,367,297
Oklahoma	(2)	(2)	(2)	32,041	10,742	42,783
Oregon				36,120	10,739	46,859
Pennsylvania	1,081,583	429,555	578,132	967,300	262,860	1,230,160
Rhode Island				5,854	7,134	12,988
South Carolina				9,237	10,365	19,602
South Dakota	(2)		(2)	4,809	1,799	6,608
Tennessee	80,372	55,960	31,292	24,905	30,799	55,704
Texas	547,436	60,640	52,269	306,832	232,233	539,065
Utah	(2)	(2)	(2)	50,263	8,304	58,567
Vermont	(2)	(2)	(2)	16	5,124	5,140
Virginia	445,158	329,660	41,700	115,097	42,101	157,198
Washington	(2)	(2)	(2)	32,896	12,976	45,872
West Virginia	(2)	(2)	(2)	205,721	25,095	230,816
Wisconsin	115,397	69,757	98,451	103,670	40,421	144,091
Wyoming				326	1,868	2,194
Undistributed [2]	975,849	477,422	1,741,158			
Total	8,612,360	4,411,303	3,580,558	6,571,798	1,952,100	8,523,898

[1] Includes 105,221 tons exported or unclassified as to destination.
[2] Figures that may not be shown separately are combined as "Undistributed" to avoid disclosure of individual company operations.

TABLE 12.—Apparent consumption of lime in continental United States in 1954, 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		
	Quick-lime	Hy-drated lime	Total	Quick-lime	Hy-drated lime	Total	Quick-lime	Hy-drated lime	Total	Quick-lime	Hy-drated lime	Total	Quick-lime	Hy-drated lime	Total
Illinois, Indiana, Michigan, Ohio	1,849,267	312,361	2,161,628	88,205	5,039	93,244	8	289	297	33,625	3,821	37,446	493	1,860	2,353
Delaware, District of Columbia, Maryland, New Jersey, New York, Pennsylvania, West Virginia	483,570	158,514	642,084	903,529	368,678	1,272,207	28,146	15,187	43,333	189,260	18,051	207,311	6,816	780	7,596
Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont	1,356	30,569	31,925	53,843	7,638	61,481	79,509	60,997	140,506	996	140	1,136	1,266	123	1,389
Florida, Georgia, North Carolina, South Carolina, Virginia	7,947	76,839	84,786	12,751	6,476	19,227	24		24	165,516	47,801	213,317	130,391	34,517	164,908
Alabama, Kentucky, Louisiana, Mississippi, Tennessee	39,248	30,062	69,310	2,391	26	2,417		4	4	25,025	874	25,899	505,455	51,241	556,696
Arkansas, Kansas, Nebraska, Oklahoma, Texas	17,962	9,966	27,928												
Iowa, Minnesota, Missouri, Wisconsin	62,872	52,972	115,844												
Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Utah, Washington, Wyoming	24,988	5,622	30,610	111	110	221					900	900			

Destination	Origin											
	Arkansas, Oklahoma, Texas, Kansas, Nebraska			Iowa, Minnesota, Missouri, Wisconsin			Arizona, California, Colorado, Montana, Nevada, Oregon, South Dakota, Utah, Washington			Total		
	Quick-lime	Hydrated lime	Total	Quick-lime	Hydrated lime	Total	Quick-lime	Hydrated lime	Total	Quick-lime	Hydrated lime	Total
Illinois, Indiana, Michigan, Ohio	214	4	218	259,111	72,021	331,132				2,230,923	395,395	2,626,318
Delaware, District of Columbia, Maryland, New Jersey, New York, Pennsylvania, West Virginia	70	1	71	11,750	17,918	29,668		25	25	1,623,141	579,154	2,202,295
Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont				95	1,309	1,404				137,065	100,776	237,841
Florida, Georgia, North Carolina, South Carolina, Virginia	563	803	1,366	3,674	780	4,454				320,866	167,216	488,082
Alabama, Kentucky, Louisiana, Mississippi, Tennessee	51,543	33,747	85,290	320,355	21,108	341,463				944,017	137,062	1,081,079
Arkansas, Kansas, Nebraska, Oklahoma, Texas	357,731	240,039	597,770	70,057	27,067	97,124				445,750	277,072	722,822
Iowa, Minnesota, Missouri, Wisconsin	3,545	78	3,623	314,814	93,557	408,371				381,231	146,607	527,838
Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Utah, Washington, Wyoming	13,328	5,619	18,947	54,705	22,692	77,397	395,673	113,875	509,548	488,805	148,818	637,623

PRICES

Lime prices increased slightly in 1954, reported value averaging \$11.79 per short ton f. o. b. plant, compared with an average value of \$11.59 per ton in 1953.

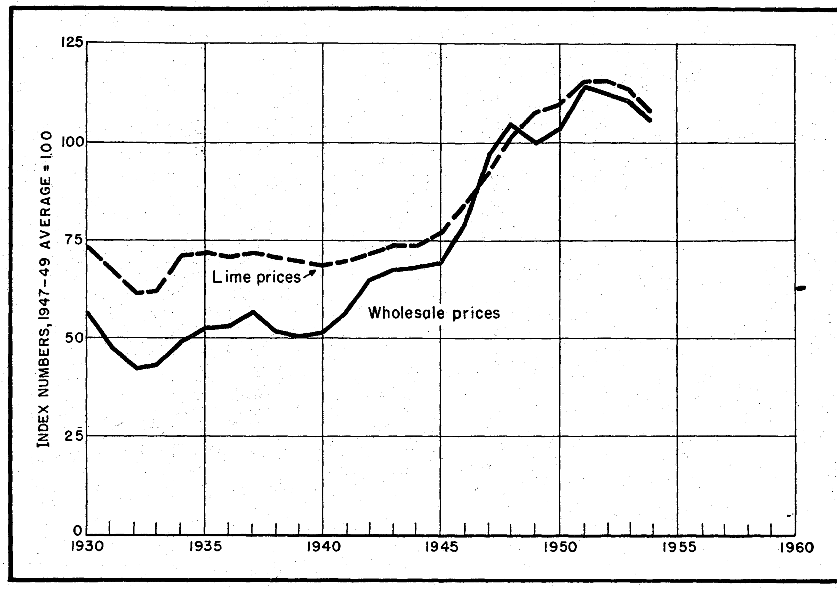

FIGURE 3.—Average price of lime per ton compared with wholesale prices of all commodities, 1930–54. Units are reduced to percentages of the 1947–49 average. Wholesale prices from U. S. Department of Labor.

FOREIGN TRADE [4]

Imports.—Lime imports into the United States were rather small compared with domestic production, although, as shown in tables 13 and 14, imports in 1953 and 1954 were somewhat above the rate in 1952. Canada was the principal foreign source of lime, most of which was imported through the Washington and Buffalo customs districts to supply local needs in border areas.

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[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 13.—Lime imported for consumption in the United States, 1945–49 (average) and 1950–54

[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
1945–49 (average)	1,545	$24,583	26,281	$327,901	866	$33,299	28,692	$385,783
1950	1,253	23,910	30,904	524,132	2,127	86,425	34,284	634,467
1951	1,131	22,704	29,849	554,362	3,045	128,207	34,025	705,273
1952	109	2,940	21,557	377,926	2,342	123,596	24,008	504,462
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

[1] "Dead-burned basic refractory material consisting chiefly of magnesia and lime."
[2] Includes weight of immediate container.
[3] Due to changes in tabulating procedures by the U. S. Department of Commerce data known not to be comparable to earlier years.

TABLE 14.—Lime imported for consumption in the United States, 1952–54, by countries and customs district [1]

[U. S. Department of Commerce]

Country and customs district	1952		1953		1954	
	Short tons [2]	Value	Short tons [2]	Value	Short tons [2]	Value
North America:						
Canada:						
Buffalo	5,857	$61,046	11,875	$135,195	4,531	$53,880
Dakota	(3)	5				
Maine and New Hampshire			101	1,040	172	1,518
St. Lawrence	1	20				
Vermont			2,853	37,130	1,559	20,034
Washington	15,762	318,481	18,496	364,253	25,524	478,802
Total	21,620	379,552	33,325	537,618	31,786	554,234
Mexico:						
Arizona	44	600				
El Paso					86	768
Total	44	600			86	768
Total	21,664	380,152	33,325	537,618	31,872	555,002
Europe:						
United Kingdom:						
Massachusetts			1	30		
New Orleans	2	713				
New York	(3)	1				
Total	2	714	1	30		
Total	2	714	1	30		
Grand total	21,666	380,866	33,326	537,648	31,872	[4] 555,002

[1] Exclusive of dead-burned basic refractory material.
[2] Includes weight of immediate container.
[3] Less than 1 ton.
[4] Due to changes in tabulating procedures by the U. S. Department of Commerce data known not to be comparable to earlier years.

Exports.—Exports were relatively small. About half of the exports in 1954 were shipped to Canada; most of the remainder went to Central and South America.

TABLE 15.—Lime exported from the United States, 1945–49 (average) and 1950–54

[U. S. Department of Commerce]

Year	Short tons	Value	Year	Short tons	Value
1945–49 (average)	46,323	$641,825	1952	64,952	$1,156,991
1950	50,491	825,927	1953	79,934	1,422,238
1951	63,295	1,157,652	1954	73,246	1,299,681

TABLE 16.—Lime exported from the United States, 1952–54, by countries of destination

[U. S. Department of Commerce]

Destination	1952		1953		1954	
	Short tons	Value	Short tons	Value	Short tons	Value
North America:						
Bahamas	49	$1,505	92	$3,145	25	$500
Canada	23,771	322,562	37,976	546,226	37,691	588,753
Canal Zone	174	3,864	12	2,326		
Costa Rica	13,363	268,270	12,242	236,269	12,241	224,016
Cuba	8	170	15	541		
Dominican Republic	124	2,389				
El Salvador	106	4,051	100	2,909	50	1,050
Haiti	(1)	220	47	1,700		
Honduras	9,738	176,338	14,212	244,839	10,137	190,738
Leeward and Windward Islands	50	2,083				
Mexico	2,540	64,524	3,110	84,218	2,315	60,046
Netherlands Antilles	55	1,286	33	631		
Nicaragua	350	7,374	555	12,793	500	11,523
Panama	6,792	138,715	6,155	152,319	4,817	96,928
Other North America	25	550	35	886	55	1,196
Total	57,145	993,901	74,584	1,288,802	67,831	1,174,750
South America:						
Chile	5	405			10	810
Colombia	5,430	107,876	4,410	97,778	4,274	94,276
Venezuela	843	18,581	594	21,057	619	13,488
Other South America	2	287			74	2,052
Total	6,280	127,149	5,004	118,835	4,977	110,626
Europe	8	578	15	317	(1)	774
Asia:						
Japan	57	3,720	25	1,250	31	2,850
Philippines	60	1,510	90	5,101	342	8,644
Saudi Arabia	1,352	25,767	114	4,422		
Other Asia	21	2,128			20	564
Total	1,490	33,125	229	10,773	393	12,058
Africa:						
Liberia	3	290	52	1,843		
Other Africa	20	1,013	50	1,668	45	1,473
Total	23	1,303	102	3,511	45	1,473
Oceania: Australia	6	935				
Grand total	64,952	1,156,991	79,934	1,422,238	73,246	1,299,681

[1] Less than 1 ton.

TECHNOLOGY

Manufacture.—A series of articles reviewing technology of lime manufacture was published.[5] The first article described a simplified procedure for evaluation of kiln performance by means of exhaust gas analysis. Gas analyses are plotted on a kiln efficiency chart which assists in evaluating the effect of variations in fuel, changes in draft, differing periods of lime draw and other innovations.

Several following articles discussed the growing importance of fuel oil in the lime industry. A limekiln fired by fuel oil was described. In the fuel system used, a recirculating fan, able to withstand high temperatures, is used to draw hot exhaust gases out of the kiln. These gases are then mixed with air and introduced into a chamber into which fuel oil also is injected. The recirculated gases then carry the fuel into a second chamber where partial combustion occurs. This gas then is injected into the kiln by means of several ports and burned. Properties and performance standards of fuel oils were reviewed in subsequent articles.

Control of heat loss, effects of kiln draft on rotary-kiln capacity, and the relationships between kiln dimensions and heat developed and absorbed were discussed in the three final articles. Heat losses are due principally to radiation, incomplete combustion, excess air and leakage air, and drawing of lime. According to the author, many rotary kilns, even those with large stacks, often have inadequate draft because of faulty design of exit areas, which become obstructed with dust and other accumulations. A discussion of the relationship between kiln dimensions, combustion efficiency, and production capacity was presented.

A paper concerning selection of rotary lime-recovery kilns was published in a trade magazine.[6] Lime sludge (precipitated calcium carbonate) is produced when lime is used to causticize sulfate liquor at sulfate pulp mills. This sludge is reburned and used as a source of lime at most modern pulp installations. Several factors that influence design and operation of lime-recovery kilns were discussed. According to the author, short, two-support-type kilns are usually employed at operations requiring less than 75 tons of lime per day. Long, large-diameter multisupport kilns are more satisfactory in operations requiring over 150 tons of lime per day. Where operations require capacity of 75 to 125 tons of reburned lime per day, either may be used. The short kiln was said to be more flexible in operation and preferred where demand fluctuates. On the other hand, fuel cost—the largest production expense in reburning lime—may be lower in long kilns. Other factors that were discussed are ease of operation, dependability, and maintenance cost.

Uses.—Research on new uses of lime, sponsored by the National Lime Association, was described.[7] Considerable effort has been ex-

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[5] Azbe, Victor J., Theory and Practice of Lime Manufacture: Rock Products, part 8, vol. 57, No. 3, March 1954, pp. 89, 90, 122; part 9, No. 4, April 1954, pp. 132, 134, 136, 138, 182, 183; part 10, No. 6, June, 1954, pp. 129–132; part 11, No. 9, September 1954, pp. 82–84; part 12, No. 10, October 1954, pp. 84, 86, 89 90, 117; part 13, No. 11, November 1954, pp. 77–78.

[6] Tock, W. H., Factors Influencing the Selection of Modern Rotary Lime-Recovery Kilns: Pit and Quarry, vol. 46, No. 12, June 1954, pp. 121–122, 124.

[7] Boynton, Robert S., Postwar Research by the National Lime Association: Rock Products, vol. 58, No. 1, January 1955, pp. 118, 120, 121, 123.

pended in developing information on industrial waste treatment and neutralization with lime. Data on storage, handling, and application of lime in treatment processes, use of lime for pickle-liquor neutralization, oil wastes, and miscellaneous wastes were summarized. Lime stabilization of roads also was described.[8] The development, types, and scope of lime stabilization, an evaluation of lime-soil mixes, description of construction methods, and cost data were included. Hydrated lime, added in small quantities to plastic, fine-grained clay soils and coarse-grained (gravelly) soils containing a highly plastic binder, decreases plasticity and increases compressive strength. As a stabilizer, hydrated lime is most effective with coarse-grained soils, such as clay-gravel, granite-gravels, caliche, and related types; is less effective with most fine-grained clay soils; and is not recommended for sandy soils. Quicklime, although more difficult to handle, produces a similar reaction with soils and is somewhat less expensive. Another type of lime stabilization is by use of a lime-fly ash mixture. Soils that were not responsive to lime alone, such as sandy soil, reacted favorably to this mixture because the fly ash imparted to the soil pozzolanic properties similar to those of clay soils. Lime-portland cement and lime-bituminous mixtures used for soil stabilization also were described.

Use of solid lime for desulfurizing pig iron was reported.[9] Because of the influence of sulfur on the quality of steel, production economy, and ease of operation, considerable study has been made of desulfurizing agents. In the method described, pig iron was treated in a rapidly rotating furnace with finely ground, burned lime. In the reaction, the iron sulfide was reduced to iron; part of the lime combined with silica to form $CaO.SiO_2$ and part with the sulfur to form CaS. Strong reducing conditions were maintained in the vessel by keeping it closed. No heating was necessary, and the lime stayed in process as a dry powder. Desulfurization was said to take place rapidly, usually in less than 15 minutes, and consumption of lime was low. According to the report, the lime process makes it possible to obtain very low sulfur pig iron and to reduce very high sulfur contents in one treatment.

Development in research on lime-bound masonry materials were discussed.[10] It was reported that, where steam under pressure was being used to prepare cement-bound masonry structural materials, advantages may be obtained by substituting lime for part of the cement. Research on lime-silica-bound products was said to have disclosed need for special forms of quicklime and hydrated lime that could be used with a minimum of water and that would not expand during curing because of incomplete hydration. Methods of producing new forms of hydrated and partly hydrated quicklime to satisfy these requirements were described and possible applications in products now made of cement pointed out.

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[8] National Lime Association, Lime Stabilization of Roads: Bull. 323, 1st ed., 1954.
[9] Eketorp, Sven, Desulphurizing With Solid Lime: Blast Furnace and Steel Plant, vol. 42, No. 10, October 1954, pp. 1159–1161, 1177.
[10] Knibbs, N. V. S., Lime-Bound Masonry Materials: Pit and Quarry, vol. 46, No. 11, May 1954, pp. 124–128.

Tests of soundness of building limes conducted in Germany were reviewed.[11] Several types of tests, starting with a well-burned, properly hydrated lime and adding increments of overburned lime, were described. It was concluded that the limes should be tested as mortars.

WORLD REVIEW

Statistical data on lime are inadequate to permit compilation of a world-production table; however, statistics and other information are available for several countries.

NORTH AMERICA

Canada.—Lime manufacture is an important industry in Canada. Six of the ten provinces are producers, and over 40 plants were reported in operation in 1954, producing lime from approximately 150 kilns ranging in size from small pot-type to large continuous rotary kilns. Production in 1954 totaled 1,227,743 tons of quick and hydrated lime valued at Can$14,899,291. In 1953 output of lime in Canada totaled 1,228,760 tons valued at Can$14,484,013.[12] Demand for lime continued strong, reflecting the country's industrial growth and the high level of construction activity. In 1954, 316,423 tons of the Canadian production, valued at Can$3,421,466, was in hydrated form, while in 1953, 305,627 tons valued at Can$3,183,099 was hydrated lime.

SOUTH AMERICA

Chile.—A new lime plant was reported planned at Talcahuano to produce lime for agricultural and industrial use.[13] Limestone from the Guarello Island was to be used to supply the new plant.

Netherland West Indies.—The Curaçao Mining Co. was reportedly operating a lime plant on a cost-plus basis for the Curaçao subsidiary of Royal Dutch Shell Oil Co. The kiln was said to have been producing at a rate of 350 tons of lime per month; all of it was being used at the refinery.[14]

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[11] Anderegg, F. O., Soundness of Building Limes: Rock Products, vol. 57, No. 6, June 1954, p. 127.
[12] Department of Mines and Technical Surveys, Lime in Canada, 1954 (Prelim.): Ottawa, Canada, 5 pp.
[13] Fertilizer Feeding Stuffs & Farm Supplies Journal (London), vol. 40, No. 6, Mar. 17, 1954, p. 231.
[14] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 4, April 1955, p. 49.

Lithium

By Joseph C. Arundale[1] and Annie L. Marks[2]

LITHIUM supplies increased greatly in 1954. Output from new and expanded facilities resulted in a record domestic production of lithium minerals and compounds. Imports of lepidolite and petalite exceeded those in any previous year. Additional domestic facilities were being built, still more were proposed, and the industry continued to grow. Prices of some lithium products were reduced. There were improvements in the technology of producing and processing lithium minerals and compounds. Research on utilization of these materials was expanded. Worldwide interest in lithium was heightened, and activity was intensified in several countries.

DOMESTIC PRODUCTION

Production (as measured by shipments) of lithium minerals and compounds in the United States during 1954 far exceeded that in any previous year. Expansion of facilities underway and proposed during the year indicated an even greater production rate to come.

Foote Mineral Co. had the first full year of production at its mine and mill in the Kings Mountain district of North Carolina and at its chemical plant at Sunbright, Va. During the year this firm made several major additions to both facilities. By the end of the year the expansions at the mine and mill had been completed, and the expansions at the chemical plant at Sunbright were nearing completion. These facilities and complementary processes were described.[3]

TABLE 1.—Shipments of lithium ores and compounds from mines in the United States, 1935–39 (average), 1945–49 (average), and 1950–54

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	1952	15,611	[1]$1,052,000	1,088
1945–49 (average)	3,334	259,457	312	1953	27,240	[1]2,134,000	1,767
1950	9,306	579,922	747	1954	37,830	[1]3,126,000	2,459
1951	12,897	[1]896,000	956				

[1] Partly estimated.

[1] Assistant chief, Branch of Construction and Chemical Materials.
[2] Statistical clerk.
[3] Trauffer, W. E., Foote's Operation Lithium: Pit and Quarry, vol. 47, No. 3, September 1954, pp. 86–90, 93.
Lenhart, W. B., Recovering Lithium by Froth Flotation: Rock Products, vol. 57, No. 6, June 1954, pp. 120–122.
Chemical and Engineering News, vol. 32, No. 18, May 3, 1954, pp. 1760–1761.

Early in 1954 Lithium Corp. of America announced plans for a spodumene-mining operation and lithium-chemicals plant near Bessemer City, N. C. The project reportedly was to cost $7 million.[4] By the end of the year mining had begun, crude ore was being stockpiled, and the chemical plant was nearing completion.[5]

It was announced that a $6 million lithium-chemicals plant would be built near San Antonio, Tex., by American Lithium Chemicals Inc., jointly owned by American Potash & Chemical Corp. and Bikita Minerals, Ltd.[6] This latter firm was said to be owned by Selection Trust, Ltd., American Potash & Chemical Corp., and American Metal Co.[7] Lepidolite from a deposit in Southern Rhodesia owned by Bikita Minerals, Ltd., was to be used as raw material in the new plant.[8]

The following producers were reported active in the Black Hills of South Dakota (mine names in parentheses): Maywood Chemical Works (Etta); Keystone Feldspar & Chemical Co. (Peerless); Uranium & Allied Minerals, Inc. (Dyke Lode); Bland Mining & Milling Co. (Beecher Lode and Mohawk); Lithium Corp. of America (Mateen and Beecher); and Black Hills Keystone Corp. (Ingersoll). A. Rapp & C. Walsh, National Processing Co. and L. W. Judson reported small shipments of spodumene from this district. Earl Anderson reported shipment of a small tonnage of amblygonite recovered from beryl operations at the Midnight Owl mine in Maricopa County, Ariz. A small shipment of lepidolite was made by Poston Mining Co. from the Brown Derby mine in Gunnison County, Colo. Later in the year a new firm—United States Lithium Corp.—was organized to operate this mine.[9]

It was reported that preliminary development work was being done on a lithium claim in the Rattlesnake Mountains in Natrona County, Wyo.[10] Spodumene and amblygonite were said to be present along with beryl. A test shipment was being prepared late in the year.

CONSUMPTION AND USES

Shortages of lithium compounds in recent years limited the consumption of these materials. However, as larger quantities of lithium compounds began to flow from expanded facilities, consumption also increased. It became apparent in 1954 that supplies of lithium minerals and compounds soon would be ample.

Although no official consumption figures were available, two uses—greases and various ceramic materials—accounted for an estimated two-thirds of the lithium consumed in 1954. Lesser quantities were used in air conditioning, refrigeration, aluminum brazing, metallurgy, organic synthesis, batteries, and other applications.

Assurance of adequate supplies and the prospect of decreasing prices for lithium compounds were powerful incentives to research on new applications.

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[4] Engineering and Mining Journal, vol. 155, No. 4, April 1954, p. 145.
[5] Mining Congress Journal, vol. 40, No. 11, November 1954, p. 88.
[6] Chemical and Engineering News, vol. 32, No. 43, Oct. 25, 1954, p. 4265.
[7] Northern Miner, Toronto, vol. 41, No. 32, Oct. 28, 1954, pp. 1, 23.
[8] Chemical Engineering, vol. 61, No. 12, December 1954, pp. 108, 110.
[9] Mining World, vol. 16, No. 11, October 1954, p. 85.
[10] Mining World, vol. 16, No. 13, December 1954, p. 80.

One lithium producer sponsored an award program designed to stimulate research on the use of lithium. Separate cash awards were offered to professional and student researchers for the best papers on the use of lithium minerals or compounds in ceramic processes or products.[11]

The Department of Defense requested the Materials Advisory Board of the National Academy of Sciences to conduct a study on lithium. A report was to be prepared on the availability of lithium, past and present, and its potential uses, with particular emphasis on the advantages that might come to the national defense from broader utilization of lithium or lithium compounds. By the end of 1954 this study had not been completed.

PRICES

Prices of lithium minerals were not quoted regularly in trade journals. However, there were occasional nominal quotations ranging from about $10 to about $12.50 per short ton unit of contained lithia in spodumene, f. o. b. the source.[12] At least one trade paper mentioned a nominal price for lepidolite of about $80 a short ton and for amblygonite of about $110 a ton, both prices c. i. f. east coast ports.[13] The agreement between Lithium Corp. of America and Quebec Lithium Corp. was said to have stipulated a price of $11 a unit f. o. b. the mine for spodumene concentrate running at least 4.5 percent lithia.[14]

According to E&MJ Metal and Mineral Markets, lithium metal, 98 percent pure, was quoted at $11 to $14 a pound, depending on quantity.

Prices on various lithium compounds during 1954 were quoted by Oil, Paint and Drug Reporter as follows: Lithium benzoate, drums, per pound, $1.65 to $1.67; lithium citrate, N. F., barrels, drums, kegs, per pound, $1.60 to $1.64; lithium hydride, powder, drums, works, per pound, $12 to $14; lithium salicylate, drums, per pound, $1.60 to $1.70.

The following lithium compounds reflected a price reduction during 1954:

Lithium bromide, N. F., barrels, works, freight equalized, per pound, January to early October, was quoted at $2.10 to $2.75; toward the end of October the price was quoted at $2.16 per pound.

Lithium carbonate, technical, drums, per pound, January to March, $0.90 to $1.10; March to November, technical, carlots, delivered, $1 per pound. In November the price both at works and delivered was quoted at $0.95 to $1; less than carlots, June to November, $1.05 to $1.20 per pound; in December $1 to $1.20.

Lithium chloride, crystals, drums, per pound, January through October, $1.22 to $1.28; in November, technical, crystals, drums, per pound, $1.10 to $1.25.

Lithium fluoride, 10,000 pound lots, January through early December, $2.15 per pound; in December, delivered, $2.17½; ton lots, January through December, $2.20 per pound; in December price reduced to $2.18½ per pound; less than ton lots, January through December, $2.25 per pound, price reduced in December to $2.23½ per pound.

Lithium hydroxide, monohydrate, ton lots, drums, through December, $1.10 per pound; in late December, works and delivered, $0.95 to $0.98½.

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[11] Chemical and Engineering News, vol. 32, No. 20, May 17, 1954, p. 1991.
[12] Northern Miner (Toronto), vol. 41, No. 19, July 29, 1954, p. 19.
[13] Northern Miner (Toronto), vol. 41, No. 35, Nov. 18, 1954, p. 5.
[14] Northern Miner (Toronto), vol. 41, No .39, Dec. 16, 1954, pp. 1, 4.

FOREIGN TRADE

Imports of lithium ores from Southern Africa—largely Southern Rhodesia, South West Africa, and Mozambique—continued to increase.

The quantity of lithium ore exported from Southern Rhodesia increased some 17,000 tons in 1953.

TECHNOLOGY

The technology of mining and processing lithium minerals, the production of lithium compounds and products, and the utilization of lithium in its many forms all improved.

Advance in technology in mining and processing of lithium minerals was represented by the expansions and improvements made at the Kings Mountain operations of Foote Mineral Co. and at that firm's limestone mine and chemical plant at Sunbright, Va. These operations were described in some detail in an article.[15]

The proposed plant of American Potash & Chemical Corp. at San Antonio, Tex., will represent the first large-scale utilization of lepidolite as the raw material in manufacturing lithium chemicals in the United States. Advances in processing as the result of intensive research made such an operation possible.[16]

Two major inovations were being incorporated in a new plant being built by Lithium Corp. of America at Bessemer City, N. C. It will operate on ore run directly from the mine without the usual concentration step to eliminate gangue. Although this means handling four and one-half times as much ore, company officials said that eliminating a processing step will more than compensate for it. In addition, the plant will be at the mine site.[17]

A project was conducted at the Knolls Atomic Power Laboratory of the Atomic Energy Commission at Schenectady, N. Y., to investigate the possibility of preparing 100-percent lithium hydride by reacting hydrogen with finely divided lithium at 179° C., the melting point of lithium. The finely divided lithium was prepared by evaporating lithium ammonate. It was concluded from this experiment that it was possible to prepare lithium hydride at temperatures between 29° and 250° C. However, the commercial practicability of the method was questioned because of the length of time required for the reaction and the inability to obtain reproducible results.[18]

The Bureau of Mines, under a contract with General Services Administration, conducted research on the recovery of beryl and spodumene from Kings Mountain district ore and the separation of these two minerals. Several processes have been tried, including selective flotation, heavy-liquid separation, and chemical extraction, hydraulic classification, tabling, electrostatic, roasting and leaching, decrepitation, and magnetic separation. Recovery of a satisfactory beryl product was not accomplished.

[15] Trauffer, W. E., Foote's Operation Lithium: Pit and Quarry, vol. 47, No. 3, September 1954, pp. 86–90, 93.
[16] Work cited in footnote 7 (p. 2).
[17] Chemical Engineering, vol. 61, No. 6, June 1954, pp. 106, 110.
[18] Swain, E. E., Jr., The Reaction Between Lithium and Hydrogen at Temperatures Between 29°–250° C., Knolls Atomic Power Laboratory, Schenectady, N. Y.: KAPL–1067, U. S. Atomic Energy Commission, Tech. Info. Service, Oak Ridge, Tenn., Mar. 1, 1954, 20 pp.

RESERVES

Estimates of reserves of lithium ore in the United States were raised in 1954. Improved mining and milling methods, which assure a greater recovery of lithium from the ores, and more accurate determination of the grade and extent of pegmatites have helped increase the figures. The tin-spodumene belt (North-South Carolina), Searles Lake (Calif.), and the Black Hills (S. Dak.) contained what is believed to be the largest reserve of lithium minerals in the United States. Further research on saline deposits and on certain types of clays may establish new sources. The majority of estimated reserves lie on or near the surface, and undoubtedly exploration at greater depths will reveal additional reserves.

The lithium "boom" in the Provinces of Quebec, Manitoba, and Northwest Territories of Canada also uncovered large reserves of pegmatite ore; continued exploration probably will increase reserves.

During 1954 the Federal Geological Survey was preparing a report on the lithium resources of North America.

WORLD REVIEW

Interest in lithium was spreading widely. In addition to the activity in Southern Africa, deposits in Australia, Brazil, Belgian Congo, and other countries were being investigated.

Argentina.—Although there were no known producers of lithium minerals in Argentina in 1954, there are occurrences principally in the provinces of Cordoba and San Luis. One mine, Las Tapias, in Cordoba, contains spodumene and beryl and is owned and operated by Fabricaciones Militares. Other lithium-ore deposits, all in the Province of San Luis, are Ojo de Agua, Las Cañas, Puerta Colorada, and Doña Julia.[19]

Brazil.—In 1952 lithium ore was embargoed for export by the Brazilian Government. However, Brazil is an important potential source of lithium minerals. The three States of Rio Grande do Norte, Paraíba, and Ceará, in northeast Brazil, are said to contain hundreds of pegmatites. A report was published on the results of a reconnaissance survey of this area involving 61 representative pegmatites.[20] Of the 61 dikes examined, 8 contained spodumene and 6 amblygonite. Two mines were reported stockpiling spodumene as a byproduct. Some of these bodies were said to contain beryl, cassiterite, and tantalite-columbite.

Canada.—Perhaps the most intense activity was in Canada. In the several known pegmatite areas a multitude of firms and individuals staked claims and were in various stages of exploration projects. One firm, Quebec Lithium Corp., was reported to have begun development of a deposit in the LaCorne region north of Val d'Or, Quebec.

Pegmatites containing lithium minerals are in the Yellowknife-Beaulieu district, Northwest Territories; the Cat Lake-Winnipeg River, the Herb Lake, and East Braintree-West Hawk Lake districts, Manitoba; and the Preissac-LaCorne district, Quebec. These

[19] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 4, April 1954, pp. 62-63.
[20] Mather, W. B., Lithium—Northeast Brazil Is Potential Source: Min. Eng., vol. 6, No. 9, September 1954, pp. 897-903.

deposits were described in an article and their general characteristics reviewed.[21] The following general characteristics were listed as being exhibited by pegmatites in Canada that contain appreciable amounts of lithium minerals:

1. The pegmatites occur in medium- to high-grade metamorphic rocks or in plutonic rocks.
2. They are associated spatially and perhaps genetically with bodies of granite that contain 20 to 40 percent microcline and 20 to 40 percent albite or oligoclase.
3. They are marginal and exterior pegmatites.
4. In districts where regional zonation of granitic pegmatites is present, the pegmatites richest in lithium minerals are farthest from the center of the associated body of granite.
5. In pegmatite bodies that contain spodumene from wall to wall except for discontinuous, narrow border and, or, wall zones, many or almost all of the spodumene crystals are oriented perpendicular to the walls, and are too fine-grained to be hand-sorted on a commercial scale.
6. Cleavlandite is generally a principal component of the wall zones.
7. In a given internal structural unit, spodumene is one of the early minerals to form.
8. Replacement bodies containing spodumene have not been found.
9. Amblygonite and montebrasite have been found only in intermediate zones.

Lithium Corp. of America acquired 100-percent interest in the Cat Lake, Manitoba, properties formerly owned by Northern Chemicals, Ltd., in which Lithium Corp. of America had for some time held a substantial but not controlling interest.[22] Although previous diamond drilling and trenching had been done, no development plans were announced.

In July an agreement was announced between Lithium Corp. of America and Quebec Lithium Corp. (a subsidiary of Sullivan Consolidated Mines, Ltd.) under which the latter company would receive the output of spodumene concentrate to be produced by the former company at its proposed mine and mill near Val d'Or, Quebec.[23] It was reported that a start was made on a shaft to go to a depth of 450 feet, with 3 levels to be established.[24]

Later reports indicated that a 3-compartment shaft would be sunk to a depth of about 700 feet.[25] These reports also stated that a 1,000-ton-a-day mill was planned. The agreement was said to call for delivery of 165 tons of concentrate a day at a price of $11 per unit of contained Li_2O. By the end of the year substantial progress had been made on the shaft and accessary buildings.

On ground adjoining Quebec Lithium Corp. on the north and west, a new company, Canadian Lithium Co., was reportedly diamond drilling.[26] Later reports showed that by the end of the year this company had done considerable exploration work on its property.[27]

It was reported that International Lithium Mining Corp. was drilling for lithium ore in Figuery and LaMotte Townships.[28]

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[21] Rowe, R. B., Pegmatitic Lithium Deposits in Canada: Econ. Geol., vol. 49, No. 5, August 1954, pp. 501-515.
[22] American Metal Market, vol. 61, No. 140, July 23, 1954, p. 1.
[23] American Metal Market, vol. 61, No. 128, July 7, 1954, p. 1.
[24] Engineering and Mining Journal, vol. 155, No. 7, July 1954, p. 144.
[25] Northern Miner (Toronto), vol. 41, No. 30, Oct. 14, 1954, pp. 1, 7, 8; No. 39, Dec. 16, 1954, pp. 1, 4. Canadian Mining Journal, vol. 75, No. 11, November 1954, p. 138.
[26] Northern Miner (Toronto), vol. 41, No. 22, Aug. 19, 1954, p. 3.
[27] Northern Miner (Toronto), vol. 41, No. 31, Oct. 21, 1954, p. 4. Canadian Mining Journal, vol. 75, No. 12, December 1954, p. 141; vol. 76, No. 1, January 1955, pp. 113-114.
[28] Northern Miner (Toronto), vol. 41, No. 34, Nov. 11, 1954, p. 19.

Other groups that had staked claims in northwest Quebec and were planning exploration programs included Martin-McNeely Mines,[29] New Metalore Mining Co.,[30] and Gaitwin Explorations,[31] Romac Mines,[32] Keyboycon Mines,[33] Magnet Consolidated Mines,[34] Valor Mines,[35] Northern Quebec Explorers Ltd.[36] and Iso Uranium Mines.[37]

It was said that about 2,000 mining claims had been staked in the LaCorne area of northwest Quebec principally for lithium during 1954. These were held by various individuals and about 40 mining companies.[38] This same paper listed the exploration projects underway at the end of 1954 and the progress made in each.

Northern Rhodesia.—Lepidolite and petalite for the first time were reported found in the Choma district of Northern Rhodesia.[39]

Southern Rhodesia.—It was reported that a plant for the manufacture of lithium salts was erected at Gwelo. The products were to be exported to United States and Britain.[40] It was also said that future production of lithium salts in the Bikita area was planned.[41]

It was reported that several deposits of petalite were discovered in the Enterprise tin belt 16 to 20 miles from Salisbury and that exploratory and quarrying operations were started at the Patronage mine. A substantial deposit of petalite also was reported on the Casa Ventura farm and eucryptite on farms Thorn Vlei and Lonly Park and the Al Hayat mine at Bikita.[42]

TABLE 2.—Lithium ore exported from Southern Rhodesia, 1952–53, by country of destination [1]

	1952		1953	
	Short tons	Value	Short tons	Value
United States	22	$420	15,243	$314,605
Germany, West	1,145	20,020	1,596	48,904
United Kingdom	365	7,425	1,378	41,526
France	534	5,807	843	13,865
Netherlands			25	641
Australia			44	448
Union of South Africa	21	207		
Belgium	3	33		
Total	2,090	33,912	19,129	419,989

[1] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 3, September 1954, pp. 61–62.

[29] Northern Miner (Toronto), vol. 41, No. 31, Oct. 21, 1954, p. 16.
[30] Northern Miner (Toronto), vol. 40, No. 12, June 10, 1954, p. 8.
[31] Canadian Mining Journal, vol. 76, No. 1, January 1955, p. 120.
[32] Engineering and Mining Journal, vol. 155, No. 11, November 1954, p. 162.
[33] Northern Miner (Toronto), vol. 41, No. 31, Oct. 21, 1954, p. 15.
[34] Northern Miner (Toronto), vol. 41, No. 31, Oct. 21, 1954, p. 16.
[35] Northern Miner (Toronto), vol. 41, No. 19, July 29, 1954, p. 8.
[36] Northern Miner (Toronto), vol. 40, No. 8, May 13, 1954, p. 4.
[37] Mining Journal (London), vol. 243, No. 6228, Dec. 31, 1954, p. 768.
[38] Northern Miner (Toronto), vol. 40, No. 51, March 10, 1955, pp. 17, 27 (reporting on a paper read at the Prospectors and Developers Assoc. Convention March 7, 1955, by M. Latulippe and W. N. Ingham, Dept. of Mines geologists).
[39] Rhodesian Mining Review, vol. 19, No. 8, August 1954, p. 21.
[40] Engineering and Mining Journal, vol. 155, No. 3, March 1954, p. 166.
[41] Mining World, vol. 16, No. 8, July 1954, p. 77.
[42] Mining World, vol. 16, No. 8, July 1954, p. 77.

The Lepidolite Development Corp. was reported conducting a series of tests to beneficiate low-grade lepidolite, which was a byproduct of its lithium-ore mines, Mauve and Winston, near Salisbury. The company was regularly producing several hundred tons monthly of high-grade massive lepidolite. This material was mined in an open pit by ½-yard diesel shovel and hand-sorted.[43]

Lepidolite Development Corp. acquired the Mops lepidolite claims near Salisbury, only a short distance from the company's Mauve mine. Two pegmatite bodies are about 10 feet thick, with the central core almost solid fine-grained lepidolite. The company also began development work at the Grand Duke lepidolite mine at Odzi in the Umtali district and was making an intensive search for other lepidolite deposits.[44]

South-West Africa.—Although only a small tonnage has been produced in the past, considerable interest was reported in the lithium ores in the Steinkop Reserve, Namaqualand. From existing prospecting pits and surface indications, the most promising areas appear to be in the vicinity of Spodumenekop, Jackalswater, and Norrabees.[45]

TABLE 3.—Lithium minerals exported from South-West Africa, 1952–53, by countries of destination [1]

	1952		1953	
	Short tons	Value [2]	Short tons	Value
Amblygonite:				
Germany, West	368	$23,394	344	$32,239
United States	22	1,330	45	3,393
Netherlands			31	2,080
United Kingdom	124	8,041	28	2,469
Lepidolite:				
United States	7,391	129,189	9,083	157,869
France	701	12,266	637	11,121
Germany, West			280	4,911
Netherlands			60	1,408
Petalite: United States	1,406	29,391	1,481	25,925
Total	10,012	203,611	11,989	241,415

[1] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 2, August 1954, p. 59.
[2] Revised figures.

In 1953, 11 firms were producing lithium ores; they are as follows:[46]

Amblygonite:
- M. H. C. Brockman, P. O. Box 4, Karibib.
- H. E. W. Fricke, P. O. Box 24, Karibib.
- E. E. Meyer, P. O. Box 30, Karibib.
- W. Stiepelmann, Sandamap, P. O. Usakos.
- E. E. Simon, Karibib.
- S. W. A. Lithium Mines, P. O. Box 1517, Windhoek.
- P. Weidner, P. O. Box 12, Warmbad.

Lepidolite:
- M. H. C. Brockman, P. O. Box 4, Karibib.
- S. W. A. Lithium Mines, P. O. Box 1517, Windhoek.
- S. W. A. Gems (Pty.), Ltd., P. O. Box 42, Swakopmund.

Petalite: S. W. A. Lithium Mines, P. O. Box 1517, Windhoek.

[43] Mining World, vol. 16, No. 9, August 1954, p. 33.
[44] Mining World, vol. 16, No. 12, November 1954, p. 65.
[45] Mining Journal (London), vol. 244, No. 6229, Jan. 7, 1955, p. 12.
[46] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 2, August 1954, p. 59.

Magnesium

By H. B. Comstock [1]

THE UNITED STATES continued to maintain its lead in production and consumption of magnesium in 1954, showing 50 percent of total estimated world output. A decline of 16 percent in consumption of magnesium in the United States was explained by the extension of time for completion of defense procurement programs and the shutdown of fabrication facilities at Midland, Mich., while being moved to Madison, Ill. Its use for cathodic protection of other metals and for production of titanium was greatly increased during 1954. Research work was noticeably expanded during 1954, both in development of new magnesium alloys and new working techniques, which was expected to lead to increased use of the metal for structural applications. By the close of 1954 demands for sheet and plate for fabrication of items for peacetime use promised to result in a substantial increase in consumption of magnesium in rolling mills during 1955.

TABLE 1.—Salient statistics of the magnesium-metal industry in the United States, 1945–49 (average) and 1950–54

	1945–49 (average)	1950	1951	1952	1953	1954
Production:						
Primary magnesium [1] ... short tons	14,411	15,726	40,881	105,821	93,075	69,729
Secondary magnesium [1] ... do	7,476	9,476	11,526	11,477	11,930	8,250
Average quoted price, per pound—primary [2] ... cents	20.5	22.0	24.5	24.5	26.6	27.0
Domestic consumption ... short tons	16,475	18,051	[3] 33,756	[3] 42,387	[3] 46,843	39,218
Exports [4] ... do	486	908	761	1,163	2,949	3,257
World production ... do	40,000	[3] 50,000	[3] 90,000	[3] 170,000	170,000	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, 1955).
[3] Revised figure.
[4] Primary magnesium and alloys.

TABLE 2.—Production of primary magnesium in the United States, 1945–49 (average) and 1950–54, by months, in short tons

Month	1945–49 (average)	1950	1951	1952	1953	1954
January	1,437	1,002	1,876	7,425	9,908	6,447
February	1,188	913	1,709	7,794	9,078	5,856
March	1,331	948	1,885	8,893	10,352	6,545
April	1,217	957	2,043	8,800	9,751	6,204
May	1,176	972	2,194	9,093	9,116	6,460
June	1,242	1,175	2,512	8,670	7,286	6,191
July	1,592	1,332	2,998	9,529	6,207	6,049
August	1,603	1,400	3,418	9,771	6,266	5,772
September	1,146	1,635	4,166	8,422	6,076	5,325
October	949	1,690	5,147	8,990	6,341	5,149
November	785	1,760	6,010	9,122	6,227	4,942
December	745	1,942	6,923	9,312	6,467	4,789
Total	14,411	15,726	40,881	105,821	93,075	69,729

[1] Commodity-industry analyst.

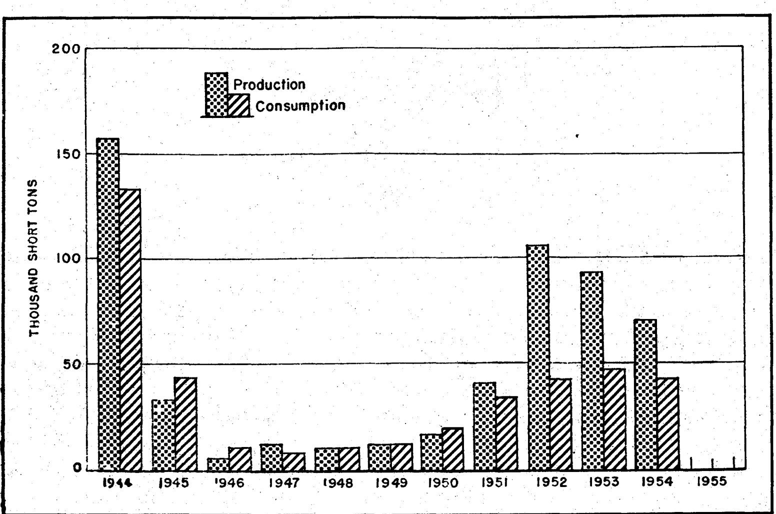

FIGURE 1.—Domestic production and consumption of primary magnesium, 1944–54.

DOMESTIC PRODUCTION

Primary.—The production of primary magnesium in 1954 was 69,700 tons, or 25 percent below production in 1953. All commercial production of primary magnesium in 1954 came from the Dow Chemical Co. plant at Freeport, Tex., and the Government-owned plant at Velasco, Tex., which was operated by Dow Chemical Co. under an agreement of lease executed in 1951, when that plant was reactivated to produce magnesium for defense during the Korean emergency. On December 30, 1954, the lease was extended to January 31, 1958.

In 1954 the Dow Chemical Co. built a plant at Freeport, Tex., to recover magnesium, which previously was lost in the waste sludge from the electrolysis of magnesium chloride. By the end of the year the recovery plant was producing magnesium ingots at the annual rate of 1,000 tons.[2]

A relatively small quantity of calcium and high-purity magnesium was produced for defense in 1954 at the Government-owned magnesium plant at Canaan, Conn.

TABLE 3.—Stocks and consumption of new and old magnesium scrap in the United States in 1954, gross weight in short tons

Scrap item	Stocks, beginning of year	Receipts	Consumption			Stocks, end of year
			New scrap	Old scrap	Total	
Cast scrap	971	3,894	1,068	3,274	4,342	523
Solid wrought scrap	[1] 135	945	1,039		1,039	41
Borings, turnings, drosses, etc	[1] 89	2,075	2,113		2,113	51
Total	[1] 1,195	6,914	4,220	3,274	[2] 7,494	615

[1] Revised figure.
[2] Includes 351 tons consumed in making magnesium castings, 3 tons in wrought products, 409 tons in aluminum alloys, 9 tons in other alloys, 4,499 tons in magnesium-alloy ingot, 2,221 tons in cathodic protection, and 2 tons in miscellaneous dissipative uses.

[2] Chemical Engineering, vol. 61, No. 12, December 1954, p. 130.

TABLE 4.—Magnesium recovered from scrap processed in the United States, 1953–54, in short tons

Recoverable magnesium content of scrap processed			Magnesium recovered from scrap processed		
Kind of scrap	1953	1954	Form of recovery	1953	1954
New scrap:					
Magnesium-base	3,945	3,305	Magnesium-alloy ingot [1]	6,710	3,581
Aluminum-base	1,947	1,692	Magnesium-alloy castings	436	289
Total	5,892	4,997	Magnesium-alloy shapes	3	3
			In aluminum alloys	3,113	2,602
Old scraps:			In zinc and other alloys	4	8
Magnesium-base	5,393	2,682	Chemical and other dissipative uses	86	2
Aluminum-base	645	571			
Total	6,038	3,253	Cathodic protection	1,578	1,765
Grand total	11,930	8,250	Grand total	11,930	8,250

[1] Figures include secondary magnesium incorporated in primary magnesium ingot.

Secondary.—Total recovery of secondary magnesium from scrap in 1954, including that treated on toll, was 8,250 tons compared with 11,930 tons in 1953. Consumption of magnesium-base scrap in 1954 declined 31 percent below 1953 mainly because of the general decrease in requirements for magnesium. In 1954 no magnesium scrap was reported used in primary magnesium-alloy ingot, whereas 3,800 tons of magnesium scrap was consumed for that purpose in 1953. Magnesium-alloy ingot containing more than 50 percent of the primary metal was considered to be a primary product.

TABLE 5.—Domestic consumption of primary magnesium (ingot equivalent and magnesium content of magnesium-base alloys) by uses, 1945–49 (average) and 1950–54, in short tons.

Product	1945–49 (average)	1950	1951	1952	1953	1954
For structural products:						
Casting:						
Sand	5,047	3,090	10,179	14,513	14,306	9,545
Die	333	242	994	2,777	2,401	1,743
Permanent mold	1,682	573	646	1,115	1,106	785
Wrought products:						
Sheet and plate	1,595	3,357	[1] 4,988	[1] 5,150	[1] 5,443	3,033
Extrusions (structural shapes, tubing)	2,531	3,400	[1] 4,060	[1] 2,715	[1] 4,744	2,461
Forgings	133	104	735	12	24	110
Total for structural products	11,321	10,766	[1] 21,602	[1] 26,282	[1] 28,024	17,677
For distributive or sacrificial purposes:						
Powder	994	56	482	1,553	1,219	582
Aluminum alloys	2,769	3,722	5,994	8,598	10,347	8,061
Other alloys	37	255	401	960	418	103
Scavenger and deoxidizer	345	473	1,332	1,229	423	80
Chemical	246	373	447	566	363	63
Cathodic protection (anodes)	143	1,937	2,364	2,100	2,539	5,479
Other [2]	620	469	1,134	1,099	3,510	787
Reducing agent for titanium, zirconium, and hafnium	(3)	(3)	(3)	(3)	(3)	6,386
Total for distributive or sacrificial purposes	5,154	7,285	12,154	16,105	18,819	21,541
Grand total	16,475	18,051	[1] 33,756	[1] 42,387	[1] 46,843	39,218

[1] Revised figure.
[2] Includes primary metal consumed for experimental purposes, debismuthizing lead, and production of nodular iron and secondary magnesium alloy.
[3] This use, which was very small before 1954, was included in the figure for other distributive purposes.

CONSUMPTION AND USES

Consumption of primary magnesium in 1954 totaled 39,218 tons, a decrease of 16 percent below 1953. The decrease of 37 percent in structural products was accounted for by the extension of time for completion of defense procurement programs and the shutdown of the Dow Chemical Co. wrought-products facilities while being moved from Midland, Mich., to Madison, Ill. The increase of 14 percent for distributive or sacrificial purposes was caused largely by the sharp expansion in use of magnesium for cathodic protection and as a reducing agent for production of titanium, zirconium, and hafnium.

Because of the technology developed to the close of 1954, the use of magnesium in production of titanium was expected to expand with increasing demand for that metal. However, by the close of 1954 one titanium-producing plant was equipped to recover the magnesium and chlorine from the magnesium chloride resulting from the process of producing titanium. Other titanium producers were expected ultimately to include this recycling process to lower their requirements for magnesium.

When the Dow Chemical Co. Madison extrusion and rolling mill was dedicated on May 26, 1954, it was announced that this was the largest magnesium facility in the world, with an annual capacity of 8,000 tons of rolled sheet and plate, 6,000 tons of extrusions, and 18,000 tons of alloys.[3] A 13,000-ton extrusion press was being installed at the Madison plant in 1954 as a part of the Air Force Heavy Press Program.[4]

The Department of Defense announced in 1954 that expanded fabrication capacity should encourage increased military applications of magnesium.[5] A broader application of magnesium and its alloys was noted in such defense items as airborne radar systems,[6] guided missles,[7] Marine Corps portable shelters,[8] and jet engine parts.[9]

The domestic magnesium fabricating industry included 80 sand foundries and 87 assembly fabrication plants in 1954. By the close of the year 4 plants were extruding or rolling sheet and plate and 7 were forging, 9 were engaged in heat treatment, 54 in machining, 55 in surface treatment, and 9 in secondary smelting.[10]

In December 1954 announcements were published concerning the use of magnesium in mass production of luggage.[11] This was stressed as the first large tonnage civilian application of magnesium.

In April 1954 Reade Manufacturing Co. announced plans to double ts facilities for producing magnesium powder.[12]

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[3] American Metal Market, Dow Dedicates World's Largest Magnesium Rolling Mill at Madison, Ill.: Vol. 61, No. 102, May 28, 1954, pp. 1, 9.

[4] Materials and Methods, Rolling Mill Will Change Magnesium Supply: Vol. 40, No. 5, November 1954, p. 11.

[5] Iron Age, Magnesium: Vol. 173, No. 22, June 3, 1954, p. 84.

[6] Modern Metals, Magnesium in Airborne Radar Systems: Vol. 10, No. 2, March 1954, p. 36.
American Metal Market, Magnesium Is An Important Factor in Modern Defense System Guarding U. S.: Vol. 41, No. 178, Sept. 16, 1954, p. 9.

[7] Bell, A. J., Magnesium in Fabrication of Guided Missles: Light Metal Age, vol. 11, No. 12, December 1954, pp. 25–27.

[8] Dow Magnesium Topics, Flying Hangar: Vol. 4, No. 6, October 1954, pp. 1, 2.

[9] American Metal Market, Magnesium Jet Engine Housing Roughed and Finished on One Lathe: Vol. 62, No. 2, Jan. 4, 1955, p. 9.

[10] Winston, Arthur W., Magnesium: Modern Metals, vol. 10, No. 12, January 1955, pp. 56–60.

[11] Wall Street Journal, Luggage Firm to Use Magnesium as Material for Making Suitcases: Vol. 144, No. 115, Dec. 13, 1954, p. 9.
American Metal Market, Shwayder Brothers to Mass Produce Luggage From Magnesium: Vol. 41, No. 230, Dec. 3, 1954. p. 9.

[12] Chemical Engineering, Modern Plant Makes Magnesium Powder: Vol. 61, No. 4, April 1954, pp. 122–124.

STOCKS

At the close of 1954 producers' stocks of primary magnesium were 14,400 tons. Consumers' stocks were 3,220 tons of primary magnesium and 5,760 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 magnesium, which had increased in 1953 from 24.5 cents per pound to 27 cents, remained at 27 cents throughout 1954.[13]

FOREIGN TRADE [14]

Imports.—During 1954 imports of magnesium dropped 70 percent below imports in 1953. About 5 percent of the imports in 1954 was in the form of scrap metal. The remainder came from Norway in the form of primary ingot and from Canada in the form of primary ingot, alloy ingot, and fabricated alloys. Tariff rates during 1954 remained, as in 1953, as follows: 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. Duty on magnesium metallic scrap was suspended on October 1, 1950, and Public Law 678, 83d Congress, extended the suspension to June 30, 1955. The imports were received from 7 countries in 1954 as compared with 10 countries in 1953. Of the 742 tons of magnesium metal and scrap imported, 550 tons was from Norway, 167 from Canada, 10 from Australia, 7 from New Zealand, 6 from United Kingdom, and 1 ton each from the Dominican Republic and Bermuda.

TABLE 6.—Magnesium imported for consumption and exported from the United States, 1945–49 (average) and 1950–54

[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
1945–49 (average)	747	$186,817	(1)	$47	1	$3,262	349	$149,894	137	$156,261	146	$117,168
1950	843	218,129	3	5,056	22	38,280	586	245,539	322	213,641	(2)	(2)
1951	3,871	998,214	18	29,525	90	190,050	575	308,865	186	228,427	(2)	(2)
1952	252	81,635	1	1,940	47	88,001	(3) 1,066	(3) 618,005	(3) 97	(3) 245,211	43	59,843
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) 1,737,787	(3) 161	(3) 605,251	34	44,605

[1] Less than 1 ton.
[2] Data not separately classified.
[3] Owing to changes in items included in each classification, data are not strictly comparable with earlier years.

[13] E&MJ Metal and Mineral Market Reports, vol. 25, No. 52, Dec. 30, 1954, p. 4.
[14] 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.

Exports.—Exports of magnesium in 1954 totaled 3,291 tons, an increase of 321 tons over 1953. In January 1954 quantitative limitation on magnesium for export was removed, but control of exports was continued to safeguard the national security.[15] Of the primary metal, alloys, and scrap exported during 1954, 1,707 tons was delivered to West Germany, 424 to Mexico, 182 to United Kingdom, 157 to Japan, 145 to Sweden, 107 to Yugoslavia, 71 to Switzerland, 43 to Canada, 42 to Saudi Arabia, 40 to the Netherlands, 33 to Venezuela, 32 to Norway, 26 to Belgium-Luxembourg, 17 to Argentina, 16 to Iran, 14 to Indonesia, 11 to Kuwait, 10 to Australia, 5 to Denmark, 3 each to Nicaragua, British Malaya, and Union of South Africa, 1 each to Cuba and Brazil; and 3 to other countries.

The United Kingdom received 23 tons of the powder exported; Canada, 6 tons; Belgium-Luxembourg, 3 tons; and Norway and the Netherlands, 1 ton each.

TECHNOLOGY

Industry, private research foundations, and research laboratories of Government agencies continued research throughout 1954 to develop new and improved magnesium alloys. A new program was announced for development of magnesium-base alloys containing additions of titanium, hafnium, rhenium, yttrium, and other high melting-point elements.[16]

This work was expected to lead to development of new alloys to meet requirements in strength for production of guided missles to operate at flight temperatures above the range of 300°–500° F., which was reached by 1954.[17]

Improvements in working techniques were published by various companies engaged in fabricating magnesium. A hot chamber method of producing die castings was described as being more versatile and more economical in many respects than the direct-chill process which was begun before 1944.[18] Additional data were published covering research completed in heat treatment of magnesium alloys for hardening and grain refining.[19]

In 1954 further improvements were announced for protecting magnesium from corrosion. A method was published for closing the pores of castings by forcing a sealing solution into them.[20] A process of infusing a resin combination into heated magnesium sheet and castings under pressure was said to increase their resistance to corrosion more than 300 percent.[21] Improvements in plating die castings with copper, nickel, and chromium were described.[22] A new chemical method for etching printing plates was introduced.[23] The use of

[15] Foreign Commerce Weekly, U. S. Department of Commerce, vol. 51, No. 4, Jan. 25, 1954, p. 23.
[16] Steel, Seeks New Alloys: Vol. 134, No. 13, Mar. 29, 1954, page 96.
[17] American Metal Market, Magnesium Alloys of Importance to Missle Program: Vol. 61, No. 250, Dec. 31, 1954, p. 5.
[18] Bennett, F. C., For Magnesium, A Hot Chamber Die Casting Machine: Modern Metals, vol. 10, No. 11, Dec. 1954, pp. 76–80.
[19] Materials and Methods, Magnesium Alloys: Vol. 40, No. 4, October 1954, p. 125.
Light Metals Bulletin, The Heat Treatment of Magnesium Alloy Casting: Vol. 17, No. 11, May 27, 1955, p. 511.
[20] Iron Age, Sealing Porous Castings: Vol. 175, No. 11, Mar. 17, 1955, p. 148.
[21] American Metal Market, New Impregnation Process May Open Up Magnesium Use: Vol. 61, No. 239, Dec. 16, 1954, p. 9.
[22] Goodeyne, L. G., and D. J., Plating Magnesium Die Castings: Metal Industry, vol. 86, No. 12, Mar. 25, 1955, pp. 232–233.
De Long, H. K., Electroplating on Magnesium: Metal Progress, vol. 67, No. 4, Apr. 1955, pp. 102–108.
[23] Metal Bulletin (London), Magnesium: No. 3918, Aug. 17, 1954, p. 26.

metal adhesives in bonding magnesium was described.[24] An analysis of resistance welding as a method of joining magnesium to dissimilar metals was published.[25]

Progress was reported in simplified design to expand the use of magnesium in producing aircraft and guided missles at marked savings in weight and cost.[26]

WORLD REVIEW

Estimated world production of magnesium in 1954 was 140,000 tons compared with 170,000 tons in 1953. However, a wider interest in use of the metal was noted in a number of countries. The United States reported 50 percent of total estimated world production and increased its exports by 11 percent compared with 1953. Early in 1954 reports came from Spain that plans were under way to erect a plant to produce 800 tons of magnesium annually.[27] The Bureau of Mines furnished a chapter for the official minerals and metals publication of Spain.[28]

TABLE 7.—World production of magnesium metal, by countries, 1945–49 (average) and 1950–54, in short tons [1]

(Compiled by Pearl J. Thompson)

Country	1945–49 (average)	1950	1951	1952	1953	1954
Canada	842	1,764	4,409	[2] 5,500	[2] 6,600	[2] 6,600
China, Manchuria	44	(3)	(3)	(3)	(3)	(3)
France	676	449	1,263	1,202	1,100	1,243
Germany:						
East [2]	500	1,100	1,100	1,100	1,100	1,100
West	132					90
Italy	298	134	746	1,076	1,595	1,836
Japan	244					
Korea	224					
Norway			338	338	3,853	5,183
Switzerland	154	276	276	331	[2] 275	
Taiwan (Formosa)	4					
U. S. S. R.[2]	19,000	25,000	35,000	45,000	55,000	45,000
United Kingdom [4]	3,483	3,307	5,512	5,071	5,936	5,577
United States	14,411	15,726	40,881	105,821	93,075	69,729
Total (estimate)	40,000	50,000	90,000	170,000	170,000	140,000

[1] This table incorporates a number of revisions of data published in previous Magnesium chapters.
[2] Estimate.
[3] Data not available; estimate by author of chapter included in total.
[4] Primary metal and remelt alloys.

Canada.—Production of primary magnesium in Canada in 1954 was reported to have remained at the level attained in 1953. Both of the producing plants were operated throughout 1954. Dominion Magnesium, Ltd., reduced cost of production of magnesium at its silicothermic plant at Haley, Ontario. Late in 1953 the company began production of ferrosilicon at its own plant at Beauharnois, Quebec. The Haley plant was reported to be the world's largest producer of calcium metal. Calcium was produced in the same type of furnaces as were used for production of magnesium.[29]

[24] Tooley, D. A., Adhesive Bonding Magnesium Assemblies: Modern Metals, vol. 10, No. 6, July 1954, pp. 40–43.
[25] Klain, Paul, Consummable Electrode Arc Welding of Magnesium: Light Metal Age, vol. 11, No. 11, December 1954, pp. 14–17.
[26] Steel, Magnesium Simplicity: Vol. 136, No. 6, Feb. 7, 1955, p. 107.
[27] Metal Bulletin (London), Magnesium: No. 3883, Apr. 6, 1954, p. 26.
[28] Comstock, H. B., The Magnesium Industry in The United States: The Production of The Mining and Metallurgical World in the Year 1954: Mineria y Metalurgie (Madrid), pp. 71–78.
[29] American Metal Market, Dominion Magnesium Finds Need of Lower Costs to Meet Competition: Vol. 61, No. 62, Apr. 1, 1954, p. 9.

Brucite was the source of magnesium in the electrolytic plant at Arvida, Quebec. Unlike the electrolytic plants in the United States, it utilized no sea water.[30]

On January 1, 1954, Dominion Magnesium, Ltd., announced a reduction of 1 cent per pound for primary magnesium and 2.5 cents per pound for magnesium alloys. This reduction brought the base price for carload lots, f. o. b. Haley, Ontario, to 31.0 cents per pound for primary magnesium ingot and 32.5 cents per pound for magnesium alloys.[31]

A further reduction was announced on July 9, 1954, which brought the base price of primary magnesium ingot to 29.5 cents per pound, f. o. b. Haley. The price of magnesium alloys remained at 32.5 cents per pound throughout the year.[32]

Consumption of magnesium in Canada in 1954 was estimated at 1,500 tons, leaving more than 3 times that quantity for export. Canada had no sheet and plate rolling facilities in 1954.[33]

France.—An increase of 13 percent above 1953 was reported for production of magnesium in France in 1954. One problem in the light-metals industry was possible shortage of electricity.[34]

Some progress was noted in use of magnesium in automotive equipment.[35]

Germany, West.—For the first time since 1945, West Germany reported production of primary magnesium in 1954. At the close of World War II the terms of disarmament of West Germany forbade the production of magnesium, and this ban had not been lifted by the end of 1954, insofar as production in commercial quantities was concerned.[36] However, early in 1954 the Allied Security Office gave permission for erection of a pilot plant near Cologne to produce 1 ton of metal per day, and production was begun in July.[37] The pilot plant was designed to operate by the electrothermal process of reducing dolomite with ferrosilicon, which was employed to a limited extent by the I. G. Farbenindustrie at Bitterfeld, Stassfurt, until the close of World War II.[38]

Increases in uses of magnesium during the year were noted especially in the automotive and electric industries. By the end of 1954 annual requirements for magnesium were estimated at 8,000 tons.[39]

Italy.—Production of primary magnesium rose slightly during 1954. Although consumption was somewhat higher during 1954 than 1953, it was less than total production, leaving a surplus of primary magnesium for export.[40] About half of the country's output of primary magnesium in 1954 was exported to Germany.

Japan.—No production of magnesium was reported in Japan during 1954. Experiments with domestic dolomite led to the announcement that its use might be possible for production of the metal, but shortages of fuel and electricity prevented any further progress in

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30 Department of Mines and Technical Surveys (Ottowa, Canada), Magnesium in Canada, 1954 (Preliminary), pp. 1–2.
31 Light Metals, Dominion Magnesium: Vol. 17, No. 191, February 1954, p. 34.
32 Work cited in footnote 30.
33 Chemical and Engineering News, Magnesium: Vol. 32, No. 42, Oct. 18, 1954, p. 4197.
34 Evans, H. R., Rare Earths in Metallurgy: Metal Industry, vol. 85, No. 18, Oct. 29, 1954, pp. 365–374.
35 American Metal Market, French Racing Car Had Body Made of Magnesium: Vol. 62, No. 114, June 14, 1955, p. 11.
36 Mining Journal (London), Magnesium: Vol. 244, No. 6240, Mar. 25, 1955, p. 333.
37 Metal Bulletin (London), Magnesium: No. 3916, Aug. 10, 1954, p. 22.
38 Metal Bulletin (London), Magnesium: No. 3919, Aug. 20, 1954, pp. 17, 19.
39 Mining Journal (London), Magnesium: Vol. 244, No. 6237, Mar. 4, 1955, p. 242.
40 Metal Bulletin (London), Italian Nonferrous Metal Output: No. 3985, Apr. 15, 1955, p. 18. Metal Industry, The Industrial Week—Italy: Vol. 86, No. 11, Mar. 18, 1955, p. 218.

plans for commercial production.[41] Japan imported 1,040 tons of magnesium during 1954, which was more than twice the quantity imported in 1953.

Norway.—Production of magnesium in Norway's only plant, at Herøya, South Norway, increased from 3,853 tons in 1953 to 5,183 tons in 1954. Most of the metal was exported in primary form, 2,440 tons going to Germany and 550 tons to the United States.

U. S. S. R.—The best available information indicates that the U. S. S. R. was the second largest magnesium producer in 1954, accounting for approximately 32 percent of world output. Reports received in November from Frankfurt-am-Main, Germany, stated that by the close of 1953, production of magnesium in the U. S. S. R. was beginning to lag behind consumption.[42]

United Kingdom.—Production of magnesium in 1954 dropped 6 percent below 1953. Imports from the Arvida plant in Canada were begun in 1954 under the agreement executed in 1952.[43] Increases were noted in consumption of magnesium for producing textile machinery and private and commercial automotive equipment; however, about 40 percent of consumption of the metal in 1954 was for defense items, mostly aircraft.

[41] Metal Bulletin (London), Magnesium: No. 3894, May 18, 1954, p. 27.
[42] American Metal Market, Russian Metal Data Presented for 1953: Vol. 61, No. 219, Nov. 17, 1954, pp. 1, 2.
[43] Daily Metal Reporter, Aluminum Co. of Canada to Boost Magnesium Output: Vol. 52, No. 129, July 4, 1952, p. 1.

Magnesium Compounds

By Hazel B. Comstock[1] and Jeannette I. Baker[2]

DOMESTIC production of crude magnesite, caustic-calcined and refractory magnesia, and dead-burned dolomite decreased during 1954 to the production level of 1949. In 1954, output of crude magnesite in the United States decreased to 7 percent of world production, compared with 13 percent in 1953. Imports of dead-burned and grain magnesia and periclase during 1954 increased 74 percent above 1953. Domestic sales of dead-burned dolomite in 1954 decreased 34 percent below 1953, while imports gained 14 percent. In 1954, domestic production and sales of high-grade magnesia, magnesium sulfate, and magnesium chloride decreased slightly below 1953. Domestic production of magnesium hydroxide in the United States in 1954 was over 7 times as great as in 1953, and a 16-percent increase was reported in the production of magnesium carbonate.

TABLE 1.—Salient statistics of magnesite, magnesia, and dead-burned dolomite in the United States, 1945–49 (average) and 1950–54

	1945–1949 (average)	1950	1951	1952	1953	1954
Crude magnesite produced:						
Short tons	338,387	429,392	670,167	510,750	553,147	284,015
Value	$2,327,178	[1]$3,091,135	[1]$4,506,712	$2,871,548	[1]$3,223,759	$1,391,392
Average per ton	$6.88	$7.20	$6.72	$5.62	$5.83	$4.90
Caustic-calcined magnesia sold or used by producers:						
Short tons	36,198	41,447	49,981	38,055	43,020	32,254
Value [2]	$2,871,323	$4,136,898	$4,810,379	$3,769,466	$3,991,309	$2,154,652
Average per ton [3]	$79.32	$99.81	$96.24	$99.05	$92.78	$66.80
Refractory magnesia sold or used by producers:						
Short tons	279,039	335,440	432,197	386,873	399,132	288,270
Value	$9,739,223	$14,915,854	$18,400,131	$17,255,837	$19,060,796	$13,850,712
Average per ton [3]	$34.90	$44.47	$42.57	$44.60	$47.76	$48.05
Dead-burned dolomite sold or used by producers:						
Short tons	1,304,797	1,759,443	1,966,460	1,928,025	2,294,815	1,520,854
Value	$13,757,637	$21,725,560	$26,375,313	$26,098,455	$31,455,384	$21,960,684
Average per ton	$10.54	$12.35	$13.41	$13.54	$13.71	$14.44

[1] Partly estimated; most of crude is processed by mining companies, and very little enters open market.
[2] Includes specialty magnesias of high unit value.
[3] Average receipts f. o. b. mine shipping point.

DOMESTIC PRODUCTION AND CONSUMPTION

Magnesite.—Production of crude magnesite (consisting of crude ore, heavy-medium concentrates, and flotation concentrates) in the United States in 1954 decreased 48 percent in quantity and 57 per-

[1] Commodity-industry analyst.
[2] Literature research clerk.

cent in value compared with 1953, according to reports by producers. The complete shutdown of one quarry and the part-time operation of other quarries resulted from the lowered demands by the iron and steel industry.[3]

The Northwest Magnesite Co., Chewelah, Stevens County, Wash., continued to be the largest producer of natural magnesite in the United States. During a shutdown in the spring improvements were made at the plant and at the company's Red Marble quarry.[4]

Magnesia.—Refractory magnesia sold or used by producers decreased 28 percent in quantity and 27 percent in value in 1954 compared with 1953. The consumption of iron ore by the iron and steel companies decreased 11 percent below 1953, which accounted for a large part of the decrease in demand for refractory magnesia.

In 1954 caustic-calcined magnesia sold or used by producers decreased 25 percent in quantity and 46 percent in value below 1953. The average value per ton of caustic-calcined magnesia was derived from reports by producers of all grades of caustic-calcined magnesia to avoid disclosing individual company operations. There were wide variations in prices of the various grades.

The proportion of magnesia derived from processes using raw sea water, sea-water bitterns, and well brines as a raw material (usually with dead-burned dolomite as a causticizer), compared with the proportion derived from processes using magnesite, brucite, and dolomite, remained at 49 percent in 1954, the same as in 1953. The proportion of refractory magnesia derived from sea water and well brines was 45 percent, compared with 44 percent in 1953. The proportion of caustic-calcined magnesia from the same sources was 90 percent in 1954, a 3-percent increase above 1953. Magnesia sold or used by producers in the United States in 1953 and 1954, by kinds and sources, is given in table 2.

TABLE 2.—Magnesia sold or used by producers in the United States, 1953–54, 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
1953						
Caustic-calcined [2]	5,781	$799,625	37,239	$3,191,684	43,020	$3,991,309
Refractory	221,869	9,024,974	177,263	10,035,822	399,132	19,060,796
Total	227,650	9,824,599	214,502	13,227,506	442,152	23,052,105
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

[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.

[3] Engineering and Mining Journal, vol. 155, No. 4, April 1954, p. 150.
[4] Engineering and Mining Journal, vol. 155, No. 5, May 1954, p. 104.

Dolomite.—Dead-burned dolomite sold or used by producers decreased 34 percent in quantity and 30 percent in value in 1954 compared with 1953. Since this material was used largely in repairing open-hearth furnace linings, the sharp drop reflected the drop in the quantity of iron ore processed during 1954 owing to a partial shutdown of some plants when defense requirements were filled.

Increasing demand by the steel companies for clinkered dolomite was reported as the reason for opening the new plant at Thornton, Ill., which began to produce this material in April.[5] Clinkered dolomite, a fused refractory material resulting from calcination in a rotary kiln of raw dolomite, iron oxide, and coal, was used to maintain the bottoms of basic open-hearth and electric furnaces.

TABLE 3.—Dead-burned dolomite sold in and imported into the United States, 1945–49 (average) and 1950–54

Year	Sales of domestic product		Imports[1]	
	Short tons	Value	Short tons[2]	Value
1945–49 (average)	1,304,797	$13,757,637	866	$33,299
1950	1,759,443	21,725,560	2,127	86,425
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

[1] Dead-burned basic refractory material consisting chiefly of magnesia and lime.
[2] Includes weight of immediate container.

Brucite.—Basic Refractories, Inc., Cleveland, Ohio, continued to produce brucite from the mine adjoining its magnesite deposit worked at Gabbs, Nev. The 1954 output was considerably larger than that in 1953.

Olivine.—The quantity of olivine sold or used by producers in the United States in 1954 was slightly less than in 1953. Harbison-Walker Refractories Co., Pittsburgh, Pa., continued to be the largest producer from its Addie quarry near Addie, N. C. Scheel Olivine, Inc., successors to H. P. Scheel Co., started production in October 1954 from its mine near Hamilton, Wash., in the large deposit on the southern slope of the Twin Sisters Mountains.[6] The Wray mine near Green Mountain, N. C., was operated by C. R. Wiseman, Spruce Pine, N. C.

Other Magnesium Compounds.—Production of extra-light and light magnesias, U. S. P. and technical grades, decreased 12 percent in quantity in 1954 compared with 1953 (table 4). Sales decreased 8 percent. Production and sales of precipitated magnesium carbonate increased materially in 1954; the production of magnesium hydroxide also increased substantially; magnesium sulfate and magnesium chloride production and sales were slightly lower than in 1953.

The mines and plants producing magnesite, brucite, and other magnesium compounds in 1954 in the United States are listed in table 5.

[5] American Metal Market, vol. 61, No. 65, Apr. 6, 1954, p. 11.
[6] Engineering and Mining Journal, vol. 155, No. 10, October 1954, p. 156.

The following percentages show the uses for caustic-calcined magnesia in 1953 and 1954:

	1953	1954
Oxychloride and oxysulfate cement	41	33
Rayon	8	3
Insulation	13	14
Fertilizer	2	2
Rubber (filler and catalyst)	1	1
Fluxes	1	1
Miscellaneous (including chemicals and paper)	34	46

Technical and U. S. P. magnesia uses and percentages in 1953 and 1954 were:

	1953	1954
Rayon	45	24
Rubber (filler and catalyst)	29	47
Refractories	13	10
Miscellaneous industrial and chemical, including neoprene compounds	10	16
Medicinal	3	3

TABLE 4.—Specified magnesium compounds produced, sold, and used by producers in the United States, 1953–54 [1]

Products [1]	Plants	Produced	Sold		Used
		Short tons	Short tons	Value	Short tons
1953					
Specified magnesias (basis, 100 percent MgO), U. S. P. and technical:					
Extra-light and light	5	2,341	2,303	$1,109,848	(2)
Heavy	4	11,434	(2)	(2)	(2)
Total	[3] 6	13,775	(2)	(2)	(2)
Precipitated magnesium carbonate	7	41,034	5,010	745,423	35,768
Magnesium hydroxide, U. S. P. and technical (basis, 100 percent $Mg(OH)_2$)	4	[4] 5,975	[4] 4,334	[4] 303,893	(2)
1954					
Specified magnesias (basis, 100 percent MgO), U. S. P. and technical:					
Extra-light and light	6	3,133	3,074	1,208,167	
Heavy	3	8,934	7,985	967,213	103
Total	[3] 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	46,320	5,282	289,804	40,770

[1] In addition, magnesium chloride, nitrate, phosphate, acetate, silicate, and trisilicate were produced.
[2] Figures withheld to avoid disclosing individual company operations.
[3] A plant producing more than 1 grade is counted but once in arriving at total.
[4] 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, 1954

Company	Location of mine or plant	Products	Raw materials
CALIFORNIA			
Kaiser Aluminum & Chemical Corp.	Moss Landing	Refractory magnesia Caustic-calcined magnesia Magnesium hydroxide	Sea water. Dead-burned dolomite
Westvaco Chemical Div., Food Machinery & Chemical Corp.	Newark	Refractory magnesia Caustic-calcined magnesia Magnesium hydroxide	Sea-water bitterns. Dead-burned dolomite. Magnesite.
	Chula Vista	Magnesium chloride, crystals	Sea-water bitterns.
Marine Magnesium Div., Merck & Co. Inc.	South San Francisco	Magnesium oxides, extra-light, light, and heavy; magnesium hydroxide; precipitated magnesium carbonate.	Sea water. Sea-water bitterns. Dead-burned dolomite.
James McPeters	Western Mine (near Livermore).	Magnesite	
ILLINOIS			
Johns-Manville Products Corp.	Waukegan	Precipitated magnesium carbonate.	Dolomite.
MICHIGAN			
The Dow Chemical Co	Ludington	Magnesium chloride, crystals Magnesium chloride, cell feed	Well brines.
	Midland	Epsom salt	Well brines. Calcined dolomite.
Michigan Chemical Corp.	St. Louis	Precipitated magnesium carbonate; magnesium hydroxide; magnesium oxide, extra-light, light, and heavy.	Well brines. Dead-burned dolomite.
Morton Salt Co	Manistee	Precipitated magnesium carbonate.	Well brines.
The Standard Lime & Stone Co.	do	Refractory magnesia	Do.
NEVADA			
The Standard Slag Co	Gabbs	Magnesite Refractory magnesia Caustic-calcined magnesia	 Magnesite. Magnesite.
Basic Refractories, Inc	do	Magnesite Brucite Refractory magnesia	 Magnesite, brucite.
NEW JERSEY			
J. T. Baker Chemical Co	Phillipsburg	High-purity magnesium chemicals.	Magnesium carbonate.
Johns-Manville Corp	Manville	Precipitated magnesium carbonate.	Calcined dolomite.
Northwest Magnesite Co	Cape May	Refractory magnesia	Sea water. Calcined dolomite.
OHIO			
Diamond Alkali Co	Fairport	Refractory magnesia	Dolomite.
PENNSYLVANIA			
Philip Carey Mfg. Co	Plymouth Meeting	Precipitated magnesium carbonate; magnesia, extra-light.	Dolomite.
Keasbey & Mattison Co	Ambler	Precipitated magnesium carbonate; magnesia, light and heavy.	Do.

TABLE 5.—Mines and plants producing magnesite, brucite, and other magnesium compounds in the United States, 1954—Continued

Company	Location of mine or plant	Products	Raw materials
TEXAS			
The Dow Chemical Co.	Freeport	Caustic-calcined magnesia Magnesium chloride, cell feed	Sea water.
WASHINGTON			
Agro Minerals, Inc.	Tonasket	Epsom salt	Lake brine.
Northwest Magnesite Co.	Chewelah	Magnesite Caustic-calcined magnesia Refractory magnesia	 Magnesite.
WEST VIRGINIA			
The Standard Lime & Stone Co.	Millville	Refractory magnesia	Dolomite.

PRICES

The prices quoted for various magnesium compounds in 1954, compared with January 1953 quotations, are listed in table 6. Most prices remained steady, but the price of caustic-calcined magnesia decreased approximately 6 cents a pound in November, and that of magnesium carbonate increased 1 cent a pound in October.

FOREIGN TRADE [7]

Imports for consumption of dead-burned and grain magnesia and periclase in 1954 increased 74 percent in quantity and 41 percent in value compared with 1953. Austria supplied 69 percent of the total compared with 84 percent in 1953, 74 percent in 1952, and 39 percent in 1951. Yugoslavia furnished 26 percent of the total compared with 9 percent in 1953, the first year in which imports from that country were reported. Canada furnished 5 percent of the total in 1954 compared with 7 percent in 1953, 8 percent in 1952, and 14 percent in 1951. No imports were reported from India, Italy, Norway, or the United Kingdom for 1954.

The imported quantity of caustic-calcined magnesia (lump and ground) decreased slightly in 1954 compared with 1953, when these two items were listed separately. Imports of other magnesium compounds in 1954 are shown in table 8.

Exports in 1954 of magnesite, magnesia, and manufactures except refractories were valued at $2,222,000 compared with $3,785,000 in 1953, a 41-percent decrease according to value.

[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 6.—Prices quoted on selected magnesium compounds, carlots, 1953–54

Commodity	Unit	Container	F. o. b.	Source	January 1953	January 1954	December 1954
Magnesite:							
Caustic-calcined, oxychloride-cement grade, powdered	Short ton	Bags	Newark, Calif.	(1)	$75.00	$80.00	$ [3] 82.50
Dead-burned, grain	do	Bulk	Chewelah, Wash.	(3)	36.30	38.00	38,00
Do	do	Bags	do	(3)	41.80	43.75	43.75
Periclase: Kiln-run, 90 percent	do	Bulk	Newark, Calif.	(1)	57.00	62.00	59.73
Epsom salt: Tech. grade	100 lb.	Bags	do	(2)	2.15	2.15	2.15
Magnesia, calcined:							
Tech. grade	Pound	Cartons	Works	(2)	.32–.3475	.32–.3475	[4] .2525–.26
Synthetic, rubber grade	do	do	do	(2)	.31	.31	[4] .2925
U. S. P.: Light	do	do	do	(2)	.34–.36	.34–.36	[4] .35–.36
Heavy	do	Barrels	do	(2)	.36–.38	.36–.38	.36–.38
Magnesium carbonate:							
Tech. grade	do	Bags	(5)	(2)	.095	.095	[6] .105
U. S. P. grade	do	do	(5)	(2)	.1125	.1125	[6] .125
Magnesium chloride: Powdered or flaked	Short ton	Barrels or Bags	Works	(3)	50.00	50.00	50.00
Magnesium hydroxide: Medicinal grade	Pound			(2)	.265–.30	.265–.30	.265–.30

[1] Westvaco Chemical Division, Food Machinery & Chemical Corp.
[2] Oil, Paint, and Drug Reporter.
[3] E&MJ Metal and Mineral Markets.
[4] Effective November 22, 1954.
[5] Magnesium carbonate is quoted freight allowed to New Jersey (except to Atlantic, Burlington, Cape May, Cumberland, Gloucester, Ocean, and Salem Counties) and to Philadelphia County, Pa. Freight is equalized with New York City on all other destinations.
[6] Effective October 11, 1954.

TABLE 7.—Magnesite imported for consumption in the United States, 1952–54, by countries

[U. S. Department of Commerce]

Country	1952		1953		1954	
	Short tons	Value	Short tons	Value	Short tons	Value
CRUDE MAGNESITE						
North America: Canada	4	$184				
Asia: India	11	290				
Grand total	15	474				
LUMP CAUSTIC—CALCINED MAGNESIA						
Europe: Yugoslavia	828	$28,391	1,413	$48,284		
Asia: India	839	32,050	1,141	50,608		
Grand total	1,667	60,441	2,554	98,892	(1)	(1)
GROUND CAUSTIC—CALCINED MAGNESIA						
North America: Canada	8	$516				
Europe:						
Austria	303	10,003	56	$1,778	83	$2,636
France					27	950
Netherlands	16	941	16	891	16	808
United Kingdom	4	528	4	551	7	1,299
Yugoslavia			61	2,352	1,235	44,556
Total Europe	323	11,472	137	5,572	1,368	50,249
Asia: India	22	1,297	22	1,300	1,070	41,570
Grand total	353	13,285	159	6,872	2,438	91,819
DEAD-BURNED AND GRAIN MAGNESIA AND PERICLASE						
North America: Canada	2,074	$204,518	2,888	$648,422	3,584	$831,949
Europe:						
Austria	18,011	785,657	33,026	1,634,786	46,641	2,466,428
Italy	2,379	92,029				
Norway	1,504	64,112				
United Kingdom	500	15,400				
Yugoslavia			3,383	185,191	17,987	859,661
Total Europe	22,394	957,198	36,409	1,819,977	64,628	3,326,089
Asia: India	1	21				
Grand total	24,469	1,161,737	39,297	2,468,399	68,212	4,158,038

[1] Beginning January 1, 1954 not separately classified; included with "Ground."

TABLE 8.—Magnesium compounds imported for consumption in the United States, 1945–49 (average) and 1950–54

[U. S. Department of Commerce]

Year	Oxide or calcined magnesia		Magnesium carbonate, precipitated		Magnesium chloride (anhydrous and n. s. p. f.)		Magnesium sulfate (epsom salt)		Magnesium salts and compounds n. s. p. f.[1]		Manufactures of carbonate of magnesia	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1945–49 (average)	10	$3,245	164	$43,551	11	$746	72	$1,987	12	$9,535	(2)	$10
1950	-------	-------	234	51,043	8	835	1,962	45,233	158	24,851	3	1,479
1951	-------	-------	194	59,847	3	292	2,547	59,373	562	90,826	96	31,915
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	(3) 226 691	33	13,086	-------	-------

1 Includes magnesium silicofluoride or fluosilicate and calcined magnesium.
2 40 pounds.
3 Due to changes in tabulating procedures by the U. S. Department of Commerce data not comparable to earlier years.

TECHNOLOGY

A number of articles on refractories published during 1954 described processes and combinations of materials for producing basic refractories with greater resistance to the increasing high temperatures used in the metallurgical processes.[8]

The development of a new electrically melted and cast basic refractory, which will reinforce the weaker zones of a furnace and give it longer life, was described.[9]

Development of testing methods to determine wear resistance, sheer strength of bonding mediums, and water resistance of oxychloride and oxysulfate cements was reported.[10]

Fundamental data were published during 1954, pointing toward an expanded use of magnesia with other constituents, in more efficient basic refractories for steel furnaces.[11]

Heavy-medium separation plants for treating magnesite, dolomite, and brucite were described.[12]

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8 Materials and Methods, Pure Magnesia Refractory Now in Quantity Production: Vol. 39, No. 6, June 1954, p. 150.
Metals Bulletin (London), Magnesite: New Use in Smelting: No. 3984, Apr. 7, 1955, p. 25.
Rock Products, vol. 57, No. 12, December 1954, p. 34.
Steel, vol. 134, No. 20, May 17, 1954, p. 117.
Harbison-Walker Co., A Story on Steel: Burns and Mixes: Vol. 8, No. 8, August 1954, pp. 2–3, 18.
White, H. E., Linings for Induction Furnaces: Metal Progress, vol. 66, No. 3, September 1954, pp. 99–106.

9 Hand, Thomas, and Bacque, H. W., An Electrically Melted and Cast Magnesite-Chrome Refractory: Am. Ceram. Soc. Bull., vol. 33, No. 6, June 1954, pp. 176, 178, 179.

10 American Society for Test Materials, Magnesium Oxychloride and Magnesium Oxysulfate Cements: Bull. 203, January 1955, p. 9.

11 Warsaw, I., and Keith, M. L. (Penn. State University, State College, Pa.), Solid Solution and Chromium Oxide Loss in Part of the System $MgO-Al_2O_3-Cr_2O_3-SiO_2$: Jour. Am. Ceram. Soc., vol. 37, No. 4, Apr. 1, 1954, pp. 161–168.
Machin, J. S., and Yee, Tin Boo, (Illinois State Geological Survey, Urbana, Ill.); Viscosity Studies of System $CaO-MgO-Al_2O_3-SiO_2$: IV, 60 and 65% SiO_2: Jour. Am. Ceram. Soc., vol. 37, No. 4, Apr. 1, 1954, pp. 177–186.
Keith, M. L. (Pennsylvania State University, State College, Pa.), Phase Equilibria in the System $MgO-Cr_2O_3-SiO_2$: Jour. Am. Ceram. Soc., vol. 37, No. 10, Oct. 1, 1954, pp. 490–496.

12 Utley, Harry F., Heavy-Media Separation Supplements Flotation in Magnesite Plant: Pit and Quarry, vol. 26, June 1954, pp. 90–92.

During 1954 reports were published covering fire tests of 85 percent magnesia thermal insulation, showing that the material would withstand a 2,000° F. flame for an extended period without appreciable damage, and thus would be adequate protection from fire damage for pipelines, flues, ducts, and other equipment.[13]

WORLD REVIEW

Estimated world production of crude magnesite decreased about 5 percent in 1954 compared with 1953. Production data, by countries, are given in table 9.

Austria.—Early in 1954 the Vietscher Magnesit Werke A. G., Austria's largest producer of mined and calcined magnesia, announced that for the first time all of its facilities were operating at full capacity.[14]

Total production of crude magnesite in 1954 was reported to have risen 3 percent above 1953.[15] Exports of caustic-calcined magnesia, dead-burned (refractory), and magnesite brick by countries of destination are listed in tables 10, 11, and 12.

Brazil.—Diamond drilling, which was begun in 1953, continued in 1954 in the state of Ceará on the Harbison-Walker properties.[16]

Canada.—Exports of dead-burned refractories from Canada increased from 4,601 short tons in 1953 to 7,887 tons in 1954.[17]

Greece.—Exports of calcined magnesia from Greece more than doubled in 1954 compared with 1953, as shown in table 13.

India.—The largest and highest grade deposits of magnesite in India were reported in the Salem district, Madras. In 1954 the Industries Minister of Madras stated that the Government would continue, as in the past, to leave magnesite mining to private interests.[18]

Italy.—Production of crude magnesite was 3,290 short tons in 1954, whereas imports were 5,051 tons. Imports of caustic-calcined magnesia in 1954 fell to 6,016 tons from 12,306 tons in 1953.[19]

Netherlands.—Exports of calcined magnesia given in table 15 show a slight increase in 1954.

Spain.—Modern installations, including English and German machinery, were completed at two of Spain's most important refractory plants, making them equal to those of other European producers. These plants, both in the Bilboa consular district, were reported to be the only completely mechanized refractory plants in Spain.

An exceptionally high grade ore discovered in 1945 at Zurubi was exploited in 1954 by the firm Magnesitas Nevarras, S. A.

Lack of standardization of sizes of refractory brick by the steel plants in Spain accounted for relatively high cost of production.[20]

[13] Iron Age, Metals and Materials Review and Forecast: Vol. 174, No. 7, Aug. 12, 1954, pp. 136, 138, 140.
[14] Engineering and Mining Journal, vol. 155, No. 2, February 1954, p. 205.
[15] Metal Bulletin (London), No. 3980, Mar. 25, 1955, p. 25.
[16] Engineering and Mining Journal, vol. 155, No. 7, July 1954, p. 150.
[17] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 4, April 1955, p. 50.
[18] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 5, May 1955, p. 63.
[19] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 4, October 1955, p. 40.
[20] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 4, April 1954, pp. 58–59.

TABLE 9.—World production of magnesite, by countries,[1] 1945–49 (average) and 1950–54, in short tons[2]

(Compiled by Helen L. Hunt)

Country[1]	1945–49 (average)	1950	1951	1952	1953	1954
North America: United States	338, 387	429, 392	670, 167	510, 750	553, 147	284, 015
Total[1 3]	490, 000	620, 000	940, 000	840, 000	880, 000	730, 000
South America:						
Brazil[3]	3, 300	11, 000	11, 000	11, 000	11, 000	11, 000
Venezuela	3, 300	1, 600	1, 800			
Total[3]	6, 600	12, 600	12, 800	11, 000	11, 000	11, 000
Europe:						
Austria	294, 956	599, 455	732, 260	818, 200	895, 971	925, 006
Czechoslovakia[3]	104, 300	190, 700	(4)	(4)	(4)	(4)
Germany, West	9, 094	1, 445				
Greece	12, 610	28, 942	70, 392	89, 939	117, 879	84, 327
Italy	1, 000	302	1, 136	1, 130	2, 269	3, 290
Norway	1, 648	2, 039	1, 602	1, 630	2, 049	915
Spain	82	8, 413	15, 138	13, 917	16, 653	34, 617
Yugoslavia	46, 455	65, 333	99, 114	41, 647	135, 052	119, 069
Total[1 3]	1, 400, 000	2, 400, 000	2, 800, 000	2, 900, 000	3, 000, 000	3, 000, 000
Asia:						
Cyprus (exports)	75	22	22	22	22	
India	59, 011	59, 202	131, 562	99, 726	103, 878	[3] 110, 231
Korea:						
Korea, Republic of	[3] 35, 825 (Republic of and North Korea combined)	(4)	(4)	362		
North Korea		(4)	(4)	(4)	(4)	(4)
Turkey	2, 585	496	557	982	386	1, 174
Total[1 3]	130, 000	190, 000	300, 000	330, 000	340, 000	340, 000
Africa:						
Egypt	11	69	961			
Kenya	26	200				
Southern Rhodesia	5, 905	9, 496	16, 330	12, 072	10, 824	8, 589
Tanganyika (exports)		91	2, 994		64	87
Union of South Africa	9, 622	12, 987	20, 694	26, 906	25, 229	26, 874
Total	15, 564	22, 843	40, 979	38, 978	36, 117	35, 550
Oceania:						
Australia	33, 073	39, 639	43, 830	47, 193	51, 965	48, 331
New Zealand	437	381	649	648	579	807
Total	33, 510	40, 020	44, 479	47, 841	52, 544	49, 138
World total (estimate)[1]	2, 100, 000	3, 300, 000	4, 100, 000	4, 100, 000	4, 300, 000	41, 000, 000

[1] Quantities in this table represent crude magnesite mined. In addition to countries listed, magnesite is also produced in Canada, China, Mexico, 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.

[3] Estimate.

[4] Data not available; estimates by senior author of chapter included in total.

TABLE 10.—Exports of caustic-calcined magnesia from Austria, by countries of destination, 1950–54, in short tons [1]

(Compiled by John E. McDaniel)

Country	1950	1951	1952	1953	1954
North America: United States	7	557	300	82	98
South America: Argentina	72	46	33	5	160
Europe:					
Belgium-Luxembourg	131	213	265	181	197
Bulgaria			65	147	44
Czechoslovakia	2, 810	3, 777	3, 502	3, 067	3, 275
Denmark	244	295	77	18	82
France	2, 747	3, 159	2, 946	3, 090	3, 297
Germany:					
East	2, 867	5, 969	5, 299	3, 421	424
West	38, 573	48, 661	48, 605	64, 440	70, 202
Hungary	2, 406	969	1, 520	63	437
Italy	2, 306	2, 824	2, 079	2, 441	2, 851
Netherlands	338	736	153	50	98
Norway	37		50	44	55
Rumania	24	8		109	
Sweden		17	17	55	83
Switzerland	1, 421	1, 401	1, 339	1, 341	1, 436
Trieste			17		
United Kingdom	309	195	260	776	1, 384
Oceania: Australia				8	
Other countries	17			39	79
Total	54, 309	68, 827	66, 527	79, 377	84, 202

[1] Compiled from Customs Returns of Austria.

TABLE 11.—Exports of refractory magnesia from Austria, by countries of destination, 1950–54, in short tons [1]

(Compiled by John E. McDaniel)

Country	1950	1951	1952	1953	1954
North America: United States	8, 694	4, 575	9, 005	7, 335	28, 741
South America:					
Argentina	913	758	728	987	1, 439
Brazil	33			196	14
Chile	13	661	1, 586	19	175
Peru	871	1, 321		45	1, 033
Europe:					
Belgium-Luxembourg	1, 097	1, 782	3, 132	1, 628	779
Bulgaria				3, 300	2
Czechoslovakia	548	29	56	429	348
Denmark	283	448	481	331	236
Finland	254	3, 323	843	475	512
France	7, 912	12, 451	14, 795	12, 368	9, 065
Germany:					
East	263	96	5, 364	3, 537	52
West	26, 041	17, 525	23, 752	21, 854	18, 409
Greece	71	187	106	37	83
Hungary	1, 343	69	127	32	7, 748
Italy	7, 379	7, 588	13, 095	10, 993	4, 986
Netherlands	245	3, 772	316	245	138
Norway	137	121	52	192	132
Poland	7, 140	4, 107	3, 043	5, 035	5, 460
Rumania	977	623	1, 145	5, 917	438
Spain				14	8
Sweden	1, 196	971	1, 682	783	832
Switzerland	1, 918	23, 650	3, 495	559	688
Trieste		110			6
United Kingdom	416	1	545	1, 283	2, 227
Yugoslavia	9, 297	7, 820	5, 868	709	134
Asia:					
India	119	110		742	1, 310
Turkey	102	8	77	41	19
Other countries	289	202	661	808	1, 904
Total	77, 551	92, 308	89, 954	79, 894	86, 918

[1] Compiled from Customs Returns of Austria.

TABLE 12.—Exports of magnesite brick from Austria, by countries of destination, 1950–54, in short tons [1]

(Compiled by John E. McDaniel)

Country	1950	1951	1952	1953	1954
South America:					
Argentina	1,563	1,383	691	801	3,430
Chile	152	109	75	229	60
Europe:					
Belgium-Luxembourg	6,889	8,193	9,946	11,361	7,715
Bulgaria	35	-----	154	288	-----
Czechoslovakia	2,934	967	1,513	510	550
Denmark	1,756	3,126	2,451	4,347	3,641
Finland	1,753	1,786	2,039	4,153	3,180
France	18,509	24,437	30,359	37,947	26,346
Germany:					
East	1,139	1,658	2,661	2,712	1,661
West	19,188	27,320	31,211	31,095	38,742
Greece	776	604	692	714	786
Hungary	4,493	4,452	5,320	4,405	245
Italy	9,037	12,215	19,134	18,231	11,896
Netherlands	1,580	2,867	3,398	3,787	2,987
Norway	685	658	643	1,096	921
Poland	7,444	4,905	7,786	15,558	11,662
Rumania	5,492	1,102	4,405	4,974	5,860
Spain	-----	-----	-----	563	515
Sweden	11,201	10,258	10,839	12,785	10,899
Switzerland	1,344	1,761	2,077	1,595	1,197
United Kingdom	-----	29	1,645	1,195	848
Yugoslavia	5,937	3,028	8,324	8,643	5,386
Asia: Turkey	2,135	709	1,828	2,355	602
Africa: Belgian Congo	-----	55	21	132	410
South Africa	66	1,106	1,499	2,515	1,101
Other countries	1,067	2,807	2,480	2,491	4,147
Total	105,175	115,535	151,191	174,482	144,787

[1] Compiled from Customs Returns of Austria.

TABLE 13.—Exports of magnesite from Greece, by countries of destination, 1950–54, in short tons [1]

(Compiled by John E. McDaniel)

Country	1950	1951	1952	1953	1954
France	-----	-----	2,362	1,323	4,850
Germany, West	-----	661	13,272	11,401	3,848
Italy	-----	-----	2,315	551	2,320
United Kingdom	1,960	3,815	579	1,880	2,315
Other countries	255	16,096	82	1,323	827
Total	2,215	20,572	18,610	[2] 16,478	14,160

[1] Compiled from Customs Returns of Greece.
[2] Figures for the year 1953, incorporate a number of revisions of data published in the previous Magnesium Compounds chapter.

TABLE 14.—Exports of calcined magnesia from Greece, 1950–54, by countries of destination, in short tons [1]

(Compiled by John E. McDaniel)

Country	1950	1951	1952	1953	1954
Germany, West	3,591	10,351	8,953	13,245	21,826
Netherlands	-----	11,465	11,990	1,555	12,007
United Kingdom	-----	-----	-----	610	2,203
United States	-----	99	4,079	-----	-----
Other countries	1,385	3,148	283	466	1,014
Total	4,976	25,063	25,305	[2] 15,876	37,050

[1] Compiled from Customs Returns of Greece.
[2] Figures for the year 1953 incorporate a number of revisions of data published in the previous Magnesium Compounds chapter.

TABLE 15.—Exports of refractory magnesia from the Netherlands, by countries of destination, 1950–54, in short tons[1]

(Compiled by John E. McDaniel)

Country	1950	1951	1952	1953	1954
Belgium-Luxembourg	410	431	507	444	503
Czechoslovakia	164	76	64		
Denmark	1,112	1,286	1,293	995	825
Egypt		116	65	57	
Finland	1,357	1,139	728	713	540
France	109	471	96	71	190
Germany, West	12,873	8,197	10,551	9,177	9,197
Netherlands Antilles			136		
New Zealand			62		
Norway	697	618	499	424	470
Portugal	45	57	108	65	99
Saar					202
Sweden	1,289	1,518	1,160	990	975
Union of South Africa	137	144	217	136	127
United Kingdom	2,137	2,627	2,232	3,211	3,746
Other countries	835	2,446	109	126	140
Total	21,165	19,126	17,827	16,409	17,014

[1] Compiled from Customs Returns of the Netherlands.

Tanganyika.—Exports of magnesite totaled 87 short tons in 1954 compared with 64 in 1953.[21]

Union of South Africa.—In 1954 production of magnesite totaled 26,874 short tons compared with 25,229 in 1953; local sales totaled 22,479 tons, compared with 22,042 in 1953.[22]

United Kingdom.—Refractories research in the iron and steel industries in 1954 resulted in the founding of a group of firms to build and operate a small-scale commercial plant for the continuous casting of steel. This involved extensive study to develop refractories for use in furnace linings.[23]

Yugoslavia.—In January 1954 a group of eight Yugoslav refractory material experts and technicians completed a month's tour of refractories plants and industrial research laboratories in the United States under the guidance of Industrial Technical Assistance Division, Foreign Operations Administration. Special attention was given to those types of refractory manufacture that Yugoslavia plans to begin in the near future, in which there is a lack of technical information and plant experience in that country.

An article on magnesite production in Yugoslavia described the geological formation of the magnesite deposits of the country and discussed methods of treatment used in processing the raw material.[24]

Shipments of dead-burned magnesia to West Germany continued. The first shipments since World War II were made in 1953.

[21] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 4, April 1955, p. 51.
[22] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 1, July 1955, p. 42.
[23] Refractories Journal (London), May 1954, No. 5, pp. 193–196.
[24] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 1, July 1954, pp. 52–53.

Manganese

By Gilbert L. DeHuff[1]

PRIMARILY as a result of Government purchases, production of domestic manganese ore containing 35 percent or more manganese was the greatest since the war year 1944. In addition, substantial shipments of low-grade ore were made to Government depots at Wenden, Ariz.; Deming, N. Mex.; and Butte-Philipsburg, Mont. Imports of ore dropped substantially from the previous year, but still exceeded 2 million short tons. Consumption was lower than in 1953 as a result of decreased steel production. These developments added up to high industrial stocks, which reached 1.75 million short tons in the course of the year. Quoted commercial prices for metallurgical ore slid to a low in September of 70 to 75 cents nominal per long-ton unit of manganese, c. i. f. United States ports, duty extra, from which some recovery was evident by year's end.

TABLE 1.—Salient statistics of manganese in the United States, 1945–49 (average) and 1950–54, gross weight in short tons

	1945–49 (average)	1950	1951	1952	1953	1954
Manganese ore (35 percent or more Mn):						
Mine shipments:						
Metallurgical ore	132,972	122,944	95,255	100,999	139,960	191,376
Battery ore	9,671	11,507	9,752	14,380	17,576	14,694
Miscellaneous ore	324					58
Total mine shipments[1]	142,967	134,451	105,007	115,379	157,536	206,128
General imports	1,510,833	1,834,925	1,767,580	2,668,780	3,500,986	2,166,147
Consumption	1,388,023	1,650,429	1,892,609	1,809,189	2,195,742	1,740,648
Ferromanganese:						
Domestic production	590,264	719,680	791,260	758,721	907,533	718,721
Imports for consumption	62,438	109,948	119,764	64,095	126,518	56,772
Exports	10,056	580	633	1,453	1,112	1,732
Consumption	618,703	774,852	883,841	796,826	931,401	716,910
Spiegeleisen:						
Domestic production	115,168	42,375	77,017	58,666	97,729	(2)
Imports for consumption	1,049	8,595		44	785	
Exports	2,052	363	85	34		
Consumption	111,808	76,280	80,556	69,029	73,512	52,082

[1] Mine shipments are used as the measure of manganese production for compiling continental United States mineral production value.
[2] Bureau of Mines not at liberty to publish.

DOMESTIC PRODUCTION[2]

Interest continued in the Defense Minerals Exploration Administration program of financial assistance for exploration of manganese deposits. Several new contracts for manganese projects were made effective, and one certificate of discovery was issued.

[1] Commodity-industry analyst.
[2] Production data for 1954 were collected jointly with the Bureau of the Census (U. S. Department of Commerce). Production totals will be compared with the Census totals when they are available and differences adjusted or explained.

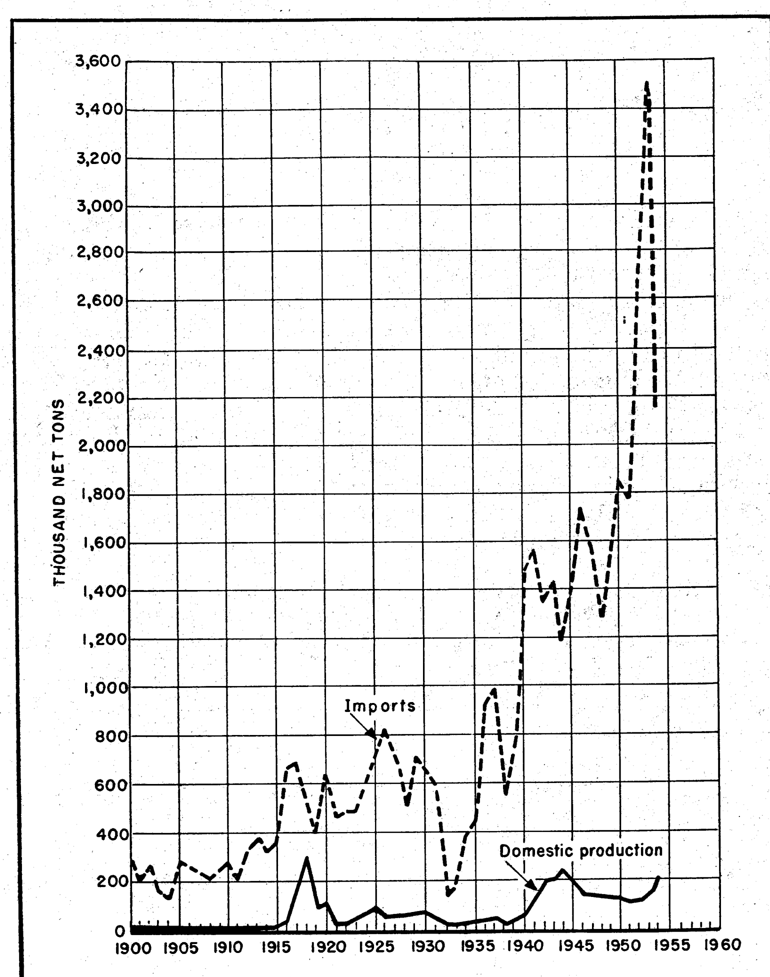

FIGURE 1.—General imports and domestic production (mine shipments) of manganese ore, 1900–54.

Stimulated by Government purchases, production as measured by shipments of manganese ore containing 35 percent or more manganese exceeded 200,000 short tons for the first time since 1944. Oxide ore from the Three Kids mine was processed to nodules containing over 45 percent manganese by Manganese, Inc., at Henderson to make Nevada the chief producing State. This was the first year since 1916 that Montana failed to lead the Nation in production of manganese ore; however, it continued to be an important contributor through the Anaconda Copper Mining Co. production of 58-percent manganese nodules, made from Butte-area carbonate ore. These two companies supplied three-fourths of the Nation's production of metallurgical-grade ore in 1954. The remainder was shipped by various participants in the Government's domestic manganese "carlot" purchase program for small producers whose total anticipated or actual production of metallurgical-grade manganese ore and concentrate meeting specifications is less than 10,000 long dry tons per calendar year. Almost half of the tonnage obtained during the year on this program came from Virginia, and half came from Arkansas and eastern Tennessee. California, Georgia, Missouri, and Nevada supplied small tonnages. Specifications continued to require a minimum manganese content of 40 percent. In July the regulations were amended to authorize acceptance on a 10-carlot weighted average basis.

TABLE 2.—Manganiferous raw materials shipped by producers in the United States, 1945–49 (average) and 1950–54, in short tons

Year	Metallurgical ore				Battery ore (25 percent or more Mn)	Miscellaneous ore	
	Manganese ore (35 percent or more Mn)	Ferruginous manganese ore (10 to 35 percent Mn)	Manganiferous iron ore (5 to 10 percent Mn)	Manganiferous zinc residuum		35 percent or more Mn	10 to 35 percent Mn
1945–49 (average)	132,972	101,551	1,154,987	221,590	9,671	324	932
1950	122,944	115,269	972,328	183,842	11,507		
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

The Western States, particularly Arizona, California, and New Mexico, but also Colorado, Idaho, Montana, Nevada, Texas, and Utah, shipped manganese ore containing 35 percent or more manganese to the GSA depots at Wenden, Ariz.; Deming, N. Mex.; and Butte and Philipsburg, Mont. These shipments, which were almost equal in quantity to those of Virginia on the "carlot" program, came from numerous scattered operations. They are not included in production (shipment) figures and will not be included until the material leaves the depots. It is most probable that before such time they will lose their identity by being blended with the low-grade ores at the depots or with concentrate made from them. These GSA depots continued to receive low-grade manganese ores in quantity from Arizona, California, Montana, and New Mexico, with relatively minor contributions from Colorado, Idaho, Minnesota, Nevada, Texas, and Utah. These low-grade ores also will not be included in production figures until shipment is made from the depots.

As of December 31, 1954, total deliveries at the various depots, expressed in long-ton units of contained manganese, were as follows: Butte and Philipsburg, 1,418,000; Deming, 2,213,000; and Wenden, 5,821,000. Total deliveries on the "carlot" program amounted to 2,276,000 long-ton units. Receipts for the year were, respectively: Butte and Philipsburg, 989,000; Deming, 1,423,000; Wenden, 3,732,000; and "carlot," 1,719,000 long-ton units.

Announcement was made in December changing the 6 million-long-ton-unit quota for each of the 3 depot programs (Wenden, Deming, and Butte-Philipsburg) from a "contained-manganese" basis to a "recoverable-manganese" basis. The quota for the "carlot" program remained at 19 million long-ton units of contained manganese.

The final registration date for participation in all the domestic

TABLE 3.—Metallurgical manganese ore shipped from mines in the United States, 1945–49 (average) and 1950–54, by States, in short tons

State	1945–49 (average)	1950	1951	1952	1953	1954
Alabama	6	138				
Arizona	338	222	173	203	(1)	
Arkansas	2,334	1,224	3,718	2,246	6,123	13,728
California	390	37		3,589	720	393
Georgia	211					(1)
Missouri					(1)	(1)
Montana	124,669	119,694	91,080	90,772	102,878	44,735
Nevada	418		58	105	18,368	(1)
New Mexico	1,071	1,320	226	2,360		
Oregon					46	
South Carolina	24					
Tennessee	50	133		126	2,625	11,823
Texas				56		
Utah		120		95		
Virginia	1,777	56		1,011	8,454	22,678
Washington	1,684			436	(1)	
Undistributed					746	98,019
Total	132,972	122,944	95,255	100,999	139,960	191,376

1 Included with "Undistributed."

TABLE 4.—Ferruginous manganese ore shipped from mines in the United States, 1945–49 (average) and 1950–54, by States, in short tons

State	1945–49 (average)	1950	1951	1952	1953	1954
Arizona	24		224			
Arkansas	5,117	6,359	1,429	896		
California	80	640		56	534	(1)
Colorado	16			76		
Michigan	390					15,361
Minnesota	696	16,206	14,728	31,502	201,090	7,552
Montana	4,439	6,810	7,598	9,357	5,598	5,266
Nevada	8,294	8,942	1,250	7,947	25,064	12,870
New Mexico	75,586	74,348	79,605	52,934	(1)	20,546
North Carolina					(2)	
Oregon					271	
Tennessee	200					(1)
Utah	5,555	1,964	1,369	3,397	5,155	97
Virginia	2,086					
Washington				142		
Wyoming					(1)	
Undistributed					35,026	135
Total	102,483	115,269	106,203	106,307	272,738	61,827

1 Included with "Undistributed."
2 Small tonnage, included with "Undistributed."

TABLE 5.—Manganiferous iron ore shipped from mines in the United States, 1945–49 (average) and 1950–54, by States, in short tons

State	1945–49 (average)	1950	1951	1952	1953	1954
Michigan	336	117,619	69,626	22,095	76,251	
Minnesota	1,141,549	853,632	995,923	880,616	890,401	496,505
New Mexico	13,102		239			
Utah		1,077				
Total	1,154,987	972,328	1,065,788	902,711	966,652	496,505

manganese purchase programs was extended another year to June 30, 1955. Expiration date for the programs remained June 30, 1958, or fulfillment of quota, whichever occurred first. The minimum acceptable manganese content, limited to ores amenable to beneficiation to National Stockpile specifications, continued to be 15 percent for Wenden and Deming and for carbonate ore at Philipsburg; 12 percent for carbonate ore at Butte. The 18-percent minimum for oxide ore at Butte and Philipsburg was lowered to 15 percent in July. A comparison of prices paid by GSA on its various domestic manganese purchase programs is shown in table 15.

Domestic shipments of the various grades of manganese-bearing ores, as given in the several tables, do not include shipments to the Wenden, Deming, or Butte-Philipsburg depots.

Battery concentrate containing 35 percent or more manganese was produced at Philipsburg, Mont., by Trout Mining Division of American Machine & Metals, Inc.; and in California at the Ladd mine near Tracy by Teekay Mines, Inc., subsidiary of Taylor Knapp Co. Low-grade Nevada and Utah ores were among the manganese ores used in producing synthetic battery ore at the Henderson, Nev., plant of Western Electrochemical Co.

Commercial shipments of low-grade manganese ores containing 10 to 35 percent manganese were made from California, Michigan, Minnesota, Montana, Nevada, New Mexico, Tennessee, and Utah. Manganiferous iron ore was shipped from Minnesota. Manganiferous zinc residuum was produced from New Jersey zinc ores.

Heavy-medium-separation plants were engaged in beneficiative manganese ores in both the eastern and western parts of the country.

CONSUMPTION AND STOCKS

A decline of about 21 percent in consumption of manganese ore in 1954 from that in the previous year mirrored closely the 21-percent drop in steel production. Domestic sources supplied 2 percent and foreign sources 98 percent of total manganese ore consumed, as compared with 4 and 96 percent, respectively, in 1953, 5 and 95 percent in 1952, 7 and 93 percent in both 1951 and 1950, and 10 and 90 percent in 1949. The manufacture of dry-cell batteries consumed 2 percent of the total, 1 percent was used in the manufacture of chemicals, and the remaining 97 percent was consumed by the metal industries. Industrial stocks of ore (1.6 million short tons at year end) were 7 percent lower than at the end of 1953.

The consumption in 1954 of manganese as ferroalloys and directly charged ore per short ton of open-hearth, bessemer, and electric steel produced was 12.7 pounds compared with 13.5 pounds in 1953. Of the 12.7 pounds, 11.4 pounds was ferromanganese, 1.0 pound silicomanganese, 0.2 pound spiegeleisen, and 0.05 pound ore and manganese metal. These data apply to the consumption of manganese in producing 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 only castings is also taken into account, the total pounds of manganese consumed per short ton of steel in 1954 becomes 13.2, of which 11.8 represents ferromanganese, 1.1 silicomanganese, 0.2 spiegeleisen, and 0.05 ore, metal, and briquets.

TABLE 6.—Manganese and manganiferous ores shipped from mines in the United States in 1954, by States

	Metallurgical			Battery			Miscellaneous			Total			
	Shippers	Short tons		Shippers	Short tons		Shippers	Short tons		Shippers	Short tons		Value
		Gross weight	Manganese content		Gross weight	Manganese content		Gross weight	Manganese content		Gross weight	Manganese content	
Manganese ore:[1]													
Arkansas	19	13,728	5,407							19	13,728	5,407	$1,020,752
California	2	393	197	1	380	144	1	58	22	3	831	363	45,091
Georgia	1	(2)	(2)							1	(2)	(2)	(3)
Missouri	1	(2)	(2)							1	(2)	(2)	(3)
Montana	1	44,735	25,768	1	13,926	6,506				2	58,661	32,274	(3)
Nevada	2	(2)	(2)	3	[4] 363	[4] 218				4	(2)	(2)	(3)
Tennessee	10	11,823	4,789							10	11,823	4,789	919,949
Utah				1	[5] 25	[5] 15				1	25	15	(3)
Virginia	16	22,678	9,615							16	22,678	9,615	1,780,934
Undistributed		98,019	45,666								98,382	45,884	(3)
Total	52	191,376	91,442	6	14,694	6,883	1	58	22	57	206,128	98,347	[6] 15,175,533
Ferruginous manganese ore:[7]													
California							1	(2)	(2)	1	(2)	(2)	(3)
Michigan	1	15,361	5,620							1	15,361	5,620	(3)
Minnesota	1	7,552	829							1	7,552	829	(3)
Montana	1	5,266	1,263							1	5,266	1,263	(3)
Nevada	5	12,870	2,415							5	12,870	2,415	165,075
New Mexico	1	20,546	2,219							1	20,546	2,219	(3)
Tennessee							1	(2)	(2)	1	(2)	(2)	(3)
Utah	1	97	25							1	97	25	(3)
Undistributed								135	40		135	40	(3)
Total	10	61,692	12,371				2	135	40	12	61,827	12,411	(8)
Manganiferous iron ore:[9] Minnesota	4	496,505	28,075							4	496,505	28,075	(8)
Total	4	496,505	28,075							4	496,505	28,075	(8)

[1] Containing 35 percent or more manganese (natural).
[2] Included with "Undistributed."
[3] Included in total.
[4] Prorated portion of synthetic battery ore produced in Nevada from low-grade Nevada ore.
[5] Prorated portion of synthetic battery ore produced in Nevada from low-grade Utah ore.
[6] Estimate.
[7] Containing 10 to 35 percent manganese (natural).
[8] Combined value for ferruginous manganese ore plus manganiferous iron ore equals $3,079,380.
[9] Containing 5 to 10 percent manganese (natural).

TABLE 7.—Manganiferous raw materials available for consumption in the United States in 1954

	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	206,128	47.71	276,758	14.60	496,505	5.65
Imports for consumption	2,244,055	45.89	108,096	21.06		
Total available for consumption	2,450,183	46.04	384,854	17.71	496,505	5.65

TABLE 8.—Consumption of manganese ore and manganese alloys in the United States, 1953–54, and stocks Dec. 31, 1954, gross weight in short tons

Category of use and form in which consumed	Quantity consumed 1953	Quantity consumed 1954	Stocks Dec. 31, 1954 [1] (including bonded warehouses)
Manganese alloys and manganese metal:			
Manganese ore:			
Domestic	74,089	33,610	5,914
Foreign	1,983,766	1,604,180	1,527,136
Total manganese ore	2,057,855	1,637,790	1,533,050
Ferromanganese, silicomanganese, and manganese metal			97,864
Spiegeleisen			11,694
Steel ingots and steel castings: [2]			
Manganese ore:			
Domestic	3,729		17
Foreign	341	7	10
Total manganese ore	4,070	7	27
Ferromanganese:			
High-carbon	810,649	619,951	158,734
Medium-carbon, Low-carbon	65,547	49,750	7,157
Total ferromanganese	876,196	669,701	165,891
Spiegeleisen	60,113	41,500	22,043
Silicomanganese	95,552	68,502	11,133
Manganese metal	896	996	191
Steel castings: [3]			
Manganese ore:			
Domestic	13	7	53
Foreign	234	193	159
Total manganese ore	247	200	212
Ferromanganese:			
High-carbon	29,370	20,021	3,714
Medium-carbon, Low-carbon	3,301	3,445	671
Total ferromanganese	32,671	23,466	4,385
Spiegeleisen	4,256	2,636	775
Silicomanganese	11,858	6,961	1,314
Manganese briquets	2,027	1,351	140
Manganese metal	301	326	47
Pig iron:			
Manganese ore:			
Domestic	6,707	1,807	1,797
Foreign	58,541	47,458	16,630
Total manganese ore	65,248	49,265	18,427
Dry cells:			
Manganese ore:			
Domestic	4,995	2,893	273
Foreign	36,552	28,142	19,856
Total manganese ore	41,547	31,035	20,129

See footnotes at end of table.

TABLE 8.—Consumption of manganese ore and manganese alloys in the United States, 1953–54, and stocks Dec. 31, 1954, gross weight in short tons—Con.

Category of use and form in which consumed	Quantity consumed 1953	Quantity consumed 1954	Stocks Dec. 31, 1954 [1] (including bonded warehouses)
Chemicals:			
Manganese ore:			
Domestic	478	292	59
Foreign	26,297	22,059	6,876
Total manganese ore	26,775	22,351	6,935
Miscellaneous products:			
Ferromanganese:			
High-carbon	16,919	[4] 19,816	[4] 3,608
Medium-carbon, Low-carbon	5,615	[4] 3,927	[4] 1,463
Total ferromanganese	22,534	[4] 23,743	[4] 5,071
Spiegeleisen	9,143	[4] 7,946	[4] 1,524
Silicomanganese	6,090	[4] 4,796	[4] 1,242
Manganese briquets	15,297	[4] 13,632	[4] 3,832
Manganese metal	(5)	[4] 617	[4] 171
Grand total:			
Manganese ore:			
Domestic	90,011	38,609	8,113
Foreign	2,105,731	1,702,039	1,570,667
Total manganese ore	[6] 2,195,742	[6] 1,740,648	[7] 1,578,780
Ferromanganese:			
High-carbon	856,938	659,788	175,347
Medium-carbon, Low-carbon	74,463	57,122	
Total ferromanganese	931,401	716,910	[8] 175,347
Spiegeleisen	73,512	52,082	36,036
Silicomanganese	113,500	80,259	[8] 13,689
Manganese briquets	17,324	14,983	[8] 3,972
Manganese metal	[9] 1,197	1,939	[8] 409
Producers' stocks of ferromanganese, silicomanganese, and manganese metal			97,864

[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] Data not available.
[6] 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.
[7] Excludes small tonnages of dealers' stocks.
[8] Excludes producers' stocks.
[9] Manufacturers of steel ingots and manufacturers of steel castings only.

Electrolytic Manganese and Manganese Metal.—Electro Manganese Corp. produced electrolytic manganese at its two plants in Knoxville, Tenn. During the year Electro Metallurgical Co. plant at Marietta, Ohio, became the country's second commercial producer. Capacity of the plant is about 6,000 tons a year.[3] Manganese metal was also produced in electric furnaces by the company. Considerable interest continued to be shown in the development of new types of stainless steel in which electrolytic manganese replaces part of the nickel component. Standard electrolytic manganese has a guaranteed minimum manganese content of 99.9+ percent.

Ferromanganese.—Production of ferromanganese in the United States was 719,000 short tons in 1954, compared with 908,000 short tons in 1953. The following plants were active producers during the year: Anaconda Copper Mining Co., Anaconda and Black Eagle,

[3] Daily Metal Reporter, vol. 54, No. 237, Dec. 14, 1954, p. 1.

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.; Pittsburgh Metallurgical Co., Charleston, S. C.; Tennessee Products & Chemical Corp., Chattanooga, Tenn.; Tenn Tex Alloy & Chemical Corp., Houston, Tex.; United States Steel Corp., Ensley, Ala., Clairton and Duquesne, Pa. The quantity of ferromanganese made in blast furnaces was two and one-half times that made in electric furnaces. Manganese ore consumed in the manufacture of ferromanganese totaled 1,443,000 short tons in 1954, of which 2 percent was of domestic origin and 98 percent foreign. The domestic portion in 1953 was 4 percent and in 1952, 6 percent. The recovery of manganese from ore was 83.2 percent in 1954, compared with 82.0 percent in 1953 and 88.6 percent in 1952. Shipments of ferromanganese from producing furnaces decreased 21 percent in quantity and 25 percent in value from 1953.

TABLE 9.—Ferromanganese imported into and made from domestic and imported ores in the United States, 1953–54

	1953		1954	
	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]	49, 338	39, 472	28, 035	22, 048
From imported ore [2]	858, 195	656, 964	690, 686	517, 316
Total domestic production	907, 533	696, 436	718, 721	539, 364
Imported	126, 518	98, 207	56, 772	44, 744
Total ferromanganese	1, 034, 051	794, 643	775, 493	584, 108
Open-hearth, bessemer, and electric [3] furnace steel produced	111, 609, 719		88, 311, 652	

[1] Number of domestic plants making ferromanganese: 1953, 18; 1954, 19.
[2] Estimated.
[3] Includes crucible.

TABLE 10.—Ferromanganese produced in the United States and metalliferous materials consumed in its manufacture, 1945–49 (average) and 1950–54

Year	Ferromanganese produced			Materials consumed (short tons)			Manganese ore used per ton of ferromanganese made (short tons)
	Short tons	Manganese contained		Manganese ore (35 percent or more Mn natural)		Iron and manganiferous iron ores	
		Percent	Short tons	Foreign	Domestic		
1945–49 (average)	590, 264	78. 62	464, 063	1, 066, 639	100, 882	4, 000	1. 978
1950	719, 680	76. 96	553, 834	1, 311, 421	105, 382		1. 969
1951	791, 260	76. 05	601, 758	1, 416, 813	110, 607	11, 667	1. 930
1952	758, 721	76. 94	583, 731	1, 364, 618	83, 614	18, 227	1. 909
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

TABLE 11.—Manganese ore used in manufacture of ferromanganese in the United States, 1950–54, by source of ore

Source of ore	1950		1951		1952		1953		1954	
	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	105,382	58.02	110,607	58.34	83,614	56.95	75,594	57.48	31,351	57.53
Foreign:										
Africa	606,248	46.00	641,013	44.36	510,452	45.59	637,934	45.85	397,153	45.51
Brazil	128,940	40.82	146,108	40.83	118,842	40.03	192,280	40.20	123,234	40.23
Chile	7,279	47.68	8,484	47.15	12,586	47.21	36,456	43.95	10,516	43.44
Cuba	42,893	39.20	103,263	39.50	136,436	39.82	172,700	39.89	144,870	39.85
India	447,749	48.15	449,780	48.03	477,428	46.03	716,568	44.51	637,475	46.10
Indonesia			801	46.94	8,291	43.77	6,763	44.48	6,988	44.86
Mexico	25,851	41.48	40,402	40.81	51,571	40.84	42,675	41.99	54,969	42.00
New Caledonia					12,092	46.35	40	47.50	4,943	46.83
Philippines	5,036	46.84	5,232	44.76	7,064	41.19	8,586	41.52	591	44.50
Turkey	2,928	45.97	9,505	42.64	16,053	39.90	8,382	45.76	8,200	45.73
U. S. S. R.	44,497	43.59	10,097	46.01			508	45.87		
Other			2,128	39.66	13,803	37.36	6,490	47.63	23,091	48.28
Grand total	1,416,803	46.77	1,527,420	45.71	1,448,232	45.07	1,904,976	44.56	1,443,381	44.91

TABLE 12.—Ferromanganese shipped from furnaces in the United States, 1945–49 (average) and 1950–54

Year	Short tons	Value	Year	Short tons	Value
1945–49 (average)	587,641	$79,365,201	1952	738,088	$133,996,006
1950	731,421	116,043,055	1953	900,110	185,192,588
1951	795,745	122,346,198	1954	707,415	139,157,801

Silicomanganese.—The quantity of silicomanganese consumed in 1954 was 11.2 percent of ferromanganese consumption compared with 12.2 percent in 1953 and 11.6 percent in 1952. Silicomanganese as marketed commonly contains 65 to 68 percent manganese, up to 3 percent carbon, and 12 to 20 percent silicon, carbon content decreasing as silicon increases. It is used by the steel industry as a furnace-control agent, as a deoxidizer, and for manganese additions. It has been found to be particularly useful for manganese additions to low-carbon and high-manganese steels.

The following plants were active producers during the year: Electro Metallurgical Co., Division of Union Carbide & Carbon Corp., Alloy, W. Va., Ashtabula, and Marietta, Ohio, Niagara Falls, N. Y., and Sheffield, Ala.; Ohio Ferro-Alloys Corp., Philo, Ohio; Pioche Manganese Co., Henderson, Nev.; Pittsburgh Metallurgical Co., Charleston, S. C.; and Tennessee Products & Chemical Corp., Chattanooga, Tenn.

Spiegeleisen.—During 1954 spiegeleisen was produced in the United States at only two plants: New Jersey Zinc Co., Palmerton, Pa., and United States Steel Corp., Ensley, Ala.

TABLE 13.—Spiegeleisen produced and shipped in the United States, 1945–49 (average) and 1950–54

Year	Produced (short tons)	Shipped from furnaces		Year	Produced (short tons)	Shipped from furnaces	
		Short tons	Value			Short tons	Value
1945–49 (average)	115,168	112,024	$4,423,230	1952	58,666	67,129	$4,730,631
1950	42,375	65,163	3,875,823	1953	97,729	67,247	5,144,470
1951	77,017	79,168	5,368,989	1954	(1)	(1)	(1)

[1] Bureau of Mines not at liberty to publish.

TABLE 14.—Foreign ferruginous manganese ore and manganiferous iron ore consumed in the United States, 1951–54, in short tons

Source of ore	Ferruginous manganese ore				Manganiferous iron ore			
	1951	1952	1953	1954	1951	1952	1953	1954
Africa	2	1,048	626					
Brazil		361						
Canada								408,467
Egypt	87,455	152,483	129,490	128,102				
Greece				1,033				
India				56				
Total	87,457	153,892	130,116	129,191				408,467

Manganiferous Pig Iron.—Pig-iron furnaces used 1,408,000 short tons of manganese-bearing ores containing (natural) over 5 percent manganese in 1954. Of this quantity, 823,000 tons was of domestic origin and 585,000 tons foreign. Of the domestic ore used, 802,000 tons contained (natural) 5 to 10 percent manganese; 19,000 tons contained 10 to 35 percent manganese; and 2,000 tons contained more than 35 percent manganese. Of the foreign ore used, 409,000 tons contained (natural) 5 to 10 percent manganese, 129,000 tons contained (natural) 10 to 35 percent manganese, and 47,000 contained 35 percent or more manganese.

Battery and Miscellaneous Industries.—Manufacturers of dry cells used 31,000 short tons of manganese ore during 1954, or 25 percent less than in 1953. Of the total, 3,000 tons was of domestic origin. Chemical plants used 22,000 tons, of which only 300 tons was of domestic origin. All of the above ore contained (natural) over 35 percent manganese.

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-ton unit for 48 percent of either contained or recoverable manganese. Table 15 compares prices paid under the different domestic purchase programs for selected percentages of manganese content. 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 $1.08 to $1.10 per long-ton unit of manganese, c. i. f. United States ports, duty extra, and dropped to reach a low of 70 to 75 cents nominal in late September. This quotation held till December, when some recovery was made to close the year at 78 to 80 cents. Long-term contracts for ore from various sources were quoted at the beginning of the year as nominal at 90 cents, late September nominal at 65 to 70 cents, and at the end of the year nominal at 75 to 78 cents, c. i. f. United States ports, duty extra. Chemical-grade ore was quoted by E&MJ Metal and Mineral Markets at the end of the year, f. o. b. Philadelphia, at $96 per ton, minimum 84 percent manganese dioxide, carloads, 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.

TABLE 15.—Comparison of manganese prices paid by General Services Administration on its various domestic manganese-purchase programs

(Price per long dry ton)

Mn, percent	Deming and Wenden	Butte [1] carbonate	Philipsburg [1] carbonate	Butte [1] oxide	Carlot [2]
12		$6.05			
15	$8.54	11.43	$6.43		
18	13.71	19.01	12.79	$4.87	
20	17.20	23.62	17.22	9.18	
25	26.94	31.74	26.53	19.82	
30	40.60	40.42	34.81	31.33	
35	56.29	59.03	57.84	43.09	
39	74.03	66.72	65.39	51.62	
40	(3)	68.64	67.28		$88.00
41					90.82
45					102.15
48					110.40
50					115.50
55					128.43
58					136.30
60					141.60

[1] Essentially for marginal or submarginal producers; therefore Government reserves right to exclude current established production.
[2] Limited to small domestic producers whose total anticipated or actual production is less than 10,000 long dry tons per calendar year.
[3] Fines—$78.00; ore—$88.00.

NOTE: Premium for low iron content; penalties for high iron, silica plus alumina, and phosphorus contents: Deming, Wenden, Butte oxide, and carlot. Credits for gold, silver, lead, zinc, and low calcium oxide plus magnesium oxide; penalties for high iron, and calcium oxide plus magnesium oxide: Butte and Philipsburg carbonate.

Manganese Alloys.—The average value, f. o. b. producers' furnaces, for ferromanganese shipped during 1954 was $196.71 per short ton, compared with $205.74 in 1953. In September major producers of ferromanganese cut the price from 10 cents per pound of alloy, which had prevailed throughout the year till that time, to 9.5 cents per pound. According to Iron Age, the selling price of ferromanganese in carlots at eastern centers averaged 9.83 cents per pound for the year. The quoted price for spiegeleisen of 19 to 21 percent content, as given by Iron Age, was $86 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; 32 cents per pound for ton lots. A premium of 0.75 cents per pound applied to hydrogen-removed metal.

FOREIGN TRADE [4]

Imports of manganese ore, although not approaching the quantity imported in 1953, continued large during 1954. The average grade (46.1 percent manganese) compared favorably with the 44.9 percent of 1953, 45.2 percent of 1952, and 46.1 percent of 1951. No ore was received from the Soviet Union, but the U. S. S. R. again became an important factor affecting world markets.

India continued to be the principal supplier of the United States, providing 40 percent of the total ore received in 1954. India, Cuba, Union of South Africa, and Gold Coast, in that order of importance, with the last three rather closely grouped, supplied three-fourths of the total United States imports for the third consecutive year.

Import data in table 16 include receipts of ore classified as battery and chemical grade, totaling 52,225 short tons in 1954, averaging 54.5 percent manganese or 86.2 percent manganese dioxide. Of this quantity 39,738 short tons came from the Gold Coast, 7,274 from Cuba, 3,265 from French Morocco, 1,092 from Greece, 672 from Chile, 160 from India, and 24 from France. Imports for consumption of battery and chemical grade totaled 51,888 short tons valued at $2,773,114 or $53.44 per short ton f. o. b. foreign ports. Of the total, Gold Coast supplied 39,401 short tons valued at $2,134,405; Cuba, 7,274 at $328,200; French Morocco, 3,265 at $202,535; Greece, 1,092 at $59,000; Chile, 672 at $23,126; India, 160 at $10,254; and France, 24 at $15,594.

Imports for consumption of ferromanganese decreased 55 percent from 1953; the value decreased 60 percent. Exports of ferromanganese increased 56 percent to 1,732 short tons. Exports of manganese ore and concentrates (10 percent or more manganese) were 6,112 short tons valued at $591,964.

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[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 16.—Manganese ore (35 percent or more Mn) imported into the United States, 1953–54, 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			
	1953	1954	1953	1954	1953	1954	1953	1954	1953	1954
North America:										
Costa Rica	364		167		455		206		$12,111	
Cuba	397,257	261,539	172,355	113,574	397,257	261,539	172,355	113,574	13,990,786	$8,844,121
Mexico	171,462	89,573	70,936	38,960	129,862	122,501	55,227	52,808	3,886,241	3,539,633
Total	569,083	351,112	243,458	152,534	527,574	384,040	227,788	166,382	17,889,138	12,383,754
South America:										
Brazil	169,768	103,655	75,821	46,453	155,373	100,064	68,844	45,260	4,863,567	3,397,212
Chile	61,799	18,559	28,306	8,096	32,416	18,503	13,969	8,150	1,126,079	577,610
Peru	4,704	4,126	2,005	1,789	1,153	4,233	570	1,872	39,326	90,635
Total	236,271	126,340	106,132	56,338	188,942	122,800	83,383	55,282	6,028,972	4,065,457
Europe:										
France		24		14		24		14		15,594
Greece	6,569	4,688	2,982	2,264	4,046	12,497	1,660	5,438	104,265	410,852
Portugal	6,593	3,360	3,106	1,636						
Turkey	39,513	3,869	18,140	1,893	40,803	13,441	18,793	6,128	1,764,381	501,429
Total	52,675	11,941	24,228	5,807	44,849	25,962	20,453	11,580	1,868,646	927,875
Asia:										
Burma	554		324							
India	1,296,905	868,291	572,640	400,064	1,218,174	952,554	539,871	437,108	38,449,667	30,364,032
Indonesia	6,984	3,902	3,092	1,842	7,390	4,981	3,472	2,332	292,235	105,990
Philippines	12,955	1,848	5,859	887	12,955	1,848	5,859	887	459,187	69,008
Portuguese Asia	88,565	28,780	36,961	12,570	79,210	28,780	33,070	12,570	3,027,397	889,685
Total	1,405,963	902,821	618,876	415,363	1,317,729	988,163	582,272	452,897	42,228,486	31,428,715

Africa:										
Angola	63, 863	46, 269	31, 141	22, 639	64, 395	46, 890	31, 343	22, 978	2, 768, 024	2, 367, 538
Belgian Congo	140, 478	161, 206	70, 198	80, 924	140, 478	159, 067	70, 198	79, 854	5, 784, 670	6, 501, 160
British East Africa		1, 094		547		1, 094		547		36, 629
Federation of Rhodesia and Nyasaland		1, 033		516		1, 033		516		45, 178
French Morocco	73, 587	73, 558	36, 761	39, 032	66, 730	60, 363	33, 616	31, 334	3, 313, 568	2, 987, 503
Gold Coast	511, 259	232, 277	253, 355	115, 085	333, 622	193, 558	164, 526	97, 250	14, 309, 989	9, 110, 108
Union of South Africa	428, 348	242, 795	177, 943	101, 814	406, 024	240, 439	168, 421	101, 168	8, 548, 845	5, 182, 522
Total	1, 217, 535	758, 232	569, 398	360, 557	1, 011, 249	702, 444	468, 104	333, 647	34, 725, 096	26, 230, 638
Oceania:										
Australia	10, 320	9, 733	4, 541	4, 794	10, 320	9, 733	4, 541	4, 794	347, 500	423, 662
British Western Pacific Islands	1, 176	5, 968	588	2, 858		5, 968		2, 858		196, 016
French Pacific Islands	7, 963		3, 699		14, 360	4, 945	6, 459	2, 355	424, 019	140, 040
Total	19, 459	15, 701	8, 828	7, 652	24, 680	20, 646	11, 000	10, 007	771, 519	759, 718
Grand total	3, 500, 986	2, 166, 147	1, 570, 920	998, 251	3, 115, 023	2, 244, 055	1, 393, 000	1, 029, 795	103, 511, 857	75, 796, 157

[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.

TABLE 17.—Ferromanganese imported for consumption in the United States, 1952–54, by countries

[U. S. Department of Commerce]

Country	1952			1953			1954		
	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	29,020	22,735	$5,473,927	341	286	$94,221	1,737	1,315	$339,226
Mexico				89	70	16,075			
Total	29,020	22,735	5,473,927	430	356	110,296	1,737	1,315	339,226
South America: Chile							336	264	40,500
Europe:									
France	3,834	2,995	579,759	21,052	16,827	4,464,421	18,194	14,508	3,246,162
Germany, West	63	25	5,198	51,856	38,894	9,358,900	15,726	11,794	2,808,175
Norway	30,296	24,674	8,550,625	29,832	24,604	9,223,263	17,180	14,078	3,815,696
Yugoslavia	882	600	149,435	112	81	16,380	524	406	67,604
Total	35,075	28,294	9,285,017	102,852	80,406	23,062,964	51,624	40,786	9,937,637
Asia: Japan				23,236	17,445	4,007,749	3,075	2,379	585,467
Grand total	64,095	51,029	14,758,944	126,518	98,207	27,181,009	56,772	44,744	10,902,830

TABLE 18.—Spiegeleisen[1] imported for consumption in the United States, 1945–49 (average) and 1950–54

[U. S. Department of Commerce]

Year	Short tons	Value	Year	Short tons	Value
1945–49 (average)	1,049	$49,322	1952	44	$3,658
1950	8,595	474,259	1953	785	63,149
1951			1954		

[1] Exclusive of spiegeleisen containing not more than 1 percent carbon.

TABLE 19.—Ferromanganese exported from the United States, 1945–49 (average) and 1950–54

[U. S. Department of Commerce]

Year	Gross weight (short tons)	Value	Year	Gross weight (short tons)	Value
1945–49 (average)	10,055	$1,543,865	1952	1,453	$474,686
1950	580	139,876	1953	1,112	389,064
1951	633	206,614	1954	1,732	614,544

TECHNOLOGY

Research by the Bureau of Mines, in both laboratories and pilot plants, continued on the mineral dressing, leaching, sintering, and smelting of manganese oxide, silicate, and carbonate ore and concentrate, pointed toward ultimate utilization of the country's low-grade and complex resources.

Considerable laboratory work was done by the Bureau in applying the oil-emulsion flotation process to various low-grade western ores.

The roles of tall oil and fuel oil, fineness of grind, pulp solids, pH, and conditioning, were all investigated. Suitable conditioning has been found to be a primary requisite for successful oil-emulsion flotation.

In the pyrometallurgical process for recovering manganese from open-hearth slags,[5] developed by the Bureau in cooperation with the American Iron and Steel Institute and briefly described in the Manganese chapter of the 1952 Minerals Yearbook, metallic iron containing 3 percent phosphorus, 1 percent manganese, and less than 1 percent carbon is obtained as a byproduct of the converter step. Removal of the phosphorus content of this metal results in a usable product. The successful accomplishment of this operation, with the attendant production of a phosphate slag suitable for agricultural use, was described.[6] This calcium phosphate, containing 18 to 25 percent P_2O_5 and less than 5 percent iron, was obtained by removing the slag from the converter before the phosphorus in the metal had been oxidized to less than 0.25 percent.

Results of Bureau of Mines experimental work upon various Aroostook, Maine, manganiferous materials were published.[7] Acid leaching of material from the Dudley Farm and from the Littleton Ridge deposits gave manganese extractions of 90 percent, whereas similar percentages of manganese and 45 percent of iron were extracted from Maple Mountain-Hovey Mountain material by means of a chloridizing roast. The manganese content of the first two deposits is largely as carbonate; at Maple Mountain-Hovey Mountain the manganese occurs predominantly as silicate.

An article[8] was published describing the differential high-temperature sulfatization process, developed by the Bureau's Minneapolis station for Cuyuná-range materials. Manganiferous, ferruginous carbonate slate is subjected to a sulfur dioxide-air roast in the proper temperature range. The sulfatized product is then leached with water and the leach solution evaporated and filtered to produce manganese sulfate crystals. Subsequent calcination yields a high-manganese product, low in iron and sulfur. It is expected that byproduct iron oxides can be beneficiated to a marketable product, thus contributing to the economics of the process.

Laboratory investigation of manganese carbonate samples from the Martin mine, Independence County, Ark., obtained concentrate meeting specifications for National Stockpile purchases. The raw material contained 10.2 percent manganese, 3.2 percent iron, 4.4 percent acid-insoluble, and 0.49 percent phosphorus. This was concentrated by high-intensity magnetic separation, the manganese carbonate minerals floated, and the flotation concentrate sintered. A combination of sink-float and high-intensity magnetic separation, preceding the flotation and sintering, improved the grade of the product but lowered the recovery. The low recoveries, approximating 50 percent, were be-

[5] Buehl, R. C., and Royer, M. B., Production of Spiegeleisen from Open-Hearth Slag in an Experimental Blast Furnace: Jour. Metals, vol. 4, No. 12, December 1952, pp. 1289–1294.
Royer, M. B., and Buehl, R. C., Production of High-Manganese Slags by Selective Oxidation of Spiegeleisen: Jour. Metals, vol. 4, No. 12, December 1952, pp. 1294–1300.
Buehl, R. C., Royer, M. B., and Riott, J. P., Manganese From Open-Hearth Slag Could Supply Half of U. S. Needs: Jour. Metals, vol. 5, No. 4, April 1953, pp. 520–521.
[6] Buehl, R. C., and Royer, M. B., Dephosphorization in a Side-Blown Basic Converter: Bureau of Mines Rept. of Investigations 5102, 1955, 20 pp.
[7] MacMillan, R. T., and Turner, T. L., Recovery of Manganese From Ores of Aroostook County, Maine: Bureau of Mines Rept. of Investigations 5082, 1954, 41 pp.
[8] Prasky, Charles, How U. S. B. M. Metallurgists Are Solving the Manganese Shortage: Eng. and Min. Jour., vol. 155, No. 11, November 1954, pp. 72–75.

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lieved due to the abundance of high-calcium, low-manganese carbonate.[9]

Considerable interest was shown by industry in the high-damping manganese-copper alloys developed for commercial production by the Bureau of Mines in cooperation with the United States Navy, Bureau of Ships. Electrolytic manganese is used for producing these alloys containing 60 to 80 percent manganese, the remainder copper. After proper heat treatment, they have properties of high vibration-damping capacity, hence high noise-damping capacity and have a strength comparable to that of structural steel. Gray iron, often used where vibration damping is desired, has a specific damping capacity of less than 8 percent, whereas for the heat-treated manganese-copper alloys specific damping capacities as high as 35 percent can be obtained with tensile strengths of 100,000 p. s. i.[10]

The Bureau of Mines continued its studies of the substitution of titanium for manganese in the manufacture of carbon steel, with considerable attention paid to its effects on the mechanical properties of the steels. The study of rare earths in the manufacture of steels, by both industry and the Bureau of Mines, and their increased use by industry, have shown them to have possibilities as a substitute for manganese in the desulfurization of steels. Present costs do not favor large-quantity substitution, however.

By the end of the year Manganese Chemicals Corp., financed largely by Government funds, was ready to begin regular production of high-purity manganese carbonate and high-grade metallurgical nodules at its Riverton, Minn., plant. The plant has a capacity of 200 tons of ore per day, with a flowsheet based on the Dean ammonium carbamate process.[11] Old manganiferous ferruginous tailings from a Cuyuna-range mine stockpile comprise the feed. Roasting converts the manganese minerals to soluble manganous oxide and the iron minerals to insoluble magnetite. Ammonium carbamate, obtained by the passage of carbon dioxide into concentrated aqueous solutions of ammonia, leaches out the manganese, which is then precipitated as the carbonate. Easy control of impurities results from the fact that most metal oxides are either insoluble in the leach liquor or will not precipitate with the carbonate. A sulfide addition, acting primarily as an accelerating agent, takes care of any other impurities. The ammonia and carbon dioxide reagents are recovered for recycling. The manganese carbonate product appears to be a promising material for the production of synthetic battery manganese dioxide.

Production of synthetic battery-grade manganese dioxide from low-grade ores by Western Electrochemical Co., Henderson, Nev., was described.[12] The crushed and ground ore is roasted in a kiln to

[9] Fine, M. M., and Frommer, D. W., Laboratory Recovery of Manganese Carbonate From the Martin Mine, Independence County, Ark.: Bureau of Mines Rept. of Investigations 5086, 1954, 10 pp.

[10] Rowland, J. A., and Jensen, J. W., Manganese-Copper Alloys Put Damper on Noise: Steel, vol. 135, No. 11, Sept. 13, 1954, p. 127.

[11] Dean, R. S., Manganese Extractions by Carbamate Solutions and the Chemistry of New Manganese-Ammonia Complexes: Min. Eng., vol. 4, No. 1, January 1952, pp. 55–60.

[12] Chemical Engineering, From Low-Grade Domestic Ores—High-Grade Manganese Dioxide: Vol. 61, No. 1, January 1954, pp. 152–155. Manganese Dioxide: Vol. 61, No. 1, January 1954, pp. 372–375.

convert the manganese oxides to soluble manganous oxide. The reduced ore is leached for 2 hours at 60° C. by spent electrolyte solution fortified with makeup sulfuric acid. Addition of barium sulfide to the crude leach solution, followed by introduction of CaO, removes nickel and cobalt. An air oxidation technique removes iron, sulfur, arsenic, and organics. After filtration the filtrate is fed to 33 electrolytic cells, each with 600 anodes, maintained at 90°–94° C. with current density kept at 7 to 9 amp. per sq. ft. The manganese dioxide is deposited on specially designed, rod-shaped graphite anodes which give long operating cycles and high ratios of deposit to rod weight. A metallurgical jig separates the manganese dioxide from the anode, after removal from the cell. The dioxide is then ground, washed, filtered, and moisture removed in a rotary drier. The plant has a capacity of 10 tons per day of final product.

A new white alloy containing copper, manganese (15 percent), and tin (6 percent), was claimed to have definite advantages over nickel-silver. It was stated that it can be produced at competitive cost, can be readily cast and processed, can be plated, and has corrosion resistance and good mechanical properties.[13]

Several high-nitrogen chrome-manganese and chrome-manganese-nickel stainless steels were announced, one means of introduction of the nitrogen being in the form of nitrided electrolytic manganese.

The magnetic properties of certain ferromagnetic manganese alloys received study [14] as did the relation of manganese and sulfur to the forgeability of steels.[15]

WORLD REVIEW

The data in table 20 are from official statistics of the various countries, supplemented by information from semiofficial and other sources.

Argentina.—High-grade ore was being hand-picked from a new manganese deposit in Juyjuy Province, 15 miles from La Quiaca, near the Bolivian border. Shipment was made to the steel mills of Altos Hornos de Palpalá (Fabricaciones Militares) by Lopez Hermanos Co.[16]

Australia.—Manganese deposits were reported as outcropping near Hopetown on the south coast of Western Australia, 6 miles from the mouth of the Hamersley River and 34 miles south-west of Ravensthorpe. They were reported to extend for 1¼ miles, with an average width of 100 feet and grade of 37 to 47 percent manganese.[17]

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[13] Iron Age, New Copper-Manganese Alloy To Be Shown At Metal Show: Vol. 174, No. 19, Nov. 4, 1954, p. 154.

[14] Morgan, E. R., Ferromagnetism of Certain Manganese-Rich Alloys: Jour. Metals, vol. 6, No. 9, September 1954, pp. 983–988.

Quigg, R. J., Conard, G. P., and Libsch, J. F., Magnetic Properties of Manganese–Germanium Alloys: Jour. Metals, vol. 7, No. 2, February 1955, p. 359.

[15] Anderson, T. C., Donaldson, V. V., Kimball, R. W., and Cattoir, F. R., Forgeability of Steels With Varying Amounts of Manganese and Sulphur: Jour. Metals, vol. 6, No. 7, July 1954, pp. 835–837.

[16] Engineering and Mining Journal, vol. 155, No. 10, October 1954, p. 171.

[17] Chemical Engineering and Mining Review (Melbourne), vol. 46, No. 7, Apr. 10, 1954, p. 290.

TABLE 20.—World production of manganese ore, by countries,[1] 1945–49 (average) and 1950–54, in short tons [2]

(Compiled by Pearl J. Thompson)

Country	Mn, percent	1945–49 (average)	1950	1951	1952	1953	1954
North America:							
Canada (shipments)	------	45	------	------	------	------	------
Cuba	36–50+	103,834	87,313	169,856	277,426	389,356	296,801
Mexico	30+	47,633	38,892	87,292	157,403	269,863	277,996
United States (shipments)	35+	142,776	134,451	105,007	115,379	157,536	206,128
Total	------	294,288	260,656	362,155	550,208	816,755	780,925
South America:							
Argentina	30–40	[3] 4,400	1,268	1,323	2,535	5,512	1,323
Brazil	38–50	[4] 182,331	215,507	224,366	274,732	255,058	[3] 220,000
Chile	40–50	21,973	36,960	40,320	59,356	60,207	58,422
Peru	40+	9	840	1,043	1,221	[3] 3,500	[3] 5,000
Total	------	208,713	254,575	267,052	337,844	324,277	[3] 285,000
Europe:							
Greece	35+	235	353	11,676	25,369	14,827	[3] 17,600
Hungary (concentrate)[3]	35–48	31,500	44,000	44,000	44,000	44,000	44,000
Italy	30	19,348	21,422	31,479	45,484	43,162	53,843
Portugal	35+	3,810	880	8,394	12,197	13,918	10,572
Rumania	30–36	35,850	([5])	([5])	([5])	([5])	([5])
Spain	30+	25,150	20,946	22,917	31,408	36,044	35,159
Sweden	30+	110	64	6	51	50	9
Switzerland	------	607	------	------	------	------	------
U. S. S. R.[3]	41+	2,000,000	2,200,000	2,800,000	2,800,000	[6] 3,900,000	[6] 4,400,000
United Kingdom	------	2,531	------	------	------	------	------
Yugoslavia	30+	10,461	14,703	14,185	13,985	11,042	10,148
Total [3]	------	2,130,000	2,400,000	3,000,000	3,000,000	4,100,000	4,600,000
Asia:							
Burma	35+	168	------	[3] 2,200	7,280	9,610	4,160
China	41	16,094	([5])	([5])	([5])	([5])	([5])
India	40+	467,318	988,882	1,447,463	1,637,738	2,125,426	1,344,002
Indonesia	35–49	1,567	------	------	8,634	20,310	16,442
Iran [7]	36–46	926	[3] 10,300	4,379	3,583	[3] 4,400	3,436
Japan	32–40	66,864	153,225	203,942	228,593	214,286	180,155
Korea, Republic of	30–48	([5])	110	2,477	8,175	3,371	1,744
Malaya	30	560	[4] 79	[4] 215	------	------	------
Philippines	35–51	12,176	32,933	24,629	22,737	23,708	10,354
Portuguese India	32–50+	4,898	33,053	95,673	122,429	165,347	[3] 117,000
Turkey	30–50	9,744	35,470	55,685	88,745	99,038	54,925
Total [3]	------	580,300	1,260,000	1,848,000	2,150,000	2,699,000	1,771,000
Africa:							
Angola	48	4,762	10,260	50,918	60,731	72,603	34,865
Belgian Congo	50	12,810	18,728	78,203	141,071	238,831	424,320
French Morocco	35–50	148,217	316,655	410,316	469,932	473,461	441,413
Gold Coast [4] [8]	48	767,715	796,732	902,812	889,491	835,510	515,475
Rhodesia and Nyasaland, Federation of:							
Northern Rhodesia	30+	------	------	1,411	4,397	7,984	18,872
Southern Rhodesia	------	39	------	------	1,580	------	18
South-West Africa	------	------	1,095	7,231	29,219	40,654	34,066
Spanish Morocco	50	147	40	1,237	4,007	1,181	852
Tunisia	35–40	6	------	------	------	------	------
Union of South Africa	40+	346,616	871,858	836,510	964,121	912,333	772,862
Total	------	1,280,312	2,015,368	2,288,638	2,564,549	2,582,557	2,242,743

See footnotes at end of table.

TABLE 20.—World production of manganese ore, by countries,[1] 1945–49 (average) and 1950–54, in short tons [2]—Continued

Country	Mn, percent	1945–49 (average)	1950	1951	1952	1953	1954
Oceania:							
Australia		4,633	16,654	8,924	7,917	36,897	31,587
Fiji		[9] 96	269	707	2,251	2,448	11,087
New Caledonia	45+	536	5,944	22,195	18,484	6,163	
New Zealand		349	395	450	357	324	268
Papua		138	24	45		47	
Total		5,752	23,286	32,321	29,009	45,879	42,942
World total (estimate)[1]		4,500,000	6,200,000	7,800,000	8,600,000	10,600,000	9,700,000

[1] In addition to countries listed, Bulgaria 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: 1945–49 (average), 43,782; 1950, 167,737; 1951, 171,259; 1952, 230,564; 1953, 307,331; and 1954, 195,694; occasionally a small tonnage contains over 35 percent manganese.
[2] This table incorporates a number of revisions of data published in previous Manganese chapters.
[3] Estimate.
[4] Exports.
[5] Data not available; estimate by author of chapter included in total.
[6] The 1953 and 1954 production estimated for ore of 35 percent or more manganese content.
[7] Year ending March 20 of year following that stated.
[8] Dry weight.
[9] Average for 1948–49.

Belgian Congo.—The Kisenge mine of Beceka Manganese, near Dilolo, Katanga, produced 211,000 metric tons of direct shipping ore (49.5 percent Mn) and 164,000 tons of ore (42 percent Mn) to be washed in a plant under construction during the year. Diamond drilling of the company holdings continued, and the exploration confirmed previous ore indications. The Kasekalesa mine of SUDKAT (Société de Recherche Minière du Sud Katanga) produced 9,000 tons of ore containing 50 percent manganese. Exploration for an extension of the deposit was successful, with the result that the mine, previously reported as nearing exhaustion, has prospects of renewed life. Exports of manganese ore from Belgian Congo in 1954 totaled 250,000 metric tons, of which 194,000 went to the United States, 18,000 to Belgium, 14,000 to West Germany, and smaller quantities to United Kingdom, Italy, and Sweden. Virtually all exports were through the Angola port of Lobito.[18]

Brazil.—The manganese mining rights of the extensive Urucum deposits of Mato Grosso have been leased to Sociedade Brasileira de Mineracão Ltda., a Brazilian company controlled by the Chamma group. This company,[19] in turn, entered into a contract of purchase and sale of manganese ore with Companhia Meridional de Mineracão, a Brazilian corporation in which United States Steel Co. has a 49-percent interest. It reportedly will take another 18 months or 2 years before preliminary operations for working of the mines can be begun. Exports of manganese ore from Brazil in 1954 totaled 94,000 metric tons (41 to 45 percent Mn), all going to the United States.[20] Construction of the 134-mile railroad and port facilities to serve the

[18] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 4, October 1955, pp. 22–23.
[19] Engineering and Mining Journal, vol. 155, No. 7, July 1954, p. 150.
[20] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 5, November 1955, p. 26.

important Amapa deposits was begun after award of the contract to Foley Brothers, Inc., of Pleasantville, N. Y.

British Guiana.—Exploration of the manganese concessions of Barima Gold Mining Co. (Canada), Ltd., by Northwest Guiana Mining Co., subsidiary of Union Carbide & Carbon Corp., was reported to have proved between 4 and 5 million tons of ore having an average grade of approximately 40 percent manganese.[21] Later reports were to the effect that Northwest Guiana Mining Co. had exercised its option to purchase all mineral rights of the concessions other than gold.

Canada.—Strategic Materials Corp., Ltd., claims that the Woodstock-Glassville district of New Brunswick has indications of 150 million tons of manganiferous material containing approximately 12 percent manganese and 16 percent iron. It was said that drilling has shown the area to be almost 18 miles long.[22] Metallurgical tests were said to show that the material can be beneficiated to a commercial product.[23] Canadian Manganese Mining Co., a subsidiary of New Delhi Mines, Ltd., has reported that 35 million tons of material containing 5 to 6 percent manganese has been indicated by diamond drilling on its property at Tetagouche Falls, about 8 miles west of Bathurst, New Brunswick. Metallurgical tests were favorable.[24]

Chile.—Manganesos de Atacama, which has been an important producer of manganese ore, was building an electric furnace of 1,700 kw. capacity to produce ferromanganese.[25]

Colombia.—Manganese deposits were reported to have been discovered in the southern part of the country, 110 miles from the port of Tumaco. Ministerio de Minas y Petróleos reported analysis of one ore sample as 47.20 percent manganese, 0.93 percent iron, 13.60 percent silica, and 1.74 percent moisture.[26]

Cuba.—The Charco Redonda mine in Oriente Province continued to be the principal producer of manganese ore in Cuba. The mine was operated by Cia. Minera Guamá, S. A., a subsidiary of Cia. Construcciones Cajigas. The deposit as mined yielded a direct shipping ore containing approximately 43 to 44 percent manganese with low iron content (less than 2 percent). Underground methods were employed exclusively. Chemical-grade ore, together with metallurgical ore, continued to be produced by small independent mines in Oriente Province.

Cyprus.—A wet-gravity pilot plant was installed to test the beneficiation of ore from a low-grade manganese deposit near the village of Leonarisso, Famagusto district.[27]

Fiji.—Production of manganese ore in 1954 (11,000 tons), showed a marked increase over that of previous years. Both metallurgical- and chemical-grade ores were mined. The colony's production is expected to increase further and to level off at 15,000 to 20,000 tons per year. Principal producers in 1954 were: Consolidated Manganese & Mining Co. of Fiji, Ltd. (Sigatoka area), Manganese Mines (Nabu

[21] Northern Miner, vol. 40, No. 12, June 10, 1954, p. 6.
[22] American Metal Market, vol. 61, No. 246, Dec. 27, 1954, p. 1.
[23] Northern Miner, vol. 41, No. 36, Nov. 25, 1954, p. 67.
[24] Northern Miner, vol. 41, No. 19, July 29, 1954, p. 23.
[25] Engineering and Mining Journal, vol. 155, No. 10, October 1954, p. 172.
[26] Engineering and Mining Journal, vol. 155, No. 12, December 1954, p. 154.
[27] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 2, August 1955, p. 23.

area), and Manganese Development Co., Ltd. (Nadi area). All these were surface operations on the island of Viti Levu. Transportation to the port of Lautoka presented a problem, necessitating construction of access roads capable of withstanding heavy rains. No attempt has been made to estimate manganese-ore reserves of the colony, which are distributed irregularly among numerous prospects not entirely confined to Viti Levu. Known deposits were small but often of high quality, low in phosphorus and other impurities. Both psilomelane and pyrolusite are mined.[28]

French Equatorial Africa.—Exploration of the manganese deposits in Gabon, northwest of Franceville, in which United States Steel Corp. has a substantial interest, was reported to have shown reserves of 80 million tons of ore having an average grade believed capable of yielding a 50-percent manganese washed product. A pilot plant for a preliminary washing test was placed in service, and surveys of possible transportation routes were continued.[29]

French Morocco.—1954 production of metallurgical manganese ore totaled 357,000 metric tons and of chemical ore, 43,000 tons. These figures compare with 376,000 and 54,000 tons, respectively, for 1953. All but 900 tons of the chemical ore in 1954 came from the Imini mine and the remainder from Bou Arfa. Approximately 86 percent of the 1954 metallurgical ore came from 3 mines: Imini, Bou Arfa, and Tiouine. The sintering plant at Sidi-Marouf processed 184,000 tons of ore to produce 150,000 tons of sinter; that at Bou Arfa treated 18,000 tons to obtain 11,000 tons of sinter. A serious drop in both French and world market prices for manganese ore in the early part of the year was reflected in reduction of the number of producing mines from 58 in 1953 to 38 in 1954. By decree of June 26, 1954, low-grade manganese ores, containing less than 36 percent manganese, became exempt from the 5-percent ad valorem tax. Among the large shippers, this benefited only the Bou Arfa mine, which ships its ore over the East Moroccan railway system to the Algerian port of Nemours.[30] In December another decree exempted certain production of ore containing 36 or more percent manganese.

Exports of manganese ore in 1954 were approximately 330,000 metric tons, including 158,000 tons of sinter. France continued to be the principal market for French Moroccan manganese ore, taking 72 percent of the total. The United States and West Germany were the only other significant receiving countries.[31]

French West Africa.—United States Steel Corp. was interested in the exploration of manganese deposits in French West Africa.[32]

Goa (Portuguese India).—Exports of manganese ore from Goa in 1954 at 102,000 long tons were only half the quantity exported the previous year. The United States received 63,000 tons, Germany 11,000, Japan 11,000, Netherlands 9,500, Belgium 5,800, and United Kingdom 1,200.[33]

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[28] Department of Lands, Mines and Surveys, Colony of Fiji, Annual Report on Mining, 1954: Legislative Council Paper 28, Mar. 22, 1955, pp. 7-9, 13. Mining and Mineral Prospects in Fiji: Legislative Council Paper 49, Fiji, July 26, 1954, pp. 1-5.

[29] United States Consulate, State Department Dispatch 25: Elisabethville, Belgian Congo, May 20, 1955, p. 5.

[30] United States Consulate General, State Department Dispatch 21: Casablanca, French Morocco, Aug. 1, 1955, pp. 15-17.

[31] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 5, May 1955, pp. 23-25.

[32] Skillings' Mining Review, vol. 43, No. 51, Mar. 26, 1955, p. 12.

[33] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 2, February 1955, p. 27.

Gold Coast.—Almost all of the manganese ore produced in Gold Coast in 1954 came from the Nsuta mine; the Hotopa mine was reported to have produced 4,000 tons. A heavy-medium-separation plant was under construction. Product of the washing plant had a manganese content of approximately 48 percent.[34] In 1953 The African Manganese Co., Ltd., employed 5,500 Africans.[35]

India.—The heavy-medium-separation plant of Central Provinces Manganese Ore Co., Ltd., was officially opened at the Dongri Buzurg mine on February 28. Plans called for the plant to treat material accumulated in old dumps at the mine. A second plant was reported being designed for the company Balaghat mine.[36] Because of a shortage of railway cars, exports from the ports of Calcutta and Madras were regulated by quota, and movement of cargoes to other ports also was controlled. Shipments were hampered further by high rail freight rates and port charges. The drop in the price of manganese ore caused many mines to close. On August 17 India abolished its 15-percent export duty on manganese ore.

Indonesia.—Three grades of manganese ore were being produced in Indonesia in 1954, the manganese content of which was, respectively: Grade 1, 46–48 percent (7–10 percent Si, 5–6 percent Fe); Grade 2, 43–46 percent; Grade 3, less than 43 percent.[37]

Jordan.—Studies were being made to ascertain ore reserves at Wadi Dana in southern Jordan. These reserves were tentatively estimated at 100,000 metric tons; their commercial value depends upon the development of economical means of removing the copper content.[38]

Mexico.—Exports of manganese ore from Mexico in 1954 contained 83,000 metric tons of elemental manganese, compared with total exports having a manganese content of 70,000 tons in 1953.[39] Numerous mines continued to ship low-grade manganese ore to the El Paso, Tex., depot of General Services Administration until all contracts were cancelled in September 1954. Cia. Minera Autlán explored and developed its San Francisco mine, near Autlán in southwestern Jalisco. Diamond drilling indicated a large deposit of commercial-grade manganese ore.

Philippines.—The Philippine Bureau of Mines reported latest known manganese ore reserves as follows: General Base Metals, Inc., 106,000 tons of shipping grade (28–45 percent Mn); Badillo Mining Corp., 30,000 tons (45 percent Mn); Siec Manganese Property, 24,000 tons (32 percent Mn); Palawan Manganese Mines, 20,000 tons (47–52 percent Mn); Palawan Mining Corp., 10,000 tons (45–54 percent Mn); Kagastihan Mining Co., 10,000 tons (48 percent Mn); Amalgamated Minerals, 9,800 tons (42–53 percent Mn); and Baybay Manganese Corp., 4,500 tons (45 percent Mn). New discoveries of manganese deposits, not yet evaluated, were reported in the Provinces of Samar, Catanduanes, Surigao, Capiz, Rizal, Tarlac, Bulacan, and Oriental Misamis. Exports of manganese ore for the first half of 1954 totaled 7,250 tons, of which 6,600 tons went to Japan and the remainder to the United States. In 1953 total exports were 24,000 tons (14,000

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34 Mining World, vol. 17, No. 5, Apr. 15, 1955, p. 120.
35 Metal Bulletin (London), No. 3948, Nov. 30, 1954, p. 27.
36 Mining Journal (London), vol. 243, No. 6204, July 16, 1954, pp. 68–69.
37 United States Embassy, State Department Dispatch 107: Djakarta, Indonesia, Sept. 2, 1954, p. 1.
38 Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 2, August 1954, p. 33.
39 Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 5, May 1955, p. 26.

to Japan and 10,000 to the United States).[40] The 9,400 tons produced in 1954 had a manganese content of 47–48 percent. General Base Metals, Inc., supplied 67 percent of this total.[41]

Rhodesia and Nyasaland, Federation of.—Production of manganese ore from the Fort Roseberry district was exported. This ore was high grade and free from impurities. Manganese-ore exports of the Federation in 1954 and 1953 went to the United States—3,000 short tons in 1954 and 1,600 tons in 1953. Production from the Broken Hill district was consumed in local copper and zinc refineries.[42]

Spain.—Manganese-ore production came mainly from the Provinces of Huelva and Ciudad Real. The manganese content of the ore from Huelva varied from 28 to 39 percent. Imports of manganese ore came from Cuba (10,500 tons), Turkey (3,250 tons), and Portugal (2,500 tons). In addition, Spanish Morocco shipped 1,500 tons to Spain. Producers of ferromanganese and silicon-manganese were supplied with 30,000 tons of local ore, while producers of batteries, glass, mineral pigments, electrodes, and chemicals, obtained 900 tons of local ore in the form of manganese peroxide.[43]

Syria.—Discoveries of manganese were reported in Latakia governorate.[44]

Turkey.—Turkish exports of manganese ore in 1954 totaled 40,000 tons, of which 10,000 tons went to the United States, 8,000 to Yugoslavia, 7,000 to Belgium, and smaller amounts to Spain, Netherlands, France, West Germany, and Italy. Total exports in 1953 were 67,000 tons, of which 29,000 tons went to Netherlands, 22,000 to the United States, and the remainder to Belgium, West Germany, Denmark, Spain, Yugoslavia, and Italy. According to A Guide to the Known Minerals of Turkey, by C. W. Ryan, FOA Mission to Turkey, 1954, there are 122 known deposits of manganese in the country.[45]

Union of South Africa.—Because of an acute shortage of railway cars, the largest producer of manganese ore in the Union, Associated Manganese Mines of South Africa, Ltd., was forced to curtail production and cut its labor force. Both this company and South African Manganese, Ltd., were reliably reported to have established large tonnages of good-grade manganese ore in a new manganese area between Lohatla and Black Rock. During the year South African Manganese, Ltd., added four 50-ton truck-trailers to its equipment for use in hauling this ore 40 miles to the railhead. A newly formed company, National Manganese Mines, Ltd., reported that it had developed approximately 1 million tons of manganese ore averaging 48 percent Mn in this area and had produced for export 20,000 tons of ore averaging 51 percent Mn. This development reflects, in a small way, the success of the two older and larger companies in their exploration of the area.[46] Exports of manganese ore from the Union of South Africa for the first half of 1954 amounted to 288,000 short tons, of which half went to the United States; 41,000 tons to the United Kingdom; 39,000 tons to France; 19,000 tons to Germany; 15,000 tons to Luxembourg; 14,000 tons to Belgium; and the remainder to Italy,

[40] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 4, October 1954, pp. 35–36.
[41] United States Embassy, State Department Dispatch 969: Manila, P. I., Mar. 28, 1955, p. 2.
[42] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 2, August 1955, pp. 23–24.
[43] United States Embassy, State Department Dispatch 466: Madrid, Spain, Nov. 17, 1955, Encl. 1, pp. 7–8.
[44] Engineering and Mining Journal, vol. 155, No. 6, June 1954, p. 163.
[45] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 5, November 1955, p. 26.
[46] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 6, June 1955, p. 24.

Japan, Netherlands and Switzerland. Local sales in the first half of the year increased to 75,000 tons, having been 47,000 tons in the first half of 1953. Exports in the first half of 1953 were 402,000 tons, with a distribution pattern similar to that for the corresponding 1954 period, except that Norway and Sweden appear among the importing countries and Japan and Switzerland are missing.[47]

U. S. S. R.—The quantity of manganese ore produced in the Soviet Union in 1954 is believed to have comprised almost half the world total, thus maintaining that country's position as the principal producer of manganese ore.

In the 12 months June 1953 to May 1954, 93,000 tons of manganese ore valued at £1,688,000 was imported into the United Kingdom from the Soviet Union. There were no British imports of manganese ore from the Soviet Union in the previous 12 months.[48] A 2,000-ton shipment of manganese ore from the Soviet Union, arriving in France about the beginning of the year, was the first such shipment since the end of World War II.[49] This was followed by other shipments under terms of a Franco-Soviet trade agreement.[50] Under a protocol to the trade agreement between the U. S. S. R. and the Netherlands the former was to export 40,000 tons of manganese ore and 3,000 tons of manganese dioxide during the year.[51] The U. S. S. R. was reported to have entered into a barter agreement extending from July 1, 1954, to the end of 1955 for the exportation of 70,000 tons of manganese ore to Japan.[52] Belgium was reported to have accepted a Soviet offer to supply ferromanganese at $160 per ton.[53] The size of the transaction and the grade of the alloy are not mentioned. According to press reports, trade agreements were also made for shipping Soviet manganese ore to Belgium, Sweden, and Yugoslavia. Amtorg Trading Corp., the official Soviet buying agency in the United States, offered to trade manganese ore for American butter.

Yugoslavia.—All manganese ore mined in Yugoslavia in 1954, totaling 9,200 metric tons, came from two mines—Cerne Bojsa near Kicevo and Cevljanici in Bosnia. The average grade was 23 percent Mn. The 10,000 tons produced in 1953 averaged 29 percent Mn, and the 13,000 tons mined in 1952 averaged 27 percent Mn. With expansion of the country's iron and steel industry, domestic requirements for manganese have mounted steadily, and there has been an intensive search for domestic sources of supply. Prospecting near Cerkne in Slovenia disclosed some ore containing as much as 24 to 30 percent manganese. New deposits of doubtful commercial value have also been found in Macedonia. According to a Zagreb press report, a pilot plant was constructed in September 1954 at the Zletovo mine to test the economic feasibility of extracting manganese from the Zletovo and Trepca lead-mine tailings, said to contain about 5 percent manganese.[54]

[47] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 4, October 1954, p. 36.
[48] United States Embassy, State Department Dispatch 4115: London, England, June 23, 1954, p. 1.
[49] Metal Industry (London), vol. 84, No. 2, Jan. 8, 1954, p. 36.
[50] Mining World, vol. 16, No. 3, March 1954, p. 75.
[51] Metal Bulletin (London), No. 3896, May 25, 1954, p. 28.
[52] Metal Bulletin (London), No. 3905, June 29, 1954, p. 25.
[53] American Metal Market, vol. 61, No. 152, Aug. 10, 1954, p. 1.
[54] United States Embassy, State Department Dispatch 218: Belgrade, Yugoslavia, Nov. 22, 1955, p. 19. Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 1, July 1954, p. 13.

Mercury

By Helena M. Meyer[1] and Gertrude N. Greenspoon[2]

SHORTAGE of mercury for sale in quantity lots during most of 1954 caused the price to rise to unprecedented heights; daily, monthly, and annual averages established new peaks. The 1954 price was 37 percent higher than in 1953 and 26 above the previous top in 1951. It is noteworthy, however, that if all prices are adjusted, using the Bureau of Labor Statistics index (1947–49=100), the average price of the 1950's was more than $100 a flask below that of 1940–42.

The year 1954 was characterized also by a continued uptrend in domestic production, by sharply reduced imports particularly in the final quarter of the year, by curtailed industrial consumption, and by reduced inventories.

Total supplies of mercury in 1954, although smaller than in 1953, were more than twice as large as industrial consumption. Nonetheless, consumers frequently had difficulty in obtaining metal, and stocks, as has been indicated, declined. United States Government purchases were a factor in the stringent spot-supply situation.

The United States Government took several actions aimed at strengthening the current and future supply situation in the United States. Mercury, which had been removed from the list of strategic commodities entitled to receive Defense Minerals Exploration Administration assistance, was reinstated on the list in March 1954. The Bureau of Foreign Commerce placed export restrictions on mercury effective June 5. Exports to all destinations except Canada were to require licenses. In July the General Services Administration announced a 3-year guaranteed-price program for mercury. The announcement stated that it was designed to "broaden the mobilization base of the metal and increase its supply for defense and industrial purposes." The program called for buying, at $225 a flask, a maximum of 125,000 flasks of domestic mercury and 75,000 flasks of Mexican metal but was scheduled to end on December 31, 1957, even if such quantities had not been obtained. The $225 price for Mexican metal included the tariff of $19. Also, the program provided for possible contracts with foreign producers, particularly those in Canada. No mercury was currently being produced in Canada, so any such contracts would involve reopening closed mines or opening new ones. Under the Internal Revenue Code of 1954 the percentage depletion for mercury, among other minerals, was raised from 15 percent to 23 percent.

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TABLE 1.—Salient statistics of the mercury industry in the United States, 1945–49 (average) and 1950–54

(Flasks of 76 pounds)

	1945–49 (average)	1950	1951	1952	1953	1954
Production	20,735	4,535	7,293	12,547	14,337	18,543
Number of producing mines	40	16	47	39	[1] 49	71
Average price per flask: New York	$94.56	$81.26	$210.13	$199.10	$193.03	$264.39
Imports for consumption	46,122	56,080	47,860	71,855	83,393	64,957
Exports	786	447	241	400	546	890
Consumption	43,134	49,215	56,848	42,556	52,259	42,796

[1] Revised.

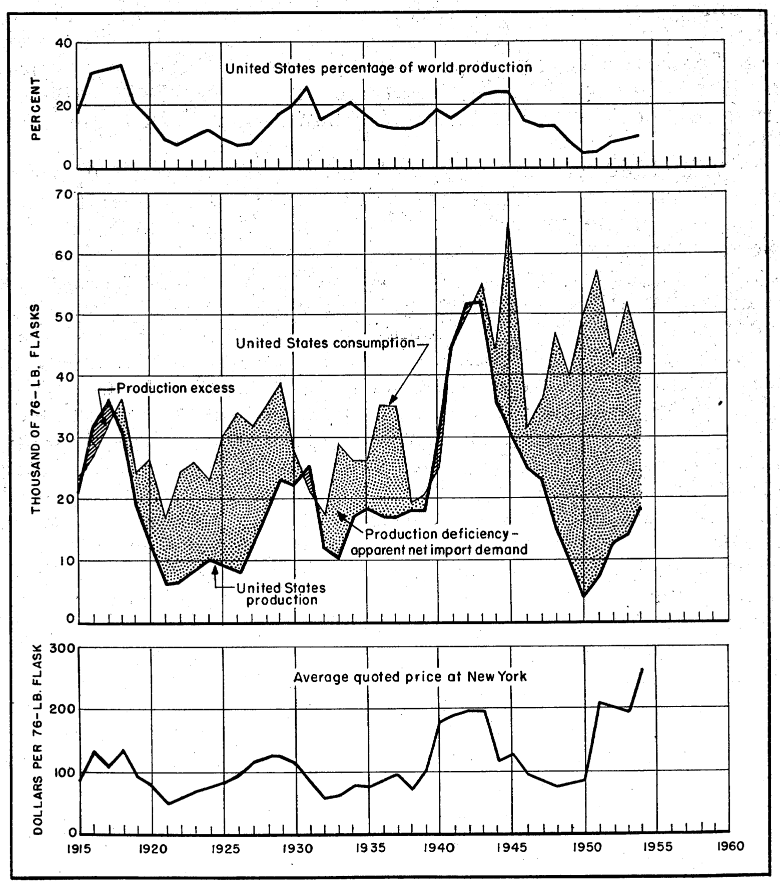

FIGURE 1.—Trends in production, consumption, and price of mercury, 1915–54.

Output of mercury in the United States responded slowly to the stimulation of high prices and Government assurances as to a floor price; the guaranteed price was substantially below the market price. In 1954 production was 29 percent above 1953, but the total was far below those for 1940–47, inclusive, for 1929–31 and for many years prior to 1920. California was the leading producer, followed by Nevada, Alaska, Idaho, Oregon, and Arizona. The Red Devil mine, Alaska, became one of the 11 principal mercury-producing mines in 1954, having resumed production in 1952 following idleness since 1946. The 11 principal mines produced 95 percent of the United States total.

Total imports of mercury (general) dropped 24 percent from 1953, but continued above all but 3 earlier years. Receipts in 1954 were again chiefly from Spain and Italy, with important quantities from Mexico and Yugoslavia.

Exports and reexports of mercury, although substantially above 1953, continued negligible in relation to imports.

World production rose in 1954 but not as much as was to be expected under prevailing prices. Spanish output merely matched the rate for 1953 despite expanded capacity, Yugoslavia was likewise unchanged, and Italy gained only 6 percent; chief percentage increases of 60, 29, and 27, respectively, were in Japan, the United States, and Mexico.

Other governments also took action in regard to mercury in 1954. In the United Kingdom and Mexico mercury exports were to require licenses effective October 20 and December 15, respectively. Canadian exports to all destinations except the United States were made subject to licensing as of September 1. The Italian Government imposed a manufacturing tax of 32,000 lire ($51.20) per flask, and 800 lire ($1.28) per kilogram on quicksilver ore contained in crude form.

Differences between Spanish and Italian producers over sale, outside of the old cartel, of Italian mercury to the United States Government in 1949 were reported to have been settled in 1954. However, there was no report of the revival of Mercurio Europeo, the Italian-Spanish cartel.

Defense Minerals Exploration Administration.—The chapters on Mercury in 1952 and 1953 listed DMEA mercury-exploration contracts to the end of 1953. The assistance advanced amounted to 75 percent of costs for approved mercury-exploration projects. In 1954 a contract was awarded to the following applicant:

State and contractor:	*Project location*	*Value* — *Total*	*Value* — *Government participation*
Oregon: John McManmon	Crook County	$9,433	$7,075

Under the DMEA program assistance for exploration of mercury properties was granted again in 1954, reserves of mercury-bearing ores were increased under contracts granted in earlier years, and the Government was repaid for part of the money expended.

DOMESTIC PRODUCTION [3]

Mine production of 18,500 flasks of mercury in 1954 was 29 percent above 1953 and the largest since 1947. Stimulation from high prices in effect since mid-1950, therefore, merely returned the domestic

[3] Production data for 1954 were collected jointly with the Bureau of the Census (U. S. Department of Commerce). Production totals will be compared with the Census totals when they are available and differences adjusted or explained.

mining industry to the levels that prevailed before World War II. After the outbreak of that war, on the other hand, production rose to 52,000 flasks in 1943—the highest rate since 1882. Of the principal mercury-producing States, output in Alaska, California, and Nevada increased over 1953, whereas that in Idaho and Oregon was less.

California remained the largest mercury-producing State and supplied 61 percent of the total; Nevada continued to rank second and contributed 27 percent. Alaska displaced Idaho, in third place since 1952, and Oregon ranked fifth. Arizona produced for the first time since 1951. Texas produced a small quantity in 1953 but none in 1954.

TABLE 2.—Mercury produced in the United States, 1951–54, by States

Year and State	Producing mines	Flasks of 76 pounds	Value [1]
1951:			
Arizona and Texas	3	77	$16,180
California	27	4,282	899,777
Idaho	1	357	75,016
Nevada	12	1,400	294,182
Oregon	4	1,177	247,323
Total	47	7,293	1,532,478
1952:			
Alaska	1	28	5,575
California	24	7,241	1,441,683
Idaho	1	887	176,602
Nevada	9	3,523	701,429
Oregon	4	868	172,819
Total	39	12,547	2,498,108
1953:			
Alaska	2	40	$7,721
California	28	9,290	1,793,249
Idaho and Texas	2	1,105	213,298
Nevada	[2] 12	3,254	628,120
Oregon	5	648	125,083
Total	[2] 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

[1] Value calculated at average price at New York.
[2] Revised.

The number of mines that contributed to the production in 1954 (71) was the largest since 1944. Eleven of the mines that produced in 1954 supplied 95 percent of the total production; each produced 100 flasks or more. The leading producers were as follows:

Alaska.—Red Devil.

Arizona.—Gila County, Ord.

California.—Lake County, Abbott; San Benito County, New Idria (including San Carlos); San Luis Obispo County, La Libertad; Santa Clara County, Guadalupe; Sonoma County, Buckman Group, and Mount Jackson (including Great Eastern).

Idaho.—Valley County, Hermes.

Nevada.—Humboldt County, Cordero.

Oregon.—Douglas County, Bonanza.

Details of mine production are in the geographic area chapters in Minerals Yearbook, volume III.

The grade of mercury ore treated in the United States increased 0.3 pound per ton in 1954, a movement contrary to the normal tendency for ore grades to decrease on rising prices; the price rose 37 percent in 1954.

TABLE 3.—Mercury produced in the United States, 1910–54, 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

[1] Includes States shown as "(2)".
[2] Included with "Other." Bureau of Mines not at liberty to publish separately.

TABLE 4.—Mercury produced in the United States, 1945–49 (average) and 1950–54, by quarters, in flasks of 76 pounds

Quarter	1945–49 (average)	1950	1951	1952	1953	1954
First	5,318	1,700	880	3,050	3,530	4,170
Second	5,412	1,010	1,400	3,000	3,790	4,700
Third	} 9,866	{ 1,100	1,600	3,320	3,040	5,160
Fourth		630	3,270	3,130	3,970	4,470
Total: Preliminary	20,596	4,440	7,150	12,500	14,330	18,500
Final	20,735	4,535	7,293	12,547	14,337	18,543

TABLE 5.—Mercury ore treated and mercury produced in the United States, 1927–54 [1]

(Until 1954 excludes some material from old dumps)

Year	Ore treated (short tons)	Mercury produced		Year	Ore treated (short tons)	Mercury produced	
		Flasks of 76 pounds	Pounds per ton of ore			Flasks of 76 pounds	Pounds per ton of ore
1927	99,969	10,711	8.1	1941	652,141	43,873	5.1
1928	142,131	14,841	7.9	1942	733,360	49,066	5.1
1929	248,314	19,461	6.0	1943	613,111	50,761	6.3
1930	288,503	18,719	4.9	1944	300,385	37,333	9.4
1931	260,471	22,625	6.6	1945	209,009	29,754	10.8
1932	108,118	11,770	8.3	1946	157,469	24,929	12.0
1933	78,089	8,381	8.2	1947	139,311	22,823	12.5
1934	126,931	13,778	8.2	1948	103,220	13,891	10.2
1935	135,100	15,280	8.6	1949	71,977	9,745	10.3
1936	141,962	14,007	7.5	1950	35,115	4,312	9.3
1937	186,578	16,316	6.6	1951	81,067	6,934	6.5
1938	199,954	17,816	6.8	1952	135,197	12,500	7.0
1939	191,892	18,505	7.3	1953	138,090	14,262	7.8
1940	449,940	37,264	6.3	1954	174,083	18,524	8.1

[1] Excludes mercury produced from placer operations and from clean-up activity at furnaces and other plants.

Before 1954 Bureau of Mines statistics on secondary mercury excluded metal reclaimed from scrapped and dismantled plants and other scrap if such metal could be identified and excluded also from consumption figures. The 1954 data for production from scrap include all secondary mercury, and consumption figures likewise are all inclusive. Production of secondary mercury is given in table 6.

TABLE 6.—Production of secondary mercury [1] in the United States, 1950–54, in flasks of 76 pounds

Year:	*Flasks of 76 pounds*
1950	2,000
1951	2,000
1952	2,500
1953	2,800
1954	6,100

[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

The consumption of mercury in industrial uses in 1954 was 18 percent below 1953 and except for 1952, the smallest since 1949, despite the fact that data for 1954 included, insofar as possible, all metal produced from scrap; data for earlier years included only metal that could not be separately identified as having been recovered from scrap. The decline in consumption resulted chiefly from the fact that for the first time in several years no new industrial installations using mercury, such as chlorine and caustic soda plants and mercury power boilers, were put into operation.

TABLE 7.—Mercury consumed [1] in the United States, 1945–49 (average) and 1950–54, by quarters, in flasks of 76 pounds

Quarter	1945–49 (average)	1950	1951	1952	1953	1954 [1]
First	10,520	10,600	16,000	10,100	12,700	11,500
Second	12,960	11,300	11,600	9,500	13,200	11,300
Third	9,500	12,400	7,400	13,200	11,000	9,000
Fourth	10,120	15,300	21,600	10,200	15,500	9,500
Total: Preliminary	43,100	49,600	56,600	43,000	52,400	41,300
Final	43,134	49,215	56,848	42,556	52,259	42,796

[1] Until 1954 included only such small quantities of secondary metal as were not separately identifiable.

TABLE 8.—Mercury consumed [1] in the United States, 1945–49 (average) and 1950–54, in flasks of 76 pounds

Use	1945–49 (average)	1950	1951	1952	1953	1954 [1]
Pharmaceuticals	5,026	5,996	2,761	1,395	1,858	1,846
Dental preparations	882	[2] 1,458	[2] 803	[2] 1,027	[2] 1,117	[2] 1,409
Fulminate for munitions and blasting caps	582	289	494	337	39	106
Agriculture (includes insecticides, fungicides, and bactericides for industrial purposes)	4,666	4,504	7,737	5,886	6,936	7,651
Antifouling paint	1,219	3,133	2,500	1,178	655	512
Electrolytic preparation of chlorine and caustic soda	680	1,309	1,543	2,507	2,380	2,137
Catalysts	3,564	2,743	2,635	1,048	826	594
Electrical apparatus	9,783	[2] 12,049	[2] 10,250	[2] 8,018	[2] 9,630	[2] 10,833
Industrial and control instruments	4,890	[2] 5,385	[2] 6,158	[2] 6,412	[2] 5,546	[2] 5,185
Amalgamation	150	192	154	151	200	203
General laboratory	345	646	524	629	1,241	1,129
Redistilled	6,623	[2] 7,600	[2] 8,776	[2] 7,547	[2] 7,784	[2] 9,281
Other	4,724	3,911	12,513	6,421	14,047	1,910
Total	43,134	49,215	56,848	42,556	52,259	42,796

[1] Until 1954 included only such small quantities of secondary metal as were not separately identifiable.
[2] A partial breakdown of the "redistilled" classification showed ranges of 53 to 28 percent for instruments, 22 to 5 percent for dental preparations, and 53 to 10 percent for electrical apparatus in the period 1945–53, compared with 43 percent for instruments, 10 percent for dental preparations, and 35 percent for electrical apparatus in 1954.

Other applications that required less mercury in 1954 than in 1953 were as follows: Catalysts and antifouling paint, 28 and 22 percent, respectively; losses in the operation of chlorine and caustic soda plants, 10 percent; and industrial and control instruments, 7 percent.

On the other hand, consumption of mercury in dental preparations increased 26 percent over 1953, the electrical use took 12 percent more, and agricultural uses (including insecticides, fungicides, and bactericides for industrial purposes) rose 10 percent.

STOCKS

Consumers' and dealers' inventories of mercury declined 14 percent in 1954 and were the smallest since 1949. A large part of the metal in industry's hands continued to be held at another large chlorine plant completed in 1952 but not put into operation by the end of 1954. Except for such metal, inventories were well below those normally held by industry.

Of the total metal in stock, the small part held by producers dropped substantially in 1954 and amounted to only 1 percent of total industry inventories.

In addition to the metal shown in table 9, noteworthy quantities of mercury are held in the National Strategic Stockpile, but data on such quantities may not be disclosed.

TABLE 9.—Stocks of mercury in hands of producers and of consumers and dealers, 1950–54, in flasks of 76 pounds

End of year	Producers	Consumers and dealers	Total
1950	2,719	32,900	35,619
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

PRICES

Mercury quotations established new alltime average daily, monthly, and annual peaks in 1954. The average annual price was 37 percent more tban in 1953 and 26 percent higher than the previous peak in 1951. Shortage of mercury for sale in quantity lots during most of the year caused the uptrend in prices. At the beginning of the year quotations ranged from $187 to $189 a flask; they rose without interruption to $325 to $330 a flask in early November. Thereafter, the price weakened to $318 to $320 by mid-December but rose in the final weeks to end the year at $322–$324. Weekly price changes are give in table 11.

The program of the United States Government to purchase mercury at guaranteed prices, below the current market, was described in the opening section of this report.

TABLE 10.—Average monthly prices per flask (76 pounds) of mercury at New York and London, and excess of New York price over London price, 1952–54

Month	1952			1953			1954		
	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	$206.35	$205.14	$1.21	$212.96	$199.01	$13.95	$187.36	$175.19	$12.17
February	202.00	205.11	[3] 3.11	205.09	199.44	5.65	188.00	180.38	7.62
March	207.00	206.26	.74	198.12	199.20	[3] 1.08	200.44	193.25	7.19
April	203.77	206.03	[3] 2.26	195.89	199.27	[3] 3.38	220.23	222.63	[3] 2.40
May	199.62	204.59	[3] 4.97	195.00	198.87	[3] 3.87	248.80	244.86	3.94
June	195.24	203.28	[3] 8.04	191.92	198.07	[3] 6.15	275.00	258.57	16.43
July	189.81	181.79	8.02	190.46	198.20	[3] 7.74	286.92	279.65	7.27
August	187.00	180.90	6.10	188.31	198.18	[3] 9.87	290.00	281.29	8.71
September	190.68	179.48	11.20	185.20	193.15	[3] 7.95	311.00	289.88	21.12
October	191.00	180.15	10.85	183.42	178.31	5.11	325.00	304.20	20.80
November	201.82	189.36	12.46	184.09	173.57	10.52	320.33	307.74	12.59
December	214.89	198.52	16.37	185.92	173.54	12.38	319.54	306.61	12.93
Average	199.10	194.89	4.21	193.03	192.49	.54	264.39	255.33	9.06

[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 11.—Weekly prices per flask (76 pounds) of mercury at New York, in 1954 [1]

Week ended—	Price range	Week ended—	Price range
Jan. 6	$187-$189	July 7	$280-$285
13	187- 189	14	285- 290
20	187- 189	21	290- 293
27	188- 190	28	290- 293
Feb. 3	188- 190	Aug. 4	290- 293
10	188- 190	11	290- 293
17	188- 190	18	290- 293
24	188- 190	25	290- 293
Mar. 3	190- 192	Sept. 1	290- 295
10	198- 200	8	298- 303
17	202- 204	15	300- 305
24	202- 204	22	320- 325
31	205- 207	29	325- 328
Apr. 7	210- 212	Oct. 6	325- 330
14	212- 215	13	325- 330
21	222- 225	20	325- 330
28	232- 235	27	325- 330
May 5	235- 238	Nov. 3	325- 330
12	240- 245	10	323- 330
19	250- 255	17	320- 325
26	260- 265	24	318- 322
June 2	260- 265	Dec. 1	318- 322
9	275- 280	8	318- 320
16	275- 280	15	318- 320
23	275- 280	22	320- 322
30	280- 285	29	322- 324

[1] E&MJ Metal and Mineral Markets.

Mercury prices also established new peaks in London. The quotation was £61 15s. (equivalent to $172.90) in early January and after considerable fluctuation was £100 (equivalent to $280.00) by mid-July, where it remained until early September. After several increases in that month, the price settled at £110 (equivalent to $308.00) about the middle of October and continued at that level for the remainder of the year, except for a week in November when it was quoted at a range of £110–£111. The average annual price in London in terms of dollars was 33 percent more than in 1953 but was 9 percent below the 1943–44 averages, when the control maximum price was in effect.

FOREIGN TRADE [4]

In 1954 imports of mercury for consumption were 65,000 flasks, or 22 percent less than the quantity that entered the country in 1953. Of the total receipts, more than 61,000 flasks was received in the first 9 months of the year; imports of less than 4,000 in the final quarter of the year were the smallest since the last quarter of 1947.

Tariff.—A duty of 25 cents a pound ($19 a flask) on imports of mercury has been in effect since 1922.

Exports of mercury, a relatively small quantity class, rose 63 percent in 1954 but continued to be negligible in relation to total imports.

Reexports also are regularly very small; they rose 57 percent in 1954 and were larger than exports. Reexports were the largest since 1947 but were equivalent to only 2 percent of imports for consumption.

Imports.—Of the total imports for consumption of 65,000 flasks in 1954 (83,400 in 1953), 29,900 (28,100) came from Spain, 22,200 (36,100) from Italy, 8,900 (13,300) from Mexico, 3,900 (5,600) from Yugoslavia; the remainder—100 (300)—came from countries that are not now producing mercury or are normally not mercury producers and must represent reshipped metal.

TABLE 12.—Mercury imported (general imports) into the United States, in 1954, by months

[U. S. Department of Commerce]

Month	Flasks of 76 pounds	Month	Flasks of 76 pounds
January	6,030	August	7,319
February	16,391	September	4,284
March	977	October	1,194
April	9,428	November	2,179
May	5,652	December	576
June	5,602		
July	5,685	Total	65,317

General imports (imports for immediate consumption plus entries into bonded warehouses) afford a better measure of material actually entering the country during a calender period than imports for consumption (imports for immediate consumption plus withdrawals from bonded warehouses for consumption).

Imports of various mercury compounds, relatively insignificant, are no longer separately classified. Of the combined total of 34,900 pounds of mercuric chloride, mercurous chloride, oxide (red precipi-

[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, 1945–49 (average) and 1950–54, in flasks of 76 pounds

[U. S. Department of Commerce]

Country	1945–49 (average)		1950		1951		1952		1953		1954	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
North America:												
Canada	355	$48,057	107	$9,407	660	$125,906	20	$7,398	171	$33,217	115	$31,221
Honduras	5	724			10	2,140						
Mexico	4,915	429,425	3,480	180,418	5,109	843,523	7,941	1,302,837	13,298	2,079,096	8,887	1,729,601
Total	5,275	478,206	3,587	189,825	5,779	971,569	7,961	1,310,235	13,469	2,112,313	9,002	1,760,822
South America:												
Bolivia					19	1,744						
Chile	223	20,295										
Peru	31	3,914							6	875		
Total	254	24,209			19	1,744			6	875		
Europe:												
Czechoslovakia	40	1,984										
Denmark			300	20,103								
Germany					250	39,904						
Italy	19,356	1,308,351	14,974	738,217	21,868	2,875,681	26,276	5,033,235	36,120	5,938,004	22,180	3,393,759
Netherlands			575	32,289	350	21,700	100	18,979	50	8,959		
Spain	18,133	1,833,902	28,462	1,265,719	11,954	1,573,982	27,102	4,404,675	28,049	4,549,115	29,884	4,875,352
Sweden			1,061	64,441	680	107,370						
Switzerland					204	23,450						
United Kingdom			800	49,600	47	3,285	1	261	(1)	36		
Yugoslavia	1,166	59,462	5,528	298,856	6,459	952,924	10,365	1,771,052	5,649	951,008	3,891	753,724
Total	38,695	3,203,699	51,700	2,469,225	41,812	5,598,296	63,844	11,228,202	69,868	11,447,122	55,955	9,022,835
Asia:												
India									25	3,666		
Japan	1,898	114,026	793	35,222	250	14,980			25	4,600		
Total	1,898	114,026	793	35,222	250	14,980			50	8,266		
Africa: French Morocco							50	8,250				
Grand total	46,122	3,820,140	56,080	2,694,272	47,860	6,586,589	71,855	12,546,687	83,393	13,568,576	[2] 64,957	[2] 10,783,657

[1] Less than 1 flask.
[2] Due to changes in tabulating procedures by the U. S. Department of Commerce data known not to be comparable to earlier years; the differences are minor.

tate), and other mercury preparations imported in 1954, 21,900 came from Canada, 7,200 from the United Kingdom, 3,800 from Spain, and 2,000 from India; 100 pounds of vermillion reds was imported from Italy.

TABLE 14.—Mercury imported (general imports) into the United States, 1945–49 (average) and 1950–54, in flasks of 76 pounds

[U. S. Department of Commerce]

Country	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Canada	360	107	660	20	171	115
Honduras	5		10			
Mexico	5,829	3,986	4,989	7,971	13,637	9,374
Total	6,194	4,093	5,659	7,991	13,808	9,489
South America:						
Bolivia			19			
Chile	284					
Peru	37				6	
Total	321		19		6	
Europe:						
Denmark		300				
Germany			250			
Italy	20,284	18,073	17,633	26,025	37,827	21,858
Netherlands		825		100	50	
Spain	18,561	29,439	13,707	24,333	28,303	29,859
Sweden	15	1,061	680			
Switzerland			204			
Turkey						54
United Kingdom	10		(1)	1	(1)	
Yugoslavia	1,389	5,980	6,525	10,186	5,765	4,057
Total	40,259	55,678	38,999	60,645	71,945	55,828
Asia: Japan	1,926	793	250		25	
Africa: French Morocco				50		
Grand total	48,700	60,564	44,927	68,686	85,784	65,317

[1] Less than 1 flask.

Exports.—Exports were 890 flasks in 1954 (546 in 1953). Of the total, 651 (147) flasks went to Brazil, 100 (210) to Canada, 51 (21) to Venezuela, 24 (1) to Belgian Congo, and the remainder in lots of less than 20 flasks to 12 other countries.

TABLE 15.—Mercury exported from the United States, 1945–49 (average) and 1950–54

[U. S. Department of Commerce]

Year	Pounds	Flasks of 76 pounds	Value	Year	Pounds	Flasks of 76 pounds	Value
1945–49 (average)	59,766	786	$84,644	1952	30,369	400	$85,974
1950	33,977	447	37,985	1953	41,497	546	105,975
1951	18,311	241	57,502	1954	67,628	890	183,417

Of the reexports of 1,436 flasks (916 in 1953), 1,057 (285) went to Canada, 145 (26) to Korea, 115 (29) to Brazil, 96 (307) to Japan, 10 (none) to the United Kingdom, 8 (4) to Venezuela, and 5 (18) to Cuba.

TABLE 16.—Mercury reexported from the United States, 1945–49 (average) and 1950–54

[U. S. Department of Commerce]

Year	Pounds	Flasks of 76 pounds	Value	Year	Pounds	Flasks of 76 pounds	Value
1945–49 (average)	135,182	1,779	$130,818	1952	19,689	259	$46,721
1950	67,311	886	63,839	1953	69,640	916	157,880
1951	51,326	675	111,274	1954	109,147	1,436	257,342

TECHNOLOGY

During the year the Geological Survey published Bulletin 1019–A, A Selected Bibliography on Quicksilver, 1811–1953, by M. J. Ebner, 62 pp.

The new plant at the Almaden mine, Spain, completed in 1953, was described.[5] It had a guaranteed rating of 225 tons of ore a day and a recovery efficiency of at least 95 percent. The plant was prefabricated in the San Francisco shops of Pacific Foundry Co., Ltd. According to Rankin, the furnace, condenser, duct-work, and ore-handling conveyors, elevators, and bins were prefabricated, and only such items as the crushers, fans, and dust collectors, purchased from other manufacturers, were not included. He said that prefabrication permitted erection of the plant at Almaden (which is remote from industrial centers of Spain and thus from location of heavy equipment—cranes, bulldozers, etc.) in 7 months with a minimum of erection equipment; in the United States it would have taken 5 months. The erecting was done by workmen and laborers native to Almaden. The ore is crushed to minus-1-inch. The two 18-foot-outside-diameter, 8-hearth furnaces installed were completely encased in a steel shell and provided with permanent gas seals; the furnaces were tight, assuring the control of excess air so important to an efficient mercury furnace. Each furnace was said to be equipped with quality refractories, and the furnace shaft, arms, and teeth were made of special heat-resisting alloys. Adequate insulation effectively reduced heat losses. The furnaces were oil fired. Maximum ore temperature of about 1,350° F. was reached on hearth 6 with hearths 7 and 8 used as soaking hearths. The mercury-free roasted ore was discharged into a sealed and brick-lined receiving bin, where it was soaked for about an hour, releasing much of its heat back into the furnace. The combustion gases containing the mercury vapor passed from the furnaces into the condenser systems where the mercury was recovered. Because of the richness of the Almaden ore, the condenser systems were oversize as compared with standard United States practice. Each condenser consisted of 99 vertical 12-inch-diameter pipes 18 feet long, divided into 3 banks and connected at top and bottom with cast-iron return bends and hoppers. The flow of gas through 1 condenser bank could be diverted into the other 2 momentarily, thus facilitating cleaning or washing of the condensers without shutting the furnaces. Thirteen inclined manifolds

[5] The Chemist and Druggist, Quicksilver: Ann. Spec. Issue, vol. 161, No. 3879, June 26, 1954, pp. 698–701. Rankin, C. S., Mercury—New Prefabricated Plant at Almaden Adds to World Metal Supply: Min. World, vol. 17, No. 7, June 1955, pp. 50–54.

discharged the condensates into the launder under a water seal. Traps at the water seal caught the free mercury, and the condenser mud was hoed to free additional metal. About 70 percent of the mercury was recovered from the condensers as free mercury. Rankin said that experience showed that a temperature of 1,375° F. should be maintained on hearth 6 with the gas exiting from the furnace at 630° F.

According to the annual report of General Dry Batteries, Inc., to stockholders, mercury cells are being used for such diverse equipment as Geiger counters, portable radios, portable two-way communications equipment, electronic measuring devices, digital computers, guided missiles, and hearing aids.

A new mercury switch, the November–December 1954 General Electric News Digest reported, had a tiny neon light in the handle that glows when the switch is turned off.

The Bureau of Mines statistics on consumption of mercury for agricultural purposes include metal used to make compounds, such as phenyl mercuric acetate, employed by the paper and pulp industry for slime control; the statistics cannot be shown separately. According to the Department of Agriculture,[6] not much change is believed to have taken place in the volume of mercury compounds used in seed treatment since 1951. Small quantities of organic mercurials are also used, the report stated, in weed control, fungicidal fruit-tree sprays, mildew proofing, and other ways.

Organic mercurials were found,[7] as a result of a survey, to be used in treating about 58 percent of the seeds of wheat, oats, and barley sown in Alberta, Canada.

The frozen-mercury casting process was recently described.[8] Liquid mercury is poured into a steel die which is then immersed in a freezing bath. The die is opened and the solid form removed. If exceptionally complex parts are to be produced they may be formed as separate frozen-mercury patterns, then joined under only the slightest pressure. The finished unit, formed into a seamless, one-piece pattern, utilizes as many individual sections as necessary to form the desired part. The finished pattern is then dipped into baths of ceramic slurry which use a nonaqueous solvent. When the resultant hardened shell has attained the thickness of approximately one-eighth inch, the mercury is allowed to melt out at room temperature. The shell mold is strengthened by firing at about 1,850° F. for 2 hours. Molten metal as required is poured into the ceramic molds, and, after sufficient cooling, the shell is broken away, leaving the finished part. Sometimes sand blasting or other standard means are utilized to clean the part. When the article was written steel castings having a diameter of 42 inches and weighing 300 pounds had been produced, but that was said to be by no means the practical limit of the process. A slight loss of mercury is occasioned by spillage or small quantities retained in the ceramic molds which are later vaporized in the firing treatment.

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[6] U. S. Dept. of Agriculture, Commodity Stabilization Service, The Pesticide Situation for 1954-55, April 1955, p. 10.

[7] Henry, Dr. A. W. A., Chemical Seed Treatment for Canada's Major Grain Crops: Canadian Chem. Proc., vol. 38, No. 4, April 1954, p. 64.

[8] American Metal Market, Frozen-Mercury Casting Process Outlined by Kramer: Vol. 61, No. 185, Sept. 25, 1954, pp. 1, 5.

A study was conducted [9] recently for the purpose of demonstrating more exactly the pH range suitable for the mercury-cell process for electrolytic production of chlorine and caustic soda.

Current information on theory, experiment, and experience in heat transfer to liquid metals was published [10] in 1952. Unexplained differences between experiment and theory, particularly for mercury and molten lead-bismuth, however, were revealed. Two later articles [11] bearing on the subject were published in May. Both articles contain bibliographies.

Modern mercury lamps combine the compactness and high wattage possibilities of incandescent lamps with the efficiency and long life of fluorescent lamps, according to Buttolph.[12] They are adaptable to far higher voltage supply lines than are used with incandescent lamps. This combination of characteristics, he said, makes mercury lamps of unique value in high bay industrial and street lighting and floodlighting applications where high mounting permits high wattage units, where replacement labor can be minimized by a small number of units, and where exact duplication of either daylight or incandescent color rendition may be unimportant.

Because of greater efficiency and more lumens per watt output, mercury vapor lamps are rapidly replacing other types of indoor and outdoor lighting, according to an article [13] recently published.

Advantages of mercury-type lighting were discussed in other articles [14] that appeared recently.

A eutectic mixture of mercury and thallium can be used for temperature measurement below the freezing point of mercury, a recent report pointed out.[15] Calibration is not affected by long or repeated use or by sudden transition in temperature, it was said.

The streaming mercury electrode has been used extensively in recent years as a substitute for the dropping electrode in certain forms of polarography, according to a recent article [16] that discussed results of measurements of the limiting steady-state current at the streaming electrode with particular reference to the effects of variable radius and surface velocity.

Organic mercury diuretics of the type now in general use were introduced in 1924, according to a recent article [17] which pointed out

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[9] Barr, Lars, The pH in Chlorine-Caustic Electrolysis by the Mercury Cell Process: Jour. Electrochem. Soc., vol. 101, No. 10, October 1954, pp. 497–506.

[10] Lyon, R. N., and others, Liquid Metals Handbook: Atomic Energy Com. and Bureau of Ships, Dept. of the Navy, June 1952, 269 pp.

[11] Johnson, H. A., Clabaugh, W. J., and Hartnett, J. P., Heat Transfer to Mercury in Turbulent Pipe Flow: Trans. ASME, vol. 76, No. 4, May 1954, pp. 505–511.
Johnson, H. A., Hartnett, J. P., and Clabaugh, W. J., Heat Transfer to Lead-Bismuth and Mercury in Laminar and Transition Pipe Flow: Trans. ASME, vol. 76, No. 4, May 1954, pp. 513–517.

[12] Buttolph, L. J., Characteristics of Mercury in Lamps: Illum. Eng., vol. 49, No. 7, July 1954, pp. 321–328.

[13] Gerber, H. L., Electrical Facts of Light: Elec. West, vol. 113, No. 3, September 1954, pp. 86–89.

[14] Electric Journal, Approaching Sunlight: Vol. 151, No. 23, Dec. 4, 1953, pp. 1853–1854.
Van Lint, Victor, J., Corona Makes Light Work Light Work: Elec. World, vol. 141, No. 1, Jan. 4, 1954, pp. 42–43.
Martin, Thos., Houston, The New City of Light: Pub. Works, vol. 85, No. 4, April 1954, pp. 81–82.
Shaw, J. Homer, Parking-Lot Lighting Boosts Offpeak Load: Elec. World, vol. 141, No. 16, Apr. 19, 1954, pp. 183–184.
Public Works, Mercury Vapor Lighting for a Heavily Traveled Thoroughfare: Vol. 85, No. 7, July 1954, pp. 76, 88.
Arthur, Guy Browing, Fluorescent Mercury-Vapor Lights in New Orleans: Pub. Works, vol. 85, No. 8, August 1954, pp. 81–82.

[15] Ehrenreich, Joseph, Mercury-Thallium Thermometers: Instruments and Automation, vol. 27, No. 7, July 1954, pp. 1070–1072.

[16] Weaver, J. R., and Parry, R. W., Reduction at the Streaming Mercury Electrode. I, The Limiting Current: Jour. Am. Chem. Soc., vol. 76, No. 24, Dec. 20, 1954, pp. 6258–6262.

[17] Werner, L. H., and Scholz, C. R., Mercurial Diuretics: Jour. Am. Chem. Soc., vol. 76. No. 9. May 5, 1954, pp. 2453–2459.

that, as a result of recent investigations, cardiac toxicity and also the irritation at the site of injection are reduced without loss of diuretic potency.

In a review of activities in the field of industrial hygiene it was pointed out [18] that, "The present accepted threshhold limit for mercury in the air of workplaces is 1 mg. per 10 m.^{3}, is based on extensive studies made a number of years ago in the felt-hat industry." Recent laboratory studies in which animals were exposed to mercury vapor for long periods contributed significantly, it was said, to knowledge of the absorption, distribution, and elimination of mercury from body tissues and fluids and confirmed earlier findings.

Industrial-hygiene control measures to assure safety in the handling of organic mercurials were discussed [19] in 1954.

A review of previous studies of kidney injury after exposure to mercury, with some new material, was included in a report [20] from Sweden. The authors conclude that:

> So long as the mechanism for the origin of kidney injury is not clearly understood, it is advisable that workers showing albuminuria should be given work in which they are not exposed to mercury.

WORLD REVIEW

More mercury was produced in the world in 1954 than in any other year since 1943; the quantity was higher than all earlier annual totals except in 1940–43, inclusive. The increase of 11 percent in 1954 as compared with 1953 resulted from almost identical quantity gains in the United States, Japan, Mexico, and Italy; production rates in Spain and Yugoslavia remained virtually unchanged.

Brazil.—Exports and reexports of mercury from the United States in 1954 included 651 and 115 flasks, respectively, shipped to Brazil. About 9,000 kilograms (261 flasks) was said [21] to be for a new chlorine and caustic soda installation using mercury cells and was shipped to the Industrias Quimicas Electro-Cloro S. A., of Santos. Several other caustic soda plants were said to be in prospect, with a possible requirement of 50,000 to 60,000 kilograms (1,450 to 1,740 flasks) of mercury.

Canada.—There has been no production of mercury in Canada since September 1944; shipments after then were from producers' stocks. The only known Canadian deposits of cinnabar are in the Omineca Mining Division of northern British Columbia. According to a recent report,[22] results of the marked rise in price of mercury in 1954 were staking activities and some exploratory work on occurrences of mercury in Pinchi Lake, Bridge River, and other areas in British Columbia. Bralorne Mines, Ltd., did limited diamond drilling on its Takla mine.

Canadian exports of mercury to all destinations except the United States were made subject to licensing effective September 1.

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[18] Schrenk, H. H., Industrial Hygiene: Ind. Eng. Chem., vol. 46, No. 2, February 1954, p. 101–A.

[19] Cadenhead, A. F. G., Organic Mercurials Can Be Safely Produced: Canadian Chem. Proc., vol. 38, No. 4, April 1954, p. 62.

[20] Friberg, Lars, Hammarström, Sven, and Nyström, Ake, Kidney Injury after Chronic Exposure to Inorganic Mercury: Am. Med. Assoc. Hygiene and Occupationa lMedicine, vol. 8, No. 2, August 1953, pp. 149–153.

[21] Kolinski, Charles J. (assistant attaché), Brazilian Mercury Requirements: State Dept. Dispatch 1539, Rio de Janeiro, Brazil, June 11, 1954, 3 pp.

[22] Department of Mines and Technical Surveys, Ottawa, Canada, Mercury in Canada: 1954 (prelim.), 2 pp.

TABLE 17.—World production of mercury, by countries,[1] 1945–49 (average) and 1950–54, in flasks of 34.5 kilograms (76 pounds) [2]

(Compiled by Pauline Roberts)

Country [1]	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Honduras	5	---	11	---	---	---
Mexico	9,568	3,757	8,064	8,732	11,643	14,755
United States	20,735	4,535	7,293	12,547	14,337	18,543
South America:						
Bolivia (exports)	1	---	19	---	---	---
Chile	671	314	114	173	100	(3)
Peru	43	---	---	---	---	77
Europe:						
Austria	(3)	38	26	15	22	27
Czechoslovakia	731	[4] 725	[4] 725	[4] 725	[4] 725	(3)
Italy	42,578	53,346	53,839	55,869	51,373	54,477
Spain	38,615	51,808	44,480	39,135	43,541	43,400
U. S. S. R. (estimate) [5]	10,150	11,600	11,600	11,600	12,300	(3)
Yugoslavia	9,236	14,368	14,649	14,620	14,272	14,446
Asia:						
China	777	[4] 1,450	[4] 4,000	[4] 4,000	[4] 5,000	(3)
Japan	2,041	1,312	1,847	3,083	6,406	10,269
Taiwan (Formosa)	11	---	---	---	---	44
Turkey	57	---	---	---	---	261
Africa:						
Algeria	303	---	---	---	---	---
Union of South Africa	323	---	---	---	---	---
Oceania:						
Australia	1	---	---	---	---	---
New Zealand	6	---	---	---	---	---
World total (estimate)	136,000	143,000	147,000	151,000	160,000	177,000

[1] Rumania and a few 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.
[3] Data not available; estimate by authors of chapter included in totals.
[4] Estimate.
[5] According to the 42d annual issue of Metal Statistics (Metallgesellschaft), except 1954.

TABLE 18.—Production of mercury in Italy, Mexico, United States, and Yugoslavia in 1954, by months, in flasks of 76 pounds [1]

Month	Italy	Mexico	United States	Yugoslavia
January	3,974	587		1,102
February	4,293	1,303	4,170	899
March	4,380	1,329		1,596
April	4,467	1,224		1,247
May	4,525	1,943	4,700	1,364
June	3,597	210		1,393
July	4,699	687		1,247
August	4,525	1,462	5,160	1,218
September	4,815	1,464		1,363
October	4,612	1,246	1,660	406
November	4,670	1,984	1,470	1,189
December	5,918	1,316	1,340	1,422
Total	54,475	14,755	[2] 18,543	14,446

[1] Sources: Bolletin mensile di Statistica, Italy; Boletin de Minas y Petroleo, Mexico; and Indeks, Yugoslavia.
[2] Quarterly and monthly data not adjusted to final figures.

Consumption of mercury was 2,816 flasks in 1954 compared with 2,788 in 1953.

Imports were 3,220 flasks in 1954, of which 2,115 was from the United States, 617 from Italy, and 483 from Mexico. A total of 83 flasks was exported to the United States.

India.—On March 10, 1954, the Indian export control authorities banned the export of mercury sulfide and other mercury salts. Such exports were not subject to the export duty which was levied on exports of mercury metal. An immediate result of the ban on exports of mercury salts was a precipitous fall in the price of mercury metal in the Bombay market.[23] It was announced [24] later that licenses would be freely granted for mercury chloride only.

Italy.—In all but 1 year—1947—since World War II Italy ranked first among mercury-producing nations of the world, despite the loss of one of its largest mercury mines, the Idria mine, to Yugoslavia as an outcome of the war. In 1950–54, inclusive, production ranged from 51,400 to 55,900 flasks and in 1954 was 54,500 flasks. Exports sharply exceeded production in 1950, fell considerably below in 1951 and 1952 and again were in excess in 1953 and 1954.

The United States, the United Kingdom, Germany, and France were the chief destinations in recent years, but India greatly surpassed other countries as a destination in 1950, and Poland and Czechoslovakia received noteworthy quantities in some years. According to Gordon I. Gould,[25] two new Gould rotary furnaces of 150 tons' capacity each were to be installed at the Monte Amiata mine in Italy in 1955, to augment current production from Pit and Cermak-Spirek furnaces. In November the Government imposed a tax of 32,000 lire (equivalent to $51.20) per flask and 800 lire ($1.28) per kilogram of ore. The taxes were payable at time of production or extraction and also applied to imports.[26] Trade sources were said to believe that the two large Italian quicksilver producers would absorb most if not all of the new taxes imposed on the metal.

TABLE 19.—Exports of mercury from Italy, by countries of destination, 1950–54 in flasks of 76 pounds [1]

(Compiled by John E. McDaniel)

Country	1950	1951	1952	1953	1954
Austria					470
Brazil	1,044	261			
Canada	1,711				400
Czechoslovakia	1,450		174	1,392	177
Finland					511
France	4,728	2,234	319	3,336	5,628
Germany	7,774	435	145	3,887	15,232
India and Pakistan	30,226	2,408			
Netherlands	3,104	203	348	493	818
Norway					145
Poland	1,653	2,176	580	2,814	749
Sweden					302
Switzerland					249
United Kingdom	8,122	2,901	3,713	8,499	16,207
United States	19,174	16,070	27,761	32,025	20,227
Other countries	3,310	812	725	2,698	803
Total	82,296	27,500	33,765	55,144	61,918

1 Compiled from Customs Returns of Italy.

Japan.—A report released [27] in 1947 stated that 20 mines in Japan produced a total of 1,167 tons (33,852 flasks) from 1925 to 1945 and that 70 percent of this total was from the Itomuka mine, in

23 Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 3, March 1954, p. 20.
24 Metal Bulletin (London), No. 3903, June 22, 1954, p. 24.
25 Gould, Gordon I., Letter to Bureau of Mines: December 1954.
26 Metal Industry, vol. 85, No. 23, Dec. 3, 1954, p. 476.
27 Supreme Commander for the Allied Powers (Natural Resources Section) Mercury Resources of Japan: Rept. 91, Sept. 10, 1947, 62 pp.

Hokkaido. In that period this mine operated only from 1939 to 1945 but produced 817 tons (23,700 flasks). From 1939 to 1953, according to a recent report,[28] the Itomuka mine produced 366,368 tons of ore, averaging 0.48 percent mercury. From this ore 1,431 tons (41,510 flasks) of mercury was recovered. The report stated that production was from opencut mining from 1939 through World War II, but thereafter the major tonnage was produced by underground mining. The mine was equipped with a 300-ton-daily-capacity concentrating plant completed in August 1944. The mined ore was rather high in native mercury, which was recovered by special equipment during crushing and classification. Over 90 percent of the native mercury was recovered in this way. One 6-hearth, 3-meter-diameter Herreshoff furnace was installed in 1940, and later one "Hitachi-type" furnace was added. Another Hitachi Herreshoff-type (6-hearth, 5-meter diameter) furnace was built in 1945, and the 2 Hitachi plants were in operation when the report was written. Lack of oil resulted in conversion of the plants to the use of coal as fuel.

Consumption of mercury, by uses, in Japan is shown in table 20.

TABLE 20.—Estimated consumption of mercury, by uses, in Japan, 1952–54, in flasks of 76 pounds

Use	1952	1953	1954
Fulminate	1,015	1,073	696
Antifouling paint	1,015	1,073	1,044
Chlorine and caustic soda:			
For new plant	1,305	754	2,828
For consumption	580	986	1,828
Organic synthetic industry	870	1,610	1,886
Inorganic chemicals	830	870	1,740
Industrial and control instruments	870	1,132	1,740
Pharmaceuticals and dental preparations	58	203	464
Agriculture	290	406	1,480
Other	102	87	348
Total	6,935	8,194	14,054

Mexico.—Under the stimulation of high prices, production in Mexico rose uninterruptedly from 3,800 flasks in 1950 to 14,800 in 1954. Exports, usually deviate little from production but owing to high demand and prices were in excess in the 5-year period; indicating stocks were reduced 4,000 flasks. Exports were 4,960 flasks in 1950, 6,904 in 1951, 7,860 in 1952, 12,474 in 1953, and 18,450 in 1954. In December Mexican authorities issued a decree requiring licensing of mercury exports. The General Services Administration of the United States included metal produced in Mexico in its 3-year mercury purchase program at guaranteed prices, beginning in July. The program was described in the opening section of this report.

Mercury mines in Mexico were listed in the December 1953 issue of Boletin de Minas y Petroleo, as follows:

(*a*) Isodoro Carrillo, Escalón 68, Escalón, Chihuahua.
(*a*) Nardonio Soria, Patoni 608 Nte., Durango, Durango.

[28] Yajima, Sumisaku, Mercury Mining in Japan and Outline of Itomuka Mine: Pamph., June 1954, 8 p.

(b) Nicolas Valdez, Sta. Maria del Oro, Durango.
(a) La Esperanza, S. C. L., Explotadora de Hierro, V. Carranza 25-406, Mexico, District Federal.
(b) Sonora Graphite Co., S. A., Apdo. 88, Guaymas, Sonora.
(b) Almada Zacatecano, Sain Alto, Zacatecas.
(b) Cía. Explotadora de Mercurio, S. A., Sain Alto, Zacatecas.
(a) Cía. Mexicana de Mercurio, S. A., Edif. Banco de Londres y Mexico, Mexico, District Federal.
(a) Mercurio Mexicano, S. A., Edif. América, Desp. 307, Apdo. 195, Torréon, Coahuila.
(a) Oro, Plata y Mercurio Compañia, S. A., Apdo. 497, Torréon, Coahuila.
(c) Cía. Minera Picacho de Lobeña, S. A., Real de Angeles, Zacatecas.
(b) Cía. Minera de Mercurio en Sain Alto, S. A., Morelos 18, Sain Alto, Zacatecas.

(a) Under exploitation; (b), under exploration; (c), idle.

Peru.—The Santa Barbara mine in the Department of Huancavelica, owned by the Fernandini interests, was reopened in 1954 and produced a small quantity of mercury following a period of idleness from the mid-1940's. Production averaged about 200 flasks annually in 1942-45; prior thereto the property had been idle many years. Mercury was discovered in Peru in 1570, and the Huancavelica district was the world's largest quicksilver-producing area for 1½ centuries. Altogether the mines have produced over 1,400,000 flasks, most of which came from the Santa Barbara mine. Production in the past 100 years has been very small.

Philippines.—The occurrence of cinnabar in a road cut in Tagburos Barrio, some 14 kilometers north of the city of Puerto Princesa on Palawan Island, was said to have been recognized in [29] 1937. Careful prospecting and stream panning in 1953, the article stated, located botryoidal cinnabar on outcrops. In general, the geology was said to resemble that of the California Coast Range. Exploration by test pitting, diamond drilling, and driving a series of short adits proved 90,000 tons of 8.5-pound ore, much of which was suited to open-pit mining. Plans were being made to purchase a furnace.

TABLE 21.—Exports of mercury from Spain, by countries of destination, 1950-54, in flasks of 76 pounds [1]

(Compiled by John E. McDaniel)

Country	1950	1951	1952	1953	1954
Argentina	1,410				
Belgium-Luxembourg	592	116	6	38	
Brazil		148	20	367	777
France	2,036	6,411	3,765	3,415	4,226
Germany	2,350	4,554	1,804	2,606	1,460
India	2,007				
Japan		1,076	377	1,761	901
Netherlands	1,256	986	1,308	441	1,016
Norway	261	551	200	290	145
Sweden	2,712	2,176	203	320	640
Switzerland	5,155	5,416	3,878	2,451	751
United Kingdom	46,636	15,516	4,566	6,701	6,315
United States	34,528	9,857	27,160	24,972	24,217
Other countries	566	1,736	966	306	3,086
Total	99,509	48,543	44,253	43,668	43,534

[1] Compiled from Customs Returns of Spain.

[29] Mining World, Philippine Islands Finds New Mining District in Development of Palawan Quicksilver Deposits: Vol. 17, No. 7, June 1955, p. 70.

Spain.—The output of mercury in Spain in 1954, 43,400 flasks, was virtually unchanged from 1953 despite the fact that the new plant at Almaden had its first full year of operation. The plant is described in the section of this report on Technology. Before the end of the year there were rumors that additional capacity was under consideration. A new shaft was being sunk at the mine in 1954. Exports of mercury roughly approximated production in 1954 and 1953. Shipments for the past 3 years went chiefly to the United States with the United Kingdom, France, and Switzerland receiving important quantities.

United Kingdom. A rough guide to the consumption of mercury in the United Kingdom is obtained by subtracting reexports from imports, although this calculation makes no allowance for industry and Government stocks, which are not available. This method indicated violent fluctuations, believed inaccurate, in yearly rates of consumption in the 5-year period, 1950–54; the annual average of 20,000 flasks, however, appears realistic.

	1950	1951	1952	1953	1954
Imports	54, 200	18, 800	9, 200	21, 300	29, 500
Reexports	14, 300	6, 100	3, 600	2, 500	6, 600
Apparent consumption	39, 900	12, 700	5, 600	18, 800	22, 900

Reexports of mercury in 1954, in flasks of 76 pounds, were as follows:[30]

Destination:	*1954*
Austria	230
Australia	364
Belgium	465
Denmark	215
Federation of Rhodesia and Nyasaland	104
Finland	622
Germany (West)	224
Hungary	415
Netherlands	115
Norway	842
Poland	1, 973
Sweden	118
Union of South Africa	285
Other	601
Total	6, 573

Under a Government order, effective October 20, licenses were required for exporting quicksilver and mercurial salts from the United Kingdom to all destinations.

Prices in London rose without interruption from a monthly average of $175 (pounds sterling converted to dollars) a flask in January to

[30] Oliver, John G. (second secretary of Embassy), U. K. Mercury Statistics: State Dept. Dispatch 461, London, England, Aug. 26, 1955, 1 p., from statistics prepared by the Board of Trade.

$308 in November and dropped to $307 in December; they averaged $255 for the year compared with an average price, duty paid, of $264 in New York.

Yugoslavia.—There has been little variation in production of mercury in Yugoslavia, since an increase in output to 14,400 flasks in 1950; output after minor fluctuation was again 14,400 in 1954. Exports in 1952–54, 700 to 2,600 flasks below production, went chiefly to the United States, Germany (West), and the United Kingdom. Quicksilver deposits in Yugoslavia were recently described [31] as follows:

Quicksilver ore occurrences are common in Jugoslavia, but with a few exceptions are not commercial. The main ore is cinnabar, which is commonly associated with antimony and arsenic ores. This is particularly true for Bosnia. As previously referred to, the Bosnian tetrahedrite deposits contain significant amounts of quicksilver. In Slovenia the lead occurrence at Littai (Litija), east of Ljubljana in the Save Valley, formerly furnished quicksilver as a by-product. Here galena and cinnabar were closely associated. This deposit belongs to the Alpine type of lead-zinc deposits. On the other hand, the cinnabar occurrence on Avala Mountain near Beograd presumably is connected with Tertiary volcanism. It has been out of production for a long period.

Through the annexation of the former Austrian province of Krain the famed quicksilver mine of Idria (Idrija) became a part of Jugoslavia. Its extensive literature of older dates has been summarized by Beyschlag-Krusch-Vogt (1). This deposit lies about 40 km. west of Ljubljana in a region characterized by extremely complicated Alpine tectonics. It is located in the immediate vicinity of a large overthrust fault along which beds of Carboniferous and Triassic ages have been pushed on top of Cretaceous limestones. The former have been folded and faulted, creating a belt of shattering, in turn dissected by crushed and brecciated zones. The ore deposit was formed by the impregnation of the crushed rock within one of these zones. Its strike length is 1,500 m. and its width ranges from 300 to 600 m. It has been developed to a depth of 350 m. Mineralization is not confined to certain types of rock but is concentrated in the brecciated limestone of the Muschelkalk Formation and in the overlying "Lagerschiefer" or "Skonzaschiefer" of the Wengen Formation (upper Triassic). These beds are crisscrossed by many small fissures that are filled with cinnabar. This network constitutes the main ore body. Locally the top strata of the so-called "Gailtaler Schiefer," a black shale of Carboniferous age, have been impregnated by cinnabar and native quicksilver to such an extent that they became ore. Due to the silvery sheen created by the globules of quicksilver this formation is called "Silberschiefer" by the miners. Rich ore pockets occasionally are found along larger fissures or at places where the ore beds have been subjected to very strong shattering and dislocation.

The genetic relationship of Idria is still uncertain. It cannot be assigned to the Tertiary volcanism, as no igneous rocks of this period are associated with the deposit.

Idria was discovered around 1470 and operated by the Austrian government from 1580 to 1920. Then it passed into Italian ownership and has belonged to Jugoslavia since 1947. The total production between 1500 and 1951 was 93,200 tons Hg. During 1951, the output was 126,600 tons of ore with a grade of 0.45 percent Hg yielding 505 tons of metallic quicksilver.

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[31] Schumacher, Friedrich, The Ore Deposits of Jugoslavia and the Development of Its Mining Industry: Econ. Geol., vol. 49, No. 5, August 1954, p. 479–480.

TABLE 22.—Exports of mercury from Yugoslavia, by countries of destination, 1950–54, in flasks of 76 pounds [1]

(Compiled by John E. McDaniel)

Country	1950	1951	1952	1953	1954
Austria	4	4	356	360	366
Belgium-Luxembourg	11	5	791	347	330
Brazil	----------	----------	----------	----------	95
Denmark	----------	----------	1	10	----------
Finland	----------	----------	----------	35	----------
France	4	16	731	300	585
Germany, West	12	13	971	2,289	3,874
Greece	----------	----------	10	----------	----------
Netherlands	13	11	450	300	----------
Sweden	7	1	485	336	260
Switzerland	3	8	565	195	977
United Kingdom	----------	12	697	2,666	1,001
United States	82	60	8,906	5,972	4,353
Other countries	3	----------	----------	6	----------
Total	139	130	13,963	12,816	11,841

[1] Compiled from Customs Returns of Yugoslavia.

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Mica

By Milford L. Skow [1] and Gertrude E. Tucker [2]

DOMESTIC MICA sold or used in the United States in 1954 increased about 10 percent in quantity and 4 percent in value compared with 1953. The tonnage was 8 percent and the value 44 percent greater than in the previous record year of 1952. Although sales of sheet mica in 1954 were 22 percent lower in quantity than in 1953, the value was 11 percent higher because of increased sales to the Government. Sales of scrap and flake mica were the highest on record. Consumption of sheet mica decreased 32 percent; but consumption of scrap mica, as indicated by quantity of ground mica sold, increased 10 percent. Total imports decreased 19 percent while exports increased 39 percent.

TABLE 1.—Salient statistics of the mica industry in the United States, 1945–49 (average) and 1950-54

	1945–49 (average)	1950	1951	1952	1953	1954
Domestic mica sold or used by producers:						
Total sheet mica:[1]						
Pounds	715, 416	578, 818	594, 884	697, 989	849, 394	662, 150
Value	$249, 889	$125, 928	$160, 322	$908, 135	$2, 153, 584	$2, 393, 041
Average per pound	$0. 35	$0. 22	$0. 27	$1. 30	$2. 54	$3. 61
Scrap and flake mica:						
Short tons	45, 894	69, 360	71, 871	75, 236	73, 259	81, 073
Value	$967, 360	$1, 742, 616	$1, 884, 087	$1, 954, 286	$1, 823, 840	$1, 733, 772
Average per ton	$21. 08	$25. 12	$26. 21	$25. 97	$24. 90	$21. 39
Total sheet, scrap, and flake mica:						
Short tons	46, 252	69, 650	72, 168	75, 585	73, 684	81, 404
Value	$1, 217, 249	$1, 868, 544	$2, 044, 409	$2, 862, 421	$3, 977, 424	$4, 126, 813
Ground mica:						
Short tons	59, 899	72, 250	70, 122	74, 806	73, 072	80, 072
Value	$2, 714, 658	$3, 935, 697	$3, 842, 628	$4, 278, 103	$4, 192, 420	$4, 889, 122
Consumption of splittings:						
Pounds	8, 211, 108	10, 783, 198	13, 379, 295	10, 220, 671	10, 346, 159	6, 732, 719
Value	$5, 550, 575	$8, 631, 421	$11, 760, 617	$9, 729, 099	$7, 902, 232	$4, 132, 418
Imports for consumption short tons	13, 141	18, 510	18, 917	13, 048	10, 989	8, 924
Exports do	1, 305	1, 547	1, 894	2, 472	2, 402	3, 328

[1] Includes small quantities of splittings in certain years.

GOVERNMENT MICA PROGRAMS

DEFENSE MINERALS EXPLORATION ADMINISTRATION

From the beginning of the exploration program in 1951 through December 31, 1954, 157 exploration contracts for strategic mica were executed. Of these, 125 contracts were canceled or terminated,

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[2] Statistical assistant.

and 32 were still in force on December 31, 1954. Total value of the 120 terminated contracts was $700,883, of which the Government advanced $488,528. Certificates of discovery or development were issued on 35 of these contracts having a total value of $255,936. Mica contracts in force during 1954 are listed in table 2.

TABLE 2.—Defense Minerals Exploration Administration mica contracts in force during 1954 by State, county, and mine

State and operator	Property	County	Contract: Total value	Contract: Government participation, percent [1]	Contract: Status, Dec. 31, 1954
ALABAMA					
Dixie Mines, Inc	Hurst	Clay	$7,120	90	Terminated.
Smith Mica Co	Fletcher Smith	do	6,000	90	Do.
Bourne, Francis C	Liberty	Randolph	18,500	90	In force.
Smith, C. E	Pate	do	6,750	75	Terminated.
GEORGIA					
Empire Mica Co	H. W. Harp	Lamar	7,400	90	Do.
Johnson, Thomas	Rev. Thaddeus Persons.	Monroe	9,000	90	In force.
Mundy, H. C., and Thomas, C. F.	Dickens	Oconee	3,100	90	Terminated.
Burleson & Phillips	Jones-Bozeman	Pickens	3,560	90	Do.
Teague, Alex	Old Denson	do	2,994	75	In force.
Tralyta Mining Co	Lake Tralyta	Union	5,716	75	Do.
Empire Mica Co	Short-Mitchell	Upson	8,600	90	Terminated.
Phillips, C. R	J. H. Reynolds	do	6,650	90	In force.
NEW HAMPSHIRE					
Maderic, J. L	Saunders	Grafton	4,510	90	Terminated.
Robinson, Henry Lee	Chandler Mills	Sullivan	1,500	75	In force.
NORTH CAROLINA					
Beam & Boone	Ingram	Avery	1,816	75	Terminated.
Pancake Miners	Pancake	do	4,940	75	In force.
Smith, Sam, Jr., et al	Benfield	do	4,413	75	Do.
Taylor, Fred	Cow Camp (South)	do	5,450	90	Terminated.
Vance, Joe C	Doublehead	do	6,475	75	Do.
Do	Joe	do	3,613	75	In force.
Vance & Odom Mining Co	Gardner	do	6,265	75	Terminated.
Bowman, C. H. and F. C	Bowman	Caldwell	3,100	90	Do.
Phillips, S. L., et al	Hefner	Catawba	4,692	75	Do.
Barn Gay Mica Co	Humphries	Cleveland	2,600	90	Do.
Beasley, J. A	Lee Carpenter	do	6,300	90	Do.
Do	Hubert Cook No. 2	do	5,050	90	Do.
Blalock, Hoyle, et al	Blalock	do	4,995	90	Do.
Do	Hamrick	do	3,300	90	Do.
Boone, R. L	Cliff Blanton	do	5,650	90	In force.
Burns-Spangler Construction Co.	Lee Cornwell	do	6,700	90	Do.
Forest City Mining Co	Old Mauney	do	7,350	90	Terminated.
Phillips & Keller	C. Ray Wilson	do	1,400	75	Do.
Wellmon, E. R	Wellmon	do	5,010	90	Do.
Willis & Snyder Mica Co	Lutz	do	7,625	90	Do.
H. R. H., Inc	Holt No. 1	Haywood	5,550	90	Do.
Poston, E. L	Old Shining Rock	do	4,170	90	Do.
Poston, E. L., and Bradley, Jim.	Old Sharp	do	3,270	90	Do.
Dixie Minerals, Inc	Shell Ridge	Jackson	4,600	90	Do.
Do	D. H. Stephens	do	5,400	90	Do.
Goodman, A. J	Engle Cope	do	6,750	90	Do.
Do	Murray Mt	do	7,475	90	Do.
Hensley, Charlie E	Betty's Creek No. 3	do	5,350	90	In force.
Hooper, Roscoe & Martin	Old Sheep Mt	do	9,900	90	Do.
Young, Latt	Cox	do	7,300	90	Terminated.

See footnote at end of table.

TABLE 2.—Defense Minerals Exploration Administration mica contracts in force during 1954 by State, county, and mine—Continued

State and operator	Property	County	Contract		
			Total value	Government participation, percent [1]	Status, Dec. 31, 1954
NORTH CAROLINA—Continued					
American Mica Corp	Beasley No. 2	Macon	$11,250	90	Terminated.
Angel, R. C	Quisenberry	do	5,300	90	Do.
Angel, Zeb	Kasson	do	9,200	90	Do.
Bauer Mining Co	Baird Cove	do	9,100	90	In force.
Bennett, R. E	Bennett	do	3,300	90	Terminated.
Bryson, J. P. (B. T. R. Mining Co.).	Terrell Bryson	do	4,900	90	Do.
Cable, H. C	Turkey Knob (Passmore).	do	7,100	90	Do.
Carpenter, Mashburn & Phillips (Burke-John Mica Miners).	Burke-John	do	8,100	90	Do.
Carpenter, et al (Macon Mica Miners).	Mashburn	do	5,200	90	Do.
Fouts, R. H	Allman Cove	do	7,540	90	Do.
Do	Sol Jacobs (Winecoff)	do	5,348	75	In force.
Meeker, Paul, et al	Bryson No. 2	do	4,700	75	Terminated.
Miller, Polly Mining Corp	Polly Miller	do	7,700	90	Do.
Phillips, Sam, et al	Mud Cut	do	5,538	75	Do.
Ward, A	Elmore	do	5,064	75	In force.
B & R Mica Co	Half Moon	Mitchell	11,650	90	Terminated.
Baker, Robert	Zinniman	do	7,370	90	Do.
Boone, Howard & Jarrett, John.	Marsh Putnam	do	5,292	75	In force.
Boone, Jeter, et al	Doc Thomas	do	5,748	75	Do.
Buchanan, Newland, et al	Johnson	do	6,500	75	Terminated.
Buchanan, Zeb	Bordon	do	6,825	90	Do.
Buchanan, Zeb, et al	R. B Phillips	do	4,016	75	In force.
Duncan Mining Co	Connolly	do	8,800	90	Terminated.
Ellis, C. W., et al (Byrd Mica Miners).	Byrd	do	5,755	90	Do.
Jarrett, John	Jarrett	do	4,538	75	In force.
Mine Creek Mica Miners	George Howell No. 2	do	7,624	75	Do.
Phillips, F. O	Phillips	do	4,193	75	Terminated.
Phillips, et al (Sinkhole Miners).	Sinkhole	do	35,755	90	Do.
Pittman, Audy	Wiseman No. 2	do	6,316	75	In force.
Sparks, E. K	E. K. Sparks	do	7,716	75	Do.
Andre, Robert K	McKinney	Yancey	6,700	90	Do.
Balsam Mica Miners	Balsam	do	2,740	90	Terminated.
Bennett & Johnson Co	Hampton	do	7,000	90	Do.
Blue Ridge Mica Co	Grant Laws	do	7,500	90	Do.
Brown, C. L., et al	Fox	do	5,788	75	In force.
Carolina Clear Mica Co	Clear	do	11,575	90	Terminated.
Chrisawn, W. B	R. S. Westall	do	3,363	90	In force.
Cook Mining Co	Charles Robinson	do	12,470	90	Do.
Grigg & West Co	Grassy Knob	do	9,650	90	Terminated.
Hyatt, Fred & Pressnell, Lonnie.	Banks	do	7,270	90	Do.
Nonmetallic Minerals Corp	White Face	do	3,300	75	Do.
Phillips, John, et al	W. A. McKinney	do	3,613	75	Do.
Phillips, Sam, et al	Rock	do	3,938	75	In force.
Pressnell, S. W. Mica Miners	S. W. Pressnell	do	11,200	90	Terminated.
Ray, B. L. & Hyde, C. E. (Murphy Mining Co.).	Red (Bennett)	do	4,550	90	Do.
South Toe Mining Co	Carson Rock	do	4,900	75	In force.
Sparks, Roy	Hector	do	5,325	75	Terminated.
Twiggs, H. J	Sam Huskins	do	5,200	90	In force.
Young & Burleson	Ruby (Shaft)	do	4,350	75	Do.
VIRGINIA					
Baltzley, W. D. & Mavos	Baltzley No. 3	Powhatan	6,250	75	Do.

[1] Total actual expenditures by the Government on terminated and certified contracts often were less than the obligated funds.

EMERGENCY PROCUREMENT SERVICE

During 1954 purchases at General Services Administration's 3 mica-purchasing depots yielded a total of 198,749 pounds of full-trimmed muscovite block mica (over 0.007 inch thick), comprising 154,890 pounds of ruby and 43,859 pounds of nonruby. Good Stained or Better qualities constituted about 36 percent of the ruby block mica and 54 percent of the nonruby; Stained quality made up about 47 percent of the ruby and 36 percent of the nonruby. About 64 percent of the ruby block mica and 94 percent of the nonruby were purchased at the Spruce Pine, N. C., depot. This depot also reported purchasing small quantities of ruby and nonruby film mica.

The total quantity of Stained or Better qualities of full-trimmed muscovite block obtained by the Government from domestic purchases in 1954 was equivalent to 10 percent of the total 1954 domestic fabrication of block and film of these qualities, irrespective of grades.

The total yields of full-trimmed muscovite ruby and nonruby mica and byproducts from domestic purchases by GSA since the start of the program in 1952 are shown in table 6 by depot, category, and year.

In May 1954 the domestic mica purchase regulation was revised: (1) To extend for 1 year (to June 30, 1955) the period of notifying the

TABLE 3.—Yield of full-trimmed muscovite ruby block mica and byproducts from domestic purchases by GSA, 1954, by quality, grade, and depot, in pounds

Depot and grade	Full-trimmed				Byproducts		
	Good Stained or Better	Stained	Heavy Stained	Total	Other	Punch	Scrap
Spruce Pine, N. C.:							
2 and larger	429.01	142.06	58.69	629.76			
3	793.08	323.40	122.05	1,238.53			
4	2,013.74	932.99	349.04	3,295.77			
5	8,850.86	4,679.83	1,776.34	15,307.03			
5½	6,710.27	4,759.22	1,914.60	13,384.09			
6	28,977.78	27,215.67	8,315.84	64,509.29			
Total	47,774.74	38,053.17	12,536.56	98,364.47		8,940.00	15,254.94
Franklin, N. H.:							
2 and larger	17.69	218.41	160.24	396.34			
3	68.29	395.63	183.10	647.02			
4	187.77	941.87	357.02	1,486.66			
5	1,065.32	4,224.87	1,157.65	6,447.84			
5½	944.97	3,503.00	859.22	5,307.19			
6	4,015.38	13,240.22	2,614.08	19,869.68			
Total	6,299.42	22,524.00	5,331.31	34,154.73	11,546.33	86,844.62	179,198.89
Custer, S. Dak.:							
2 and larger	1.12	17.89	16.43	35.44			
3	3.52	86.20	73.76	163.48			
4	17.70	361.66	334.70	714.06			
5	129.44	1,958.94	1,612.43	3,700.81			
5½	133.40	1,506.09	1,227.40	2,866.89			
6	929.86	8,048.08	5,912.33	14,890.27			
Total	1,215.04	11,978.86	9,177.05	22,370.95	1,072.19	42,924.63	320,948.10
Grand total	55,289.20	72,556.03	27,044.92	154,890.15	12,618.52	138,709.25	515,401.93

TABLE 4.—Yield of full-trimmed muscovite nonruby block mica and byproducts from domestic purchases by GSA, 1954, by quality, grade, and depot, in pounds

Depot and grade	Full-trimmed: Good Stained or Better	Full-trimmed: Stained	Full-trimmed: Heavy Stained	Full-trimmed: Total	Byproducts: Other	Byproducts: Punch	Byproducts: Scrap
Spruce Pine, N. C.:							
2 and larger	109.15	114.74	64.37	288.26			
3	375.26	240.17	95.52	710.95			
4	1,087.81	608.99	244.18	1,940.98			
5	4,465.09	2,227.58	690.92	7,383.59			
5½	3,008.73	1,820.86	509.97	5,339.56			
6	14,358.37	9,590.89	1,831.24	25,780.50			
Total	23,404.41	14,603.23	3,436.20	41,443.84			
Franklin, N. H.:							
2 and larger	.08	1.81	.17	2.06			
3	.51	5.38	1.11	7.00			
4	2.41	22.84	4.25	29.50			
5	21.28	110.69	13.36	145.33			
5½	26.14	120.33	7.83	154.30			
6	98.29	430.34	25.00	553.63			
Total	148.71	691.39	51.72	891.82	1,019.74	6,385.00	14,164.67
Custer, S. Dak.:							
2 and larger	1.31	1.10	.75	3.16			
3	2.09	3.53	4.53	10.15			
4	7.69	13.62	18.28	39.59			
5	46.63	101.56	100.41	248.60			
5½	39.84	82.88	78.81	201.53			
6	188.69	479.28	352.16	1,020.13			
Total	286.25	681.97	554.94	1,523.16	551.16	1,463.09	42,225.53
Grand total	23,839.37	15,976.59	4,042.86	43,858.82	1,570.90	7,848.09	56,390.20

Government of the desire to participate in the program; (2) to permit acceptance of block and film mica containing less than the formerly required 20 percent Good Stained or Better qualities; (3) to increase the prices offered for Good Stained or better qualities of nonruby block and film mica to the same values as for similar qualities of ruby block and film mica, (4) to permit acceptance of hand-cobbed mica yielding not less than 40.5 pounds of Good Stained or Better qualities of full-trimmed mica per short ton; and (5) to increase the price for nonruby hand-cobbed mica from $480 to $540 per short ton.

TABLE 5.—Yield of full-trimmed muscovite ruby and nonruby film mica from domestic purchases by GSA at Spruce Pine, N. C., depot, 1954, by grade, in pounds

Grade	Ruby	Nonruby	Grade	Ruby	Nonruby
2 and larger	0.61		5½	7.50	1.14
3	1.25		6	32.07	5.25
4	4.11	0.12			
5	10.67	.67	Total	56.21	7.18

TABLE 6.—Yield of full-trimmed muscovite ruby and nonruby mica and byproducts from domestic purchases by GSA, 1952–54

Category and depot	1952 [1]	1953	1954	Total
Full-trimmed:				
Spruce Pine, N. C.	36,831	113,270	139,872	289,973
Franklin, N. H.	4,289	25,303	35,046	64,638
Custer, S. Dak.	14,395	26,125	23,894	64,414
Total	55,515	164,698	198,812	419,025
Other:				
Spruce Pine, N. C.	196			196
Franklin, N. H.	1,765	1,821	12,566	16,152
Custer, S. Dak.		7,995	1,623	9,618
Total	1,961	9,816	14,189	25,966
Punch:				
Spruce Pine, N. C.	296	16	8,940	9,252
Franklin, N. H.	933	23,052	93,229	117,214
Custer, S. Dak.	30,354	193,505	44,388	268,247
Total	31,583	216,573	146,557	394,713
Scrap:				
Spruce Pine, N. C.	43	47	15,255	15,345
Franklin, N. H.	1,581	21,708	193,363	216,652
Custer, S. Dak.	50,906	157,505	363,174	571,585
Total	52,530	179,260	571,792	803,582

[1] Figures for July–December.

DOMESTIC PRODUCTION [3]

Sheet Mica.—The quantity of crude sheet mica sold or used by producers in 1954 was 22 percent less than in 1953 but had a value 11 percent greater as the quantity of sheet mica (calculated full-trimmed equivalent) sold to the Government increased 16 percent. North Carolina, with 72 percent of the total domestic output, again ranked first in quantity sold or used, followed in order by Connecticut, New Hampshire, Georgia, Maine, South Dakota, Idaho, Alabama, New Mexico, Virginia, South Carolina, Maryland, and Montana.

Plans to obtain sheet and scrap mica from pegmatite deposits at the southern tip of the Alaska Panhandle and on adjacent Sitklan Island were being made by B. C. Mica Mines, Ltd., Vancouver, B. C.[4]

Scrap and Flake Mica.—In 1954, 11 percent more scrap and flake mica was sold or used by grinders than in 1953. The value was 5 percent less, however, because of the greater proportion of flake mica produced.

The silt accumulated in the lake behind Nolichucky Dam near Greeneville, Tenn., was found to contain commercially exploitable quantities of flake mica. The Tennessee Valley Authority announced its willingness to permit recovery operations on a royalty basis.[5]

[3] Production data for 1954 were collected jointly with the Bureau of the Census (U. S. Department of Commerce). Production totals will be compared with the Census when they are available and differences adjusted or explained.

[4] Northern Miner (Toronto), Form B. C. Mica: Vol. 39, No. 49, Feb. 25, 1954, p. 23.
Engineering and Mining Journal, vol. 155, No. 11, November 1954, p. 126.

[5] Mining World, Eastern States: Vol. 16, No. 11, October 1954, pp. 91–92.
Chemical and Engineering News, Dip Down for Mica in Davy Crockett Lake: Vol. 32, No. 41, Oct. 11, 1954, p. 4070.
Rock Products, vol. 57, No. 11, November 1954, p. 83.

TABLE 7.—Mica sold or used by producers in the United States, 1945–49 (average) and 1950–54

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
1945–49 (average)	633,042	$87,152	82,374	$162,737	715,416	$249,889	45,894	$967,360	46,252	$1,217,249
1950	546,433	86,675	32,385	39,253	578,818	125,928	69,360	1,742,616	69,650	1,868,544
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:										
Arizona							3,721	114,870	3,721	114,870
Colorado							1,599	19,455	1,599	19,455
Georgia	8,848	1,522	5,215	72,284	14,063	73,806	(4)	(4)	(4)	(4)
Idaho			24,216	223,266	24,216	223,266			12	223,266
Maine	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	87	33,532
New Hampshire	62,522	11,343	28,194	371,337	90,716	382,680	(4)	(4)	(4)	(4)
North Carolina	518,917	74,782	100,978	1,233,712	619,895	1,308,494	56,834	1,428,793	57,144	2,737,287
South Dakota			11,174	77,352	11,174	77,352	1,687	27,388	1,693	104,740
Undistributed [5]	76,954	10,363	12,376	77,623	89,330	87,986	9,418	233,334	9,428	744,274
Total	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			9,661	65,222	9,661	65,222	1,510	26,943	1,515	92,165
Undistributed [5]	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] 212,045	[3] 2,341,094	662,150	2,393,041	81,073	1,733,772	81,404	4,126,813

[1] Includes small quantities of splittings in certain years.
[2] Includes finely divided mica recovered from mica and sericite schist, and as a byproduct of feldspar and kaolin beneficiation.
[3] Includes the full-trimmed mica equivalent of hand-cobbed mica.
[4] Included with "Undistributed" to avoid disclosure of individual company operations.
[5] Figures include Alabama, California (1954), Colorado (1954), Connecticut (1953), Georgia (1954), Idaho (1954), Maryland (1954), Montana (1954), New Mexico (1954), Pennsylvania, South Carolina (1954), Virginia, a small quantity undistributed by State in 1953, and States indicated by footnote 4.

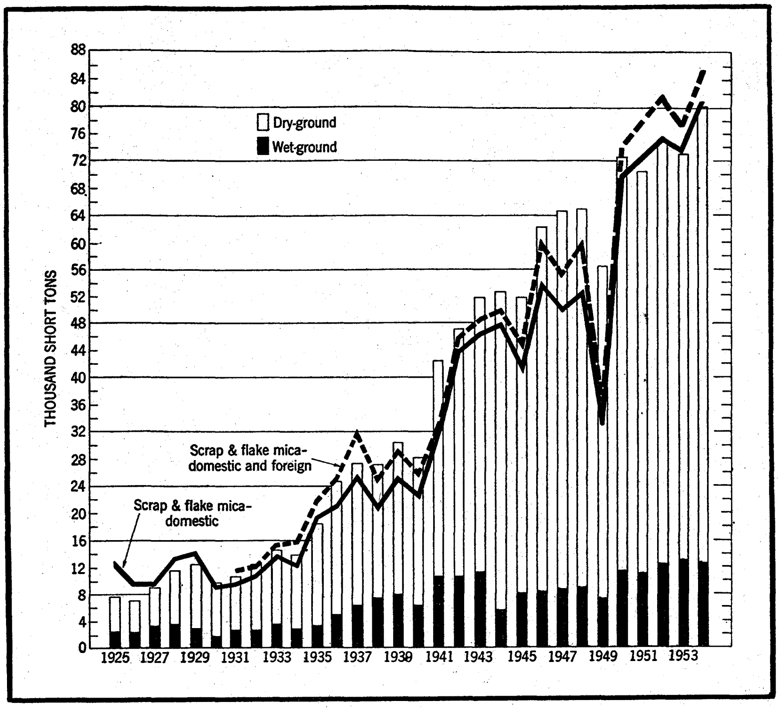

FIGURE 1.—Scrap, flake, and ground mica sold in the United States, 1925–54.

Ground Mica.—Sales of ground mica reached a new high in 1954, as they increased 10 percent in quantity and 17 percent in value compared with 1953. About 84 percent of the total was dry-ground mica. More than 50 percent of the total sales of wet-ground mica were to paint manufacturers and about 25 percent to rubber companies. Nineteen companies reported sales of dry-ground mica in 1954, and 7 companies sold wet-ground mica. The method of grinding and the location of each company are listed in table 9.

TABLE 8.—Ground mica sold by producers in the United States, 1945–49 (average) and 1950–54, by methods of grinding

Year	Dry-ground		Wet-ground		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1945–49 (average)	51, 591	$1, 712, 967	8, 308	$1, 001, 691	59, 899	$2, 714, 658
1950	61, 139	2, 374, 089	11, 111	1, 561, 608	72, 250	3, 935, 697
1951	59, 200	2, 294, 620	10, 922	1, 548, 008	70, 122	3, 842, 628
1952	62, 465	2, 526, 407	12, 341	1, 751, 696	74, 806	4, 278, 103
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

TABLE 9.—Mica grinders in 1954, by State, county, and method of grinding

State	County	Nearest town	Company	Method of grinding	
				Wet	Dry
Alabama	Chilton	Clanton	Ellis Inslow		X
Arizona	Maricopa	Buckeye	Buckeye Mica Co		X
Do	Mohave	Kingman	Huntley Industrial Minerals, Inc		X
California	Los Angeles	Los Nietos	Sunshine Mica Co		X
Colorado	Pueblo	Pueblo	Western Non-Metallics, Inc		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	East Rutherford	U. S. Mica Co., Inc		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	X
Do	do	Kona	International Minerals & Chemical Corp.		X
Do	Yancey	Newdale	Deneen Mica Co		X
Pennsylvania	York	Hokes	General Mining Associates		X
South Dakota	Custer	Custer	Monarch Mines, Inc		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	Warwick	Newport News	Richmond Mica Corp	X	

CONSUMPTION

Sheet Mica.—Consumption of sheet mica (block, film, and splittings) in 1954 was about 32 percent lower than in 1953.

Domestic fabricators consumed more than 3.2 million pounds of muscovite block and film mica, 25 percent less than in 1953. Fabrication of Lower Than Stained qualities accounted for 48 percent of the total; Stained quality, 47 percent; Good Stained or Better, 5 percent. Of the total muscovite block and film mica fabricated, electronic applications consumed 62 percent, which was distributed by qualities as follows: Good Stained or Better, 7 percent; Stained, 72 percent; and Lower Than Stained, 21 percent. Grade 6 block mica constituted about 52 percent of the consumption of muscovite block and film.

Fabrication of block and film mica in 1954 was reported by 27 companies in 9 States, and 16 companies in 3 States—New York (6), New Jersey (6), and North Carolina (4)—furnished 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.

Consumption of mica splittings in 1954 decreased 35 percent compared with 1953. Most of the splittings used were from India (91 percent by weight); the remainder was phlogopite from Madagascar

TABLE 10.—Fabrication of muscovite ruby and nonruby block and film mica and phlogopite block mica, by quality and end-product use in the United States, 1954, 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	867	57,668	1,306	59,841	6,532	1,160	7,692	67,533
Stained	19,514	1,381,850	28,018	1,429,382	4,105	65,810	69,915	1,499,297
Lower Than Stained	13,295	331,256	78,451	423,002	30	[1] 1,131,726	1,131,756	1,554,758
Total	33,676	1,770,774	107,775	1,912,225	10,667	[1] 1,198,696	1,209,363	3,121,588
Film:								
First quality	15,621			15,621		84	84	15,705
Second quality	68,986			68,986		230	230	69,216
Other	8,248			8,248				8,248
Total	92,855			92,855		314	314	93,169
Block and film:								
Good Stained or Better [2]	85,474	57,668	1,306	144,448	6,532	1,474	8,006	152,454
Stained [3]	27,762	1,381,850	28,018	1,437,630	4,105	65,810	69,915	1,507,545
Lower Than Stained	13,295	331,256	78,451	423,002	30	1,131,726	1,131,756	1,554,758
Total	126,531	1,770,774	107,775	2,005,080	10,667	1,199,010	1,209,677	3,214,757
Phlogopite: Block (all qualities)		20	1,144	1,164		13,206	13,206	14,370

[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, 1954, 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	6,276	2,916	9,852	44,921		63,965
Stained	52,634	110,754	98,414	1,169,939		1,431,741
Lower Than Stained	130,898	168,711	30,467	381,483	656,660	1,368,219
Total	189,808	282,381	138,733	1,596,343	656,660	2,863,925
Nonruby:						
Good Stained or Better	1,786	246	702	834		3,568
Stained	3,175	2,707	524	61,150		67,556
Lower Than Stained	20,283	65,145	2,381	72	98,658	186,539
Total	25,244	68,098	3,607	62,056	98,658	257,663
Film:						
Ruby:						
First quality	2,252	3,467	2,811	5,629		14,159
Second quality	11,078	22,319	9,224	22,835		65,456
Other quality					8,237	8,237
Total	13,330	25,786	12,035	28,464	8,237	87,852
Nonruby:						
First quality	406	700	150	290		1,546
Second quality	1,152	2,063	484	61		3,760
Other quality					11	11
Total	1,558	2,763	634	351	11	5,317

[1] Figures for block mica include "all smaller than No. 6" grade and "punch" mica.

and Canada. A total of 15 companies in 10 States reported consuming mica splittings for producing built-up mica.

Built-Up Mica.—Consumption of domestically produced built-up mica in 1954 decreased 23 percent in weight and 24 percent in value compared with 1953, as shown in table 15. This decline was caused principally by substantially reduced production of heavy electrical equipment and, to a smaller extent, by substitution of reconstituted mica. Various forms of built-up mica were produced for use principally as electrical insulation. Built-up mica was produced domestically in 1954 by 13 companies operating a total of 15 plants.

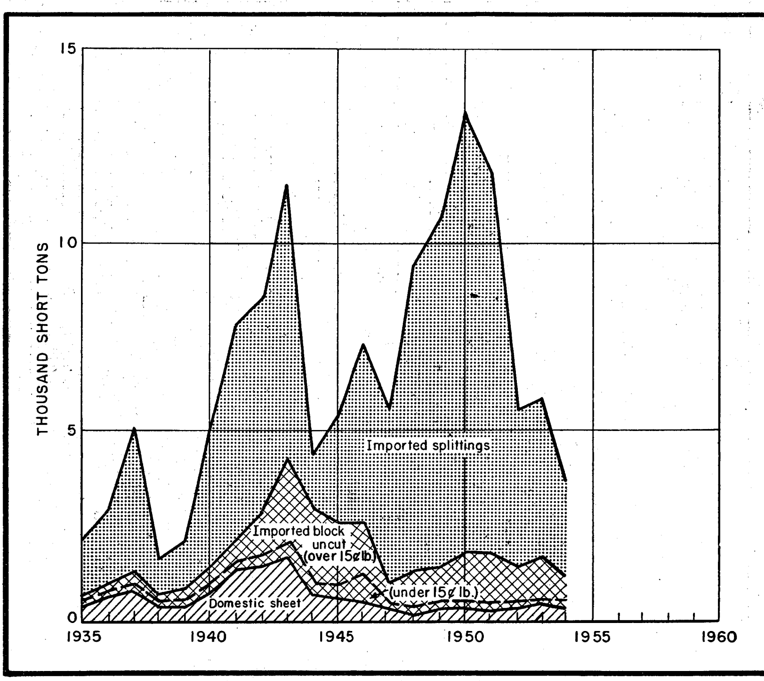

FIGURE 2.—Block mica and splittings imported for consumption in the United States and sales of domestic sheet mica, 1935–54.

TABLE 12.—Mica fabricators by State, county, and products for which muscovite and phlogopite mica were fabricated in 1954

State	County	Nearest town	Company	Products for which mica was fabricated			
				Muscovite			Phlogopite
				Block		Film	
				Electronic uses	Nonelectronic uses	Electronic and nonelectronic uses	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 Div., Aerovox Corp			X	
Do	Essex	Danvers	Vulcan Electric Co				X
Do	Suffolk	Boston	The Huse-Liberty Mica Co	X	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	Camden	Camden	Radio Corporation of America	X			
Do	Essex	Newark	Micacraft Products, Inc	X	X	X	X
Do	Hudson	Harrison	Radio Corporation of America	X			
Do	Monmouth	Manasquan	American Mica Insulation Co	X		X	
New York	Kings	Brooklyn	Ford Radio & Mica Corp	X			
Do	do	do	Reliance Mica Co	X	X	X	X
Do	do	do	Victory Mica Mfg. Co., Inc	X			
Do	New York	New York	American Mica Products Co		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	X		X	X
Do	Mitchell	Spruce Pine	Carpenter & Phillips Mica Co		X		
Do	do	do	Spruce Pine Mica Co	X	X		X
Ohio	Fairfield	Lancaster	Diamond Power Specialty Corp		X		
Pennsylvania	Lancaster	do	Radio Corporation of America	X			
Do	McKean	Smethport	Sylvania Electric Products, Inc	X			X
Rhode Island	Washington	Hope Valley	Cornell-Dubilier Electric Corp	X		X	
Virginia		Newport News	Asheville Mica Co	X	X	X	X

TABLE 13.—Consumption and stocks of mica splittings in the United States, 1945–49 (average) and 1950–54, by sources

	1945–49 (average)		1950		1951	
	Pounds	Value	Pounds	Value	Pounds	Value
Consumption:						
Domestic	[1][2] 51,826	[1][2] $29,502	[3] 200,728	[3] $105,717	[3] 164,213	[3] $104,868
Canadian	[2][4] 237,183	[2][4] 130,477				
Indian	7,488,907	5,094,992	9,847,591	8,032,918	12,306,853	10,995,620
Madagascan	407,755	279,207	734,879	492,786	908,229	660,129
Mexican	[1][4] 25,437	[1][4] 16,397	(3)	(3)	(3)	(3)
Total	8,211,108	5,550,575	10,783,198	8,631,421	13,379,295	11,760,617
Stocks (Dec. 31):						
Domestic	[5] 12,448	[5] 5,728	[3] 235,537	[3] 182,999	----------	----------
Canadian	[4][5][6] 152,436	[4][5][6] 87,119			50,784	24,486
Indian	4,257,304	3,076,410	5,464,294	5,552,016	9,756,536	9,379,176
Madagascan	376,764	276,344	450,581	432,872	522,110	497,658
Mexican	[4][6] 16,357	[4][6] 10,237	(3)	(3)	----------	----------
Total	4,815,309	3,455,838	6,150,412	6,167,887	10,329,430	9,901,320

	1952		1953		1954	
	Pounds	Value	Pounds	Value	Pounds	Value
Consumption:						
Domestic	----------	----------	----------	----------	----------	----------
Canadian	184,541	$74,197	158,343	$98,738	67,311	$37,505
Indian	9,356,561	9,091,784	9,443,645	7,225,899	6,158,769	3,727,441
Madagascan	679,569	563,118	744,171	577,595	506,639	367,472
Mexican	----------	----------	----------	----------	----------	----------
Total	10,220,671	9,729,099	10,346,159	7,902,232	6,732,719	4,132,418
Stocks (Dec. 31):						
Domestic	----------	----------	----------	----------	----------	----------
Canadian	63,588	23,352	39,354	20,423	(7)	(7)
Indian	8,218,683	8,356,888	6,688,997	6,110,975	5,206,178	3,901,194
Madagascan	512,158	460,015	387,905	316,610	[7] 330,900	[7] 256,767
Mexican	----------	----------	----------	----------	----------	----------
Total	8,794,429	8,840,255	7,116,256	6,448,008	5,537,078	4,157,961

[1] Mexican included with domestic in 1948.
[2] Domestic included with Canadian in 1949.
[3] Mexican included with domestic and Canadian.
[4] Mexican included with Canadian 1947.
[5] Domestic included with Canadian in 1948 and 1949.
[6] Mexican included with domestic and Canadian in 1949.
[7] Canadian included with Madagascan.

TABLE 14.—Consumption of mica splittings in the United States, 1954, by States

State	Number of consumers	Quantity (pounds)
Indiana, Michigan, Ohio, and Wisconsin	5	1,150,715
Massachusetts and New Hampshire	3	2,174,660
New York	2	1,974,098
North Carolina, Pennsylvania, and Virginia	5	1,433,246
Total	15	6,732,719

TABLE 15.—Built-up mica [1] sold or used in the United States, 1952–54, by kinds of product

Product	1952		1953		1954	
	Pounds	Value	Pounds	Value	Pounds	Value
Molding plate	1,682,742	$3,137,011	1,704,644	$3,323,141	1,184,965	$2,213,392
Segment plate	2,094,397	3,972,515	2,106,226	4,054,997	1,504,028	2,778,582
Heater plate	511,120	1,419,575	822,207	2,221,995	580,846	1,681,071
Flexible (cold)	721,037	2,002,263	559,671	1,713,996	355,608	946,862
Tape	(2)	(2)	[3] 2,254,587	[3] 8,704,367	[3] 2,130,759	[3] 7,672,310
Other	2,139,670	10,916,674	201,174	705,837	149,582	537,433
Total	7,148,966	21,448,038	7,648,509	20,724,333	5,905,788	15,829,650

1 Consists of a composite of alternate layers of a binder and irregularly arranged and partly overlapped splittings.
2 Included with "Other." Separate figures for "tape" were not recorded before 1953.
3 Includes a small quantity of built-up mica for "other combination materials."

Reconstituted Mica.—Reconstituted mica is manufactured by paper-making procedures from natural mica scrap and is a substitute for built-up mica in many applications. The General Electric Co. (Laminated and Insulating Products Dept., Coshocton, Ohio) and the Mica Insulator Co., Schenectady, N. Y. (in conjunction with its subsidiary Samica Corp., Rutland, Vt.), again were producers in 1954. Total production was more than double that in 1953.

Ground Mica.—Sales of ground mica in 1954, which increased 10 percent in quantity and 17 percent in value compared with 1953, were the largest on record. Roofing materials continued to use the largest proportion of the ground mica (41 percent), and paint ranked second (23 percent). Other uses included well-drilling compounds, rubber, and plastics.

TABLE 16.—Ground mica sold by producers in the United States, 1953–54, by uses

Use	1953			1954		
	Short tons	Percent of total	Value	Short tons	Percent of total	Value
Roofing	32,389	44	$935,208	32,663	41	$1,024,572
Wallpaper	598	1	79,522	772	1	105,040
Rubber	5,668	8	547,654	5,021	6	484,063
Paint	15,258	21	1,435,294	18,696	23	1,764,717
Plastics	1,641	2	153,440	1,352	2	111,048
Welding rods	1,538	2	85,665	695	1	46,404
Well drilling	4,347	6	195,152	6,157	8	285,138
Miscellaneous [1]	11,633	16	760,485	14,716	18	1,068,140
Total	73,072	100	4,192,420	80,072	100	4,889,122

1 Includes mica used for molded electric insulation, house insulation, Christmas-tree snow, manufacture of axle greases and oil, annealing, and other purposes.

PRICES

Prices offered by fabricators for domestic sheet mica, as shown in table 17, were mostly unchanged from those of 1953. The only variation was the price for Stained or electric mica, which sold at approximately the same prices as clear sheet for the first 6 months and 10 to 15 percent lower during the last 6.

In May 1954 the Government started paying as much for nonruby muscovite block and film mica of Good Stained or Better qualities as for the corresponding qualities of ruby mica and increased the price for nonruby hand-cobbed mica from $480 to $540 per short ton. Prices before May 26 were identical to those shown in the Minerals Yearbook for 1953.

North Carolina scrap mica was quoted at $32 to $35 per short ton, depending on quality, until late in June when the price became $25 to $30.

Dry- and wet-ground mica prices were steady throughout the year and unchanged from those during the latter part of 1953.

TABLE 17.—Prices for various grades of clear sheet mica in North Carolina district, Dec. 31, 1954, in dollars per pound [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 effective May 26, 1954, for domestically produced muscovite mica purchased by the Government

	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:					
Ruby	$600 per short ton.				
Nonruby	$540 per short ton.				

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FOREIGN TRADE [6]

Imports.—In 1954 imports of mica of all varieties decreased 19 percent in quantity compared with 1953 (tables 19 and 20). Most categories contributed to the decline in imports, but the largest factor was the 42 percent drop in the quantity of films and splittings entering the United States.

Imports of muscovite block and film in 1954 were 50 percent less than in 1953 (table 21). Brazil furnished 57 percent of these total imports and India, 39 percent. Of the Stained or Better qualities of block and film mica, India furnished 49 percent and Brazil, 47 percent.

Tariff Commission compilations of general imports of muscovite block and film mica by quality and principal source are compared in table 22 with United States Department of Commerce data on imports for consumption of unmanufactured and manufactured muscovite mica.

TABLE 19.—Mica imported into and exported from the United States, 1945–49 (average) and 1950–54

[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
1945–49 (average)	3,152,622	$2,435,890	4,762	$62,696	6,801	$8,673,326	13,139	$11,171,912	1,305	$690,804
1950	3,334,652	3,094,616	4,402	59,014	12,441	20,506,774	18,510	23,660,404	1,547	859,796
1951	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	[1] 10,910,292	10,990	[1] 15,261,665	2,402	1,109,865
1954	1,829,457	[2] 3,197,918	4,647	[2] 63,341	3,363	[2] 5,448,706	8,924	[2] 8,709,965	3,328	1,514,738

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

[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 20.—Mica imported for consumption in the United States, 1945–49 (average), 1950–53 [1] (totals) and 1954, 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
1945–49 (average)	3,682,943	$25,721	5,841,347	$36,975	301,936	$50,371	648,370	$78,254	2,202,316	$2,307,265
1950	896,400	6,988	7,908,526	52,026	129,400	21,755	429,269	41,384	2,775,983	3,031,477
1951	494,740	4,284	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:										
North America:										
Canada	448,171	6,487			40,050	9,448	14,408	1,009	3,811	7,717
Mexico									198	149
Total	448,171	6,487			40,050	9,448	14,408	1,009	4,009	7,866
South America:										
Argentina							22,046	1,546	27,022	11,658
Brazil							93,871	8,374	934,730	1,498,884
Total							115,917	9,920	961,752	1,510,542
Europe:										
France									716	3,200
Germany, West									5,843	3,665
United Kingdom									779	3,420
Total									7,338	10,285
Asia: India			6,472,939	37,032					570,325	1,468,785
Africa:										
Angola							2,205	265	10,184	16,495
British East Africa									25,331	75,933
Federation of Rhodesia and Nyasaland			314,995	1,545					2,547	2,044
Madagascar									68,395	73,742
Mozambique									6,334	8,155
Union of South Africa	101,305	1,034	1,956,512	17,243					500	369
Total	101,305	1,034	2,271,507	18,788			2,205	265	113,291	176,738
Oceania:										
Australia									162	3,060
Total unmanufactured	549,476	7,521	8,744,446	[2]55,820	40,050	9,448	132,530	11,194	1,656,877	[2,3]3,177,276

See footnotes at end of table.

TABLE 20.—Mica imported for consumption in the United States, 1945–49 (average), 1950–53 [1] (totals) and 1954, by kinds and by countries of origin—Con.

Country	Manufactured—films and splittings							
	Not cut or stamped to dimensions				Cut or stamped to dimensions		Total films and splittings	
	Not above 12/10,000 inch thick		Over 12/10,000 inch thick					
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1945–49 (average)	11, 754, 623	$7, 880, 167	592, 595	$558, 861	16, 023	$77, 195	12, 363, 241	$8, 516, 223
1950	23, 086, 329	18, 387, 967	1, 090, 082	1, 505, 827	27, 799	363, 097	24, 204, 210	20, 256, 891
1951	19, 665, 057	13, 533, 318	1, 823, 938	3, 848, 677	43, 405	729, 059	21, 532, 400	18, 111, 054
1952	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	[1] 2, 645, 230	[1] 5, 069, 044	69, 349	1, 218, 721	[1] 11, 092, 452	[1] 10, 329, 737
1954:								
North America:								
Mexico			75, 905	67, 546	5, 892	115, 088	81, 797	182, 634
South America:								
Brazil	110	123	665, 216	613, 816			665, 326	613, 939
Uruguay			508	646			508	646
Total	110	123	665, 724	614, 462			665, 834	614, 585
Europe:								
France	1, 102	471			14	251	1, 116	722
Germany, West					3, 153	100, 836	3, 153	100, 836
Italy					255	7, 032	255	7, 032
United Kingdom					7, 548	193, 711	7, 548	193, 711
Total	1, 102	471			10, 970	301, 830	12, 072	302, 301
Asia:								
India	4, 436, 721	1, 484, 145	721, 122	1, 945, 617	6, 937	99, 462	5, 164, 780	3, 529, 224
Japan					6, 478	143, 655	6, 478	143, 655
Total	4, 436, 721	1, 484, 145	721, 122	1, 945, 617	13, 415	243, 117	5, 171, 258	3, 672, 879
Africa:								
Angola			125	276			125	276
British East Africa	12, 406	4, 949	5, 250	6, 903			17, 656	11, 852
Madagascar	356, 999	168, 096	124, 098	108, 921			481, 097	277, 017
Total	369, 405	173, 045	129, 473	116, 100			498, 878	289, 145
Total films and splittings	4, 807, 338	[2] 1, 657, 784	1, 592, 224	[2] 2, 743, 725	30, 277	[2] 660, 035	6, 429, 839	[2] 5, 061, 544

See footnotes at end of table.

TABLE 20.—Mica imported for consumption in the United States, 1945–49 (average), 1950–53 [1] (totals) and 1954, by kinds and by countries of origin—Con.

Country	Manufactured—cut or stamped to dimensions, shape, or form		Manufactured—other: Mica plates and built-up mica		Manufactured—other: All mica manufactures of which mica is the component material of chief value		Manufactured—other: Ground or pulverized	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1945–49 (average)	150, 878	$115, 242	1, 965	$3, 637	6, 814	$11, 075	1, 082, 428	$27, 149
1950	82, 353	112, 136	9, 779	25, 619	25, 590	86, 314	560, 000	25, 814
1951	106, 176	119, 008	25, 840	79, 568	55, 566	217, 281	779, 910	41, 237
1952	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:								
North America:								
Canada			250	2, 267			200, 000	12, 000
Mexico	3, 359	4, 547	12, 260	27, 419	8, 497	23, 895		
Total	3, 359	4, 547	12, 510	29, 686	8, 497	23, 895	200, 000	12, 000
South America:								
Brazil	57	1, 853			32, 374	125, 933		
Europe:								
Germany, West			4, 501	7, 178				
Italy			1, 007	34, 176	94	3, 052		
United Kingdom			2, 575	65, 987	1, 720	25, 029		
Total			8, 083	107, 341	1, 814	28, 081		
Asia: India	24, 360	45, 520	3, 000	4, 496	716	3, 810		
Total manufactured	27, 776	51, 920	23, 593	[2] 141, 523	43, 401	[2] 181, 719	200, 000	12, 000

[1] Changes in Minerals Yearbook, 1953, should read as follows: Manufactured (films and splittings): Not cut or stamped to dimensions and over 12/10,000 inch thick—India, 1,298,790 pounds ($3,647, 365); total—India, 8,906,695 pounds ($7,407,139).

[2] Due to changes in tabulating procedures by U. S. Department of Commerce data known not to be comparable to earlier years.

TABLE 21.—Muscovite block and film mica, United States general imports, 1953–54, by quality and principal sources,[1] [2] in pounds

Quality	Total		Countries					
			India		Brazil		Other	
	1953	1954	1953	1954	1953	1954	1953 [3]	1954 [4]
Block:								
Good Stained or Better	527, 967	213, 206	298, 387	72, 479	191, 402	121, 349	38, 178	19, 378
Stained	2, 395, 272	1, 193, 410	1, 189, 206	515, 904	1, 135, 899	639, 009	70, 167	38, 497
Heavy Stained	989, 576	571, 034	276, 062	110, 488	675, 425	426, 582	38, 089	33, 964
Lower	551, 353	309, 601	236, 541	84, 504	296, 753	225, 097	18, 059	--------
Total	4, 464, 168	2, 287, 251	2, 000, 196	783, 375	2, 299, 479	1, 412, 037	164, 493	91, 839
Film:								
First quality	116, 212	54, 831	116, 210	54, 771	--------	--------	2	60
Second quality	329, 426	136, 414	327, 003	135, 904	1, 267	--------	1, 156	510
Other quality	5, 176	2, 900	4, 976	2, 900	200	--------	--------	--------
Total	450, 814	194, 145	448, 189	193, 575	1, 467	--------	1, 158	570
Block and film:								
Good Stained or Better [5]	973, 605	404, 451	741, 600	263, 154	192, 669	121, 349	39, 336	19, 948
Stained [6]	2, 400, 448	1, 196, 310	1, 194, 182	518, 804	1, 136, 099	639, 009	70, 167	38, 497
Heavy Stained	989, 576	571, 034	276, 062	110, 488	675, 425	426, 582	38, 089	33, 964
Lower	551, 353	309, 601	236, 541	84, 504	296, 753	225, 097	18, 059	--------
Total	4, 914, 982	2, 481, 396	2, 448, 385	976, 950	2, 300, 946	1, 412, 037	165, 651	92, 409

[1] Compiled by the U. S. Tariff Commission from official documents of the U. S. Bureau of Customs.
[2] For 1953, does not include imports of mixed grades and qualities from Angola, Australia, Brazil, Canada, Portugal, and Union of South Africa—total, 32,359 pounds. For 1954, does not include imports of mixed grades and qualities from Angola, Brazil, Canada, Mexico, Portuguese East Africa, and Union of South Africa—total, 79,130 pounds.
[3] Includes imports from Argentina, Canada, Mexico, Northern Rhodesia, Southern Rhodesia, and Tanganyika.
[4] Includes imports from Tanganyika.
[5] Includes first- and second-quality film.
[6] Includes other-quality film.

TABLE 22.—Mica block and film imported into the United States, 1953–54, by variety and principal sources, in pounds

	U. S. Tariff Commission data		U. S. Department of Commerce data	
	1953	1954	1953	1954
Muscovite block:				
India	2, 000, 196	783, 375	[1] 1, 016, 040	570, 325
Brazil	2, 299, 479	1, 412, 037	[1] 2, 123, 059	1, 599, 946
Other	[2] 164, 493	[3] 91, 839	[1] 100, 480	105, 171
Total	4, 464, 168	2, 287, 251	[4] 3, 239, 579	[4] 2, 275, 442
Muscovite film:				
India	448, 189	193, 575	[1] [5] 1, 298, 790	[5] 721, 122
Brazil	1, 467	--------	--------	--------
Other	1, 158	570	--------	--------
Total	450, 814	194, 145	1, 298, 790	721, 122

[1] Revised figure.
[2] Includes imports from Argentina, Canada, Mexico, Northern Rhodesia, Southern Rhodesia, and Tanganyika.
[3] Includes imports from Tanganyika.
[4] Includes imports of unmanufactured mica valued about 15 cents per pound, minus phlogopite valued about 15 cents per pound, plus imports from Brazil of manufactured films and splittings, not cut or stamped to dimensions, over 12/10,000 inch thick.
[5] Manufactured films and splittings, not cut or stamped to dimensions, over 12/10,000 inch thick, from India.

Exports.—Exports of mica and mica products in 1954 compared with 1953 increased 39 percent in quantity. Exports of ground mica, constituting the bulk of the mica exported, increased 33 percent, and other manufactured mica exports increased 42 percent. Exports of unmanufactured mica were 7 times those in 1953.

TABLE 23.—Mica and manufactures of mica exported from the United States 1945–49 (average), 1950–53 (totals), and 1954, by countries of destination

[U. S. Department of Commerce]

Country	Unmanufactured		Manufactured			
			Ground or pulverized		Other	
	Pounds	Value	Pounds	Value	Pounds	Value
1945–49 (average)	272,712	$44,021	2,067,126	$103,660	270,770	$543,123
1950	335,941	98,614	2,567,807	158,947	190,075	602,235
1951	398,662	93,572	3,136,548	189,836	254,179	818,569
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:						
North America:						
Canada	60,472	2,860	2,177,050	88,000	172,542	701,254
Cuba			244,000	11,522	2,495	5,841
Mexico	121,232	17,609	225,000	11,231	2,723	10,412
Panama					400	2,810
Total	181,704	20,469	2,646,050	110,753	178,160	720,317
South America:						
Brazil					5,113	20,119
Chile	200	2,740			716	2,252
Peru					2,151	3,797
Surinam					170	1,260
Venezuela			844,100	43,632	10,600	3,185
Total	200	2,740	844,100	43,632	18,750	30,613
Europe:						
Belgium-Luxembourg	325	1,001	546,700	51,272	17,717	98,461
France			616,418	47,645	22,646	59,874
Germany, West			469,000	38,140		
Iceland			19,500	1,350		
Italy			289,000	16,690	3,493	13,659
Netherlands			146,100	9,779	28,513	132,747
Sweden			17,650	1,552	3,327	11,901
Switzerland			17,600	1,554		
Turkey					426	1,009
United Kingdom	15,800	34,386	60,000	3,975		
Total	16,125	35,387	2,181,968	171,957	76,122	317,651
Asia:						
India	9,285	18,426	60,000	4,200	100	1,158
Indonesia					416	1,151
Israel			16,000	898		
Japan	111,204	2,288	60,000	2,020	5,003	15,829
Philippines			60,000	2,500	542	1,364
Total	120,489	20,714	196,000	9,618	6,061	19,502
Africa:						
Belgian Congo			20,000	1,250		
Liberia					850	1,040
Tunisia			50,000	2,165		
Union of South Africa			120,000	3,485	110	639
Total			190,000	6,900	960	1,679
Oceania: Australia					362	2,806
Grand total	318,518	79,310	6,058,118	342,860	280,415	1,092,568

TECHNOLOGY

In research on synthetic mica at the Electrotechnical Laboratory, Norris, Tenn., the Bureau of Mines continued to investigate means of growing large single crystals of synthetic mica. In another approach to the problem of substitutes for synthetic block and film mica, various methods were tried for bonding synthetic-mica flake into a continuous sheet having properties suitable for electronic applications. A reconstituted sheet produced by bonding a high-melting synthetic mica with a low-melting synthetic mica, as described in a patent,[7] was not suitable for electronic uses, but some promise was shown by other methods under development. Work continued on the development of synthetic mica-metal cermets as materials of construction and on the measurement of their physical properties. Samples of low-melting synthetic micas were prepared for industrial evaluation as bonding agents in abrasive wheels. Combinations of synthetic mica with boron nitride or nickel powder gave materials for possible use as abradable seals. Isomorphic substitution and subsequent hydrogen reduction of nickel in the fluorphlogopite lattice gave a material potentially useful for compacting into precision noninductive electrical resistors. In further studies on synthetic mica ceramics as dielectric materials, the experimental development and measured properties of phosphate-bonded micas of several compositions were described in detail,[8] and the effect of temperature on the dielectric properties of hot-pressed synthetic mica ceramics up to 400° C. was compared with corresponding data on related commercial materials.[9] Means of achieving the necessary close control of furnacing operations in various phases of the research were reported.[10] Results of the investigation of accurate methods for analyzing fluorsilicates were published.[11] During advanced engineering studies in cooperation with the Mycalex Corp. of America on the internal electric-resistance melting process for synthesizing mica, a total of 80 tons of synthetic mica was produced with some individual melts as large as 6 tons. These large-scale experiments demonstrated that synthetic mica flake could be produced at an operating cost of about 12 cents per pound, exclusive of capital and overhead charges.

On the basis of the results of these large-scale tests, Mycalex Corp. began constructing a plant at Caldwell, N. J., to have a capacity of 1,000 tons of synthetic-mica flake per year.[12] This material is not a substitute for strategic block and film mica but has properties superior to natural mica when used in glass-bonded ceramics. The company

[7] Hatch, R. A., and Comeforo, J. E. (assigned to United States of America as represented by the Secretary of the Interior), Synthetic Mica Containing Fluorine: U. S. Patent 2,675,853, Apr. 20, 1954.

[8] Comeforo, J. E., Synthetic Mica Investigations: V, A Low-Shrinkage Machinable Ceramic of Phosphate-Bonded Synthetic Mica: Jour. Am. Ceram. Soc., vol. 37, No. 9, September 1954, pp. 427–432.

[9] Comeforo, J. E., and Hatch, R. A., Synthetic Mica Investigations: IV, Dielectric Properties of Hot-Pressed Synthetic Mica and Other Ceramics at Temperatures up to 400° C.: Jour. Am. Ceram. Soc., vol. 37, No. 7, July 1954, pp. 317–322.

[10] Humphrey, R. A., and Worden, E. C., Synthetic Mica Investigations: III, Precision-Controlled Electric Furnaces for Temperatures up to 1,500° C.: Jour. Am. Ceram. Soc., vol. 37, No. 4, April 1954, pp. 196–202.

[11] Shell, H. R., and Craig, R. L., Determination of Fluoride and Silica in Fluorsilicates: Anal. Chem., vol. 26, No. 6, June 1954, pp. 996–1001.

[12] Chemical Week, Strategic Synthesis: Vol. 74, No. 21, May 22, 1954, pp. 46–57.
Engineering and Mining Journal, Metal and Mineral Markets: Vol 25, No. 20, May 20, 1954, p. 7.
The Mining Journal (London), Synthetic Mica Production This Year: Vol. 242, No. 6197, May 28, 1954, pp. 635–636.
Daily Metal Reporter, Synthetic Mica Plant Due to Start Output in 1955: Vol. 54, No. 222, Nov. 20, 1954, p. 2.
Engineering and Mining Journal, Synthetic Mica Corp.: Vol. 155, No. 12, December 1954, p. 117.

expected to continue research on producing large sheets of synthetic mica. Synthetic Mica Corp. was organized as a wholly owned subsidiary responsible for synthetic mica production and research.

An article discussed the possibilities of using synthetic mica to produce glass-bonded mica, reconstituted sheets, and hot-pressed machinable blocks and where possible compared the corresponding use of natural mica.[13] A method of manufacturing a glass-bonded mica was patented [14] and electrical tests of glass-bonded mica were reported.[15] Detailed results were given of tests with a hot-pressed synthetic mica which showed promise for applications in vacuum tubes.[16]

Additional results of investigations by Brush Beryllium Co., Cleveland, Ohio, under contract to the Office of Naval Research, included the effects of manufacturing variables on properties of a hot-pressed synthetic mica. The synthetic mica used in these tests was a microcrystalline material made by solid-state reaction.[17] Hot-pressed synthetic mica was being considered for use as a heat-resistant material in jet engine construction.[18]

A patent was issued for electrical insulation composed of mica flakes bonded to pliable synthetic-resin sheets,[19] and a new device for industrial inspection of mica insulating tape for voids was announced.[20]

The process of Integrated Mica Corp., Woodmere, N. Y., for manufacturing mica paper from natural mica scrap was described.[21]

Intricate dies for fabricating mica required specialized production methods.[22] The performance of mica components in electronic tubes [23] and capacitors [24] was investigated.

The Bureau of Mines issued a progress report on its investigations to develop an integrated process for recovering a major portion of the economic minerals, including mica, of the pegmatites of the Black Hills, S. Dak.[25]

The Federal Geological Survey released a report on the pegmatites of New Hampshire, Maine, and Connecticut, which contain significant deposits of mica and other minerals.[26]

Two articles appeared which discussed natural sheet mica, especially its classification.[27]

13 Merrill, T. B., Jr., Three Forms of Synthetic Micas: Materials and Methods, vol. 40, No. 2, August 1954, pp. 80–83.

14 Kilpatrick, J. S., Manufacture of Micaceous Insulating Materials: U. S. Patent 2,669,764, Feb. 23, 1954.

15 Materials and Methods, Glass-Bonded Mica: Vol. 39, No. 4, April 1954, p. 192.

16 Hanley, T. E., Synthetic Mica for Vacuum-Tube Use: Office of Naval Research, Research Reviews, February 1954, pp. 7–10.

17 Beaver, W. W., and Theodore, J. G., Fabrication of Synthetic Micaceous Materials: Brush Beryllium Co., Cleveland, Ohio, Quarterly Status Rept., Dec. 15, 1953 to Mar. 14, 1954, 13 pp.

18 Iron Age, Mica Enters Jet Field: Vol. 173, No. 22, June 3, 1954, p. 129.

19 Berberich, L. J., and Philofsky, H. M. (assigned to Westinghouse Electric Corp.), Electrical Coils Insulated With Mica and Synthetic Resins: U. S. Patent 2,656,290, Oct. 20, 1953.

20 South African Mining and Engineering Journal, Automatic Detection of Voids in Mica Insulating Tape: Vol. 55, No. 3194, May 1, 1954, p. 319.

21 Iron Age, Mica Paper; New Method Produces Paper-Thin Insulation Sheets: Vol. 174, No. 23, Dec. 9, 1954, p. 182.

Chemical and Engineering News, U. S. Manufactures Mica; Integrated Mica Corp.: Vol. 32, No. 51, Dec. 20, 1954, p. 5048.

22 Wright, J. P., Artists Sculpture Mica Dies: Am. Machinist, vol. 98, No. 19, Sept. 13, 1954, pp. 145–160.

23 Roberts, E. A. O., Study of Some Properties of Materials Affecting Valve Reliability: Proc. Inst. Elec. Eng. (London), vol. 101, part 3, No. 72, July 1954, pp. 197–205.

24 Rayner, G. H., and Ford, L. H., Performance of Dried and Sealed Capacitors: Jour. Sci. Instr., vol. 31, No. 1, January 1954, pp. 3–6.

25 Runke, S. M., Binyon, E. O., and Cunningham, J. B., Progress Report on Pegmatite Investigations in South Dakota, for Fiscal Years 1952–53: Bureau of Mines Rept. of Investigations 5061, 1954, 21 pp.

26 Cameron, E. N., and others, Pegmatite Investigations, 1942–45, New England: Geol. Survey Prof. Paper 255, 1954, 352 pp.

27 Otis, L. M., Charts Simplify Mica-Grading Problem: Eng. Min. Jour., vol. 155, No. 1, January 1954, p. 83.

Dietrich, W. F., and Waggaman, W. H., The Sheet-Mica Industry: Min. Cong. Jour., vol. 40, No. 10, October 1954, pp. 59–62, 77.

The American Society for Testing Materials revised the method of testing for power factor and dielectric constant of natural mica[28] and the specifications for natural-mica block and film.[29]

A flowsheet described recovery of punch and scrap mica from 12.5 tons per hour of ore containing about 25 percent mica,[30] and a patent covered a method of recovering mica by flotation.[31]

The effect of ground mica on the light resistance of latex alkyd paints was discussed in a pamphlet,[32] information on using mica as a pigment extender was reported,[33] and a method of using ground mica to conceal defects in a surface being finished was patented.[34]

WORLD REVIEW

The estimated world production of mica in 1954 was 12 percent greater than in 1953. The increase was almost entirely due to the increased quantity of scrap mica produced in the United States and India as sheet-mica production decreased in the principal producing countries.

Argentina.—Production of trimmed mica appeared to have leveled off at an annual rate of about 264 short tons, with production of scrap about 4 times as much. Exports of trimmed mica in 1954 totaled about 41 short tons, mostly to Italy, compared with 112 short tons in 1953.[35]

Australia.—All block mica produced was purchased at controlled prices by the Commonwealth Mica Pool. In October 1954 the Minister of Supply announced the Cabinet's decision to continue to operate the Commonwealth Mica Pool for an additional 5 years, to December 31, 1959. In 1953–54 the value of the ouptut of the Hart's Range and Plenty River districts, Northern Territory, averaged about £30,000 per quarter (1 Australian £ equaled US$2.2263).[36]

Brazil.—Exports of mica decreased from 1,316 short tons in 1953 to 727 in 1954. The Government's doubling of the minimum wage and the attempt to eliminate the practice of undervaluation of exports narrowed the profit margin of exporters.[37]

Canada.—Production of mica declined 34 percent in quantity and 44 percent in value below 1953. Phlogopite production came largely from Quebec, where Templeton, Wakefield, Buckingham, Wentworth, and Amherst townships supplied significant quantities. Ontario produced the remainder of the phlogopite in North Burgess and Bedford townships. No production of muscovite was reported in 1954. Geo. W. Richmond Co., Ltd., and Fairey & Co., Ltd., both of Vancouver, continued to grind mica schist, mined near Alberta, for the roofing

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[28] American Society for Testing Materials, Standard Method of Test for Power Factor and Dielectric Constant: D–1082–54, 1954, pp. 931–934.

[29] American Society for Testing Materials, Tentative Specifications for Natural Block Mica and Mica Films Suitable for Use in Fixed Mica-Dielectric Capacitors: D–748–54T, 1954, pp. 906–921.

[30] Denver Equipment Co., Size Separation Mica: Bull. No. M7–F28, 1954, 2 pp.

[31] Zukosky, A. W., Treatment of Froth Flotation Concentrates: U. S. Patent 2,665,004, Jan. 4, 1954.

[32] Wet-Ground Mica Assoc. Inc., Studies on the Effect of Mica in Latex Alkyd Paints: Bull. 17, 1954, 2 pp.

[33] McCleary, R. L., Developments in Calcium Carbonate and Mica Extender Pigments: Paint, Oil and Chemical Rev., vol. 117, No. 7, Apr. 8, 1954, p. 32.

[34] Kowall, A. E. (assigned one-half to E. A. Kirwin), Concealing Defects in a Surface: U. S. Patent 2,663,651, Dec. 22, 1953.

[35] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 4, April 1955, p. 51.

[36] Mining World and Engineering Record, Mica in Australia: Vol. 167, No. 4353, Sept. 4, 1954, p. 138. Chemical Engineering and Mining Review (Melbourne), vol. 47, No. 1, Oct. 11, 1954, p. 31. Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 4, October 1954, pp. 60–61.

[37] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 4, April 1955, pp. 51–52. State Department Despatch No. 816, American Embassy, Rio de Janeiro, Brazil, Dec. 27, 1955, p. 3.

TABLE 24.—World production of mica, by countries,[1] 1945–49 (average) and 1950–54, in thousand pounds [2]

(Compiled by Helen L. Hunt)

Country [1]	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Canada (sales):						
Block	7,094	284	615	183	280	1,504
Splittings		2	7	7	9	
Ground		2,216	2,064	988	666	
Scrap		1,376	2,277	838	1,312	
United States (sold or used by producers):						
Sheet	715	579	595	698	849	662
Scrap	91,788	138,720	143,742	150,472	146,518	162,146
Total	99,597	143,177	149,300	153,186	149,634	164,312
South America:						
Argentina:						
Sheet	1,951	165	397	485	540	529
Scrap [3]		2,200	2,200	2,200	2,200	2,200
Brazil	3,256	3,997	3,655	4,676	4,347	[3] 2,200
Peru	309	—	—	—	—	—
Uruguay	11	2	2	2	2	—
Total [3]	5,500	6,400	6,300	7,400	7,100	5,000
Europe:						
Austria	231	811	677	—	—	—
Italy	60	—	—	—	—	—
Norway, including scrap	384	1,219	2,172	1,171	2,185	[3] 2,200
Spain	24	31	24	18	29	18
Sweden:						
Block	209	4	93	18	7	4
Ground		364	381	346	377	331
Total [1] [3]	29,000	43,000	59,000	57,000	58,000	58,000
Asia:						
Ceylon	—	—	(4)	20	13	—
India (exports):						
Block	25,331	1,704	3,609	3,261	3,840	3,034
Splittings		26,610	30,730	12,650	12,211	10,950
Scrap		8,236	20,615	18,516	11,444	26,105
Korea:						
Korea, Republic of	[3] 110	—	—	13	—	—
North Korea		(5)	(5)	(5)	(5)	(5)
Taiwan (Formosa):						
Sheet	18	—	33	2	51	44
Scrap		—	1,036	29		
Total [1] [3]	25,600	36,800	57,100	36,700	32,000	51,200
Africa:						
Angola:						
Sheet	134	33	33	64	42	24
Scrap and splittings		340	267	441	22	362
Eritrea	2	2	—	—	—	—
French Morocco:						
Sheet	[6] 152	2	26	—	(5)	11
Scrap		163	55	13	29	18
Kenya	2	13	2	4	—	—
Madagascar (phlogopite):						
Block	[7] 1,325	126	2,112	90	115	101
Splittings		1,680	—	2,266	1,684	1,056
Mozambique, including scrap	49	90	24	4	7	2
Rhodesia and Nyasaland, Federation of:						
Northern Rhodesia, sheet	4	4	13	35	18	7
Southern Rhodesia:						
Block	628	168	207	209	148	183
Scrap		730	560	1,464	201	—
South West Africa, scrap	—	130	251	—	—	—
Tanganyika (exports):						
Block	366	110	154	238	165	174
Ground		132	—	33	—	—
Scrap		55	—	2	115	62
Uganda	4	(4)	(4)	(4)	—	(4)

See footnotes at end of table.

TABLE 24.—World production of mica, by countries,[1] 1945–49 (average) and 1950–54, in thousand pounds [2]—Continued

Country [1]	1945–49 (average)	1950	1951	1952	1953	1954
Africa—Continued						
Union of South Africa:						
Sheet	3, 241	31	11	11	11	4
Scrap		2, 992	3, 911	5, 871	4, 284	4, 107
Total	5, 907	6, 801	7, 626	10, 745	6, 841	6, 111
Oceania: Australia [8]	847	1, 627	1, 182	1, 105	1, 069	1, 316
World total (estimate)[1]	165, 000	240, 000	280, 000	265, 000	255, 000	285, 000

[1] In addition to countries listed, mica is also produced in China, Rumania, and U. S. S. R., but data on production are not available; estimates for these countries are included in total.
[2] This table incorporates a number of revisions of data published in previous Mica chapters.
[3] Estimate.
[4] Less than 0.5 ton.
[5] Data not available; estimate by senior author of chapter included in total.
[6] Average for 1946–49.
[7] Includes a small tonnage of muscovite.
[8] These figures include the following tonnages of damourite produced in South Australia, in thousands of pounds: 1945–49 average, 745; 1950, 1,559; 1951, 1,131; 1952, 1,032; 1953, 996; 1954, 1,151.

TABLE 25.—Salient statistics of the Canadian mica industry, 1953–54 [1]

	1953		1954	
	Pounds	Value	Pounds	Value
Production (primary sales):				
Trimmed	50, 933	$65, 949	(²)	(²)
Splittings	8, 289	16, 568	(²)	(²)
Sold for mechanical splittings	168, 537	30, 521	(²)	(²)
Rough, mine run, or rifted	62, 744	5, 310	(²)	(²)
Ground or powdered	664, 741	25, 236	(²)	(²)
Scrap	1, 309, 884	17, 544	(²)	(²)
Total	2, 265, 128	161, 128	1, 503, 229	$90, 479
Imports (including manufactures), from:				
India	(²)	231, 519	(²)	43, 666
United Kingdom	(²)	16, 021	(²)	14, 417
United States	(²)	472, 004	(²)	395, 122
Total	(²)	719, 544	(²)	453, 205
Exports, unmanufactured:				
Rough, to: United States	240, 500	43, 704	60, 200	12, 647
Trimmed, to:				
Japan	57, 800	55, 775	16, 800	18, 884
United States	21, 600	37, 785	600	2, 699
Total	79, 400	93, 560	17, 400	21, 583
Scrap, to: United States	1, 354, 700	19, 583	453, 600	6, 241
Ground, to:				
France			40, 000	1, 319
United States	320, 000	19, 158	200, 000	12, 000
Total	320, 000	19, 158	240, 000	13, 319
Total exports of unmanufactured mica	1, 994, 600	176, 005	771, 200	53, 790
Exports, mica manufactures, to:				
Brazil	(²)			512
United States	(²)	123		2, 335
Total	(²)	123		2, 847

[1] Bruce, C. G., Mica in Canada, 1954 (Prelim.), Canadian Dept. of Mines and Tech. Surveys, 1954, pp. 2–3.
[2] Data not available.

industry.[38] Salient statistics of the Canadian mica industry in 1953 and 1954 are shown in table 25.

Finland.—Mica, which occurs in several localities, was produced in connection with feldspar operations of Suomen Mineraali Oy. Imports of mica in 1954 totaled 13 tons.[39]

French Morocco.—The Société des Mines de Zenaga is exploring the mica lens at Timgharine.[40]

At the Mines des Timghraghrine in 1954, 10,204 pounds of sheet mica, no punch mica, and 8.8 short tons of scrap mica were produced.[41]

India.—The Government referred the question of a central organization to regulate mica exports to the Madras Mica Assoc., which advised against setting up such an organization.[42]

Production of mica, as given by the Geological Survey of India, is shown in table 26.[43]

TABLE 26.—Production of mica in India, 1954 [1]

	Pounds	Value
Sheet (block)	3,616,256	$7,562,162
Splittings	10,855,040	6,023,108
Other	23,032,240	217,948
Total	37,503,536	13,803,218

[1] Data from Geological Survey of India.

Mozambique.—Production of mica in 1954 totaled 1,694 pounds.[44]

Northern Rhodesia.—Sheet-mica production in 1954 was 6,464 pounds valued at £808 compared with 16,439 pounds valued at £4,841 in 1953 (£1 equals about US$2.81).[45]

Southern Rhodesia.—The principal mica deposits are in the Miami district. About half the known mines in this district operated in 1954. About 9 percent of the mica recovered in Southern Rhodesia was usable, and the balance was left in immense dumps of scrap. These increasing piles of scrap mica constituted a potential basis for establishing an industry to recover punch mica and other pieces suitable for electrical use and to produce ground mica. Most exports of mica went to the United Kingdom.[46]

A total of 184,897 pounds of block mica valued at £53,776 was produced in 1954 compared with 147,068 pounds valued at £47,073 in 1953 (£1 equals about US$2.81).[47]

Taiwan.—Scheduled production of mica by the Taiwan Mica Mining Co. was postponed because of lack of capital, uncertainty as to the quantity and quality of the mica in the deposits, and the question of

[38] Bruce, C. G., Mica in Canada, 1954 (Prelim.): Canadian Department of Mines and Tech. Surveys, 1954, 9 pp.
[39] State Department Despatch 7, Helsinki, Finland, July 5, 1955, p. 4.
[40] Mining World, French Morocco: Vol. 16, No. 11, October 1954, p. 77.
[41] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 4, April 1955, pp. 52–53.
[42] Industrial and Mining Standard (Melbourne), Export of Mica From India: Vol. 109, No. 2757, Jan. 21, 1954, p. 4.
[43] State Department Despatch 403, New Delhi, India, Nov. 25, 1955.
[44] State Department Despatch 61, Lourenco Marques, Oct. 27, 1955.
[45] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 2, August 1955, pp. 42–43.
[46] South African Mining and Engineering Journal, Scrap Mica in Southern Rhodesia: Vol. 65, Part I, No. 3195, May 8, 1954, p. 355.
[47] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 2, August 1955, pp. 42–43.

the ability of the dry-grinding process to produce a high-quality mica powder.[48]

Tanganyika.—Only 66.2 short tons of sheet mica was produced in 1954, compared with 88.3 short tons in 1953. The quantity of sheet mica exported in 1954—about 86 short tons—was almost the same as in 1953, but the value was about 30 percent lower. The Uluguru Mica Mining Cooperative Society, Ltd., was formed. Its members, all Africans, mined mica in the area of a mining lease and marketed it collectively.[49]

Union of South Africa.—Production in 1954 of sheet mica totaled 3,968 pounds compared with 10,872 pounds in 1953, and production of scrap mica totaled 2,054 tons compared with 2,142 tons in 1953. Exports were of scrap mica only and totaled 4,258 tons valued at £37,572 f. o. b. in 1954 compared with 2,315 tons valued at £18,261 in 1953 (£1 equals US$2.80).[50]

An article reported that good-quality mica of various grades is abundantly scattered through the mineralized pegmatites of Namaqualand. Most of the mica is less than 1 inch in diameter, but material 6 inches and over is quite abundant. However, the remoteness of the area makes economic mining of the mica unlikely.[51]

[48] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 4, October 1954, p. 61.
[49] State Department Despatch 125, Dares Salaam, Tanganyika, July 13, 1954, p. 19.
South African Mining and Engineering Journal, Tanganyika's Mineral Production in 1954: Vol. 65, No. 3235, Part 2, Feb. 12, 1955, p. 1047.
[50] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 1, July 1955, p. 46.
[51] South African Mining and Engineering Journal, Namaqualand's Mineral Wealth: Vol. 64, No. 3184, Part II, Feb. 20, 1954, p. 889.

Molybdenum

By Wilmer McInnis[1] and Mary J. Burke[2]

UNITED States production of molybdenum concentrate in 1954 was 90 percent of the estimated world output. Domestic production and shipments of concentrate approached alltime highs set in 1943 and 1942, respectively. Consumption of concentrate and production of primary products[3] were less than in any year since 1949. Industry stocks of both concentrate and primary products declined in 1954.

Exports of molybdenum ore and concentrate in 1954 increased 92 percent over 1953 and were higher than in any year since they have been recorded in pounds of contained molybdenum.

Effective December 10, 1954, quoted prices for molybdenite concentrate and several primary products were advanced about 10 percent.

TABLE 1.—Salient statistics of molybdenum in the United States, 1945–49 (average) and 1950–54, thousand pounds of contained molybdenum

	1945–49 (average)	1950	1951	1952	1953	1954
Concentrate:						
Production of concentrate	25, 060	28, 480	38, 855	43, 259	57, 243	58, 668
Shipments of concentrate [1]	25, 122	44, 544	37, 955	42, 717	53, 823	64, 779
Value of shipments, thousand dollars [2]	18, 087	37, 729	36, 177	40, 845	52, 362	64, 843
Shipments for export	[3] 2, 967	5, 386	3, 270	5, 290	5, 893	12, 974
Consumption of concentrate	22, 605	26, 029	33, 691	32, 715	31, 193	24, 710
Imports for consumption	50	3	4	50	--------	154
Stocks of concentrate, end of year [4]	20, 037	4, 326	5, 058	6, 856	11, 326	5, 317
Primary products: [5]						
Production of products	22, 435	25, 348	32, 775	32, 383	30, 283	24, 328
Shipments to domestic destinations	20, 437	32, 736	29, 845	30, 211	29, 595	23, 717
Shipments for export [6]	1, 033	1, 955	1, 388	1, 844	1, 107	1, 640
Total shipments of primary products	21, 470	34, 691	31, 233	32, 055	30, 702	25, 357
Stocks of primary products [7]	8, 980	1, 495	3, 037	3, 373	3, 894	3, 430

[1] Including exports.
[2] Largely estimated by Bureau of Mines.
[3] Actual exports; includes roasted concentrate except for 1949.
[4] At mines and at plants making molybdenum products.
[5] Comprises ferromolybdenum, molybdic oxide, and molybdenum salts and metal.
[6] Reported by producers to the Bureau of Mines.
[7] Producers' stocks, end of year.

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[1] Commodity-industry analyst.
[2] Statistical clerk.
[3] Includes ferromolybdenum, molybdic oxide, and molybdenum salts and metal.

DOMESTIC PRODUCTION OF ORES AND CONCENTRATES[4]

Total production of molybdenum in concentrate in 1954 was 2 percent more than in 1953 but 5 percent less than the alltime high set in 1943; however, domestic monthly production reached an alltime high in November but declined in December.

Virtually all molybdenum mined in 1954 was derived from the mineral molybdenite (MoS_2). A relatively small quantity of molybdenum was derived from the mineral powellite [$Ca(Mo,W)O_4$] as a byproduct of tungsten-mining operations. Some molybdenum contained in tungsten concentrate is recovered at steel plants; this material is not included in the statistical tables.

Molybdenite was produced at mines operated chiefly for molybdenum and as a byproduct from copper and tungsten mining operations. The molybdenite content of ore mined at the former ranged from about 0.45 to 2.7 percent; at the latter the range was about 0.01 to 0.07 percent. Concentrate produced from the ore ranged from about 54 to 92 percent molybdenite content. The output of mines operated chiefly for molybdenum increased 14 percent over 1953; byproduct concentrate from copper and tungsten operations decreased 19 percent. Byproduct molybdenum production as compared with production from mines operated chiefly for molybdenum is shown in figure 1 for the years since 1936, when byproduct production commenced.

Molybdenum was produced in six States in 1954. In order of importance they were: Colorado, Utah, Arizona, New Mexico, Nevada, and California. Shipments of molybdenum concentrate (metal content) comprised 51,805,000 pounds to domestic destinations and 12,974,000 pounds for export. Total shipments increased 20 percent compared with 1953 and were more than in any prior year except 1942. Nearly all of the concentrate consumed was shipped to plants in Pennsylvania and Ohio for conversion to primary products; however, the output of Miami Copper Co. was roasted before shipment. A relatively small quantity of molybdenite concentrate was used directly by a few steel companies as an addition in the ladle when both molybdenum and sulfur were required in the product.

Molybdenum Mines.—The Climax, Colo., mine of Climax Molybdenum Co. and the Questa, N. Mex., mine of the Molybdenum Corp. of America were the only domestic mines operated chiefly for molybdenum in 1954. Construction and development at the Climax mine completed early in the year raised the daily ore capacity to about 27,000 tons, according to the company annual report to the stockholders.[5] "The mine produced and the mill treated 8,709,900 tons of ore during 1954." Production of concentrate was 14 percent more than in 1953. The Questa mine, which has been a regular producer since 1923, produced 1 percent more than in 1953.

Byproduct Sources.—Output of molybdenum concentrate as a byproduct of copper and tungsten mining declined 19 percent in 1954 compared with 1953. Reduced demand for copper early in 1954 and strikes at copper mines later in the year led to the lower output at copper operations.

[4] Production data for 1954 were collected jointly with the Bureau of the Census (U. S. Department of Commerce). Production totals will be compared with Census totals when they are available and differences adjusted or explained.

[5] Climax Molybdenum Co., Annual Report to the Stockholders, 1954, p. 3.

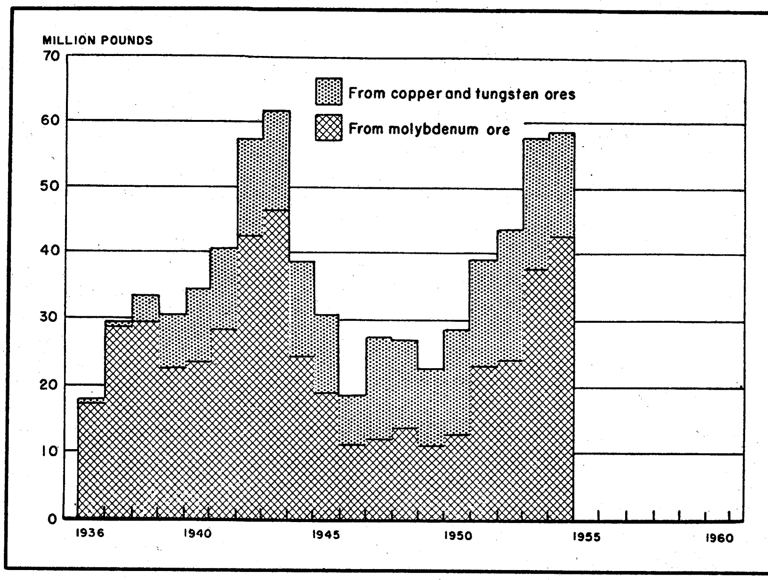

FIGURE 1.—Production of molybdenum contained in concentrates in the United States, 1936–54.

Bagdad Copper Corp., Bagdad, Ariz.; Kennecott Copper Corp., Chino Mines Division (Hurley, N. Mex.), Nevada Mines Division (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., operated units recovering molybdenum concentrates from copper ores. Bagdad Copper Corp. plans for more than doubling production over the next 10 years were described.[6]

United States Vanadium Co. recovered molybdenum concentrates and oxide as byproducts of tungsten ores and concentrates at its Pine Creek mill and chemical treatment unit near Bishop, Calif.

CONSUMPTION AND USES

Domestic consumption, as measured by primary products of molybdenum shipped to consumers, was the lowest since 1949.

Of the total molybdenum consumption in the United States, it is estimated that about 70 percent was employed in alloy steels, 15 percent in alloyed cast iron, and the remaining 15 percent in nonferrous alloys, nonmetallic uses, and as molybdenum metal.

Molybdenum-metal forms were produced in such basic shapes as wire, rod, sheet, plate, bar, and seamless tubing. Much of the wire was consumed in the electrical and electronic industry to make heaters for furnaces and supports for vacuum-tube components. Sheet was used to make plate and grids for vacuum tubes, furnace boats, and radiation shields. Molybdenum rod was used to make heavy-duty

[6] Mining World, This Is What Streamlined Mining and Improved Haulage Did for Bagdad: Vol. 7, No. 9, August 1954, pp. 40–43.

contact breakers, resistance-welding electrodes, and glass-to-metal seals. Seamless tubing was used in the chemical industry. The stocks, receipts, and disposition of molybdenum wire, rod, and sheet in 1954 are listed in table 2.

By far the largest use of molybdenum was in ferrous alloys to which it is added in the form of oxide, calcium molybdate, and ferromolybdenum, except for a relatively small quantity of molybdenite that is added to the ladle by some steel companies, when both sulfur and molybdenum are desired.

The alloying effect of molybdenum in steel is very pronounced. It is usually added in comparatively small amounts and generally in combination with other alloying elements. In general, some properties that molybdenum imparts to steel are: Promotes uniform hardness and strength, increases strength at elevated temperature, reduces softening when tempering, imparts red hardness to high-speed steel, and reduces the tendency of certain steels to become brittle after tempering.

The range of molybdenum-bearing steels can roughly be divided into low-molybdenum steels that contain 0.10 to 1.0 percent molybdenum and high-molybdenum steels that contain over 1.0 percent molybdenum. In cast iron molybdenum increases tensile strength, transverse strength and deflection, and hardness and improves resistance to fatigue.

Molybdenum was used in a wide variety of nonferrous and special-purpose alloys for its contribution to hardness, elevated-temperature strength, corrosion resistance, resistivity, or other desired property depending upon the type of base alloy. Some chemical uses of molybdenum compounds were: Reagents, catalysts, pigments, and lubricants and in fertilizers.

STOCKS

Industry stocks of both concentrates and products decreased during the year; details are listed in table 1.

TABLE 2.—Stocks, receipts and disposition of molybdenum wire, rod, and sheet in 1954, in thousand pounds of contained molybdenum

Product	Producers' stocks, Jan. 1, 1954	Production	Used to make other products listed here	Net production	Received from other producers	Shipments [1]	Net shipments	Producers' stocks, Dec. 31, 1954
Molybdenum powder	107	485	388	97	2	110	108	96
Molybdenum wire	11	89		89	1	98	97	3
Molybdenum rod	10	215	125	90	4	97	93	7
Miscellaneous [2]	3	139		139	1	140	139	3
Total	131	928	513	415	8	445	437	109

[1] Includes quantities consumed by producing firms for manufacture of products not listed here.
[2] Includes molybdenum wire; rod and sheet undistributed.

PRICES

Quoted prices for molybdenite concentrate, technical-grade molybdic oxide, calcium molybdate, and ferromolybdenum were increased about 10 percent, effective December 10, 1954. The new quoted prices, f. o. b. plant, were: Molybdenite concentrate containing a minimum of 90 percent MoS_2—\$1.05 per pound of contained molybdenum plus cost of containers; the previous price was 60 cents per pound of MoS_2 (equivalent to \$1 per pound of contained molybdenum). Technical-grade molybdic oxide—bagged \$1.24 and canned \$1.25 per pound of contained molybdenum. Calcium molybdate—\$1.28 per pound of contained molybdenum. Ferromolybdenum—55 to 65 percent molybdenum content; powdered \$1.57 and all other \$1.49 per pound of contained molybdenum. Molybdenum metal (99 percent) was quoted at \$3 a pound throughout 1954.

FOREIGN TRADE [7]

Combined exports of molybdenum ore and concentrates and roasted concentrates in 1954 reached an alltime high since they were first recorded in pounds of contained molybdenum in 1940 and were 92 percent higher than in 1953. Before 1940 exports were recorded in gross weight of concentrate. Exports are listed by countries in table 3. Details regarding raw concentrate shipments, along with products as reported to the Bureau of Mines, are listed in table 4; because of the timelag between shipment from mine or plant and an actual export, this information is not directly comparable to the data in table 3. Exports of specified molybdenum products are listed in table 5.

General imports of molybdenum ore and concentrates (including roasted concentrates) were 154,288 pounds (molybdenum content) in 1954, all from Canada.

Tariff.—The tariff on molybdenum concentrates and products remained unchanged in 1954. The duty on ore and concentrate was 35 cents a pound on the metallic molybdenum contained and 25 cents a pound of molybdenum contained plus 7.5 percent ad valorem on ferromolybdenum, molybdenum metal and powder, calcium molybdate, and other compounds and alloys of molybdenum.

[7] 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 3.—Molybdenum ore and concentrates (including roasted concentrates) exported from the United States, 1945–49 (average) and 1950–54, by countries of destination

[U. S. Department of Commerce]

Country	1945–49 (average)		1950		1951		1952		1953		1954	
	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	211,760	$145,678	226,297	$194,187	294,687	$313,957	535,800	$609,414	404,626	$454,294	232,287	$248,305
Canal Zone			465	458	700	712	450	352	590	881		
Cuba	388	163										
Mexico	1,074	650	345	247			12,622	13,082	3,119	3,050	2,716	3,096
Total	213,222	146,491	227,107	194,892	295,387	314,669	548,872	622,848	408,335	458,225	235,003	251,401
South America:												
Argentina	410	362										
Venezuela	160	147										
Total	570	509										
Europe:												
Austria	4,385	3,684	20,918	19,515	9,996	11,397	34,965	39,859	80,020	91,823	305,588	351,833
Belgium-Luxembourg							23,154	27,971	13,400	15,745	15,480	18,392
Czechoslovakia	4,364	3,084										
Denmark							3,000	3,900				
Finland					2,957	7,841	4,400	5,720				
France	805,351	619,063	674,296	591,249	420,161	397,125	1,735,176	1,958,951	1,368,112	1,386,909	2,306,383	2,321,539
Germany	79,669	64,335	1,105,577	956,329	761,731	786,750	[1] 1,986,670	[1] 2,121,494	[1] 1,028,275	[1] 1,087,912	[1] 3,725,351	[1] 3,872,874
Italy	104,097	80,928	43,420	38,638	135,712	147,408	192,994	225,967	7,056	8,700	145,860	164,835
Netherlands	8,126	6,869	61,200	65,000	41,524	50,000			4,410	5,027	710,945	774,619
Norway	12,000	11,284										
Spain							9,990	13,447				
Sweden	266,128	200,792	274,406	211,195	241,349	257,051	479,680	546,475	339,208	379,062	806,247	847,576
Switzerland							2,476	3,120	595	1,050		
Trieste											33,919	38,390
U. S. S. R.	334,967	225,355										
United Kingdom	1,340,884	1,068,656	3,786,920	3,342,637	1,758,108	1,711,739	882,355	892,693	3,420,028	3,465,136	4,717,073	4,770,026
Total	2,959,971	2,284,050	5,966,737	5,224,563	3,371,538	3,369,311	5,354,860	5,839,597	6,261,104	6,441,364	12,766,846	13,160,084

Asia:												
Japan	----------	----------	40, 677	34, 197	62, 340	51, 476	199, 035	250, 192	366, 547	406, 368	540, 661	572, 701
Taiwan	----------	----------	----------	----------	----------	----------	----------	----------	350	578	----------	----------
Total	----------	----------	40, 677	34, 197	62, 340	51, 476	199, 035	250, 192	366, 897	406, 946	540, 661	572, 701
Africa: Rhodesia, Republic of, 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, 173, 763	2, 431, 050	6, 234, 521	5, 453, 652	3, 729, 265	3, 735, 456	6, 171, 932	6, 791, 695	7, 037, 436	7, 307, 789	13, 546, 510	13, 988, 886

[1] West Germany.

TABLE 4.—Molybdenum reported by producers as shipments for export from the United States, 1952–54, in thousand pounds of contained molybdenum

	1952	1953	1954
Concentrates (not roasted)	5,290	5,893	12,974
Roasted concentrates (oxide)	1,173	796	1,427
All other primary products	671	311	213
Total	7,134	7,000	14,614

TABLE 5.—Exports of specified molybdenum products, 1952–54, gross weight in pounds

	1952	1953	1954
Ferromolybdenum [1]	1,090,104	646,411	247,763
Metals and alloys	172,285	21,826	34,358
Wire	14,605	15,980	10,563
Powder	4,096	17,290	15,423
Primary forms, mainly rods, sheets, and tubes	8,040	13,078	26,001

[1] Ferromolybdenum contains about 60–65 percent molybdenum.

TECHNOLOGY

Mining.—Molybdenum ores were mined in large quantities from low-grade deposits and in relatively small quantities from small, high-grade ore bodies. In addition, significant quantities of molybdenite concentrate were produced as a byproduct of copper mining operations.

At the world-famous Climax mine, where the caving method was employed, mining operations have progressed from the Leil level at 12,145 feet elevation downward to the White level at 11,940 feet and the Phillipson level at 11,470 feet to the newly developed Storke level at 11,170 feet. Development of the Storke level was described.[8] At Molybdenum Corp. of America's Questa mine (the only other molybdenum mine in the United States) the "cut-and-fill" stope method was employed.

Milling and Production of Primary Products.—Molybdenum ores of all types require upgrading to make a useful product. The flotation system was commonly used in the production of molybdenite concentrates. At Climax a rougher concentrate was produced with a ratio of concentration of 10 or 12:1; it was reground and refloated to produce a final concentrate with an overall ratio of about 200:1. Differential flotation was employed at plants producing molybdenum as a byproduct of copper mining.

Except for the relatively small quantities added directly to steel and purified for the manufacture of lubricants, all molybdenite concentrate was processed further by roasting to the oxide. The oxide

[8] Eisenach, E. J., and Matsen, E., Storke Level Operations Makes Climax North America's Biggest Underground Mine: Min. Eng., vol. 6, No. 3, March 1954, pp. 273–278.

was used as a raw material for nearly all other primary molybdenum products and for direct addition to iron and steel.

Metal and Alloys.—Considerable research was conducted on molybdenum metal and on alloys of molybdenum. A patent was issued [9] covering a process of producing recrystallized ductile molybdenum base metal from the group consisting of molybdenum and alloys of molybdenum and tungsten in solid solution. Electrolytic preparation of molybdenum was described.[10] Application of molybdenum to steel and other metals by the metallizing process was described.[11] Several patents pertaining to molybdenum base alloys were issued.[12]

WORLD REVIEW

The accompanying table 6 shows the production of molybdenum in ore and concentrate, by countries, through 1954; annual figures before 1905 are combined. The data for several producing countries are incomplete, and in some instances the molybdenum content was estimated from ore production. Although more than 20 countries have produced molybdenum, the Western Hemisphere countries—Canada, Chile, Mexico, Peru, and the United States—have produced over 93 percent of the total estimated output.

Canada.—All 1954 molybdenum production was derived from the La Corne mine about 25 miles north of Val d'Or, western Quebec. The sole producer, Molybdenite Corp. of Canada, Ltd., resumed milling in March after increasing daily mill capacity to over 400 tons.[13] Operations had been suspended at the property during 1953 and early 1954 to permit opening up two new levels.

Exploratory work by Quebec Metallurgical Industries, Ltd., on a molybdenite property near Quyon, Quebec, was carried out during the year.

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[9] Bechtold, J. H., Lustman, B. L., and Scott, H. (assigned to Westinghouse Electric Corp.), Process of Producing Ductile Molybdenum: U. S. Patent 2,666,721, Jan. 19, 1954.

[10] Brenner, Abner J., and Senderoff, Seymour, Preparation of Molybdenum from Fused Salts: Jour. Electrochem. Soc., vol. 101, No. 1, January 1954, pp. 16–27.

[11] Shepard, A. P., Molybdenum Coatings Expands Uses of Metallizing: Iron Age, vol. 173, No. 26, July 1954, pp. 105–107.

[12] Beidler, Edward A., and Campbell, Ivor E. (assigned to Fansteel Metallurgical Corp.), Highly Refractory Molybdenum Alloys: U. S. Patent, 2,665,474, Jan. 12, 1954.

Bens, F. F., Ham, J. L., Herzig, A. J., and Timmons, G. A. (assigned to Climax Molybdenum Co.), Molybdenum-Tantalum Alloys: U. S. Patent 2,678,270, May 11, 1954. Molybdenum-Titanium Alloys: U. S. Patent 2,678,269, May 11, 1954. Molybdenum-Zirconium Alloys: U. S. Patent 2,678,271, May 11, 1954. Molybdenum-Vanadium Alloys: U. S. Patent 2,678,268, May 11, 1954. Molybdenum-Columbium Alloys: U. S. Patent 2,678,272, May 11, 1954. Method for Heat-Treating Molybdenum-Base Alloy: U. S. Patent 2,679,455, May 25, 1954.

[13] Department of Mines and Technical Surveys, Ottawa, Canada, Molybdenum in Canada: 1954 (Prelim.), p. 1.

TABLE 6.—World production of molybdenum in ores and concentrates, by countries,[1] through 1954, in thousand pounds

Year [2]	Australia	Austria	Canada	Chile	China		Finland	Italy	Japan	Korea[3]	Mexico	Morocco, French	Norway	Peru	Spain	Sweden	United States	Yugoslavia	Total world
					Manchuria	Other provinces													
Before 1905	203	------	(4)	------	------	------	------	------	------	------	------	------	115	------	------	------	282	------	600
1905	93	------	------	------	------	------	------	------	------	------	------	------	35	------	------	------	(5)	------	200
1906	127	------	------	------	------	------	------	------	------	------	------	------	31	------	------	------	------	------	200
1907	99	------	------	------	------	------	------	------	------	------	------	------	29	------	------	------	------	------	200
1908	110	------	------	------	------	------	------	------	86	------	------	------	29	------	------	------	------	------	300
1909	137	------	------	------	------	------	------	------	11	------	------	------	22	------	------	------	------	------	200
1910	187	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	200
1911	137	------	------	------	------	------	------	------	------	------	------	------	2	------	------	------	------	------	200
1912	179	------	------	------	------	------	------	------	209	------	------	------	9	------	------	------	------	------	400
1913	163	------	------	------	------	------	------	------	4	------	------	------	2	------	18	------	------	7	200
1914	170	------	2	------	------	------	------	------	------	------	------	------	71	------	31	2	2	11	300
1915	148	------	18	------	------	------	------	------	7	------	------	------	99	------	11	9	182	15	600
1916	150	------	95	------	4	------	------	------	18	------	------	------	115	------	300	2	207	11	1,000
1917	216	33	174	------	4	------	------	------	18	------	31	------	181	------	68	46	351	7	1,300
1918	227	26	227	------	2	------	------	------	9	------	2	------	148	------	44	55	862	------	1,800
1919	216	29	51	------	------	------	------	------	------	------	4	------	73	------	2	(4)	298	------	900
1920	99	24	------	------	[6] 22	------	------	------	117	------	4	------	------	------	24	(4)	35	------	400
1921	18	51	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	100
1922	[7] 73	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	100
1923	82	66	------	------	------	------	------	------	------	------	------	------	49	------	------	------	22	------	300
1924	66	86	11	------	------	------	------	------	------	------	(8)	------	95	------	------	------	298	------	600
1925	49	18	15	------	------	------	------	------	------	9	(8)	------	159	------	------	18	1,155	------	1,500
1926	49	40	13	------	------	------	------	------	------	7	(8)	------	154	------	------	7	1,432	------	1,800
1927	(8)	(4)	------	------	------	------	------	------	------	33	(8)	------	163	------	------	------	2,299	------	2,700
1928	(8)	7	------	------	------	------	------	------	------	35	(8)	------	223	------	------	------	3,428	------	3,800
1929	(4)	7	18	------	------	9	------	------	------	33	(8)	------	234	------	------	------	[9] 4,021	------	4,400
1930	(8)	(4)	------	------	------	4	------	------	------	29	7	------	282	------	------	------	3,723	------	4,200
1931	(4)	------	------	------	------	------	------	------	------	26	7	------	227	------	------	------	3,133	------	3,500
1932	4	------	------	------	------	(4)	------	------	------	49	7	(8)	348	7	------	------	2,431	------	2,900
1933	9	------	------	------	------	(4)	------	------	------	117	88	130	547	9	------	------	5,682	------	6,600
1934	7	------	------	------	------	(4)	------	------	7	115	1,027	172	322	13	------	------	9,362	------	11,300
1935	13	------	------	------	------	[11] 4	------	------	9	117	1,512	150	855	15	------	------	11,512	------	14,400

1936	24	----	----	----	----	[10] 7	----	20	9	88	1,177	172	930	26	----	----	17,186	----	19,900
1937	73	----	9	----	----	[10] 13	----	2	4	93	1,387	220	758	134	----	----	29,419	163	32,600
1938	68	----	7	----	(8)	[10] 7	----	9	2	130	1,065	146	1,019	203	----	----	33,297	99	36,200
1939	86	----	(4)	66	(8)	[10] 7	----	4	37	882	1,153	198	941	364	----	(8)	30,324	170	34,400
1940	44	----	11	589	(8)	[10] 15	104	33	31	1,000	683	77	633	336	----	----	34,313	115	38,300
1941	13	----	104	505	[11] 165	[10] 11	326	40	42	866	1,151	68	505	322	----	----	40,363	----	44,800
1942	15	9	95	1,279	[11] 847	[10] 7	278	40	86	1,016	1,885	13	811	340	----	----	56,942	----	64,000
1943	31	11	392	1,499	[11] 1,138	(8)	238	20	185	1,021	2,509	15	501	187	----	26	61,667	----	69,700
1944	22	15	1,122	2,317	[11] 1,138	(8)	243	(4)	414	800	1,581	----	547	137	----	44	38,679	----	47,300
1945	(4)	(4)	503	1,854	[11] 66	(8)	203	----	209	342	1,032	----	168	64	----	7	30,802	474	36,000
1946	9	44	406	1,235	(8)	(8)	218	----	114	----	1,803	86	22	9	----	----	18,218	159	23,900
1947	4	4	456	886	(8)	(8)	159	----	46	11	300	62	216	7	----	----	27,047	----	30,900
1948	4	4	183	1,173	(8)	(8)	----	----	2	4	----	----	174	4	----	2	26,706	----	30,000
1949	7	20	----	1,230	(8)	(8)	----	----	----	24	----	----	156	4	----	11	22,530	536	25,200
1950	7	40	62	2,187	(8)	(8)	----	----	29	----	----	----	148	2	----	13	28,480	384	32,000
1951	(4)	42	229	3,803	(8)	(8)	----	----	118	11	----	----	276	7	----	----	38,855	679	44,800
1952	(4)	40	304	3,624	(8)	(8)	----	----	196	15	----	----	282	7	----	----	43,259	1,453	49,800
1953	(4)	(8)	194	3,031	(8)	(8)	----	----	397	20	(4)	----	317	7	----	----	57,243	818	62,600
1954	(4)	(8)	586	2,646	(8)	(8)	----	(8)	450	22	159	----	335	2	----	----	58,668	1,920	65,500

[1] Molybdenum production in Bolivia, Burma, France, Germany, Hong Kong, Indochina, India, Greece, Rumania, and U. S. S. R. included in estimate for years in which production was made. Before 1931 world estimate includes production in Chile, Italy, and Peru. For the years 1946–54 estimate also includes North Korea and Spain for years in which production was made. Annual estimates are rounded and do not necessarily agree with the combined totals of the producing countries.

[2] This table incorporates a number of revisions of data published in previous molybdenum chapters.

[3] Beginning 1946, South Korea only.

[4] Less than 1,000 pounds.

[5] Not reported separately; included with steel-hardening metals.

[6] Exports.

[7] 590 long tons of ore exported from Victoria not included.

[8] Data not available, estimate included in world total.

[9] In addition to the ore milled, a small quantity of ore averaging 16 percent MoS_2 was sold crude.

[10] Data represent areas designated as Free China during period of Japanese occupation.

[11] Exports to Japan proper.

Chile.—The Braden Copper Co. continued to be the only producer of molybdenum in Chile.

Finland.—Although no molybdenum was mined, geologic test drillings in molybdenum-bearing ores were reported,[14] to have been made in 1954.

Japan.—The Honshu, Shimane, and Gamasa mines in Gifu Prefecture and the Taiyo-Daito mine in Shimane Prefecture produced molybdenum in 1954.

Mexico.—The only known producer of molybdenum was the Cia Minera Bemnewilco, in the municipality of Nacozari Garcia, Sonora. The company began production in January 1954 and was reported [15] to have made an initial shipment of 100,000 pounds of concentrates through the United States en route to France, Japan, and the United Kingdom.

Norway.—The Knaben mine, near Egersund on the southwestern coast of Norway, has been almost a continuous producer of molybdenum since before the beginning of the century. The mine has supplied most of the molybdenum output of Norway.

[14] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 4, April 1955, p. 30.
[15] Mining Record—Denver, Mexican Molybdenum Ore Shipped Through United States: Vol. 65, No. 24, June 1954, p. 3.

Natural and Manufactured Iron Oxide Pigments

By Milford L. Skow[1] and Eleanor V. Blankenbaker[2]

THE TONNAGE of finished iron oxide pigments sold in 1954 decreased to the lowest total in 10 years. This was caused in part by the use of a larger proportion of manufactured (synthetic) iron oxide pigments, which have a greater tinting strength than natural pigments. The quantity of manufactured pigments sold increased 18 percent over 1953 and constituted 64 percent of the total tonnage of finished iron oxide pigments.

DOMESTIC PRODUCTION

Raw materials for producing natural iron oxide pigments were mined in 8 States by 11 producers. Production and sales data for these crude iron oxide pigment materials were obtained for the first time in 1954 (tables 1 and 2). Red iron oxide composed 69 percent of the quantity and 66 percent of the value of crude natural pigment sold.

Total sales of finished iron oxide pigments for 1954 were 10 percent lower in quantity and 2 percent in value than in 1953 (tables 3 and 4). Natural iron oxide pigments represented 36 percent of the total tonnage and 19 percent of the value. Red pigments predominated,

TABLE 1.—Crude iron oxide pigment materials produced and sold by processors in the United States, 1954, by kinds

Pigment	Quantity mined (short tons)	Quantity sold (short tons)	Value
Black iron oxide:			
Magnetite			
Brown iron oxide:			
Metallic brown	956	956	$4, 720
Sienna			
Umber	508	458	9, 773
Vandyke brown			
Red iron oxide	27, 366	23, 725	230, 036
Yellow iron oxide:			
Natural yellow iron oxide	2, 378	1, 958	17, 276
Ocher	2, 214	2, 214	7, 976
Sienna	891	723	35, 412
Sulfur mud	694	694	6, 492
Other	4, 303	4, 303	34, 891
Total	39, 310	35, 031	346, 576

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

and the quantity totaled 41 percent of the natural and 77 percent of the manufactured iron oxide pigments.

TABLE 2.—Production and sales of crude iron oxide pigment materials in the United States, 1954, by States

State	Number of producers	Quantity mined (short tons)	Quantity sold (short tons)
Pennsylvania	2	533	533
Georgia Virginia Michigan New York	5	33,879	29,600
Illinois Minnesota Oregon	4	4,898	4,898
Total	11	39,310	35,031

TABLE 3.—Finished iron oxide pigments sold by processors in the United States, 1945–49 (average) and 1950–54 [1]

Year	Short tons	Value	Year	Short tons	Value
1945–49 (average)	109,423	$10,305,449	1952	105,242	$13,267,766
1950	129,256	14,762,782	1953	108,350	14,246,726
1951	126,432	14,987,075	1954	97,951	13,977,538

[1] For 1945–51, includes mineral blacks.

TABLE 4.—Finished iron oxide pigments sold by processors in the United States, 1953–54, by kinds

Pigment	1953		1954	
	Short tons	Value	Short tons	Value
Blacks:				
Magnetite	(1)	(1)	16	$954
Manufactured magnetic black (pure)	2,220	$542,122	2,198	533,979
Browns:				
Natural brown iron oxide (metallic)	8,792	713,787	6,234	494,743
Manufactured brown iron oxide (pure)	1,139	311,196	1,204	340,549
Sap brown			39	6,570
Umbers:				
Burnt	3,026	387,258	2,721	366,623
Raw	580	67,922	587	72,030
Vandyke brown	67	12,610	122	24,772
Reds:				
Natural red iron oxide	31,523	1,462,268	13,230	645,832
Sienna, burnt	966	173,134	818	173,339
Manufactured red iron oxide:				
Pure red iron oxides:				
Calcined copperas	24,265	5,670,748	15,720	3,979,417
Other chemical processes			5,445	1,396,977
Mixtures of natural and pure red iron oxides	(1)	(1)	6,699	828,963
Other manufactured red iron oxides	9,031	1,262,358	16,498	1,468,786
Venetian red	4,067	442,585	4,094	449,955
Pyrite cinder	1,483	131,750	299	26,001
Yellows:				
Natural yellow iron oxide	3,594	92,815	84	11,592
Ocher	2,632	114,872	5,909	210,404
Manufactured yellow iron oxide (pure)	12,638	2,629,848	11,175	2,380,785
Sienna, raw	1,068	178,341	873	156,895
Other	1,259	53,112	3,986	408,372
Total	108,350	14,246,726	97,951	13,977,538

[1] Not separately classified.

Twenty companies reported sales of finished natural and manufactured iron oxide pigments in 1954 (table 5). Production was reported from 9 States; Pennsylvania had a larger proportion of the tonnage (33 percent) and a greater number of producers (4) than any other State.

TABLE 5.—Sales of finished iron oxide pigments in the United States, 1954, by States

State	Number of producers	Quantity (short tons)
Oregon	1	50
Pennsylvania	4	31,970
Georgia, Maryland, Virginia	4	14,902
Illinois, Ohio	4	29,223
New Jersey, New York	4	4,354
Other [1]	3	17,452
Total	20	97,951

[1] Includes California, and a quantity unspecified by State.

PRICES

Prices of various iron oxide pigments were stable during 1954. Quotations from Paint Oil and Chemical Review during December 1954 are given in table 6.

TABLE 6.—Prices of finished iron oxide pigments in 1954 [1]

Blacks:		
Mineral blacks	short ton	$32.00
Black oxide of iron	pound	.12¾
Browns:		
Brown, metallic	short ton	60.00
Precipitated brown oxide	pound	.13¾
Spanish browns:		
High grade	short ton	60.00
Low grade	do	45.00
Umber, Turkey, burnt, powdered	do	120.00
Umber, American	pound	.05½
Vandyke brown	do	.10
Reds:		
Indian red, American common	do	.09¼
Indian red, American pure	do	.12¼
Indian red, English	do	.11½
Oxide, domestic natural, in casks	do	.03
Oxide, red copperas, in casks	do	.04
Oxide, Spanish, light, dark	do	.06
Sienna, American, burnt and powdered, in bags	short ton	105.00
Sienna, Italian, burnt and powdered, in barrels	do	230.00
Venetian red	pound	.03½
Yellows:		
Hydrate iron oxide	do	(2)
Iron oxide, yellow	do	10½
Ocher, domestic:		
Strong	do	.01¾
Medium	do	.01½
Golden	do	.03¾
Ocher, French	do	(2)
Sienna, American, raw, powdered, in bags	short ton	110.00
Sienna, Italian, raw, powdered, in barrels	do	245.00

[1] Quotations from Paint Oil and Chem. Rev., vol. 117, No. 26, Dec. 30, 1954, p. 36.
[2] Not quoted.

FOREIGN TRADE [3]

Total imports of iron oxide pigments into the United States in 1954 decreased 3 percent in quantity but increased 6 percent in value compared with 1953, while imports of natural varieties decreased 12 percent in quantity and 13 percent in value. Natural varieties accounted for 53 percent of the total quantity and 29 percent of the total value of iron oxide pigments imported (table 7).

Manufactured iron oxide pigments were imported principally from Germany (71 percent) and Canada (25 percent), with the remainder from the United Kingdom, the Netherlands, and Spain. Natural iron oxide pigments, not otherwise specified by kind, came from Spain (83 percent), United Kingdom (9 percent), Canada, French Morocco, France, and West Germany. Imports of ocher came exclusively from the Union of South Africa and those of Vandyke brown entirely from West Germany. Of the imports of umber, Malta supplied 95 percent of the crude and 92 percent of the refined, with the balance of the crude coming from Italy and the balance of the refined from the United Kingdom. Sienna was imported from Italy (75 percent); Malta, Gozo, Cyprus (18 percent); and France.

TABLE 7.—Selected iron oxide pigments imported for consumption in the United States, 1951–54

[U. S. Department of Commerce]

Pigments	1951		1952		1953		1954	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Natural:								
Ocher, crude and refined	815	$37,494	798	$46,777	177	$9,122	154	$8,666
Sienna, crude and refined	779	62,421	566	49,702	700	59,747	338	34,848
Umber, crude and refined	3,457	93,761	1,603	44,435	2,725	78,310	2,598	74,276
Vandyke brown	174	10,765	119	6,685	164	8,958	89	5,194
Other, n. s. p. f.[1]	3,476	160,015	2,388	118,914	2,716	123,432	2,546	120,600
Total	8,701	364,456	5,474	266,513	6,482	279,569	5,725	243,584
Manufactured (synthetic)	5,303	643,918	3,317	432,451	4,531	522,618	4,997	602,847
Grand total	14,004	1,008,374	8,791	698,964	11,013	802,187	10,722	846,431

[1] Not specially provided for.

Exports of iron oxide pigments, the lowest tonnage since 1939, decreased 15 percent in quantity and 1 percent in value compared with 1953 (table 8). The major portion again went to Canada.

[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 8.—Iron oxide pigments exported from the United States, 1951–54, by countries of destination

[U. S. Department of Commerce]

Country	1951		1952		1953		1954	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
North America:								
Canada	2,528	$282,136	2,545	$288,382	2,886	$351,393	2,208	$265,266
Cuba	294	61,885	297	59,502	293	69,652	197	48,578
Dominican Republic	29	8,302	33	9,693	35	11,529	22	5,122
Guatemala	49	13,180	23	5,877	42	13,515	33	8,162
Haiti	52	12,761	45	5,049	23	4,615	9	3,260
Honduras	5	1,512	20	4,559	2	527		
Mexico	106	48,629	90	31,787	181	47,474	128	61,525
Netherlands Antilles	21	6,354	10	3,657	3	990	10	2,720
Panama	17	3,456	11	2,900	7	1,686	37	5,193
Other North America	51	19,557	32	10,825	38	12,350	22	8,320
Total	3,152	457,772	3,106	422,231	3,510	513,731	2,666	408,146
South America:								
Argentina	(1)	600	46	20,250				
Bolivia	25	8,819	1	187	2	526	4	1,060
Brazil	93	18,185	41	11,786	3	912	78	21,116
Chile	37	8,322	18	4,950	45	8,750	8	3,290
Colombia	120	46,179	93	31,728	94	31,450	176	76,478
Peru	29	9,694	10	2,954	32	9,507	15	5,196
Uruguay	7	2,078	6	1,602			1	528
Venezuela	104	29,785	133	33,842	137	35,489	210	38,943
Other South America	10	3,258	3	1,167	27	5,328	5	1,717
Total	425	126,920	351	108,466	340	91,962	497	148,328
Europe:								
Belgium-Luxembourg	39	9,859	8	2,912	15	4,504	40	11,824
France	17	10,874	9	12,179	47	13,864	5	9,212
Greece	7	2,279	2	652			3	695
Iceland	13	839					7	7,347
Italy	37	5,197	6	14,942	13	6,520	14	11,007
Netherlands	341	13,766	135	5,292	75	3,006	104	5,918
Portugal	2	1,126	5	1,356	7	1,740	11	3,068
Sweden	24	5,276	6	1,578	10	2,230	7	1,902
Switzerland	27	7,496	14	3,934	4	3,746	45	9,948
United Kingdom	275	14,867	3	720	1	252		
Other Europe	7	1,864	2	443	(1)	112	1	564
Total	789	73,443	190	44,008	172	35,974	237	61,485
Asia:								
Hong Kong	2	702	(1)	136	3	720		
Indonesia	11	4,016	31	9,284				
Israel and Palestine	17	4,783	4	895	(1)	106	[2] 2	[2] 1,400
Japan	17	4,186	24	8,108	14	4,327	13	7,074
Philippines	93	24,362	47	10,321	27	8,219	69	33,656
Other Asia	7	1,524	18	4,878	6	4,762	16	5,022
Total	147	39,573	124	33,622	50	18,134	100	47,152
Africa:								
Belgian Congo	9	1,839	2	460	6	2,569		
Union of South Africa	127	36,635	87	23,690	94	25,726	51	16,100
Other Africa			8	950			1	576
Total	136	38,474	97	25,100	100	28,295	52	16,676
Oceania	3	1,984	2	340	1	235	2	542
Grand total	4,652	738,166	3,870	633,767	4,173	688,331	3,554	682,329

1 Less than 1 ton.
2 Israel.

TECHNOLOGY

A number of articles concerning pigment materials contained information on iron oxide pigments.[4] On the general subject of iron oxide pigments, the literature contained a review of past and present methods of manufacturing iron oxide pigments,[5] a description of iron oxide manufacture,[6] and a discussion of the development of manufactured iron oxide pigments and the improvement of the manufactured and natural types through research.[7]

A patent was granted for a process in which hydrous ferric oxide was precipitated and converted to a pigment containing spherical particles of controlled size, having a color intensity comparable to the organic pigments used for dark reds and maroons, and possessing a permanent resistance to sunlight.[8] Other patents described a method of preparing finely divided metallic oxide pigments by continuous oxidation of aqueous chloride solutions, such as ferric chloride, in a specially designed reaction chamber[9] and an apparatus for drying, oxidation, reduction, and reoxidation of iron ore to iron oxides.[10]

By control of the precipitation and oxidation rates, soft pigments with good hiding power and colors ranging from light ocher to reddish brown can be produced from solutions of ferrous chloride.[11] An article in a series on the precipitation of brown and yellow iron oxide was published.[12]

A controlled treatment of aqueous ferric chloride to produce an unusual form of ferric oxide characterized by striking optical activity and high color value in pigments was described.[13] The procedure for determining the specific gravity of dry pigments and the specific gravity of some pigments,[14] information on the oil absorption of inorganic pigment particles,[15] and data on heat conductivity of coatings of iron oxide pigments were reported.[16]

WORLD REVIEW

French Morocco.—Production of ocher (75 to 80 percent pure) totaled 2,214 metric tons in 1954; stocks were 605 tons on January 1,

[4] Paint and Varnish Production, Recent Developments in Pigment Technology: Vol. 43, No. 10, October 1953, pp. 31–47.
Paint, Oil, and Colour Journal (London), Review of Paints and Paint Materials, 1953: Vol. 125, 1954, pp. 97–100, 112; Chem. Abs., vol. 48, No. 7, Apr. 10, 1954, p. 4227d.
Beakes, Henry, Inorganic Colors in House Paints: Paint Ind. Mag., vol. 69, No. 11, November 1954, pp. 33–34.

[5] Cauterman, P. J., How Iron Oxide Pigments Are Made: Canadian Paint and Varnish Mag. (Toronto), vol. 28, No. 5, 1954, pp. 34, 36, 58–59.

[6] Cauterman, P. J., Permanent Pigments From the Earth and Air: Canadian Chem. Processing (Toronto), vol. 38, No. 1, January 1954, pp. 50–54.

[7] Clare, E. C., New Look in Iron Oxides: Paint Oil and Chem. Rev., vol. 117, No. 7, Apr. 8, 1954, p. 22.

[8] Naponen, G. E. (assigned to Minnesota Mining & Mfg. Co.), Red Iron Oxide of High Color Purity and Process of Making Same: U. S. Patent 2,665,193, Jan. 5, 1954.

[9] Weber, Robert, and Frey, Walter (assigned to Saurefabrik Schweizerhall), Finely Divided Metallic Oxide Pigments: U. S. Patent 2,635,946, Apr. 21, 1953.

[10] Sato, Tsunemi, Strongly Magnetic Iron Oxides: Japanese Patent 6,468, Dec. 16, 1953.

[11] Kunzweiler, J., [The Manufacture of Iron Oxide Pigments From Ferrous Chloride]: Deutsch. Farben-Ztschr. (Stuttgart), vol. 7, 1953, pp. 442–443; Chem. Abs., vol. 48, No. 4, Feb. 25, 1954, p. 2387e.

[12] Gupta, S. R., and Ghosh, Satyeshwar, [Precipitation of Brown and Yellow Hydrated Iron Oxide: V, The Solubility of Different Iron Oxides in Hydrochloric Acid]: Kolloid-Ztschr., vol. 137, No. 1, 1954, pp. 26–28; Chem. Abs., vol. 48, No. 22, Nov. 25, 1954, p. 13362a.

[13] Steele, F. A., Another Form of Alpha Ferric Oxide: Jour. Colloid Sci., vol. 9, 1954, pp. 166–174; Chem. Abs., vol. 48, No. 16, Aug. 25, 1954, p. 9150e.

[14] Haug, Robert, and Funke, Werner, [The Determination of Specific Gravity of Dry Pigments]: Deutsch. Farben-Ztschr., vol. 8, 1954, pp. 309–313; Chem. Abs., vol. 48, No. 20, Oct. 25, 1954, p. 12420c.

[15] Ando, Tokuo, and Tsubata, Toniko, [Oil Absorption of Inorganic Pigment Particles]: Osaka Kogyo Gijutsu Shikenjo Hokoku (Rept. Osaka Ind. Research Inst.), No. 302, 1954, 26 pp.

[16] Fuchslocher, Gerhard, and Funke, Werner, [The Measurement of the Heat Conductivity of Pigmented and Nonpigmented Coatings and Its Significance]: Deutsch. Farben-Ztschr., vol. 8, 1954, pp. 350–354; Chem. Abs., vol. 48, No. 22, Nov. 25, 1954, p. 14239e.

1954, and 941 tons on January 1, 1955. Compagnie Minière et Metallurgique, Kettara, was the producer.[17]

India.—The total production of ocher for 1953 was reported to be 15,173 long tons valued at 179,353 rupees (US$37,664). Data for 1954 were not available.[18]

Spain.—Output of ocher totaled 7,566 metric tons in 1953, the latest year for which figures were reported.[19]

[17] Department of Mines of the Protectorate Government's Direction de la Production Industrielle et des Mines.
[18] Geological Survey of India, Mineral Production of India During 1953: September 1954.
[19] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 5, May 1954, p. 41.

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Nickel

By Hubert W. Davis[1]

TWO NEW nickel-refining plants—one in Canada and the other in the United States—and a nickel-smelting plant in the United States were completed in 1954; however, the refinery in Canada was the only one put into commercial operation. The smelter was to begin commercial production early in 1955, and the other refinery was scheduled to start later in the year 1955. The planned annual capacity of these plants was 13,000 short tons. The capacity of the refinery in Norway was expanded further in 1954. Several new mines were brought into production in 1954, and a 75-percent expansion in the nickel-producing facilities in Cuba was begun in October.

Chiefly as a result of an 11-percent gain in Canada, total world production of nickel outside the U. S. S. R. advanced for the fourth consecutive year to establish a new high of 195,000 short tons in 1954 or about 16,000 tons more than in 1953. A further increase of about 13,000 tons is anticipated in 1955. Cuba, United States, and Union of South Africa also showed gains in 1954, but output in New Caledonia declined. Canada produced about 82 percent of the total in 1954.

Despite the increase in supply and a reduction in defense requirements, insufficient nickel was available to satisfy civilian needs in 1954, chiefly because of the accelerated Government stockpiling program.

TABLE 1.—Salient statistics for nickel, 1945–49 (average) and 1950–54

	1945–49 (average)	1950	1951	1952	1953	1954
United States:						
Production:						
Primary .... short tons	765	913	756	633	602	2,645
Secondary .... do	7,760	8,795	8,602	7,479	8,352	8,605
Imports (gross weight)[1] .... do	[2] 103,403	96,640	101,620	118,372	131,169	143,662
Exports (gross weight)[3] .... do	7,309	3,645	4,622	6,941	15,168	14,245
Consumption .... do	84,061	99,989	86,683	101,397	105,681	94,733
Price per pound[4] .... cents	31½–40	40–50½	50½–56½	56½	56½–60	60–64½
Canada:						
Production .... short tons	119,537	123,659	137,903	140,559	[5] 143,693	159,992
Exports .... do	119,136	119,984	130,239	142,022	143,818	157,233
World production .... do	155,000	162,000	184,000	205,000	[5] 223,000	242,000

[1] Comprises refined metal, matte, oxide, and oxide sinter.
[2] Figures for 1945–47 include nickel scrap.
[3] Excludes "Manufactures" for 1945–52, weight of which is 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, 1948–54.
[5] Revised figure.

For the fifth consecutive year imports of nickel into the United States increased to establish a new record, 11 percent higher than in

[1] Commodity-industry analyst.

1953. Canada and Norway supplied 88 percent of the 1954 total; the nickel imported from Norway was produced from Canadian ore.

Consumption of nickel in the United States was 10 percent less than in 1953. The steel industry continued to be the chief consumer; 36 percent of all nickel used in 1954 was in stainless and engineering alloy steels.

Prices of electrolytic nickel, nickel oxide, and nickel oxide sinter were increased 4½ cents a pound, effective November 24, 1954.

PRODUCTION

Domestic production of nickel (other than from imported matte and oxide) was small and comprised chiefly metal recovered from scrap (nickel anodes and nickel-silver and copper-nickel alloys, including Monel metal), primary nickel recovered in copper refining, and nickel contained in ore produced at Riddle, Oreg., and Cobalt, Idaho. In Idaho the nickel was recovered as a byproduct of the cobalt ore at the Blackbird mine in Lemhi County.

The United States will become a larger producer of nickel from domestic ore in 1955. The Hanna Nickel Smelting Co. was scheduled to place two furnaces in commercial operation in January 1955 to smelt ore from the deposit near Riddle, Oreg. During 1954 some ore was mined and moved over the new 2-mile aerial tramway from the top of the mountain to the storage yard at the plant, and a small quantity of ferronickel was produced to demonstrate the applicability of the d'Ugine process. The ore produced in 1954 averaged 1.51 percent nickel, and the ferronickel made from it averaged 40 percent nickel. A new refinery built by National Lead Co. at Fredericktown, Mo., also was scheduled to begin commercial operation in 1955. The plant will treat an iron-concentrate reject that carries values in nickel, cobalt, and copper. 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 producing engineering alloys and stainless steels, but no figures on the quantity are available.

A total of 1,277,000 pounds of nickel, in the form of both crude and refined nickel sulfate, was recovered in 1954 as a byproduct of copper refining at Baltimore, Md.; Carteret and Perth Amboy, N. J.; Laurel Hill, N. Y.; and Tacoma, Wash. Shipments were 1,312,000 pounds (content), the bulk (1,194,000 pounds) of which was crude nickel sulfate sold to refiners for use as an intermediate in manufacturing refined nickel sulfate and other nickel salts. Although all 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.

In addition to the nickel recovered as a byproduct of copper refining in 1954, 4,173,000 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.

The total production of refined nickel salts in the United States was 4,293,000 pounds (nickel content) in 1954; shipments to consumers for electroplating, catalysts, and ceramics totaled 4,348,000 pounds.

TABLE 2.—Nickel produced in the United States, 1945–49 (average) and 1950–54

Year	Primary (short tons)[1]		Secondary	
	Byproduct of copper refining	Other	Short tons	Value
1945–49 (average)	678	87	7,760	$5,874,519
1950	913	----------	8,795	8,408,020
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

[1] Value withheld to avoid disclosing individual company operations.

CONSUMPTION AND CONSUMERS' STOCKS

Tables 3, 4, and 5 give data on consumption of nickel, as determined by a Bureau of Mines survey.

Total consumption of nickel in 1954 was 10 percent less than in 1953. Of the 1954 total consumption 36 percent was utilized in stainless and engineering alloy steels. Usage of nickel in stainless steel was 8 percent less than in 1953, and that for engineering alloy steels was 28 percent smaller.

Consumption of nickel in cast irons, nonferrous alloys, high-temperature and electrical-resistance alloys, catalysts, and magnets was smaller by 2, 9, 20, 6, and 15 percent, respectively; but usage for

TABLE 3.—Nickel (exclusive of scrap) consumed and in stock in the United States, 1953–54, by forms, in short tons of nickel

Form	1953			1954		
	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]	73,773	6,348	255	67,241	8,477	151
Oxide and oxide sinter	19,997	2,769	191	16,191	1,372	25
Matte	10,470	353	----------	9,710	255	----------
Salts[2]	1,441	433	6	1,591	490	4
Total	105,681	9,903	452	94,733	10,594	180

[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.

TABLE 4.—Nickel (exclusive of scrap) consumed in the United States, 1950–54, by forms, in short tons of nickel

Form	1950	1951	1952	1953	1954
Metal	74,429	68,001	75,007	73,773	67,241
Oxide and oxide sinter	14,802	8,798	15,472	19,997	16,191
Matte	8,922	8,741	9,766	10,470	9,710
Salts[1]	1,836	1,143	1,152	1,441	1,591
Total	99,989	86,683	101,397	105,681	94,733

[1] Figures estimated to represent about 80 percent of total.

electroplating and ceramics was larger by 4 and 21 percent, respectively.

As heretofore, most nickel consumed in 1954 was in the form of metal, but the proportion of oxide and oxide sinter was smaller in 1954 than in 1953.

TABLE 5.—Nickel (exclusive of scrap) consumed in the United States, 1950–54, by uses, in short tons of nickel

Use	1950	1951	1952	1953	1954
Ferrous:					
Stainless steels	20,911	21,792	27,343	22,274	20,399
Other steels	17,777	16,425	17,978	18,959	13,637
Cast iron	4,881	3,716	3,639	4,214	4,115
Nonferrous [1]	29,409	26,952	32,018	30,807	28,053
High-temperature and electrical-resistance alloys	5,704	7,408	8,020	8,221	6,597
Electroplating:					
Anodes [2]	16,179	5,410	6,139	13,274	13,460
Solutions [3]	1,227	455	484	972	1,323
Catalysts	1,200	1,384	1,460	1,435	1,344
Ceramics	393	249	199	251	304
Magnets	973	646	595	798	681
Other	1,335	2,246	3,522	4,476	4,820
Total	99,989	86,683	101,397	105,681	94,733

[1] Comprises copper-nickel alloys, nickel-silver, brass, bronze, beryllium alloys, magnesium and aluminum alloys, Monel, Inconel, and malleable nickel.
[2] 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.
[3] Figures estimated to represent about 70 percent of total.

SUBSTITUTES

Because of the inadequate supply, efforts to conserve nickel by developing steels containing less nickel and by search for substitutes were continued. In this connection, 2 new grades of high-nitrogen chromium-manganese-nickel steels (17 percent Cr, 4 percent Ni, 6 percent Mn and 18 percent Cr, 5 percent Ni, and 8 percent Mn) were developed as substitutes for types 301 and 302 (18 percent Cr and 8 percent Ni).[2] One of the important features of the new steels, according to this article, is their comparatively high stress to rupture strength at elevated temperatures, associated with excellent ductility, toughness and strength both at room and subzero temperatures. Detailed results from stress to rupture tests between about 1,000° and 1,500° F. have shown that these steels are as strong under these conditions as the columbium-bearing type 347 (18 percent chromium, 8 percent nickel). Another new type of stainless steel, AM 350 (17 percent Cr, 4.2 percent Ni, 2.75 percent Mo, 0.60 percent Mn, 0.40 percent Si, 0.08 percent C) was developed with a composition between the 300 (chromium-nickel steels) and 400 (chromium steels) series.[3]

The standard nickel-silver alloy containing 12 percent nickel can, it is reported,[4] be used instead of the more traditional 18-percent nickel alloy for spring applications. An alloy containing about 20 percent chromium and 9 percent nickel has been developed as a substitute for an alloy containing about 26 percent chromium and 12 percent nickel

[2] Iron Age, Metals and Alloys: Vol. 175, No. 1, Jan. 6, 1955, p. 172.
[3] Lena, A. J., New Stainless Alloy "Bridges Gap" Between 300 and 400 Series: Iron Age, vol. 174, No. 23, Dec. 2, 1954, pp. 113–116.
[4] Materials and Methods ,vol. 40 ,No. 3 ,September 1954, p. 3.

in the intermediate temperature range of 1,200° to 1,600° F.[5] Copper-manganese-tin alloys of suitable composition are reported to compare favorably in color and mechanical properties with copper-nickel-zinc alloys.[6]

PRICES

Effective November 24, 1954, the contract price to United States buyers for electrolytic nickel in carlots f. o. b. Port Colborne, Ontario, was advanced to 64½ cents a pound, including duty of 1¼ cents. For nickel oxide sinter (no duty) the price was raised to 60¾ cents a pound (nickel content) f. o. b. Copper Cliff, Ontario. Former prices, which had been in effect since January 14, 1953, were 60 and 56¼ cents, respectively. Cuban nickel oxide powder and nickel oxide sinter were priced at 59½ and 60¾ cents per pound (nickel content) in bags f. o. b. Philadelphia, Pa., in 1954.

FOREIGN TRADE[7]

The quantity of new nickel imported into the United States advanced for the fifth consecutive year; it was 11 percent more than in 1953 and the largest of record. Imports were comprised chiefly of metal, oxide, oxide sinter, and matte. As heretofore, Canada was the chief source of the imports. The roasted and sintered matte was refined to Monel metal and other products at the plant of International Nickel Co., Inc., at Huntington, W. Va.

TABLE 6.—New nickel products imported for consumption in the United States, 1953–54, by countries, gross weight in short tons

[U. S. Department of Commerce]

Country	Metal		Ore and matte		Oxide and oxide sinter		Nickel residues[1]	
	1953	1954	1953	1954	1953	1954	1953	1954
North America:								
Canada	74,383	85,478	14,497	14,135	13,606	14,255	516	211
Cuba					18,236	18,009		
Total	74,383	85,478	14,497	14,135	31,842	32,264	516	211
Europe:								
Austria			(2)					
France	249	674						
Germany, West	38	94			3	(3)		
Norway	9,377	10,914						
United Kingdom	208	42			5			
Total	9,872	11,724	(2)		8	(3)		
Asia: Japan[4]	459	61						
Oceania: New Caledonia[5]			108					
Grand total	84,714	97,263	14,605	14,135	31,850	32,264	516	211

1 Reported to Bureau of Mines by importers.
2 220 pounds.
3 30 pounds.
4 Beginning Jan. 1, 1954, excludes Nansei and Nanpo Islands, n. e. c.
5 Assumed source; classified in import statistics under "French Pacific Islands."

5 Steel, Way to Save Nickel: Vol. 134, No. 7, Feb. 15, 1954, p. 122.
6 Materials and Methods, New Alloys Promise Nickel Economies: Vol. 39, No. 5, May 1954, pp. 254–256.
7 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.

TABLE 7.—Nickel products (excluding residues) imported for consumption in the United States, 1952–54, by classes

[U. S. Department of Commerce]

Class	1952		1953		1954	
	Short tons (gross weight)	Value	Short tons (gross weight)	Value	Short tons (gross weight)	Value
Nickel ore and matte	14,430	$4,994,511	14,605	$5,794,264	14,135	$5,357,824
Nickel pigs, ingots, shot, cathodes, etc.[1]	79,538	89,322,904	84,714	102,461,751	97,263	124,178,843
Nickel scrap [1]	547	126,800	865	288,518	444	275,587
Nickel oxide and oxide sinter	24,404	18,558,457	31,850	26,286,337	32,264	25,234,419
Total		113,002,672		134,830,870		155,046,673

[1] Separation of metal from scrap is on basis of unpublished tabulations.

TABLE 8.—New nickel products imported for consumption in the United States, 1945–49 (average) and 1950–54, in short tons [1]

[U. S. Department of Commerce]

Year	Gross weight				Total	
	Metal	Ore and matte	Oxide and oxide sinter	Residues [2]	Gross weight	Nickel content (estimated)
1945–49 (average)	[3] 70,175	16,740	16,488	(4)	[5] 103,403	[6] 93,553
1950	69,199	11,135	16,306	178	96,818	91,347
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

[1] Figures, by years, for 1926–48 in Minerals Yearbook, 1948, p. 885.
[2] Reported to Bureau of Mines by importers.
[3] Figures for 1945–47 include nickel scrap.
[4] Not available.
[5] Excludes "Residues."
[6] Figures for 1945–47 include nickel content of nickel scrap, and those for 1947–49 include nickel content of "Residues."

The nickel content of refined nickel, oxide, oxide sinter, matte, and residues imported into the United States is estimated at 131,800 short tons in 1954 compared with 118,700 tons in 1953.

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, oxide sinter, and matte enter the United States duty free.

Exports of nickel comprise largely 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 (7,845,000 pounds), United Kingdom (7,297,000 pounds), and West Germany (10,890,000 pounds) were the chief foreign markets in 1954.

TABLE 9.—Nickel products exported from the United States, 1952–54, by classes

[U. S. Department of Commerce]

Class	1952 Short tons	1952 Value	1953 Short tons	1953 Value	1954 Short tons	1954 Value
Nickel and nickel-alloy metals in ingots, bars, rods, and other crude forms, and scrap	6,807	$6,526,996	14,712	$9,673,576	12,818	$8,939,332
Nickel and nickel-alloy metal sheets, plates, and strips					941	1,925,327
Nickel and nickel-alloy semifabricated forms not elsewhere classified	(1)	503,110	278	935,722	336	1,068,818
Nickel-chrome electric resistance wire, except insulated	134	482,530	178	609,110	150	522,457
Total		7,512,636		11,218,408		12,455,934

[1] Quantity not recorded.

TECHNOLOGY

Bureau of Mines.—The Bureau of Mines conducted research on samples of nickel ore from several localities in 1954. The results of smelting tests at its Northwest Electrodevelopment Laboratory, Albany, Oreg., on low-grade nickel ore from the Red Flats deposit near Gold Beach, Oreg., and the results of studies and diamond drilling on the deposit were described.[8] The tests indicated that it is technically feasible to recover a low-carbon ferronickel product from the Red Flats nickel ore, but for a commercial operation a grade of ore considerably higher in nickel than the sample tested will be required.

Also at Albany, continuous smelting tests were made on two 5-ton samples of nickeliferous serpentine and laterite from the Surigao area, Philippines. The dried serpentine and laterite samples analyzed 1.89 and 1.84 percent Ni and 8.47 and 22.8 percent Fe, respectively. After calcining, the sample of serpentine weighed 3.8 tons; the Ni analysis was increased to 2.25 percent and the Fe to 11 percent. The sample of calcined laterite weighed 3.2 tons; the Ni analysis was increased to 2.20 percent and the Fe to 26.9 percent. Two smelting tests were run on each lot of ore. In the first tests a very limited amount of reductant was used; consequently, only 38 percent of the nickel charged to the furnace was recovered in the ferronickel product. The alloy recovered from smelting the calcined serpentine contained 68.3 percent Ni and 29.9 percent Fe. The alloy product recovered from smelting the calcined laterite contained 37.4 percent Ni and 61.6 percent Fe. The limited amount of ore was insufficient for developing complete smelting data; therefore, the slags from the first tests were crushed, sampled, and resmelted to determine the nickel recovery to be expected by electric smelting of these ores with enough reductant. Over 90 percent of the nickel was recovered as low-carbon ferronickel. The alloys

[8] Hundhausen, R. J., McWilliams, J. R., and Banning, L. H., Preliminary Investigation of the Red Flats Nickel Deposit, Curry County, Oreg.: Bureau of Mines Rept. of Investigations 5072, 1954, 19 pp.

recovered from smelting the serpentine and the laterite slags contained 52.1 and 48.0 percent nickel, respectively. The final slag products from these tests contained 0.21 percent nickel. The results of these preliminary smelting tests indicate that it is feasible to produce a commercial ferronickel from these ores, but additional tests should be performed before a plant is designed. A detailed report describing the smelting tests was scheduled for publication in 1955.

At the Bureau's Intermountain Experiment Station, Salt Lake City, Utah, reductive roasting tests employing fluidized-solids techniques were continued on Cuban nickeliferous laterite and serpentine to determine the optimum roasting and subsequent leaching conditions for recovering nickel and cobalt. Batch and continuous roasting tests were made in the FluoSolids reactor on laterite, serpentine, and a blend of 2 parts laterite and 1 part serpentine, using a gas containing 6 to 9 percent CO for reduction. The best nickel extractions obtained on the laterite and serpentine from batch tests were 93.5 and 68.1 percent compared with 87 percent from a continuous test on the blend. Cobalt extractions averaged about 70 percent. Increasing the CO content of the gas from 6 to 22 percent reduced the roasting time required for laterite and serpentine from 150 minutes to 60 or less. Use of enriched gas improved extraction from the serpentine but had little effect with laterite. Fine-grinding the quenched calcines invariably improved nickel extraction and tended to overcome the deleterious effect of overreduction. No appreciable improvement in nickel extraction was obtained by increasing the concentration of the ammonia leach solution from 5 percent to 10. Addition of air during atmospheric agitation increased the nickel extraction on overreduced laterite calcine. Pressure-leaching tests using air or oxygen failed to increase nickel extraction.

A review of metallurgical investigations of Cuban nickel ores was published.[9]

Industry.—International Nickel Co. of Canada, Ltd., intensified its research activities in those fields where future markets provided by new uses for nickel are most likely to be found. Special attention was given to alloys that provide the properties needed in an age of electronic devices, jet-propelled aircraft, and the generation of power by nuclear reaction. Progress in architectural and decorative metalwork and in the chemical and process industries was being facilitated by improvements in plating, the development of new corrosion-resistant alloys, and the accumulation of knowledge of the properties of various alloys.

Construction of Inco's pyrrhotite plant near Copper Cliff, Ontario, for the recovery of iron ore was well underway and operations were expected to begin in 1955. An atmospheric pressure-leaching process developed by the company will be employed. This new, flexible proc-

[9] McMillan, W. D., and Davis, H. W., Nickel-Cobalt Resources of Cuba: Bureau of Mines Rept. of Investigations 5099, 1955, pp. 19–31.

ess is suitable also for treating nickel-bearing sulfide concentrates of low precious-metal content.

Apart from continuous research on process and product improvement, metallurgical investigation by Falconbridge Nickel Mines, Ltd., was concerned primarily with developing a pyrrhotite treatment process; a commercial-size pilot plant was constructed at Falconbridge, Ontario.[10] A Cottrell dust-collecting plant was under construction at Falconbridge in 1954.

Extraction of nickel from low-grade ores by the d'Ugine process was the subject of British Patent 713,713, August 18, 1954, issued to Société d'Électro-chimie d'Électrometallurgie et des Aciéries Électriques d'Ugine. According to Chemical Abstracts:[11]

> Nickel is extracted from low-grade ores, as an Fe-Ni alloy, by mixing successive charge of molten ore with molten Fe and periodically withdrawing a part of the metal. Exothermic heat from oxidation of added Si or Al compensates for heat losses. Formation of CO from C addition causes bubbling. Treatment of ore containing NiO 1.5, FeO 35, and SiO_2 35 percent with Fe and Fe-Si in a converter reduces the ore to 0.20 percent Ni and after processing gives a 30 percent Ni alloy.

Mining of nickel ore at the Ocujal mine in Oriente Province, Cuba, and recovery of nickel from the ore at the Nicaro plant were described.[12]

Patents were issued for processes for separating nickel and cobalt.[13]

Two new nickel-plating processes were described.[14]

Nickel has been found to give better resealing qualities than copper or cadmium in plating on aluminum,[15] an electro-deposited nickel was found to have advantages over other build-up methods for worn and overmachined parts.[16]

Nickel-aluminum-bronze alloy, now being produced, was reported to be superior to manganese-bronze alloy for ship propellers.[17]

WORLD REVIEW

Table 10 shows world production of nickel by countries, 1945–49 (average) and 1950–54, insofar as statistics are available. Canada has supplied 87 percent of the world output outside the U. S. S. R. since 1950.

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[10] Falconbridge Nickel Mines, Ltd., 26th Annual Report: 1954, p. 7.

[11] Chemical Abstracts, vol. 49, No. 4, Feb. 25, 1955, p. 2285.

[12] Lutjen, G. P., Nicaro Proves Lateritic Nickel Can Be Produced Commercially: Eng. and Min. Jour., vol. 155, No. 6, June 1954, pp. 81–89.

[13] DeMerre, Marcel, Separation of Nickel From Solutions Containing Cobalt and Nickel: U. S. Patent 2,671,712, Mar. 9, 1954.

Schaufelberger, F. A. (assigned to Chemical Construction Corp.), Separation of Nickel and Cobalt Metal From Acidic Solution: U. S. Patent 2,694,005, Nov. 9, 1954.

Schaulfelberger, F. A. (assigned to Chemical Construction Corp.), Separation of Nickel and Cobalt Metal From Ammine Solution: U. S. Patent 2,694,006, Nov. 9, 1954.

[14] Gutzeit, Gregoire, Kanigen Nickel Plating: Metal Progress, vol. 66, No. 1, July 1, 1954, pp. 113–120, 146.

Bart, S. G., Electrolytic Nickel-Clad Plate Offers Low-Cost Corrosion Protection: Iron Age, vol. 174, No. 18, Oct. 28, 1954, pp. 87–89.

[15] Baker, Sam, Plating Nickel on Aluminum: Steel, vol. 134, No. 21, May 24, 1954, pp. 115–116.

[16] Zlatin, Norman, and Prine, W. H., Increase Tool Life in Machining Nickel Plate: Iron Age, vol. 173, No. 26, July 1, 1954, pp. 118–120.

[17] American Metal Market, Nickel-Aluminum Alloy Used for Ship Propellers: Vol. 61, No. 113, June 15, 1954, p. 1.

TABLE 10.—World mine production of nickel, by countries, 1945–49 (average) and 1950–54, in short tons of contained nickel [1]

(Compiled by Berenice B. Mitchell)

Country	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Canada [2]	119,537	123,659	137,903	140,559	143,693	159,992
Cuba (content of oxide)	5,325			8,924	13,844	14,545
United States [3]	[4] 765	913	756	633	[4] 602	[4] 2,645
Total	125,627	124,572	138,659	150,116	158,139	177,182
South America: Brazil (content of ore)	15	(5)	(5)	[6] 33	[6] 55	(5)
Europe:						
Finland (content of concentrates)	455		94	446	418	187
Italy	[6] 3					
Norway (content of ore)	126					
Sweden (content of ore)	86					
U. S. S. R.[6]	23,900	32,000	36,000	41,000	44,000	47,000
Total (estimate)	24,570	32,000	36,094	41,446	44,418	47,187
Asia:						
Burma (content of speiss)			700	70	16	95
Japan (content of ore)	143					
New Caledonia (content of ore)	3,611	4,685	7,400	11,750	18,800	15,100
Total	3,754	4,685	8,100	11,820	18,816	15,195
Africa:						
French Morocco (content of cobalt ore)				201	132	162
Rhodesia and Nyasaland, Fed. of (content of ore) Southern Rhodesia					(5)	(5)
Union of South Africa (content of matte)	562	929	1,254	1,444	1,891	2,112
Total	562	929	1,254	1,645	2,023	2,274
World total (estimate)	155,000	162,000	184,000	205,000	223,000	242,000

1 This table incorporates a number of revisions of data published in previous Nickel chapters.
2 Comprises refined nickel, nickel in oxide, and recoverable nickel in matte, etc., exported.
3 Byproduct in electrolytic refining of copper.
4 Includes some production from ore.
5 Data not available.
6 Estimate.

NORTH AMERICA

Canada.—Virtually all 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., East Rim Nickel Mines, Ltd., and Nickel Offsets, Ltd., all in the Sudbury district, and Sherritt Gordon Mines, Ltd., in the Lynn Lake area—accounted for virtually all production in 1954. Nickel production in Canada was 160,000 short tons in 1954, an 11-percent gain over 1953 and the highest of record. Exports of nickel from Canada also established a new high of 157,200 short tons in 1954, a 9-percent gain over 1953.

Sales of nickel in all forms by the International Nickel Co. of Canada, Ltd., were 141,000 short tons in 1954 compared with 125,700 tons in 1953.[18]

The results of years of research in mining methods and of very large expansion in underground mines by Inco are reflected in a record output of ore from underground of 11,988,208 short tons in 1954 compared with 11,095,199 tons in 1953. Indicating the progress in

18 International Nickel Co. of Canada, Ltd., Annual Report: 1954, p. 6.

utilizing bulk mining methods, over 70 percent of the total tonnage of underground ore mined resulted from block-caving and blasthole operations. Open-pit ore mined was 2,468,046 tons compared with 2,571,896 tons in 1953. A total of 14,456,254 tons—also an alltime high—was mined in 1954 compared with 13,667,095 tons in 1953. According to the company, proved ore reserves at the end of 1954 were 261,619,000 tons containing 7,875,000 tons of nickel-copper compared with 261,541,000 tons containing 7,817,000 tons of nickel-copper at the end of 1953. Underground development in the producing mines advanced 121,590 feet (23 miles) in 1954, bringing the total footage to 1,981,873 or 375 miles. Concerning developments at certain mines, the company reported as follows:[19]

Excavation work was started at the Frood-Stobie mine for the installation of facilities to provide for the underground storage and subsequent pumping from the mine of large quantities of water from spring run-offs and heavy rains. This volume has increased with the mining of additional stopes through to the surface in the open pit area. Provision is being made to hold 25,000,000 gallons at a time. At the Creighton mine, development started for a third crusher station at the 28 level and the main ore pass and ventilation system was completed in the current caving areas.

Installation was started at the Murray mine of a new semi-automatic electric ore hoist using 15-ton bottom-dump skips and operating to the 3,200-foot level. In the Garson mine, skips and cages now operate to the 3,800-foot and the 4,000-foot shaft stations and new shaft stations have been established at the 3,200-foot, 3,400-foot, and 3,600-foot levels.

Important progress was made at the Levack mine on the program for developing the area below the 1,600-foot level down to the 2,650-foot level by the installation of a crusher and rotary tipple at the lower level. Shafts No. 2 and No. 3 were extended to total depths of 3,067 feet and 3,220 feet, respectively.

The conversion from open-pit to completely underground mining at the Inco Sudbury mines and the underground mining and stoping methods employed at its five mines were described in several magazine articles.[20]

Inco continued exploration for new sources of nickel in Canada, as well as in 12 other countries. The cost of the program was $5,255,462 in 1954 compared with $6,084,742 in 1953. Exploration at its Sudbury properties included 480,000 feet of diamond drilling. Field exploration was also conducted in Manitoba, Northwest Territories, and Saskatchewan. In the Mystery Lake area of Manitoba, a deposit adjacent to Moak Lake that may prove an important source of nickel-bearing ore was investigated. Extensive drilling has been done and to obtain additional information on the nature of the deposit, a prospect shaft was being sunk to 1,300 feet, with development scheduled on 2 levels where crosscutting, drifting, and diamond drilling will be done.

Falconbridge Nickel Mines, Ltd., again established new records in production of ore and matte in 1954. Ore produced at the Falconbridge, McKim, Mount Nickel, Hardy, and East mines in the Sudbury district was 1,408,666 short tons compared with 1,165,953 tons in 1953. In addition to company ore, 113,530 tons of ore and concen-

[19] Work cited in footnote 18, p. 9.
[20] Mining Journal (London), International Nickel Co. of Canada's Underground Mining Program: Vol. 243, No. 6219, Oct. 29, 1954, pp. 486–487.
Mining Journal (London), Underground Mining Practice at International Nickel's Sudbury Properties: Vol. 243, No. 6220, Nov. 5, 1954, pp. 514–517.
Mining Journal (London), International Nickel's Mining Methods and Metallurgical Techniques: Vol. 243, No. 6221, Nov. 12, 1954, pp. 550–551.

trates was received for treatment from independent mines in the district in 1954 (140,723 tons in 1953). Ore and concentrates treated were 1,523,360 tons—1,409,830 tons of ore from company mines and 113,530 tons of ore and concentrates from the East Rim and Nickel Offsets mines in 1954. Production of nickel in matte was 23 percent more than in 1953.

The following information concerning developments, exploration, expansions, and reserves was abstracted from the 26th Annual Report of Falconbridge Nickel Mines, Ltd., for 1954.

Of the six Falconbridge mines under development in 1953, Mount Nickel, Hardy, and East mines were brought into production in 1954. The Longvack, Boundary, and Fecunis mines continued under development. Additional milling capacity came into use at Falconbridge, and the new mill at Hardy was nearly ready to treat ore at the end of 1954. At Mount Nickel mine underground work was chiefly stope preparation, diamond drilling, and stoping. At Hardy the ore pass, fill pass and ventilation systems and their controls were completed and placed in operation. Over 5,000 feet of lateral development was completed; some 4,000 feet of raising and 15,000 feet of test drilling aided in outlining the ore. At the East mine development advances totaled 13,339 feet; 4 stopes were started by end of 1954 and 8 were under preparation. Original plans to mine the Longvack ore body by open-pit method were changed to an inclined shaft and conveyor-belt hoisting system to provide more complete extraction of the ore deposit. By the year end the shaft had reached a slope depth of 597 feet. Shaft sinking at Fecunis mine was well ahead of schedule; the main shaft had reached a depth of 3,108 feet and the service shaft a depth of 1,565 feet by the end of 1954. Systematic drilling was continued in the Levack and Junior Frood areas. A substantial ore body was being outlined east of Boundary.

A number of prospects were examined by Falconbridge outside of the Sudbury area, mostly in Manitoba and Ontario. Considerable drilling was done on the property of Kenora Nickel Mines, Ltd., in western Ontario; results were encouraging, but further investigation underground will be required to establish structural continuity and permit a realistic estimate of possible reserves and grade. Investigations in the Concession area in Newfoundland failed to indicate possibilities for nickel mineralization as encouraging as other areas in which the company was interested and the concession was not renewed at its 3-year termination date.

Ore reserves totaled 35,515,700 short tons on December 31, 1954, and comprised 15,612,600 tons of developed ore averaging 1.58 percent nickel and 0.84 percent copper in the Falconbridge, East, McKim, Mount Nickel, and Hardy mines and 19,903,100 tons of indicated ore averaging 1.59 percent nickel and 0.81 percent copper in Sudbury-district holdings. Despite extraction of 1,408,700 tons during 1954, total ore reserves were increased 944,700 tons.

The year 1954 was one of the most important in the history of Sherritt Gordon Mines, Ltd., as it marked completion of its main construction program and the beginning of commercial nickel production.[21] It is worthy to note that a period of slightly less than 9 years

Sherritt Gordon Mines, Ltd., Annual Report: 1954, p. 2.

elapsed between the first discovery of nickel ore at Lynn Lake, Manitoba, and shipment of the first carload of nickel metal from the company refinery at Fort Saskatchewan, Alberta.

The mining and milling operation at Lynn Lake exceeded company estimates for the first year of production by 33 percent, and the grade of the nickel concentrate produced and the overall metal recoveries in the mill also exceeded preproduction estimates. In 1954 ore hoisted was 560,460 short tons. All output was from the "A" mine before May, when production from the "EL" mine began. Ore milled totaled 557,589 dry short tons averaging 1.94 percent nickel, from which was produced 70,400 tons of concentrate averaging 13.28 percent and containing 18,703,110 pounds of nickel. Thus, 86.53 percent of the contained nickel in the ore was recovered in concentrates.

Production of nickel at the refinery at Fort Saskatchewan was begun July 22, and the first carload shipment was made August 7. Metal produced totaled 3,965,900 pounds in 1954. A metal-powder briquetting plant was put into operation.

Among the smaller companies, 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 exploration was carried on by many companies, including the North Rankin Nickel Mines, Ltd., at its property on the west shore of Hudson Bay; Western Nickel Mines, Ltd., at a property near Choate, B. C.; and Hudson Bay Mining & Smelting Co., Ltd., at its Wellgreen property in the Kluane Lake district, Yukon Territory. At the Wellgreen property a shaft was sunk from the adit, and a new level was established 200 feet below the adit horizon.[22] Ore reserves of Hudson Bay were expected to be up considerably from the estimate, made in the fall of 1954, of 500,000 tons averaging 2.15 percent nickel.

Cuba.—Production of nickel in Cuba established a new high in 1954 and was 5 percent greater than in 1953, itself a record year. Output of oxide was 18,187 short tons (14,545 tons nickel plus cobalt content) in 1954 compared with 17,834 tons (13,844 tons nickel plus cobalt content) in 1953. The 1954 output consisted of 12,843 tons of oxide powder averaging 77.69 percent nickel plus cobalt and 5,344 tons of sinter averaging 85.47 percent nickel plus cobalt. Commercial production of nickel oxide sinter was begun at the Nicaro plant in June 1954.

Exports of nickel oxide from Cuba in 1954 were 18,008 short tons (15,006 tons nickel plus cobalt content) and consisted of 13,480 tons of oxide powder averaging 77.73 percent nickel plus cobalt and 4,528 tons of sinter averaging 86.24 percent nickel plus cobalt.

Production of ore was 1,337,562 dry short tons in 1954 compared with 1,330,224 tons in 1953. Ore fed to the driers was 1,368,569 dry short tons averaging 1.42 percent nickel in 1954 compared with 1,279,604 tons averaging 1.37 percent nickel in 1953.

A 75-percent expansion of the nickel-producing facilities at the United States Government-owned plant at Nicaro, Cuba, was begun in October 1954.

General Services Administration and Freeport Sulphur Co. entered into an agreement that provides for constructing and operating by

[22] Canadian Mining Journal, vol. 76, No. 3, March 1955, p. 88.

Freeport of a pilot plant to study, on a large scale, a new process for producing nickel and cobalt from laterite deposits at Moa Bay on the northeast coast of Cuba. The plant, to be financed by the Government, will be near New Orleans and will treat 50 tons of ore a day supplied by Freeport without charge to the Government. The pilot plant is scheduled for completion in the fall of 1955. In addition to the pilot-plant agreement the Government entered into a contract to buy nickel and cobalt from a commercial plant that Nicaro Nickel Co., a Freeport subsidiary, plans to build upon successful completion of the pilot-plant program.

The Bureau of Mines, under an agreement with General Services Administration, completed drilling in the Levisa Bay district of Cuba. A total ore reserve of 34,789,000 dry short tons averaging 1.39 percent nickel, 0.10 percent cobalt, and 35.8 percent iron was indicated by the exploration project. A report giving detailed information on the exploration, with information on significance of the nickel-ore reserves of Cuba and history of operations of the nickel-recovery plant at Nicaro, Cuba, was being prepared.

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. The ore from the Nivala mine was converted into a low-grade concentrate and in previous years had been further converted into nickel matte at Harjavalta. The latter process was discontinued in 1954. Instead, the concentrate, with other nickel-bearing materials from the Outokumpu mine, was used for producing nickel sulfate at the Pori metal works of Outokumpu Oy. Nickel sulfate production was 416 short tons containing about 89 tons of nickel in 1954 compared with 386 tons containing 76 tons of nickel in 1953. The entire output of nickel sulfate in both years was exported.

Production of ore at the Nivala mine was 36,861 short tons averaging 0.67 percent nickel in 1954 compared with 85,179 tons in 1953. Production of concentrates was 3,326 tons averaging 5.6 percent nickel in 1954 compared with 7,843 tons in 1953.

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 pure metal was 5,320 short tons in 1954 compared with 3,269 tons in 1953.

Greece.[23]—The first shipment of machinery for installation at the Kardista mine at Larymna was received May 6, 1954. Initial annual output of ore will be about 143,000 tons, the capacity of the processing kiln. Production was scheduled to begin in 1955.

Norway.—Output of nickel at the refinery of Falconbridge Nickel Mines, Ltd., at Kristiansand from matte imported from Canada established a new high of about 19,100 short tons in 1954 compared with 16,462 tons in 1953, itself a record year. Deliveries of nickel were 19,395 short tons in 1954 compared with 16,412 tons in 1953. Refining capacity was increased, in line with expected mining, milling, and smelting capacities. Further expansion in capacities will con-

[23] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 6, December 1954, pp. 28–29.

tinue until balanced operations at a production level of 55,000,000 pounds of nickel a year have been reached.[24]

ASIA

Japan.[25]—Production of nickel in Japan consisted of 2,630 short tons of pure nickel and 2,147 tons (nickel content) of ferronickel in 1954. Exports in 1954 included nearly 900 tons each of metal and ferronickel to West Germany and over 100 tons of metal to each of Australia, Great Britain, and Italy. Domestic requirements were about 1,100 tons of metal and 1,400 tons of ferronickel in 1954. New Caledonia was the main source of nickel ore.

New Caledonia.—According to L'Activité Minière de la Nouvelle Caledonie, production of nickel ore in New Caledonia was 578,397 short tons containing 15,100 tons of nickel in 1954 compared with 691,517 tons containing 18,800 tons of nickel in 1953. Exports of nickel ore were 163,719 short tons in 1954, of which 163,168 tons went to Japan and 551 tons to France.

Production of nickel matte, fonte, and ferronickel by Société le Nickel was 22 percent more in 1954 than in 1953.

TABLE 11.—Production of nickel matte, ferronickel, and fonte by Société le Nickel in 1952–54, in short tons

Product	1952		1953		1954	
	Gross weight	Nickel content	Gross weight	Nickel content	Gross weight	Nickel content
Matte	4,469	3,452	6,303	4,853	8,277	6,365
Fonte	10,459	3,461	8,415	} 2,764	{ 10,800	2,915
Ferronickel	221	82	2,667			----------
Total	15,149	6,995	17,385	7,617	19,077	9,280

TABLE 12.—Nickel ore and nickel products exported from New Caledonia, 1952–54, gross weight in short tons

	1952	1953	1954
Ore	121,122	229,204	163,719
Matte	4,227	5,778	8,317
Fonte	9,623	5,374	12,955
Ferronickel	170	2,107	----------

AFRICA

Federation of Rhodesia and Nyasaland.—The Noel nickel mine at Gwanda, Southern Rhodesia, was reopened in 1953, when 63 short tons of nickel ore was produced. Production was 62 tons in 1954.

Union of South Africa.—Since 1938 there has been a small annual output of nickel as matte from the sulfide ore in the Rustenburg

[24] Falconbridge Nickel Mines, Ltd., 26th Annual Report: 1954, p. 6.
[25] American Metal Market, Feb. 25, 1955, pp. 1, 3.

district by Rustenburg Platinum Mines, Ltd. Production was 2,112 short tons in 1954 compared with 1,891 tons in 1953. The matte was exported to England for refining.

Nickel Corporation of Africa, Ltd., reported that it had acquired option and prospecting contracts in the Klerksdorp/Venterspost district and that drilling contracts had been let.[26]

[26] Engineering and Mining Journal, vol. 155, No. 11, November 1954, p. 197.

Nitrogen Compounds

By Milford L. Skow [1]

CONTINUED rapid growth in domestic demand for synthetic nitrogen compounds was more than balanced by the large expansion in plant capacity in 1954. For the first time in a decade there was an adequate supply of nitrogen at year's end, when the total productive capacity of the synthetic nitrogen industry in the United States was more than 2.9 million short tons of nitrogen per year. The Office of Defense Mobilization, however, anticipating a need for still greater capacity, raised the nitrogen-expansion goal from 2.9 million tons by 1955 to 3.5 million tons by January 1, 1957, and granted certificates of necessity to 13 chemical companies for additional capacity to meet the new goal.

DOMESTIC PRODUCTION

Synthetic anhydrous ammonia production in 1954 was 19 percent greater than in 1953, the previous record year. Ammonium sulfate production in byproduct coking plants was 13 percent lower than in 1953 as a result of the sharp decline in steel production. However, the total quantity of ammonium sulfate produced in 1954 (53 percent derived from synthetic ammonia) was exceeded only in 1950. Ammonium nitrate production increased 19 percent over the former alltime high of 1953. Synthetic sodium nitrate continued to be

TABLE 1.—Principal nitrogen compounds produced in the United States, 1945–49 (average) and 1950–54, in short tons

Commodity	1945–49 (average)	1950	1951	1952	1953	1954
Ammonia (NH_3):						
Synthetic plants:						
Anhydrous ammonia [1]	954, 407	1, 565, 569	1, 777, 074	2, 052, 114	2, 287, 785	2, 719, 666
Byproduct coking plants (NH_3 content):						
Aqua ammonia	25, 164	23, 387	24, 878	22, 060	24, 846	16, 104
Ammonium sulfate	190, 249	207, 754	224, 566	200, 603	236, 533	205, 705
Subtotal	215, 413	231, 141	249, 444	222, 663	261, 379	221, 809
Grand total	1, 169, 820	1, 796, 710	2, 026, 518	2, 274, 777	2, 549, 164	2, 941, 475
Principal ammonium compounds:						
Ammonium sulfate:						
Synthetic plants [1 2]	310, 407	1, 137, 721	622, 084	812, 795	576, 232	928, 447
Byproduct coking plants	760, 995	831, 016	898, 263	802, 412	946, 133	822, 818
Total	1, 071, 402	1, 968, 737	1, 520, 347	1, 615, 207	1, 522, 365	1, 751, 265
Ammonium nitrate, basis solution, 100 percent NH_4NO_3 [1]	848, 061	1, 213, 911	1, 346, 443	1, 467, 341	1, 558, 457	1, 857, 626

[1] Data from Bureau of Census Facts for Industry series.
[2] Includes ammonium sulfate produced at byproduct coking plants from purchased ammonia.

[1] Commodity-industry analyst.

produced by only Allied Chemical & Dye Corp., Hopewell, Va., and Olin-Mathieson Chemical Corp., Lake Charles, La.

A list of the plants producing synthetic anhydrous ammonia in the United States at the end of 1954 follows. Their capacity at that time, according to Business and Defense Services Administration, United States Department of Commerce, totaled 3,545,000 tons of anhydrous ammonia per year.

Plants producing anhydrous ammonia in the United States, December 31, 1954 [1]

Allied Chemical & Dye Corp., Hopewell, Va.
Allied Chemical & Dye Corp., Omaha, Nebr.
Allied Chemical & Dye Corp., South Point, Ohio.
American Cyanamid Co., New Orleans, La.
Atlantic Refining Co., Philadelphia, Pa.
Brea Chemicals Inc., Brea, Calif.
Commercial Solvents Corp., Sterlington, La.
Cooperative Farm Chemicals Assoc., Lawrence, Kans.
Deere & Co., Pryor, Okla.
Dow Chemical Co., Freeport, Tex.
Dow Chemical Co., Midland, Mich.
Dow Chemical Co., Pittsburg, Calif.
E. I. du Pont de Nemours & Co., Belle, W. Va.
E. I. du Pont de Nemours & Co., Niagara Falls, N. Y.
Grace Chemical Co., Memphis, Tenn.
Hercules Powder Co., Louisiana, Mo.
Hercules Powder Co., Pinole, Calif.
Hooker Electrochemical Co., Tacoma, Wash.
Lion Oil Co., El Dorado, Ark.
Lion Oil Co., Luling, La.
Mississippi Chemical Corp., Yazoo City, Miss.
Olin-Mathieson Chemical Corp., Lake Charles, La.
Olin-Mathieson Chemical Corp., Morgantown, W. Va.
Olin-Mathieson Chemical Corp., Niagara Falls, N. Y.
National Distillers Corp., Tuscola, Ill.
Pennsylvania Salt Manufacturing Co., Wyandotte, Mich.
Phillips Chemical Co., Etter, Tex.
Phillips Chemical Co., Port Adams, Tex.
San Jacinto Chemical Corp., Pasadena, Tex.
Shell Chemical Corp., Pittsburg, Calif.
Shell Chemical Corp., Ventura, Calif.
Spencer Chemical Co., Henderson, Ky.
Spencer Chemical Co., Pittsburg, Kans.
Spencer Chemical Co., Vicksburg, Miss.
Tennessee Valley Authority, Wilson Dam, Ala.

The Nitrogen Division of Allied Chemical & Dye Corp. completed plans for additional expansion of ammonia production capacity at Hopewell, Va., by 50,000 tons per year;[2] planned an increase of 20,000 tons per year in ammonia-production capacity at South Point, Ohio;[3] and decided to double the ammonia capacity and install facilities to produce nitrogen solutions at its Omaha, Nebr., plant, which began producing ammonia in April and urea in August.[4] The first plant using byproduct hydrogen from petroleum refining to produce synthetic anhydrous ammonia was put on stream at Philadelphia by

[1] Data from Business and Defense Services Administration, United States Department of Commerce.
[2] Commercial Fertilizer, vol. 88, No. 6, June 1954, p. 97.
Oil and Gas Journal, vol. 53, No. 3, May 24, 1954, p. 280.
[3] Commercial Fertilizer, vol. 89, No. 3, September 1954, p. 24.
Farm Chemicals, vol. 117, No. 10, October 1954, p. 14.
[4] Commercial Fertilizer, vol. 89, No. 3, September 1954, p. 22.
Oil and Gas Journal, vol. 53, No. 15, Aug. 16, 1954, p. 96.
Chemical and Engineering News, vol. 32, No. 33, Aug. 16, 1954, p. 3251.
Oil, Paint, and Drug Reporter, vol. 166, No. 6, Aug. 9, 1954, p. 5.

Atlantic Refining Co.[5] At Brea, Calif., Brea Chemicals, Inc., began operating ammonia and ammonium phosphate plants and contracted for construction of adjacent nitric acid and ammonium nitrate facilities.[6] Columbia River Chemicals Co., awarded contracts for a plant at Attalia, Wash., on the Columbia River, to produce ammonia, ammonium sulfate, and urea.[7] Construction began at Natrium, W. Va., on the plant of Columbia-Southern Chemical Corp., to produce ammonia from hydrogen obtained as a byproduct of electrolytic chlorine and caustic soda.[8] Cooperative Farm Chemicals Association started producing ammonia, nitric acid, and ammonium nitrate at Lawrence, Kans.;[9] John Deere Chemical Co. began to produce ammonia and urea at Pryor, Okla.;[10] and Dow Chemical Co. doubled its ammonia-production capacity.[11] Grace Chemical Co. began to produce ammonia at Woodstock, Tenn., in December.[12] Hercules Powder Co. signed a lease with an option to buy the Government-owned Missouri Ordnance Works and put the ammonia facilities into production.[13] Hercules also joined with Alabama By-Products Corp. to form a jointly owned company, Ketona Chemical Corp., which awarded contracts for construction of a plant at Birmingham, Ala., to synthesize 45,000 tons of anhydrous ammonia per year from coke-oven gas.[14] Lion Oil Co., in a new plant at Luling, La., began daily production of 300 tons of anhydrous ammonia, most of which was to be converted to ammonium nitrate.[15] Contracts were awarded by Mississippi River Fuel Corp. for a plant near Crystal City, Mo., to produce ammonia, ammonium nitrate, and ammonium solutions.[16] Output of ammonia at the Mississippi Chemical Corp. plant in Yazoo City, Miss., was increased from 120 to 195 tons per day and, with further process modifications and additional equipment, was expected to reach 290 tons per day early in 1955.[17] The Phillips Chemical Co. doubled its anhydrous ammonia production with the start of operations at a new plant at Adam's Terminal on the Houston, Tex., ship channel.[18] Shell Chemical Corp. started shipping 5 million cubic feet of hydrogen daily by pipeline from the Shell Oil Co. refinery at Martinez, Calif., to its ammonia plant at Pittsburg, Calif. This will conserve natural gas and effectively use the byproduct hydrogen.[19]

[5] Commercial Fertilizer, vol. 89, No. 3, September 1954, p. 25.
Chemical Engineering, vol. 61, No. 11, November 1954, p. 132.
Oil, Paint, and Drug Reporter, vol. 166, No. 4, July 26, 1954, p. 5.
[6] Chemical and Engineering News, vol. 32, No. 15, Apr. 12, 1954, pp. 1456–1457.
Chemical Engineering Progress, vol. 50, No. 3, March 1954, p. 46.
Chemical Week, vol. 75, No. 4, July 24, 1954, p. 14.
Commercial Fertilizer, vol. 88, No. 5, May 1954, p. 53.
[7] Chemical and Engineering News, vol. 32, No. 27, July 5, 1954, p. 2682.
Commercial Fertilizer, vol. 89, No. 1, July 1954, p. 74.
[8] Chemical and Engineering News, vol. 32, No. 30, July 26, 1954, p. 2957.
Commercial Fertilizer, vol. 89, No. 2, August 1954, p. 37.
[9] Chemical and Engineering News, vol. 32, No. 34, Aug. 23, 1954, p. 3346.
Chemical Engineering, vol. 6, No. 11, November 1954, p. 114.
Oil, Paint, and Drug Reporter, vol. 166, No. 7, Aug. 16, 1954, p. 4.
[10] Commercial Fertilizer, vol. 89, No. 3, September 1954, p. 25.
[11] Chemical and Engineering News, vol. 32, No. 51, Dec. 20, 1954, p. 5032.
[12] Chemical and Engineering News, vol. 33, No. 3, Jan. 17, 1955, pp. 212–213.
Commercial Fertilizer, vol. 90, No. 1, January 1955, p. 41.
Oil and Gas Journal, vol. 53, No. 34, Dec. 27, 1954, p. 109.
[13] Chemical and Engineering News, vol. 32, No. 27, July 5, 1954, p. 2681.
[14] Chemical and Engineering News, vol. 32, No. 44, Nov. 1, 1954, pp. 4372–4374.
[15] Chemical and Engineering News, vol. 32, No. 24, June 14, 1954, pp. 2368–2369; vol. 32, No. 45, Nov. 8, 1954, p. 4465.
[16] Oil, Paint, and Drug Reporter, vol. 165, No. 24, June 14, 1954, p. 4.
[17] Chemical and Engineering News, vol. 32, No. 41, Oct. 11, 1954, p. 4060.
Chemical Engineering Progress, vol. 50, No. 10, October 1954, p. 46.
Commercial Fertilizer, vol. 89, No. 4, October 1954, p. 24.
[18] Chemical Engineering, vol. 61, No. 3, March 1954, p. 386.
[19] Chemical and Engineering News, vol. 32, No. 9, Sept. 27, 1954, p. 3858.

The first commercial operation of the partial-oxidation process for producing anhydrous ammonia began at the Vicksburg, Miss., plant of Spencer Chemical Co.[20] This company also planned to add nitric acid facilities to its Henderson, Ky., plant.[21] Standard Oil Co. (Indiana) and Sinclair Refining Co. jointly planned a plant at Hammond, Ind., to produce 300 tons of anhydrous ammonia per day from byproduct hydrogen piped from its refineries at Whiting and East Chicago, Ind. The plant will be owned by a new company to be formed by the parent firms and is expected to start producing early in 1956.[22] Scheduled for completion late in 1955 was a plant in the Toledo-Lima, Ohio, area in which Standard Oil Co. (Ohio) planned to produce 300 tons of anhydrous ammonia per day and to convert about two-thirds of it into urea, nitric acid, and ammonia solutions.[23] Stauffer Chemical Co., in a new plant at Tacoma, Wash., began producing ammonium phosphate and sulfate by the Italian Rumianca process.[24] Sun Oil Co. planned to enter the anhydrous ammonia field with a 300-ton-per-day plant at the Marcus Hook, Pa., refinery, where byproduct hydrogen will be a raw material.[25] United States Steel Corp. contracted for construction, at its Geneva, Utah, works, of a plant to produce 200 tons of anhydrous ammonia per day using coke-oven gas as a raw material.[26] Proposed ammonia plants also were announced during 1954 for Westvaco Division of Food Machinery and Chemical Corp. at South Charleston, W. Va.,[27] Salt Lake Chemical Co., near Salt Lake City, Utah,[28] and Utah Chemical Co., near Salt Lake City, Utah.[29]

CONSUMPTION AND USES

Agriculture continued to be the major consumer of nitrogen. Most nitrogen used by agriculture and industry was combined in various chemical compounds, but a small quantity of elemental nitrogen was used by industry. About 1.85 million short tons of nitrogen was consumed by agriculture in the United States during the fiscal year ended June 30, 1954, an increase of 13 percent over the preceding fiscal 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) ammonium sulfate, (4) anhydrous and aqua ammonia, (5) calcium cyanamide, and (6) calcium nitrate.

According to the United States Department of Agriculture, consumption of anhydrous ammonia, ammonium nitrate, calcium nitrate, sodium nitrate, and ammonium sulfate as fertilizers increased 61, 9, 6, 1, and 0.4 percent, respectively, but 17 percent less calcium cyanamide was used as fertilizer than in 1952–53.

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20 Chemical and Engineering News, vol. 32, No. 7, Feb. 15, 1954, pp. 572–573.
21 Commercial Fertilizer, vol. 89, No. 1, July 1954, pp. 72–73.
22 Chemical Engineering Progress, vol. 50, No. 11, November 1954, p. 66.
Chemical Week, vol. 75, No. 14, Oct. 2, 1954, p. 24.
Oil and Gas Journal, vol. 53, No. 21, Sept. 27, 1954, p. 49.
23 Commercial Fertilizer, vol. 89, No. 3, September 1954, p. 24.
24 Commercial Fertilizer, vol. 88, No. 3, March 1954, p. 57.
25 Chemical Engineering Progress, vol. 50, No. 11, November 1954, p. 42.
Oil and Gas Journal, vol. 53, No. 24, Oct. 18, 1954, p. 132.
26 Chemical and Engineering News, vol. 32, No. 46, Nov. 15, 1954, p. 4537; vol. 32, No. 47, Nov. 22, 1954, p. 4644.
Steel, vol. 135, No. 24, Dec. 13, 1954, p. 91.
27 Commercial Fertilizer, vol. 89, No. 2, August 1954, p. 37.
28 Chemical Engineering, vol. 61, No. 1, January 1954, p. 118.
Farm Chemicals, vol. 117, No. 5, May 1954, p. 8.
29 Western Industry, vol. 19, No. 1, January 1954, p. 158.

PRICES

Prices of nitrogen compounds were mostly steady throughout 1954. Prices for various nitrogen compounds, in effect at the beginning and end of 1954, and the effective date of price changes as quoted in the Oil, Paint, and Drug Reporter, are shown in table 2.

TABLE 2.—Prices of major nitrogen compounds in 1954, per short ton [1]

Commodity	Jan. 4, 1954	Dec. 27, 1954	Effective date of change
Chilean nitrate, port, warehouse, bulk	$53.00	$51.25	Oct. 18.
Sodium nitrate, synthetic, domestic, c. l. works, crude, bulk	43.50	43.50	
Ammonium sulfate, coke ovens, bulk	44.00–47.00	42.00–47.50	July 26.
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	77.50	74.50	July 5.
Western, domestic, works, bags	68.00–70.00	68.00–70.00	
Anhydrous ammonia, fertilizer, tanks, works	85.00–88.00	85.00–88.00	
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 [30]

Total imports of nitrogen compounds were 13 percent less than in 1953. Imports of natural Chilean nitrate in 1954 exceeded imports of any other nitrogenous material and increased 29 percent in quantity and 15 percent in value compared with 1953. The average value per ton decreased from $40.90 in 1953 to $36.66 in 1954.

Chilean potassium-sodium nitrate imports were 6 percent greater in quantity and 4 percent less in value than in 1953. The average value per ton dropped from $50.03 in 1953 to $45.30 in 1954.

Total exports of nitrogen compounds were 2½ times those in 1953. Approximately 80 percent of the total increase was accounted for by shipments to 5 countries—Korea, Peru, Cuba, Canada, and Venezuela.[31]

TECHNOLOGY

This section includes the technology of producing synthetic ammonia; the conversion of ammonia to nitric acid, nitrates, and various fertilizer compounds; the recovery of ammonia from various sources; developments in the fixation of nitrogen; and significant commercial developments in production and uses of nitrogen compounds. Many literature references, largely on thermodynamics and chemistry (analytical, organic, and physical) of nitrogen and its many compounds, nitriding of metals, cyanidation of ores, refractory nitrides, and corrosion by various nitrogen compounds, are omitted from the following technology section because the volume of information is so large.

[30] 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.
[31] Foreign Commerce Weekly, vol. 52, No. 11, Sept. 13, 1954, p. 18.

TABLE 3.—Major nitrogen compounds imported for consumption into and exported from the United States, 1951–54, in short tons

[U. S. Department of Commerce]

	1951	1952	1953	1954
Imports:				
Industrial chemicals:				
Ammonium nitrate	4			
Fertilizer materials:				
Ammonium nitrate mixtures:				
Containing less than 20 percent nitrogen	361	624	8,294	(1)
Containing 20 percent or more nitrogen	342,757	467,166	755,087	524,938
Ammonium phosphates	134,962	133,288	166,497	164,133
Ammonium sulfate	216,106	238,063	523,858	305,012
Calcium cyanamide	68,231	96,195	82,218	84,211
Calcium nitrate	55,743	39,466	67,794	68,637
Nitrogenous materials, n. e. s.:				
Organic	26,023	22,067	17,104	[2] 17,748
Inorganic and synthetic, n. e. s	(3)	(3)	(3)	16,991
Potassium nitrate, crude	3,367	12,738	15,941	732
Potassium-sodium nitrate mixtures, crude	8,655	16,460	12,516	13,228
Sodium nitrate	737,324	675,329	568,873	731,530
Exports:				
Industrial chemicals:				
Anhydrous ammonia	5,907	15,431	15,119	39,257
Ammonium nitrate	5,049	5,709	6,013	7,560
Fertilizer materials:				
Ammonium nitrate	1,255	3,833	2,172	9,402
Ammonium sulfate	134,100	121,587	39,440	202,249
Nitrogenous chemical materials, n. e. s	63,768	48,109	[4] 46,585	48,871
Sodium nitrate	43,669	9,441	24,209	25,316

1 Effective Jan. 1, 1954 not separately classified; included in "inorganic and synthetic materials n. e. s."
2 Due to changes in classification data, not strictly comparable to earlier years.
3 Not separately classified.
Revised figure.

The first plant to use the partial-oxidation process (direct thermal re-forming) to obtain hydrogen for synthesis of ammonia started operating.[32]

For the first time in the United States, it was planned to use coke-oven gas as a source of hydrogen for synthesizing ammonia in 2 plants scheduled to produce at least 115,000 tons of ammonia annually by 1956. Three possible processes were described.[33]

The high purity of the hydrogen and nitrogen used in a new 100-ton-per-day anhydrous ammonia plant, the first to use byproduct hydrogen from a catalytic re-former, made possible unusually low synthesis pressures.[34]

Developments in ammonia synthesis were reviewed and the economics of various processes were discussed.[35] A method of preparing synthesis gas was the subject of a patent.[36] Processes and innova-

32 Chemical and Engineering News, New Oxidation Process Used at Spencer Chemicals: Vol. 50, No. 3, March 1954, p. 46.
Chemical Engineering, Synthetic Ammonia: Vol. 61, No. 4, April 1954, p. 126; No. 5, May 1954, pp. 332–335.
Mayland, B. J., Comley, E. M., and Reynolds, J. C., Ammonia, V. Partial Oxidation with Air. Its Relative Costs and Potential Advantages Over Conventional Processes: Oil Gas Jour., vol. 53, No. 25, Oct. 25, 1954, pp. 94–97.
33 Chemical Week, Ammonia Operates From a New Base: Vol. 75, No. 23, Dec. 4, 1954, pp. 50–54.
34 Chemical and Engineering News, vol. 32, No. 31, Aug. 2, 1954, pp. 3037–3038.
35 Brown, C. O., Which Ammonia Process?: Chem. Eng. Prog., vol. 50, No. 11, November 1954, pp. 556–559.
Mayland, B. J., Comley, E. A., and Reynolds, J. C., Ammonia Synthesis Gas—Evaluation of Processes With Natural Gas: Chem. Eng. Prog., vol. 50, No. 4, April 1954, pp. 177–181.
Reidel, J. C., Natural Gas to Ammonia. I. A Look at Round Two of Ammonia Expansion: Oil Gas Jour., vol. 52, No. 44, Mar. 8, 1954, pp. 86–91, 109–110, 112.
36 Malin, J. B. (assigned to Texas Co.), Generation of Gas for Ammonia Synthesis: U. S. Patent 2,694,003 Nov. 9, 1954.

TABLE 4.—Sodium nitrate and potassium-sodium nitrate imported for consumption in the United States, 1945–49 (average) and 1950–54, by countries

[U. S. Department of Commerce]

	1945–49 (average)		1950		1951		1952		1953		1954	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Sodium nitrate:												
North America:												
Canada	50	$2,803	8	$1,137	84	$4,622	50	$4,138	1	$45		
South America:												
Chile	666,430	18,885,685	617,999	22,387,123	737,188	27,015,854	675,279	27,626,811	568,872	23,268,068	731,530	$26,817,842
Europe:												
France					33	3,213						
Germany			11	1,330	5	576						
Poland					14	968						
Total			11	1,330	52	4,757						
Grand total	666,480	18,888,488	618,018	22,389,590	737,324	27,025,233	675,329	27,630,949	568,873	23,268,113	731,530	26,817,842
Potassium-sodium nitrate mixtures:												
North America:												
Canada					3	148						
South America:												
Chile	2,740	104,325	20,409	882,582	8,652	389,749	16,460	830,693	12,516	626,149	13,228	599,230
Grand total	2,740	104,325	20,409	882,582	8,655	389,897	16,460	830,693	12,516	626,149	13,228	599,230

tions in several new plants were described,[37] a brief review of the nitrogen industry was published,[38] and production of ammonia in petrochemical plants was discussed briefly on a worldwide basis.[39] The potentialities of a synthetic ammonia industry in North Dakota were summarized in a report that included pertinent data on the manufacture and use of synthetic ammonia products.[40]

The conversion of an ammonia plant to use natural gas instead of coke as a raw material was described.[41]

A demonstration unit for production of nitric acid by direct fixation of nitrogen [42] discontinued operations, and additional information relating to this process was published.[43] Another possible method for direct fixation of nitrogen from the air was patented.[44]

The oxidation of ammonia and recovery of nitrogen oxides and nitric acid were described [45] as well as the formation of nitrogen, nitrous acid, and nitric oxide by bacterial action.[46]

For commercial manufacture of ammonium nitrate, operation of the Stengel process was described,[47] and a novel 2-stage crystallization process was reported.[48]

Methods of improving the physical characteristics of ammonium nitrate were patented.[49]

Ammonia and nitric acid were used to treat phosphates and other materials to be used as fertilizers.[50]

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[37] Chemical Engineering, Ammonia—How It's Made Today: Vol. 61, No. 5, May 1954, pp. 140–142.
Chemical Engineering, New Ammonia Process Starts Up: Vol. 61, No. 4, April 1954, p. 126.
Chemical Engineering, Ammonia Process Has High-Pressure Re-former: Vol. 61, No. 2, February 1956, pp. 105–106.

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Additional information was made available on the use of ammonia and its compounds in extractive metallurgy.[51]

Current interest in the use of ammonia in paper making was indicated.[52]

The recovery of ammonia from ammonia-base sulfite liquor,[53] coke-oven gas,[54] and ammonium chloride [55] was described.

The use of hydrazine (N_2H_4) as a propellant first encouraged industrial exploitation and remained the major market, but agricultural, pharmaceutical, metallurgical, and chemical uses are assuming importance rapidly.[56]

Research on rocket propellants included investigation of various nitrogen compounds.[57]

WORLD REVIEW

According to the reports of Aikman (London), Ltd., world production and consumption of nitrogen (excluding U. S. S. R.) increased in 1954–55 compared with 1953–54. Detailed data in table 5 revealed that, although most countries reported increases, the United States reported by far the largest gains as it expanded its share of

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TABLE 5.—World production and consumption of fertilizer nitrogen compounds, fiscal years ended June 30, 1953–55, by principal countries, in short tons of contained nitrogen

Country	Production			Consumption		
	1952–53	1953–54 [1]	1954–55 [2]	1952–53	1953–54 [1]	1954–55 [2]
North America:						
British West Indies	---------	---------	---------	9,049	8,696	9,475
Canada	192,903	196,209	196,209	41,226	40,013	40,013
Costa Rica	---------	---------	---------	6,640	8,158	8,157
Cuba	---------	---------	---------	29,762	29,762	29,762
Mexico	14,727	14,975	18,718	18,116	26,066	32,582
United States [3]	1,418,660	1,514,560	1,699,747	1,803,363	1,915,798	2,099,882
Other countries	---------	---------	---------	7,249	7,713	8,113
Total	1,626,290	1,725,744	1,914,674	1,915,405	2,036,206	2,227,984
South America:						
Argentina	2,561	2,561	2,561	11,379	11,379	11,379
Brazil	3,858	3,858	3,858	14,330	14,330	14,330
Chile	250,662	276,898	276,898	15,357	15,261	15,261
Peru	32,323	33,069	33,069	37,065	39,053	39,053
Other countries	---------	20	20	8,973	11,117	11,607
Total	289,404	316,406	316,406	87,104	91,140	91,630
Europe:						
Austria	110,855	118,861	118,861	26,122	30,864	33,069
Belgium	194,507	229,317	234,134	92,043	103,495	99,207
Czechoslovakia	33,400	33,400	33,400	44,092	44,092	44,092
Denmark	---------	---------	---------	89,179	88,845	88,184
Finland	5,622	18,188	18,739	28,571	36,376	44,092
France	317,793	322,015	352,736	295,527	335,430	352,736
Germany:						
East	234,790	234,790	234,790	216,051	220,460	220,460
West	692,024	716,495	744,053	461,864	485,012	507,058
Greece	---------	---------	---------	30,956	39,683	55,115
Ireland	---------	---------	---------	10,241	10,940	11,023
Italy	234,269	280,866	330,690	199,898	223,767	242,506
Netherlands	270,725	281,087	297,621	175,376	181,880	181,880
Norway	182,199	206,130	213,846	39,693	39,132	40,234
Poland	71,650	71,650	71,650	82,673	82,673	82,673
Portugal [4]	6,668	6,668	6,668	37,990	37,990	37,990
Spain	29,762	41,887	41,887	124,560	134,481	134,481
Sweden	26,643	31,557	31,967	78,867	82,097	83,775
Switzerland	16,535	12,125	12,125	12,125	11,023	11,023
United Kingdom	343,918	348,327	348,327	257,718	275,575	281,087
Yugoslav [4]	7,385	7,385	7,385	10,638	10,638	10,638
Other countries	4,409	5,032	11,574	9,584	13,504	10,847
Total	2,783,154	2,965,780	3,110,453	2,323,768	2,487,957	2,572,170
Asia:						
Ceylon	---------	---------	---------	14,942	15,838	15,838
India	70,601	74,406	78,252	115,567	88,849	89,055
Indonesia	---------	---------	---------	18,631	20,869	20,869
Israel	---------	---------	---------	8,989	10,703	11,023
Japan and Ryukyus	565,480	617,288	628,311	444,227	501,547	497,137
Korea (South)	---------	---------	---------	138,814	108,566	114,309
Pakistan	---------	---------	---------	5,805	11,401	13,476
Philippines	---------	6,614	11,023	29,464	31,625	38,581
Taiwan	18,029	16,881	17,675	78,594	83,003	93,144
Turkey	1,039	1,389	1,389	10,417	10,458	10,458
Other countries	26	26	26	16,399	18,846	18,969
Total	655,175	716,604	736,676	881,849	901,705	922,859
Africa:						
Algeria				5,390	8,907	8,818
British Africa	---------	---------	---------	6,635	6,762	7,508
Egypt	20,503	23,920	24,251	114,561	122,432	122,355
Mauritius	---------	---------	---------	6,669	6,779	6,779
Union of South Africa	441	441	9,921	13,150	14,220	14,330
Other countries	---------	---------	---------	12,234	12,270	12,664
Total	20,944	24,361	34,172	158,639	171,370	172,454
Oceania:						
Australia	16,759	16,435	16,204	18,009	19,278	30,313
Other countries	2,687	2,687	2,687	4,813	4,874	4,991
Total	19,446	19,122	18,891	22,822	24,152	35,304
World total [5]	5,394,413	5,768,017	6,131,272	5,389,587	5,712,530	6,022,401

SOURCE: United Nations Food and Agricultural Organization.
[1] Preliminary figures.
[2] Forecast.
[3] Includes overseas territories.
[4] Calendar years 1953–55.
[5] Exclusive of U. S. S. R.

world production from 26 to almost 28 percent and its share of world consumption from less than 34 to almost 35 percent.

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
1950–51	4,448	849	4,393	849
1951–52	4,889	893	4,806	893
1952–53	5,407	1,003	5,357	1,003
1953–54	5,969	1,135	5,963	1,135
1954–55	6,454	1,317	6,432	1,317

[1] Exclusive of U. S. S. R.

SOURCE: Aikman (London), Ltd., Half-Yearly Report on the Nitrogen Industry: May 23, 1955.

Algeria.—Société d'Etudes Nord-Africaines de l'Azote planned to build a plant at Colomb-Bechar with an annual capacity of 100,000 tons of nitrogenous fertilizers.[58]

Australia.—Production began at the new 55,000-ton-per-year ammonium sulfate plant at the Risdon Works of the Electrolytic Zinc Co. of Australasia, Ltd., Hobart, Tasmania. Hydrogen from electrolysis of water and nitrogen from distillation of liquid air were used to synthesize ammonia.[59]

Austria.—Austrian Nitrogen Works, Ltd., of Linz reported production of 544,000 tons of ammonium lime nitrate in the year ended June 30, 1954 compared with 457,000 tons in the previous year.[60]

Canada.—Consolidated Mining & Smelting Co. of Canada, Ltd., announced an immediate start on a major expansion of its ammonia production facilities at Calgary, Alberta.[61]

Dow Chemical of Canada planned to expand, within 1 year, its ammonia facilities to a capacity of more than 100-tons-per-day.[62]

The New British Dominion Oil Co. planned a fertilizer plant in southern Alberta with a 100-ton-per-day plant for ammonia from natural gas.[63]

Sherritt Gordon Mines, Ltd., planned to double the capacity of its 75-ton-per-day synthetic ammonia plant at Fort Saskatchewan.[64]

Chile.—The total production of 1,581,000 metric tons of nitrates, about ⅔ by the Guggenheim process and ⅓ by the Shanks process, was 11 percent greater than in 1953.[65] Exports of nitrate increased 28 percent compared with 1953.

The industry was hampered by high production costs, owing principally to problems with exchange rates and increased wages. Even the producer with lowest costs was making little profit. Competition

[58] Chemical Week, vol. 75, No. 7, Aug. 14, 1954, p. 32.
[59] Fertiliser and Feeding Stuffs Journal (London), vol. 41, No. 4, Aug. 18 1954, pp. 129–131.
[60] Commercial Fertilizer, vol. 89, No. 3, September 1954, p. 25.
[61] Commercial Fertilizer, vol. 88, No. 4, April 1954, p. 46.
Oil, Paint, and Drug Reporter, vol. 165, No. 14, Apr. 5, 1954, p. 5.
[62] Commercial Fertilizer, vol. 88, No. 3, March 1954, p. 57.
[63] Chemical and Engineering News, vol. 32, No. 33, Aug. 16, 1954, p. 3254.
Fertiliser and Feeding Stuffs Journal (London), vol. 41, No. 5, Sept. 1, 1954, p. 171.
[64] Oil and Gas Journal, vol. 53, No. 7, June 21, 1954, p. 113.
[65] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 2, February 1955, pp. 51–52.

TABLE 7.—Exports of nitrate from Chile, 1954, by countries of destination

Country of destination	Short tons	Country of destination	Short tons
North America:		Europe—Continued	
Costa Rica	1,528	Poland	34,764
Cuba	1,560	Portugal	38,273
El Salvador	7,955	Spain	133,311
Guatemala	1,254	Sweden	34,775
Mexico	8,929	United Kingdom	21,086
United States	736,947	United Kingdom (for reexport)	197
		Yugoslavia	11,603
Total	758,173		
		Total	730,992
South America:			
Argentina	24,256	Asia:	
Bolivia	88	Japan	9,630
Brazil	57,586	Syria	2,561
Colombia	2,337	Lebanon and Jordan	3,023
Ecuador	1,543	Turkey	2,178
Peru	11,365	India	13,075
Uruguay	4,328		
Venezuela	1,102	Total	30,467
Total	102,605	Africa:	
		Egypt	101,312
Europe:		Egypt (for reexport)	3,880
Belgium	51,653	Mauritius	4,970
Denmark	31,526		
France	153,233	Total	110,162
Germany	57,154		
Greece	52,563	Oceania:	
Hungary	8,225	Australia	5,829
Ireland	3,322	New Zealand	3,361
Italy	49,286	Total	9,190
Netherlands	44,147		
Netherlands (for reexport)	5,874	Grand total	1,741,589

SOURCE: Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 2, February 1955, p. 52.

from synthetic nitrogen compounds precluded increasing prices, as in most markets the cost per unit of nitrogen was greater in Chilean nitrates than in synthesized compounds. Plant modification to increase production and reduce costs was delayed since funds were unavailable because of the unsettled conditions. Anglo-Lautaro Nitrate Co. and Tarapaca & Antofagasta Co. planned extensive improvements in their plants, contingent upon improved conditions.[66]

An agreement that would change the basic law governing the nitrate industry was signed in December by Chilean Government officials and representatives of the two major producers but required passage by Congress before taking effect.[67]

Egypt.—Production of calcium nitrate was expected to reach 200,000 metric tons. Plans were underway for construction of a 370,000-ton ammonium nitrate plant at Khattara near the electrification project at Aswan Dam.[68]

[66] Aikman (London), Ltd., Annual Report on the Nitrogen Industry, Dec. 2, 1954; Half-Yearly Report on the Nitrogen Industry, June 1, 1954.
Farm Chemicals, vol. 117, No. 5, May 1954, p. 8.
[67] Aikman (London), Ltd., Half-Yearly Report on the Nitrogen Industry: May 23, 1955.
[68] Foreign Commerce Weekly, vol. 52, No. 21, Nov. 22, 1954, p. 27.
Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 4, September 1954, pp. 54–55.

Finland.—The Government planned to double the capacity of the fertilizer plant at Oulu to 32,000 metric tons of nitrogen per year.[69]

Formosa.—A fertilizer plant to produce 85,800 metric tons of urea per year at Nankong on the Keelung River was to be financed by the Foreign Operations Administration (⅔) and the Chinese Government (⅓).[70]

Germany, West.—Knapsack-Griesheim A. G. planned to build a plant with a capacity of 2,000 tons of ammonia per year.[71]

India.—The Government considered measures to increase operational efficiency of the plant at Sindri to achieve the rated capacity of 1,000 tons of ammonium sulfate per day. Present production is about 800 tons per day.[72] At this plant additional facilities for manufacturing nitrogenous fertilizers from coke-oven gases were to be installed to produce 90 tons of ammonia per day for further processing to 70 tons of fertilizer-grade urea and 110 tons of ammonium nitrate.[73]

Ireland (Eire).—An ammonium nitrate plant using peat as the basic raw material was to be financed by the Government.[74]

Israel.—The following facilities of Fertilizer & Chemicals, Ltd., Haifa, were scheduled for completion by September: An ammonia plant with a capacity rated at 42 tons per day with the present gas shortage but at 75 tons per day as soon as sufficient gas becomes available; a nitric acid plant with a capacity of 40 tons per day; and an ammonium sulfate plant with a capacity of 100 tons per day using the direct neutralization process.[75]

Italy.—The discovery of natural gas in the Po Valley stimulated an unprecedented growth in the production and use of nitrogenous fertilizers. Italy had a capacity to produce 350,000 metric tons of nitrogen annually.[76]

Mexico.—The Cuautitlan plant of Guanos y Fertilizantes, the Government fertilizer-producing corporation, using natural gas from the Poza Rica fields to produce 80,000 tons of ammonium sulfate per year, filled a large part of Mexican needs for nitrogenous fertilizers. The Government tentatively approved the proposed 180-ton-per-day anhydrous ammonia plant at Coatzacoalcos, expansion of present facilities at Cuautitlan, and facilities to recover byproduct ammonium sulfate at the Monclova steel mill.[77]

Netherlands.—Norsk Hydro and N. V. Maatschappij tot Exploitatic van Kooksovengassen are testing the harnessing of the heavy tidal flow in producing potassium nitrate from sea water by the Norduco process.[78]

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[69] Chemical Week, vol. 75, No. 23, Dec. 4, 1954. p. 30.
[70] Foreign Commerce Weekly, vol. 52, No. 21, Nov. 22, 1954, p. 28.
[71] Chemical Week, vol. 75, No. 11, Sept. 11, 1954, p. 26.
[72] Chemical Age (London), vol. 70, No. 1812, Apr. 3, 1954, pp. 779–780.
[73] Chemical and Engineering News, vol. 32, No. 3, Jan. 18, 1954, pp. 241–242; vol. 32, No. 13, Mar. 29, 1954, p. 1226.
[74] Commercial Fertilizer, vol. 88, No. 2, February 1954, p. 46.
[75] Chemical Engineering, vol. 61, No. 2, February 1954, p. 120.
[76] Foreign Commerce Weekly, vol. 53, No. 4, Jan. 24, 1955, p. 20.
[77] Farm Chemicals, vol. 118, No. 9. September 1955, pp. 47–48.
Foreign Commerce Weekly, vol. 53, No. 2, Jan. 10, 1955, p. 23.
[78] Commercial Fertilizer, vol. 88, No. 3, March 1954, p. 57.

Norway.—Norsk Hydro increased its production capacity at the Glomfjord, Rjukan, and Notoden plants by a total of 34,000 tons of nitrogen per year, making the total capacity 230,000 tons per year.[79]

Pakistan.—Pakistan Industrial Development Finance Corp. started construction of an ammonium sulfate plant with a capacity of 50,000 tons per year at Daudkhel in the Punjab.[80]

Philippines.—National Power Corp., in the new Maria Cristina plants at Iligan City, Mindanao, planned to manufacture annually 50,000 metric tons of standard commercial, crystalline ammonium sulfate.[81]

Portugal.—Uniao Fabril do Azoto increased its output of ammonium sulfate from 19,300 tons in 1953 to 33,300 in 1954 and Amoniaco Portugues from 14,600 to 25,400. Portuguese demands could not be met, so the Government authorized imports of 5,000 tons of ammonium sulfate. The shortage of electrical power prevented the two nitrogen fixation companies from operating at full capacity.[82] The Government 6-year program for expanding industry will increase annual capacity from 13,400 to 52,600 metric tons of nitrogen.[83]

Sweden.—Swedish Shale Oil Co. planned a plant in west-central Sweden to produce 22,000 tons of ammonia annually for use in fertilizers.[84]

Turkey.—Contracts were sought for constructing a nitrogen-fixation plant at Kutahya with an annual output of 117,000 tons of nitrogenous fertilizer and nitric acid.[85]

Union of South Africa.—African Explosives & Chemical Industries, Ltd., began enlarging its Modderfontein facilities for producing ammonia, nitric acid, and ammonium nitrate. A modernized Haber-Bosch synthesis was to produce 40,000 tons of ammonia per year.[86] South African Cyanamid (PTY), Ltd., started constructing a calcium cyanamid plant at Witbank.[87]

Venezuela.—Montecatini Chemical Co. of Italy was to construct a plant using natural gas as a raw material to fix annually 30,000 tons of nitrogen, the ammonia to be converted to nitric acid, ammonium nitrate, ammonium sulfate, and urea.[88]

Yugoslavia.—A new plant with a capacity of 27,000 tons of nitrogen per year started operating at Gorazda, Bosnia.[89]

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79 Commercial Fertilizer, vol. 88, No. 2, February 1954, p. 46.
80 Commercial Fertilizer, vol. 88, No. 1, January 1954, p. 34; vol. 88, No. 3, March 1954, p. 57.
81 Chemical Age (London), vol. 70, No. 1814, Apr. 17, 1954, p. 897.
82 Fertiliser and Feeding Stuffs Journal (London), vol. 43, No. 1, July 6, 1955, p. 33.
83 Foreign Commerce Weekly, vol. 52, No. 8, Aug. 23, 1954, p. 23.
84 Industrial and Engineering Chemistry, vol. 46, No. 5, May 1954, p. 5A.
85 Fertiliser and Feeding Stuffs Journal (London), vol. 41, No. 6, Sept. 15, 1954, p. 222.
86 Fertiliser and Feeding Stuffs Journal (London), vol. 41, No. 2, July 21, 1954, p. 57.
87 Mining and Industrial News, vol. 22, No. 3, March 1954, p. 19.
88 Mining World, vol. 17, No. 4, April 1955, p. 67.
89 Fertiliser and Feeding Stuffs Journal (London), vol. 41, No. 12, Dec. 8, 1954, p. 503.

Perlite

By Oliver S. North [1] and Annie L. Marks [2]

NEW RECORDS were established in 1954 for production and value of crude and expanded perlite. By the end of the year perlite plants were operating in or near almost all major market areas. Competition from mill-mixed perlite plaster and from other mineral aggregates had become increasingly important factors affecting the consumption of independently produced, expanded perlite.

DOMESTIC PRODUCTION

Crude Perlite.—Fifteen firms with 17 mines in 6 States reported the output of crude perlite in 1954. Of these mines, 5 produced only for sale to other companies, 8 for use only in their own expanding furnaces, and 4 both for sale to other expanders and for use in their own furnaces. Gains for crude perlite in 1954 over 1953 were 11 percent in tonnage and 22 percent in total value.

Of the 219,700 short tons of crude perlite used in the United States in 1954, 111,000 tons was produced in New Mexico; this comprised 51 percent of the total United States output compared with 43 percent in 1953. Virtually all of the remainder came from Nevada and Colorado; small tonnages were also produced in California, Utah, and Arizona. For the first time since 1946 no crude perlite was reported to have been produced in Oregon.

Output of crude perlite in 1950–54 is shown in table 1. To avoid disclosing individual company operations, separate State totals are not published.

TABLE 1.—Crude and expanded perlite produced and sold or used by producers in the United States, 1950–54

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
1950	110,694	59,802	$411,205	41,734	$237,957	88,892	86,962	$4,741,383
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	[1] 9,254,374
1954	261,024	154,531	1,375,706	65,172	386,394	196,447	195,499	10,278,745

[1] Revised figure.

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

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Expanded Perlite.—Production of expanded perlite in 1954 was reported from 81 plants, operated by 72 companies, in 31 States. Of these plants, 12 were in California, 7 in Texas, 6 in New York, 5 each in Illinois and Pennsylvania, and 4 in Ohio. The tonnage of expanded perlite produced and sold or used in 1954 was 12 percent greater than in 1953; this increase was lower, percentagewise, than in any year since production of this material was first recorded by the Bureau of Mines and continued a leveling-off trend evident in the preceding 2 years.

The output of expanded perlite in 1953–54 is shown in table 2. Separate figures could not be published for Texas and New York because only combined statistics were available for certain companies operating plants in several States.

TABLE 2.—Expanded perlite produced and sold by producers in the United States, 1953–54, by States

State	1953				1954			
	Produced (short tons)	Sold			Produced (short tons)	Sold		
		Short tons	Value	Average value per ton		Short tons	Value	Average value per ton
California	35,403	35,342	$1,601,988	$45.33	25,354	24,794	$1,079,775	$43.55
Florida	(1)	(1)	(1)	(1)	5,301	5,109	336,398	65.84
Illinois	11,127	11,127	712,238	64.01	10,877	10,952	573,513	52.37
New Jersey	(1)	(1)	(1)	(1)	4,179	4,174	203,830	48.83
Ohio	10,344	10,015	675,207	67.42	10,064	9,868	753,649	76.37
Pennsylvania	13,158	13,109	810,965	61.86	15,234	15,289	960,954	62.85
Other Western States [2]	49,680	49,253	[3] 2,340,974	[3] 47.53	62,392	62,296	3,181,755	51.07
Other Eastern States [4]	55,522	55,615	[3] 3,113,002	[3] 55.97	63,046	63,017	3,188,871	50.60
Total	175,234	174,461	[3] 9,254,374	[3] 53.05	196,447	195,499	10,278,745	52.58

[1] Included with "Other Eastern States."
[2] Includes Arizona, Arkansas, Colorado, Iowa, Kansas, Louisiana, Minnesota, Missouri, Nebraska, Nevada, New Mexico, Oklahoma, Oregon, South Dakota (1954 only), Texas, and Utah.
[3] Revised figure.
[4] Includes Florida (1953 only), Indiana, Maryland, Massachusetts, Michigan, New Jersey (1953 only), New York, North Carolina, Tennessee, Virginia, and Wisconsin.

Mine and Plant Developments.—Coarse expanded perlite for use in oil-well cementing operations was produced at the Midland, Tex., plant of Perlite Industries, Inc. Coproducts were plaster aggregate and a soil conditioner.[3]

The Nevada Perlite Co. announced plans for constructing a mill near Fallon, Nev., to crush and size perlite from deposits 18 miles south of that town.[4]

Perlite-processing equipment of Dant & Russell, Inc., at Maupin, Oreg., was sold and dismantled, ending one of the pioneer perlite operations of the United States.

Western Mining Corp,. Boise, Idaho, announced plans to use crude perlite from Owyhee County, Idaho, in a popping plant at Nampa, Idaho.[5]

[3] Persons, H. C., Two Kilns in Series Produce Perlite: Rock Products, vol. 57, No. 7, July 1954, p. 81.
[4] Mining and Industrial News, Nevada Perlite to Ship 500 Tons Daily at Fallon: Vol. 22, No. 5, May 1954, p. 13.
[5] Rock Products (news item), vol. 57, No. 7, July 1954, p. 48.

Diamond drilling of perlite deposits near Sheaville, Malheur County, Oreg., continued during 1954. Despite the characteristic shell-like fracture of crude perlite, excellent core recovery was reported.[6]

A perlite expanding unit was put into operation early in 1954 by the National Gypsum Co., Buffalo, N. Y., in its gypsum products plant at Fort Dodge, Iowa. The material was to be used in manufacturing mill-mixed plaster.[7]

CONSUMPTION AND USES

Crude Perlite.—Although small quantities found other applications, in this chapter consumption statistics on crude perlite refer almost entirely to the material from which expanded perlite was made. The total consumption of crude perlite in the United States is the sum of the quantity sold by producers and that used by producers in their own expansion units. These figures are shown in table 1.

Expanded Perlite.—Based on producers' estimates of the approximate percentages of their output used for different purposes, the following estimated use breakdown of expanded perlite in 1954 was compiled: Plaster aggregate (premixed and job-mixed), 158,000 short tons (141,000 tons in 1953); concrete aggregate (exclusive of oil-well concretes), 22,000 tons (18,000 tons); oil-well muds and concretes, 7,000 tons (7,500 tons); filter aid, 2,000 tons (4,500 tons); and other uses, 6,500 tons (4,000 tons).

Nearly all perlite-expanding plants sold sizable quantities for use as plaster aggregate, and over half of the plants showed some fraction of their output used as concrete aggregate. The Perlite Institute estimated that perlite aggregate was used in 40 percent of all base-coat plaster in the United States in 1954. The Bureau of Mines cannot publish separately the quantity of perlite used in premixed perlite plaster, as it would reveal the magnitude of individual company operations.

Most of the expanded perlite used in oil-well muds and concretes was produced in New Mexico, California, and Texas, while companies in California, Tennessee, Texas, and Maryland reported nearly all of the perlite used as a filter aid. Expanders throughout the country reported minor quantities used for loose-fill insulation, horticultural purposes, paint filler, oil absorbent, and refractory brick.

Other applications included the use of expanded perlite in the foundry industry to insulate risers and as an additive to core and facing sands; for exterior cement stucco work, for packing ceramic and other fragile articles, as a filler in plastics and rubber and as an abrasive.

The numerous uses of perlite were listed in an article in the trade press.[8] In addition, technical, economic, and marketing problems encountered by perlite processors, and trends and developments in the industry, were discussed.

PRICES

The mill value of crude perlite (crushed and sized) sold by producers averaged $8.90 per short ton in 1954 compared with $7.59 in 1953 and $6.46 in 1952, while the average estimated value of crude material

[6] Rock Products (news item), vol. 57, No. 12, December 1954, p. 61.
[7] Rock Products (news item), vol. 57, No. 5, May 1954, p. 58.
[8] Roberts, L., Perlite Growing in Use in Construction and Chemical Industries: Rock Products, vol. 57, No. 6, June 1954, pp. 136, 138–140, 142–143.

processed by the companies by which it was mined was $5.93 per short ton in 1954 compared with $6.40 in 1953 and $4.36 in 1952. The average value of all crude perlite sold or used in the United States in 1954 was $8.02 per short ton compared with $7.24 in 1953 and $6.08 in 1952.

The average value of expanded perlite in bags at the plant was $52.58 per short ton in 1954 compared with $53.05 (revised figure) in 1953 and $51.74 in 1952.

TECHNOLOGY

Patents.—Two furnaces suitable for processing perlite were patented. One was a horizontal, rotary kiln apparently primarily designed to treat other minerals, such as talc, black sands, and low-grade metal sulfide ores, but said to be adaptable to expanding perlite.[9] The other was a vertical furnace designed to produce in the moving gases one or more zones of relatively high temperature and pressure; it was claimed that such zones cause sudden or "flash" expansion and result in a more uniform product.[10]

A patent[11] described the use of several lightweight mineral aggregates, including perlite, in manufacturing heat-insulating molded panels. Light weight of the product is maintained principally by foaming the mixture; the dry, absorbent aggregates are added mainly to take up the excess moisture therein.

A patent covered conversion of a number of siliceous minerals, including perlite, to more chemically reactive forms having properties that make them suitable for manufacturing lightweight heat-insulating materials of high strength. This object is accomplished by reacting the silica-containing material with an alkaline-earth silicate-producing compound, such as lime, and acidifying the resulting composition.[12]

A method for manufacturing lightweight acoustic tile from expanded perlite, potato and corn starches, and polyvinyl acetate was patented. The perlite is mixed into a slurry of the starches and polyvinyl acetate. This mixture is spread in pans and the surface is screeded to improve the appearance of the finished tile. The tile are dried under controlled conditions of humidity and temperature. The resulting product was claimed to be a relatively tough, light, strong, fireproof acoustic tile.[13]

A method of manufacturing decorative lightweight tile from expanded perlite was disclosed in a patent. A colored surface is obtained by first placing in the specially designed mold a waterproof-cement concrete containing the desired coloring material. On top of that layer is poured the main portion of the tile—a layer of concrete

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[9] Diehl, C. P. (assigned to John Deca Mines Furnace, Inc., Pasadena, Calif.), Furnace for Exfoliating Perlite or the Like: U. S. Patent 2,674,445, Apr. 6, 1954.

[10] Culver, P. C., and Kelly, J. G. (said Culver assignor to said Kelly), Perlite Popping Furnace: U. S. Patent 2,666,632, Jan. 19, 1954.

[11] Willson, C. D., Making Molded Panels: U. S. Patent 2,674,775, Apr. 13, 1954.

[12] Shea, F. L., and Hsu, H. L. (assigned to Great Lakes Carbon Corp., Morton Grove, Ill.), Siliceous Composition and Method for Manufacturing the Same: U. S. Patent 2,698,256, Dec. 28, 1954.

[13] Kirksey, F. B. (assigned to Dant & Russell, Inc., Portland, Oreg.), Acoustical Tile and Method of Manufacture: U. S. Patent 2,690,594, Oct. 5, 1954.

prepared from expanded perlite, water, and waterproofed white cement. This tile was claimed to be useful for various interior and exterior applications.[14]

According to a recent patent, extremely fine expanded perlite can be used to protect stored wheat and other grains from weevil and flour beetles.[15]

Two patents granted during the year covered the use of expanded perlite in oil-well drilling operations. One patentor described its use with portland or special oil-well cement and bentonite for cementing.[16] Another described a "mud" composition suitable for pumping into drill holes to seal or plug porous or cracked formations through which well-drilling fluid is being lost.[17] According to the latter patent, approximately equal parts, by weight, of expanded perlite, expandable-type bentonite, and either diatomaceous earth or expanded perlite fines are dry mixed. Fifty to eighty pounds of this mixture per barrel of water is made into slurry and pumped down through the drill string. When lodged in formation pores or cracks, the bentonite continues over a period of time to absorb water and swell, and with the perlite and diatomaceous earth forms a plug or seal. As the materials are relatively inert, it was claimed that the resulting seal will perform well under the pressures, temperatures, and chemical conditions that normally exist in oil and gas wells. Expanded perlite is used mainly because of its light weight and ability to be carried readily to the locations where circulation fluid is being lost.

A patent was issued on a filter aid of expanded perlite to be used where a high rate of flow is more important than crystal clarity of filtrate. The material is composed of screened, air-classified, vesicular particles of intermediate size blended in suitable proportions with fragmental fine particles. It is brought into suspension in the liquid to be clarified, and the liquid is then passed through a filter press. To prevent the perlite from sticking to the filter cloth, it may be desirable to precoat the cloth with a thin layer of diatomaceous earth filter aid. This perlite filter aid was claimed to be especially useful in high-speed filtration of liquors not requiring absolute clarification, for example solutions of pectins, gums, algins, and the like, in which the greater part of the suspensoids are solids.[18]

Properties.—An infrared absorption study was made to learn the nature of the water in crude perlite. It was concluded that the structure of perlite might be a three-dimensional network similar, with some modifications, to that ascribed to artificial glass. The presence of the hydroxyl radical and hydrogen-bonded water in the inferred structure is believed to explain the relatively low temperature of liquefaction of the perlite when it is expanded, and the subsequent rise in fusion temperature and viscosity after the water is driven off.[19]

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[14] Terriere, O. J., Method of Making Tile: U. S. Patent 2,689,381, Sept. 21, 1954.
[15] Klein, E., Method of and Composition for the Protection of Grain: U. S. Patent 2,673,158, Mar. 23, 1954.
[16] Sidwell, C. V., Cement Compositions and Cementing Operations: U. S. Patent 2,695,669, Nov. 30, 1954.
[17] Armentrout, A. L., Material for Recovering Lost Circulation in Wells: U. S. Patent 2,683,690, July 13, 1954.
[18] Bollaert, A. R., and Neu, E. L. (assigned to Great Lakes Carbon Corp., Chicago, Ill.), High-Flow-Rate Mineral Filter Aid: U. S. Patent 2,665,813, Jan. 12, 1954.
[19] Keller, W. D., and Pickett, E. E., Hydroxyl and Water in Perlite From Superior, Ariz.: Am. Jour. Sci., vol. 252, No. 2, February 1954, pp. 87-98.

Use.—The relative resistance to cracking of portland-cement exterior stuccos made with various heavy and light-weight mineral aggregates was investigated. Perlite was used in five of the test panels. All panels showed some early cracking, but those made with the light-weight aggregates were particularly susceptible. Further research, under carefully controlled conditions, on a wider range of mixes—especially mixes containing a larger proportion of aggregate—was recommended. Also, it was thought that portland cement might be too brittle for best results and that the adaptability of masonry cements should be tested.[20]

In a discussion of a published article [21] relating to alkali reactivity of certain volcanic glasses used as aggregate and the same materials used for pozzolanic advantages it was stated that perlite when used as a pozzolan is in the form of very finely divided particles and that the reaction is so immediate, rapid, and dispersed that only insignificant pressures, if any, are produced in the concrete. Also, when perlite is used in important proportions as aggregate, the gel produced by the reaction is absorbed into the voids, which are available in large number, without attendant damage to the concrete. It was said that harmful alkali reactivity may occur when perlite is used in fairly large particle sizes, in the proportion of roughly 15 percent of the total aggregate.

An article [22] described the production, properties, and applications of perlite insulating concrete, including discussion of the mining and processing of the perlite, basic cost data, the physical properties of perlite concrete, and the significance of aggregate hardness. It was stated that merely specifying the basic "1 to 6" mix is not sufficient to insure good, inexpensive insulating concrete, but it is also necessary to check the perlite aggregate for qualities and the particular requirements of the job. Perlite can be blended with other aggregates, depending on needs and specifications to be met. Examples of the use of perlite in insulating roof decks and roof fills and other applications were cited.

New data for the design of effective perlite concrete roof decks, floors, precast slabs and blocks, and monolithic work were published by the Perlite Institute.[23] In addition to a revised mix design chart, much information was supplied on best methods of mixing, placing, and curing different types of perlite concrete. It was pointed out that rodding, tamping, and vibrating perlite concrete should usually be avoided, and that the same attention should be given to providing expansion joints in monolithic perlite concrete work as in concretes made with heavier aggregates.

WORLD REVIEW

No data were available on the quantities of crude and expanded perlite produced in other countries. It was believed that there was small to moderate production of crude perlite in Australia, Ireland,

[20] Plastering Industries, Must "Roll With the Punch" for Best Portland Cement (Exterior Stuccos): Vol. 33, No. 1, February 1954, pp. 10-11.
[21] Holland, W. Y., and Cook, R. H., Alkali Reactivity of Natural Aggregates in Western United States (Discussion by D. H. Reynolds and W. L. Merritt): Min. Eng., vol. 6, No. 11, November 1954, pp. 1114-1116.
[22] Brouk, J. J., Perlite Insulating Concrete: Am. Concrete Inst. Jour., vol. 25, No. 10, June 1954, pp. 857-867.
[23] Perlite Institute, Perlite Insulating Concrete: A. I. A. File No. 3-D-3, not dated, 4 pp.

Italy, Japan, Mexico, and New Zealand and that perlite-expanding plants—some perhaps only experimental or semicommercial—were in operation in Australia, Canada, England, France, Italy, Japan, Mexico, New Zealand, and Venezuela. Except for imports of crude perlite into Canada from the United States, into England from Ireland and Italy, and into France from Italy, there was little, if any, international trade in crude perlite. Because of transportation cost limitations, there was virtually no movement between countries of expanded perlite, except as a component of other products.

NORTH AMERICA

Canada.—It was estimated that 1,950,000 cubic feet of expanded perlite (approximately 7,800 short tons) valued at $585,000 was produced in Canada in 1954.[24] The locations of 6 perlite expanding plants were given.

EUROPE

Iceland.—Information on Iceland's perlite occurrences was published.[25] An exceptionally large deposit was said to have been found at Priest Mountain, at the southwestern end of Long Glacier, which though less than 30 miles from a good allyear harbor, could be worked only about 5 months of the year. This deposit was owned by the Government of Iceland. A privately owned deposit was noted on the east coast just north of Seydisfjordur, where a perlite dike extends almost to a deep, narrow fjord that would provide a usable anchorage for a ship.

OCEANIA

Australia.—Continued interest was evinced in the perlite occurrences of northeast New South Wales and southeast Queensland. It was reported that a plant in Melbourne and another in Sydney were producing expanded perlite.

New Zealand.—An investigation of the acid volcanic rocks in North Island showed that the most promising perlite deposits are in glassy rhyolites of the Taupo-Rotorua and Tairau districts.[26] In those areas the perlites are characterized by: Pumiceous or perlitic textures, or a combination of both; very low proportion of phenocrysts; and a combined water content of 2 to 4 percent. Several additional perlite locations were described, and it was believed that further exploration would disclose others. As in the United States, the principal markets for expanded perlite in New Zealand were stated to be as aggregate in gypsum plasters and insulating concretes, and for loose-fill insulation.[27]

[24] Wilson, H. S., Lightweight Aggregates in Canada, 1954 (Prelim.): Canada Mines Branch, Dept. Min. and Tech. Surveys, Ottawa, undated, 5 pp.
[25] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 4, October 1954, p. 63.
[26] Thompson, B. N., and Reed, J. J., Perlite Deposits in New Zealand. Part I. Geology: New Zealand Jour. Sci. and Geol. (Wellington), vol. 36, No. 3, November 1954, pp. 208–218.
[27] Dunn, L. R. L., and Billinghurst, W. M., Perlite Deposits in New Zealand. Part II. Evaluation: New Zealand Jour. Sci. and Geol. (Wellington), vol. 36, No. 3, November 1954, pp. 218–226.

Phosphate Rock

By E. Robert Ruhlman [1] and Gertrude E. Tucker [2]

TONNAGES of mined phosphate-rock ore, marketable production, and total sold or used increased in 1954. The world output of phosphate rock reached a new high, 12 percent above 1953.

TABLE 1.—Salient statistics of the phosphate-rock industry in the United States, 1953–54

	1953				1954			
	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	40,139,000	5,102,000	([1])	([1])	45,585,837	5,745,425	([1])	([1])
Marketable production [2]	12,503,830	3,987,412	[3] $76,631,755	[3] $6.13	13,821,100	4,359,955	[3] $86,669,081	[3] $6.27
Sold or used by producers:								
Florida:								
Land pebble	9,009,220	3,029,215	54,498,217	6.05	9,565,529	3,189,941	58,890,565	6.16
Soft rock	75,910	15,565	470,062	6.19	90,519	18,835	554,234	6.12
Hard rock	81,725	28,800	643,993	7.88	74,303	26,184	585,363	7.88
Total Florida	9,166,855	3,073,580	55,612,272	6.07	9,730,351	3,234,960	60,030,162	6.17
Tennessee	1,622,170	428,687	12,251,117	7.55	1,700,572	437,675	12,012,314	7.06
Western States:								
Idaho	1,070,773	280,758	4,090,599	3.82	878,920	231,833	4,299,824	4.89
Montana and Wyoming [4]	658,125	191,825	4,643,087	7.06	733,981	218,846	5,167,756	7.04
Total Western States	1,728,898	472,583	8,733,686	5.05	1,612,901	450,679	9,467,580	5.87
Total United States	12,517,923	3,974,850	76,597,075	6.12	13,043,824	4,123,314	81,510,056	6.25
Imports	101,171	([1])	[5] 2,545,081	[5] 25.16	122,016	([1])	[5] 3,081,430	[5] 25.25
Exports [6]	2,061,329	([1])	13,254,906	6.43	2,278,572	([1])	14,971,010	6.57
Apparent consumption [7]	10,557,765	([1])	------------	--------	10,887,268	([1])	------------	------
Stocks in producers' hands Dec. 31: [6]								
Florida	1,602,000	534,000	([1])	([1])	2,309,000	754,000	([1])	([1])
Tennessee [8]	[9 10] 530,000	[9 10] 139,000	([1])	([1])	463,000	124,000	([1])	([1])
Western States	[9] 481,000	[9] 133,000	([1])	([1])	619,000	165,000	([1])	([1])
Total stocks	2,613,000	806,000	([1])	([1])	3,391,000	1,043,000	([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] Includes some matrix not previously included in stocks.

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

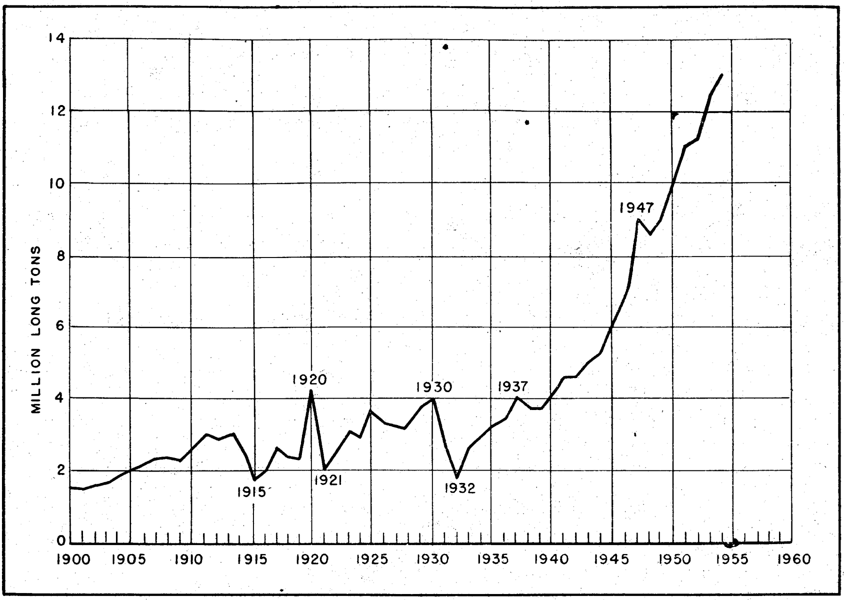

FIGURE 1.—Marketed production of domestic phosphate rock, 1900–54.

DOMESTIC PRODUCTION

Production of phosphate-rock ore in the United States totaled more than 45.5 million long tons in 1954. Marketable production rose 11 percent; Florida continued to be the largest producer, followed by the Western States.

An additional 1,000 acres of phosphate-bearing land between Bartow and Fort Meade, Fla., was acquired by American Cyanamid Co.[3]

The Armour Fertilizer Works was constructing a washing and flotation plant adjoining its fertilizer plant near Bartow, Fla.[4]

Permission to mine phosphate rock in the many lakes of Polk County, Fla., was denied.[5]

The new triple superphosphate plant of Davison Chemical Co., Division of W. R. Grace & Co., at Ridgewood, Fla. began operation during 1954. Rated yearly capacity of the plant was 200,000 tons.[6]

Plans were announced for constructing a phosphate-rock custom-grinding plant at Lake Charles, La.[7]

The Shea Chemical Corp., an elemental phosphorus producer, acquired phosphate-rock deposits near Kettle Mills, Tenn. No plans were announced for immediate development of these deposits.[8]

The second electric furnace of Monsanto Chemical Co. at Soda Springs, Idaho, began operation late in 1954. This company now operates eight electric furnaces.[9] Monsanto also was expanding facil-

[3] Chemical and Engineering News, vol. 32, No. 39, Sept. 27, 1954, p. 3817.
[4] Mining World, vol. 16, No. 2, February 1954, p. 85.
[5] Mining World, vol. 16, No. 12, November 1954, p. 91.
[6] Forger, Robert, New Triple Superphosphate Plant: Mines Mag., vol. 44, No. 8, August 1954, pp. 34, 59.
[7] Rock Products, vol. 57, No. 5, May 1954, p. 58.
[8] Chemical Week, vol. 75, No. 14, Oct. 2, 1954, p. 24.
[9] Monsanto Chemical Co., Annual Report—1954: St. Louis, Mo., Dec. 31, 1954, p. 11.

TABLE 2.—Marketable production of phosphate rock in the United States, 1945–49 (average) and 1950–54, by States, in long tons

Year	Florida [1]	Tennessee [2]	Western States [3]	United States
1945–49 (average)	5,871,265	1,393,990	723,785	7,989,040
1950	8,597,227	1,472,017	1,044,915	11,114,159
1951	8,211,820	1,424,516	1,138,696	10,775,032
1952	9,205,138	1,444,737	1,415,017	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

[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 1945–46 and 1954, white rock in 1953–54, and a small quantity of apatite from Virginia in 1945–47.
[3] Mine production of ore (rock), plus a quantity of washer and drier production.

ities for producing phosphorus chemicals and planned construction of a new phosphate-chemical plant at Kearny, N. J.[10]

The J. R. Simplot Co. operated its open-pit Gay mine at Fort Hall, Idaho, and another recently opened surface mine on Rex Peak near Randolph, Utah. Rex Peak rock was trucked 16 miles to the Sage, Wyo., railroad siding.[11]

In addition to operating open-pit mines in Idaho and Wyoming, the San Francisco Chemical Co. produced phosphate rock from the Arickeree, Pawnee, and Emma underground mines in Utah.[12]

Westvaco Mineral Products Division, Food Machinery & Chemical Corp., acquired a large, patented, phosphate-rock claim in the Crawford Mountains, Utah. Westvaco, a producer of elemental phosphorus at Pocatello, Idaho, had not yet undertaken phosphate-rock mining. Furnace feed was obtained from the J. R. Simplot Co. mine at Fort Hall.[13]

The elemental phosphorus industry in the United States continued to expand. At the end of 1954, 32 electric furnaces were operating with a total annual capacity of more than 280,000 long tons of elemental phosphorus.[14]

Consolidation of the National Fertilizer Association and the American Plant Food Council was being considered.[15]

A new trade organization, the American Superphosphate Institute, was established during the year with headquarters in Washington, D. C.

CONSUMPTION AND USES

Apparent consumption of phosphate rock again set a new record, rising 3 percent above 1953 and 115 percent above 1944. Data on phosphate rock sold or used by producers are shown in tables 4–9. Phosphate rock sold or used, by uses (table 9) gives detailed distribution for a 2-year period on the new basis established in 1953. Production, shipments, and stocks of superphosphate are shown in table 10.

[10] Chemical and Engineering News, vol. 32, No. 31, Aug. 2, 1954, p. 3025.
[11] Mining World, vol. 16, No. 1, January 1954, p. 89.
[12] Rock Products, vol. 57, No. 6, June 1954, p. 68.
[13] Mining and Industrial News, vol. 22, No. 9, September 1954, p. 23.
[14] Industrial and Engineering Chemistry, vol. 46, No. 6, June 1954, p. 1120.
[15] Oil, Paint and Drug Reporter, vol. 166, No. 15, Oct. 11, 1954, p. 3

TABLE 3.—Apparent consumption[1] of phosphate rock in the United States, 1945–49 (average) and 1950–54, in long tons

Year	Long tons	Year	Long tons
1945-49 (average)	6,908,009	1952	10,032,406
1950	8,580,925	1953	10,557,765
1951	9,511,545	1954	10,887,268

[1] Quantity sold or used by producers plus imports minus exports.

TABLE 4.—Phosphate rock sold or used by producers in the United States, 1945–49 (average) and 1950–54

Year	Long tons	Value at mines		Year	Long tons	Value at mines	
		Total	Average			Total	Average
1945-49 (average)	7,870,034	$40,710,072	$5.17	1952	11,324,158	$68,120,918	$6.02
1950	10,253,552	59,027,848	5.76	1953	12,517,923	76,597,075	6.12
1951	11,095,204	66,158,078	5.96	1954	13,043,824	81,510,056	6.25

TABLE 5.—Florida phosphate rock sold or used by producers, 1945–49 (average) and 1950–54, by kinds

Year	Hard rock			Soft rock[1]		
	Long tons	Value at mines		Long tons	Value at mines	
		Total	Average		Total	Average
1945-49 (average)	63,141	$469,663	$7.44	80,765	$329,184	$4.08
1950	71,319	538,601	7.55	81,542	408,595	5.01
1951	75,615	582,247	7.70	92,183	495,243	5.37
1952	81,086	625,175	7.71	75,853	433,203	5.71
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

Year	Land pebble			Total		
	Long tons	Value at mines		Long tons	Value at mines	
		Total	Average		Total	Average
1945-49 (average)	5,672,297	$28,366,508	$5.00	5,816,203	$29,165,355	$5.01
1950	7,933,009	44,430,646	5.60	8,085,870	45,377,842	5.61
1951	8,329,033	49,185,072	5.91	8,496,831	50,262,562	5.92
1952	8,624,186	50,483,421	5.85	8,781,125	51,541,799	5.87
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

[1] Includes material from waste-pond operations.

TABLE 6.—Tennessee phosphate rock[1] sold or used by producers, 1945–49 (average) and 1950–54

Year	Long tons	Value at mines		Year	Long tons	Value at mines	
		Total	Average			Total	Average
1945-49 (average)	1,344,152	$7,631,023	$5.68	1952	1,452,508	$10,874,760	$7.49
1950	1,384,473	10,028,404	7.24	1953	1,622,170	12,251,117	7.55
1951	1,419,892	10,604,638	7.47	1954	1,700,572	12,012,314	7.06

[1] Includes small quantity of Tennessee blue rock in 1945-47 and 1954, white rock in 1952-54, and Virginia apatite in 1945-47 and 1949.

TABLE 7.—Western States phosphate rock sold or used by producers, 1945–49 (average) and 1950–54

Year	Idaho [1]			Montana [2]		
	Long tons	Value at mines		Long tons	Value at mines	
		Total	Average		Total	Average
1945–49 (average)	437,345	$2,118,766	$4.84	234,176	$1,597,808	$6.82
1950	573,044	2,125,065	3.71	210,165	1,496,537	7.12
1951	695,026	1,750,974	2.52	304,507	2,353,381	7.73
1952	620,551	2,163,608	3.49	332,299	2,620,764	7.89
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

Year	Wyoming			Total		
	Long tons	Value at mines		Long tons	Value at mines	
		Total	Average		Total	Average
1945–49 (average) [3]	38,158	$197,119	$5.17	709,679	$3,913,693	$5.51
1950	(1)	(1)	(1)	783,209	3,621,602	4.62
1951	178,948	1,186,523	6.63	1,178,481	5,290,878	4.49
1952	137,675	919,987	6.68	1,090,525	5,704,359	5.23
1953	(2)	(2)	(2)	1,728,898	8,733,686	5.05
1954	(2)	(2)	(2)	1,612,901	9,467,580	5.87

[1] Idaho includes Utah in 1946–48 and 1950–52 and Wyoming in 1949–50.
[2] Montana includes Utah and Wyoming in 1953–54.
[3] Includes Wyoming data for 1947–48 only.

TABLE 8.—Phosphate rock sold or used by producers in the United States in 1953–54, 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
1953								
Below 60	210,018	2	1,122,466	69	941,962	55	2,274,446	18
60 to 66	14,946	(2)	358,342	22	145,862	8	519,150	4
68 basis, 66 minimum	1,091,721	12	34,369	2	205,856	12	1,331,946	11
70 minimum	1,321,142	14	106,993	7	435,218	25	1,863,353	15
72 minimum	1,073,636	12					1,073,636	8
75 basis, 74 minimum	3,752,416	41					3,752,416	30
77 basis, 76 minimum	1,702,976	19					1,702,976	14
Total	9,166,855	100	1,622,170	100	1,728,898	100	12,517,923	100
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

[1] Bone phosphate of lime, $Ca_3(PO_4)_2$.
[2] Less than 0.5 percent.

TABLE 9.—Phosphate rock sold or used by producers in the United States, 1953–54, by uses and States

Uses	Florida		Tennessee		Western States		Total United States	
	Long tons	Percent of total	Long tons	Percent of total	Long tons	Percent of total	Long tons	Percent of total
1953								
Domestic:								
Agricultural:								
Ordinary superphosphate	4,868,828	53	79,844	5	95,510	6	5,044,182	41
Triple superphosphate	927,701	10	62,376	4	164,460	9	1,154,537	9
Nitraphosphate	2,820	(1)					2,820	(1)
Direct application to soil	[2] 732,984	[2] 8	191,440	12	101,902	6	1,026,326	8
Stock and poultry feed	139,362	2	21,365	1	357	(1)	161,084	1
Fertilizer filler	(2)	(2)	13,157	1			13,157	} 1
Other fertilizers [3]			54,876	3	1,340	(1)	56,216	}
Total agricultural	6,671,695	73	423,058	26	363,569	21	7,458,322	60
Industrial:								
Elemental phosphorus, ferrophosphorus, phosphoric acid	397,916	5	1,197,417	74	1,064,124	62	2,659,457	21
Phosphoric acid (wet process)	302,566	3			30,334	2	332,900	3
Undistributed [4]			1,695	(1)	4,220	(1)	5,915	(1)
Total industrial	700,482	8	1,199,112	74	1,098,678	64	2,998,272	24
Exports [5]	1,794,678	19			266,651	15	2,061,329	16
Grand total	9,166,855	100	1,622,170	100	1,728,898	100	12,517,923	100
1954								
Domestic:								
Agricultural:								
Ordinary superphosphate	4,912,435	50	77,113	5	79,628	5	5,069,176	39
Triple superphosphate	1,036,406	11	40,832	2	[6] 220,481	[6] 14	1,297,719	10
Nitraphosphate	12,851	(1)					12,851	(1)
Direct application to soil	543,003	6	166,829	10	64,184	4	774,016	6
Stock and poultry feed	124,747	1	18,617	1	893	(1)	144,257	1
Fertilizer filler			13,764	(1)			13,764	} (1)
Other fertilizers [3]			45,942	3			45,942	}
Total agricultural	6,629,442	68	363,097	21	365,186	23	7,357,725	56
Industrial:								
Elemental phosphorus, ferrophosphorus, phosphoric acid	696,866	7	1,333,158	79	934,130	58	2,964,154	23
Phosphoric acid (wet process)	439,056	5			(6)	(6)	439,056	3
Undistributed [4]			4,317	(1)			4,317	(1)
Total industrial	1,135,922	12	1,337,475	79	934,130	58	3,407,527	26
Exports [5]	1,964,987	20			313,585	19	2,278,572	18
Grand total	9,730,351	100	1,700,572	100	1,612,901	100	13,043,824	100

[1] Less than 0.5 percent.
[2] Direct application to soil includes fertilizer filler.
[3] Includes phosphate rock used in calcium metaphosphate, fused tricalcium phosphate, Rhenania-type phosphate, and other uses.
[4] Includes phosphate rock used in pig-iron blast furnaces, parting compounds, research, defluorinated phosphate rock, refractories, and other uses.
[5] As reported to the Bureau of Mines by domestic producers.
[6] Rock for phosphoric acid (wet process) included with "triple superphosphate."

TABLE 10.—Production, shipments, and stocks of superphosphates,[1] 1945–49 (average) and 1950–54, in short tons

[U. S. Bureau of the Census]

	1945–49 (average)	1950	1951	1952	1953	1954
Normal and enriched superphosphates:						
Production	1,550,687	1,673,289	1,708,825	1,765,000	1,678,459	1,644,515
Shipments	833,106	911,718	883,849	874,846	850,970	847,759
Stocks in manufacturers' hands Dec. 31	168,879	190,122	196,349	235,950	236,313	222,206
Concentrated superphosphates:						
Production	177,690	309,084	322,420	388,055	457,235	561,870
Shipments	167,088	323,516	313,323	375,112	433,097	500,194
Stocks in manufacturers' hands Dec. 31	29,555	24,863	29,860	39,200	51,304	101,557

[1] 100 percent available phosphoric acid.

STOCKS

Producers' stocks on hand at the end of 1954 were 30 percent more than the 1953 figure (table 1). The stock figures do not include quantities of matrix reported by Florida and Tennessee producers, except as noted.

PRICES

The prices of Florida land-pebble phosphate rock fluctuated during the year and were slightly lower at the end 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 1954, by grades

[Oil, Paint, and Drug Reporter of dates listed]

Grades (percent B. P. L.)[1]	Jan. 4	Mar. 29	July 5	July 26	Dec. 20
68/66	(2)	(2)	$4.69	$4.69	$4.60
70/68	$4.68½	$5.08	5.09	5.09	5.00
72/70	5.68½	5.68	5.09	5.74	5.65
75/74	6.68½	6.68	5.74	6.74	6.65
78/76	7.68½	7.68	7.74	7.74	7.65

[1] B. P. L. signifies bone phosphate of lime, $Ca_3(PO_4)_2$.
[2] Not quoted.

FOREIGN TRADE[16]

Data on imports and exports of phosphate rock and phosphatic materials are given in tables 12–15.

Sales or shipments of phosphate rock for export, as reported by domestic producers to the Bureau of Mines, are given in the section on Consumption and Uses.

[16] 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.

Imports.—Curaçao (Netherlands Antilles) continued to be the major source of crude phosphate rock imported into the United States. French Pacific Islands, Mexico, and Canada also shipped crude phosphate rock into the United States. Total imports increased 21 percent above 1953. Imports of superphosphates, continuing the downward trend, decreased 24 percent from 1953 and originated mostly in Canada, with smaller quantities from the Netherlands. Fertilizer-grade ammonium phosphate imports in 1954 were slightly lower and originated mostly in Canada. Other phosphatic fertilizer materials were imported from the Benelux countries, West Germany, United Kingdom, and Peru. The imports from Canada were largely fertilizers manufactured from phosphate rock produced in the United States.

TABLE 12.—Phosphate rock and phosphatic fertilizers imported for consumption in the United States, 1953–54

[U. S. Department of Commerce]

Fertilizer	1953		1954	
	Long tons	Value	Long tons	Value
Phosphates, crude, not elsewhere specified	101,171	$2,545,081	122,016	[1] $3,081,430
Superphosphates (acid phosphate):				
Normal (standard), not over 25 percent P_2O_5 content	3,060	100,800	1,170	[1] 99,898
Concentrated (treble), over 25 percent P_2O_5 content	1,885	114,331	2,795	192,771
Ammoniated	296	41,485	4	455
Total superphosphates	5,241	256,616	3,969	[1] 293,124
Ammonium phosphates, used as fertilizer	148,658	11,419,915	146,547	[1] 11,835,881
Bone dust, or animal carbon and bone ash, fit only for fertilizer	[2] 15,587	[2] 789,090	16,975	901,209
Guano	61	5,391	196	25,596
Slag, basic, ground or unground	79	2,138	34	3,333
Dicalcium phosphate (precipitated bone phosphate), all grades	[2] 4,631	[2] 257,160	5,142	283,747

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

Exports.—Exports of phosphate rock were 14 percent higher in 1954 than in 1953. Hard-rock exports, all to countries in the Western Hemisphere, were 50 percent below 1953. Florida land-pebble exports went mainly to Japan (39 percent), West Germany (14 percent), Netherlands (12 percent), Canada (11 percent), United Kingdom (7 percent), and Italy (6 percent). Exports of "other phosphate rock," which is mainly phosphate rock from Montana shipped to Canada for manufacturing fertilizers, increased 12 percent in 1954 compared with 1953.

TABLE 13.—Phosphate rock exported from the United States, 1953–54, by grades and countries of destination

[U. S. Department of Commerce]

Grade and country	1953		1954	
	Long tons	Value	Long tons	Value
Florida:				
High-grade hard rock:				
North America:				
Bahamas	10	$200		
Canada	155	3,694	2,888	$35,810
Costa Rica	90	1,135		
Jamaica			44	934
Mexico	64	2,190		
Total	319	7,219	2,932	36,744
South America:				
Brazil	8,744	187,054	5,905	97,433
Colombia	1,000	14,880	1,447	23,028
Ecuador	446	22,000		
Venezuela	97	6,710		
Total	10,287	230,644	7,352	120,461
Asia: Taiwan	10,086	91,391		
Total high-grade hard rock	20,692	329,254	10,284	157,205
Land pebble:				
North America:				
Canada	214,824	1,723,257	231,561	1,816,967
Costa Rica	89	1,270		
Cuba	16,013	105,942	27,624	185,661
Mexico	49,477	339,059	19,114	136,086
Total	280,403	2,169,528	278,299	2,138,714
South America:				
Brazil	18,684	210,527	36,945	417,160
Colombia	1,267	18,933		
Peru			196	2,547
Venezuela	532	11,991	303	6,160
Total	20,483	241,451	37,444	425,867
Europe:				
Austria			15,161	110,008
Belgium-Luxembourg	70,005	593,148	9,439	82,119
Denmark	10,014	86,621	14,992	132,631
Germany, West	192,114	1,458,074	289,551	2,196,306
Italy	162,905	1,574,308	117,898	1,142,760
Netherlands	311,600	2,831,910	241,270	2,227,182
Sweden	45,658	432,002	51,522	455,360
United Kingdom	88,957	750,241	133,293	1,104,094
Yugoslavia	38,115	276,342		
Total	919,368	8,002,646	873,126	7,450,460
Asia:				
Japan	528,965	3,713,388	788,991	6,054,112
Korea, Republic of			5,083	40,664
Taiwan	35,329	311,528	40,252	605,936
Total	564,294	4,024,916	834,326	6,700,712
Africa:				
Liberia	4	244		
Union of South Africa			19,961	177,653
Total	4	244	19,961	177,653
Total land pebble	1,784,552	14,438,785	2,043,156	16,893,406

TABLE 13.—Phosphate rock exported from the United States, 1953–54, by grades and countries of destination—Continued

[U. S. Department of Commerce]

Grade and country	1953		1954	
	Long tons	Value	Long tons	Value
Other phosphate rock:[1]				
North America:				
Canada	294,742	$3,586,378	328,746	$4,025,013
Cuba	410	7,085	267	3,460
El Salvador	389	5,949	946	13,157
Guatemala	13	293		
Panama			36	679
Total	295,554	3,599,705	329,995	4,042,309
South America: Brazil			1,578	76,100
Total other phosphate rock	295,554	3,599,705	331,573	4,118,409
Grand total	2,100,798	18,367,744	2,385,013	21,169,020

[1] Includes colloidal matrix, soft phosphate rock, and Tennessee, Idaho, and Montana rock.

TABLE 14.—"Other phosphate material"[1] exported from the United States, 1945–49 (average) and 1950–54

[U. S. Department of Commerce]

Year	Long tons	Value	Year	Long tons	Value
1945–49 (average)	1,621	$183,657	1952	1,144	$187,605
1950	1,350	247,880	1953	8,477	178,168
1951	2,316	372,685	1954	5,243	456,330

[1] Class includes animal carbon, apatite, basic slag, bone-ash dust, bone meal, char dust, defluorinated phosphate rock, duplex basic phosphate, permanente thermosphos (granular), tricalcium phosphate (fused).

TECHNOLOGY

Several reports on geological investigations in the western phosphate field were published.[17] The airborne radioactivity surveys of certain phosphate-rock deposits in Florida disclosed several anomalies, two of which were investigated by ground studies.[18]

The occurrence of phosphate rock in Texas was reported.[19] The deposits investigated were small, low grade, and of questionable market value.

Two new phosphate minerals were reported from Minas Gerais, Brazil. Tavorite and barbosalite, both secondary minerals, were found in the Sapucaia pegmatite. This pegmatite has yielded significant quantities of muscovite and beryl.[20]

[17] Cheney, T. M., Sheldon, R. P., Waring, R. G., and Warner, M. A., Stratigraphic Sections of the Phosphoria Formation in Wyoming, 1951: Geol. Survey Circ. 324, 1954, 22 pp.
Sheldon, R. P., Cressman, E. R., Carswell, L. D., and Smart, R. A., Stratigraphic Sections of the Phosphoria Formation in Wyoming, 1952: Geol. Survey Circ. 325, 1954, 24 pp.
Peterson, J. A., Gosman, R. F., and Swanson, R. W., Stratigraphic Sections of the Phosphoria Formation in Montana, 1951: Geol. Survey Circ. 326, 1954, 27 pp.
Smart, R. A., Waring, R. G., Cheney, T. M., and Sheldon, R. P., Stratigraphic Sections of the Phosphoria Formation in Idaho, 1950–51: Geol. Survey Circ. 327, 1954, 22 pp.

[18] Moxham, R. M., Airborne Radioactivity Surveys for Phosphate in Florida: Geol. Survey Circ. 230, 1954, 4 pp.

[19] Barnes, V. E., Phosphorite in Eastern Llano Uplift of Central Texas: Texas Bur. of Econ. Geol., Rept. of Investigations 23, 1954, 9 pp.

[20] Lindberg, M. L., and Pecora, W. T., Tavorite and Barbosalite: Science, vol. 119, No. 3099, May 21, 1954, p. 739.

TABLE 15.—Superphosphates (acid phosphates) exported from the United States, 1953–54, by countries of destination

[U. S. Department of Commerce]

Country	1953		1954	
	Long tons	Value	Long tons	Value
North America:				
Canada	181,838	$4,285,104	173,273	$4,674,583
Costa Rica	1,339	80,450	2,678	211,150
Cuba	18,204	543,521	26,819	855,708
Dominican Republic	268	13,658	2,344	137,051
El Salvador	22	1,688	446	27,040
Guatemala	112	4,958		
Mexico	3,879	242,002	781	52,913
Nicaragua	162	16,667	45	2,875
Other North America	51	1,914	19	1,144
Total	205,875	5,189,962	206,405	5,962,464
South America:				
Argentina			498	22,997
Brazil	427	15,424	70,512	2,071,507
Chile	15	1,525	45	4,814
Colombia	286	16,615	2,267	134,302
Ecuador	842	53,941	987	46,868
Peru	80	8,100	2,692	77,950
Uruguay			984	61,150
Venezuela	749	40,614	1,949	85,957
Total	2,399	136,219	79,934	2,505,545
Asia:				
Korea, Republic of	41,393	1,058,884	100,172	2,775,250
Philippines	879	32,633	1,156	37,713
Saudi Arabia	134	11,190	134	8,648
Other Asia	45	2,900	31	2,455
Total	42,451	1,105,607	101,493	2,824,066
Africa	13	620	39	3,560
Grand total	250,738	6,432,408	387,871	11,295,635

The Bureau of Mines, in cooperation with private industry, continued the research program to develop low-cost underground mining methods applicable to typical conditions that are or will be encountered in mining western phosphate rock. A pneumatic vibrating-blade planer, designed for continuous, long-face mining of inclined beds, has been tested with encouraging results. Production up to 1 ton per minute was reported in one of the tests.

The planning and development of Monsanto Chemical Co. operations in the western phosphate-rock field were described.[21] The article includes drilling before mining, mining, and ore handling, as well as a brief description of Monsanto's elemental phosphorus furnace.

Improvement was reported in machinery controls and materials-handling equipment. More efficient mining of Florida land-pebble phosphate rock was achieved by a newly designed control cab.[22] Greatly increased requirements of phosphate rock resulted in expansion of existing and installation of new storage and handling equipment.[23] Rotary and double-winged stackers, capable of handling up to 700 long tons per hour, were installed.

[21] Emigh, G. D., Development of Monsanto's Western Phosphate Operation: Min. Eng., vol. 6, No. 11, November 1954, pp. 1077–1079.
[22] Ramsey, R. H., Revolution in Control: Eng. and Min. Jour., vol. 155, No. 4, April 1954, pp. 73–77.
[23] Lyle, G. L., Jr., Wet Phosphate-Rock Storage and Handling: Min. Eng., vol. 6, No. 8, August 1954, pp. 798–799.
Lenhart, W. B., One of the World's Largest Material Stockpiling Systems: Rock Products, vol. 57, No. 6, June 1954, pp. 82–85.

A generalized flowsheet of phosphate flotation used in Florida was published.[24]

New drying techniques were incorporated in a recent installation.[25] This concurrent-fired rotary drier had an hourly rate of consumption of 700 gallons of fuel oil and a production of 200 tons of dried phosphate rock. Efficient dust collection and elaborate controls are other features of this drying plant.

Possible methods of treatment for more economic disposal and potential uses of the phosphate slimes in Tennessee and Florida were described.[26] The use of ultrasonic techniques in hastening the settling of these slimes was reported.[27] Ultrasonic waves were said to produce many phenomena, including an increased rate of coagulation.

The Tennessee Valley Authority investigated means of recovering the sulfur from the calcium sulfate, a waste product from the manufacture of superphosphate.

Fluorine recovery in phosphate processing in the United States has been limited largely to ordinary superphosphate and wet-process phosphoric acid plants. Improved recovery of fluorine from these and other manufacturing processes in more marketable forms would make available large supplies of various fluorine compounds.[28]

Several new uses for phosphorus compounds were reported. Sodium hexametaphosphate and sodium tripolyphosphate were sold for meat processing.[29] Phosphate compounds were sprayed on zinc and other metal surfaces for a paint base.[30] Phosphorus compounds were added to graphite products to increase oxidation resistance at high temperatures. Also, increased production of sodium tripolyphosphate was needed to meet the requirements of detergent manufacturers.[31]

New sources of trace-element plant foods, special ceramic frits, were tested over a 5-year period and the results were published.[32]

WORLD REVIEW

NORTH AMERICA

Canada.—Large apatite-magnetite deposits were reported at Nemegos, Ontario, north of the Sudbury district. Development of these deposits would greatly reduce the need for imported phosphate rock, which exceeds 600,000 tons per year. Reserve estimates ranged from 4 to 7 million tons averaging 22 percent apatite and more than 60 percent magnetite. Tentative plans call for processing plants at Sudbury, 160 miles south, where sulfuric acid is available.[33]

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[24] Deco Trefoil, vol. 18, No. 3, May-June 1954, pp. 15-16.
[25] Hughes, C. V. O., Drying Phosphate Rock at Rate of 200 T. P. H.: Rock Products, vol. 57, No. 6, June 1954, pp. 78-82.
[26] Tyler, P. M. and Waggaman, W. H., Phosphatic Slime—a Potential Mineral Asset: Ind. Eng. Chem., vol. 46, No. 5, May 1954, pp. 1049-1056.
[27] Thompson, D., and Vilbrandt, F. C., Effect of Ultrasonic Energy on Settling of Solids in Phosphate Tailing: Ind. Eng. Chem., vol. 46, No. 6, June 1954, pp. 1172-1180.
[28] Hill, W. L., and Jacob, K. D., Phosphate Rock as an Economic Source of Fluorine: Min. Eng., vol. 6, No. 10, October 1954, pp. 994-1000.
[29] Chemical and Engineering News, vol. 32, No. 35, Aug. 30, 1954, p. 3463.
[30] Industrial and Engineering Chemistry, vol. 46, No. 8, August 1954, p. 113.
[31] Chemical Week, Tripoly Nears a Plateau: Vol. 75, No. 18, Oct. 30, 1954, pp. 90-92.
[32] McIntyre, G. H., Ceramic Fertilizers: Ceram. Bull., vol. 33, No. 12, Dec. 15, 1954, pp. 358-360.
[33] Fertiliser and Feeding Stuffs Journal, vol. 40, No. 13, June 23, 1954, pp. 534-535.

TABLE 16.—World production of phosphate rock, by countries,[1] 1945–49 (average), and 1950–54, in long tons [2]

[Compiled by Helen L. Hunt]

Country [1]	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Canada	67	115	5			
United States	8,070,437	11,114,159	10,775,032	12,064,892	12,503,830	13,821,100
West Indies:						
Jamaica (guano)			840	650	695	705
Netherlands Antilles (exports)	62,977	102,594	105,452	105,214	94,578	123,960
Total	8,133,481	11,216,868	10,881,329	12,170,756	12,599,103	13,945,765
South America:						
Brazil (apatite)	6,042	13,631	[3] 12,500	17,675	[3] 12,500	[3] 14,800
Chile (apatite)	29,771	13,225	36,595	45,044	58,242	[3] 54,000
Total	35,813	26,856	[3] 49,100	62,719	[3] 70,700	[3] 68,800
Europe:						
Austria	[3] 3,400					
Belgium	51,089	50,043	127,027	58,052	35,329	25,860
France	82,877	91,280	110,502	100,389	71,847	82,815
Germany, West	[3] 400					
Ireland	8,874	(4)	(4)	(4)		
Italy	315					
Spain	20,721	23,700	22,470	23,103	25,517	21,873
Sweden (apatite)	45,785	2,012	8,871	21,084	6,203	(4)
U. S. S. R.:						
Apatite [3]	1,152,000	2,070,000	2,260,000	2,460,000	2,760,000	3,100,000
Phosphate rock [3]	502,000	935,000	1,035,000	1,130,000	1,205,000	1,330,000
Total [3]	1,870,000	3,200,000	3,590,000	3,820,000	4,100,000	4,600,000
Asia:						
British Borneo (guano)	339	643	649	696	632	620
China [3]	11,800	19,700	19,700	19,700	24,600	29,500
Christmas Island (Indian Ocean) (exports)	100,327	315,364	333,345	349,160	280,194	350,962
India (apatite)	662	3,025	416	445	4,359	[3] 4,400
Indochina	3,937					
Indonesia	1,378	[3] 4,900			815	
Israel			[5] 292	16,928	22,727	[3] 57,300
Japan	5,327	254	141			
Jordan	[6] 3,730		6,530	23,424	39,368	73,816
North Korea	[3] 15,700	(4)	(4)	(4)	(4)	(4)
Philippines (guano)	2,165	32,091	4,745	4,164	630	1,800
Total [3]	145,000	381,000	366,000	415,000	385,000	540,000
Africa:						
Algeria	594,209	673,846	764,364	691,493	593,236	745,903
Angola (guano)	[3] [7] 700	1,017	928			
British Somaliland (guano) (exports)	[8] 348	303	680	521	358	[3] 500
Egypt	342,924	390,935	492,081	513,968	476,531	526,247
French Morocco	2,818,337	3,811,098	4,642,322	3,890,681	4,090,377	4,940,236
French West Africa (aluminum phosphate)	2,066	11,721	24,113	[9] 63,531	[9] 92,713	[9] 77,457
Madagascar				1,284	1,531	1,319
Seychelles Islands (exports)	15,530	9,847	4,475	10,944	8,719	[3] 7,900
Southern Rhodesia	[7] 22	35				
South-West Africa (guano)	1,163	572	773	1,649	1,579	811
Tanganyika Territory	193	461	452	166	149	60
Tunisia	1,410,791	1,500,756	1,652,395	2,228,882	1,691,394	1,794,567
Uganda	4,553	460	2,207	4,931	5,362	2,967
Union of South Africa	39,957	51,025	80,548	95,043	78,860	93,008
Total	[3] 5,230,800	6,452,076	7,665,338	7,503,093	7,040,809	[3] 8,191,000

See footnotes at end of table.

TABLE 16.—World production of phosphate rock, by countries,[1] 1945–49 (average), and 1950–54, in long tons[2]—Continued

Country [1]	1945–49 (average)	1950	1951	1952	1953	1954
Oceania:						
Angaur Island	82,293	[6] 149,842	[6] 142,556	[6] 82,580	[6] [3] 110,700	[6] 121,828
Australia	3,335	1,627	7,929	5,544	3,368	[3] 7,900
Makatea Island (French Oceania) (exports)	226,160	266,032	224,260	210,183	246,555	225,286
Nauru Island (exports)	311,512	1,053,457	928,056	1,145,658	1,159,758	1,178,157
New Zealand	3,840	----------	----------	----------	----------	----------
Ocean Island (exports)	124,811	247,251	252,402	245,602	282,364	292,202
Total	751,951	1,718,209	1,555,203	1,689,567	[3] 1,802,700	[3] 1,825,000
World total (estimate) [1]	16,200,000	23,000,000	24,100,000	25,700,000	26,000,000	29,200,000

[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.
[3] Estimate.
[4] Data not available; estimate by author of chapter included in total.
[5] Production started second half of December 1951.
[6] Exports.
[7] Average for 1947–49.
[8] Average for 1946–49.
[9] Includes calcium phosphate, production of which is reported as follows: 1952, 21,400 tons; 1953, 41,800 tons; 1954, 5,500 tons.

SOUTH AMERICA

Brazil.—Production at the Olinda phosphate-rock deposit was about 300 tons per day at the year end. Larger mining equipment began operation early in 1954, and the drying and grinding plant started processing in August. Additional mining equipment was ordered. Fosforita Olinda S/A reported that the new machinery would be in operation early in 1956 with a planned annual production of about 400,000 tons.[34] Small phosphate-rock deposits near Joao Pessoa, Paraiba, north of Recife, were mined at a rate of 50 tons per day. Nearly all the Brazilian phosphate rock was used as a direct application fertilizer.

Domestically produced apatite from Sao Paulo was used in manufacturing superphosphate.

Peru.—Reconnaissance studies during 1954 of phosphate-rock occurrences in the following areas of Peru did not disclose any commercial deposits: (1) Cajamarca–Calendin–Huslgayoc region of the Department of Cajamarca; (2) Tarma region of the Department of Junin and the Department of Huahco; and (3) Yauyos region of the Department of Lima.[35]

EUROPE

Germany, East.—The elemental phosphorus plant at Piesteritz, largely dismantled following World War II, was again in limited production and substantial expansion was planned.[36]

Norway.—Expansion of the facilities of Norsk Hydro was announced. This plant, at Salten, Norway, will be capable of producing 8,500 tons of elemental phosphorus per year.[37]

[34] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 2, August 1954, pp. 62–64.
[35] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 1, January 1955, p. 48.
[36] Chemical and Engineering News, vol. 32, No. 9, Mar. 1, 1954, p. 826.
[37] Chemical and Engineering News, vol. 32, No. 9, Mar. 1, 1954, p. 826.

Poland.—Exploration in the Sieradz, Radom, and Janow districts disclosed extensive phosphate-rock deposits. It was planned to develop these deposits by underground mines. At the present time requirements are met by imports.[38]

United Kingdom.—The elemental phosphorus plant of Albright & Wilson, Ltd., at Portishead, near Bristol, began production in February 1954. The rated capacity of the 6 electric furnaces was 40 million pounds of phosphorus, which was reported to be greater than the previous total production in the United Kingdom.[39]

ASIA

Israel.—At the close of 1954 phosphate-rock output was about 300 tons per day, with a P_2O_5 content up to 30 percent.[40] Additional calcining equipment was ordered to allow further expansion. In addition to supplying the domestic phosphate market, export markets were being developed. A barter agreement with the Netherlands was made to exchange Israeli phosphate rock for Netherland nitrogenous fertilizers.[41]

Jordan.—The phosphate-rock industry continued to expand with development of more foreign markets. Belgium and Italy were among the countries receiving phosphate rock from Jordan.[42]

AFRICA

Algeria.—Phosphate-rock production increased 26 percent in 1954 over 1953. Compagnie des Phosphates de Constantine and Compagnie Minière du M'zaïta continued to be the major producers.

The price of 68 percent B. P. L. phosphate rock, f. o. b. Algerian ports, was $8.56 per long ton at mid-1954.[43]

Exports of phosphate rock (table 17) from Algeria were 19 percent greater in 1954 than in 1953. France, Spain, United Kingdom, and West Germany received 28, 20, 12, and 11 percent, respectively, of total exports. Eleven percent of the exports went to Communist-dominated countries.

French Morocco.—Production of phosphate rock in 1954 was 21 percent more than in 1953. In addition to the Louis-Gentil and Khouribga mines, the recently developed Oued Zem deposits began producing during the year. At these new deposits draglines were used for both stripping and mining operations. The average grade of the rock produced from the Oued Zem deposits was 76 percent B. P. L., compared with 75 from the Khouribga mine and 70 from the Louis-Gentil mine.

Exports of phosphate rock from French Morocco (table 18) were greater in 1954 than in 1953; 90 percent went to European markets. The Union of South Africa received 7 percent.

[38] Fertiliser and Feeding Stuffs Journal (London), vol. 40, No. 12, June 9, 1954, p. 500.
[39] Chemical Age (London), vol. 70, No. 1805, Feb. 13, 1954, p. 428.
[40] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 4, October 1954, p. 68.
[41] Chemical and Engineering News, vol. 32, No. 49, Dec. 6, 1954, p. 4850.
[42] Chemical Week, vol. 75, No. 11, Sept. 11, 1954, p. 29; Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 2, February 1954, p. 63.
[43] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 4, October 1954, pp. 63–64.

TABLE 17.—Exports of phosphate rock from Algeria, 1950–54, by countries of destination, in long tons [1]

Country	1950	1951	1952	1953	1954
Europe:					
Belgium-Luxembourg	3,445	5,029	7,431	-----	1,378
Czechoslovakia	8,610	28,769	14,173	-----	19,586
France	145,980	188,303	113,990	103,755	184,283
Germany, West	81,174	164,167	118,657	61,808	75,981
Hungary	25,939	12,194	11,712	11,860	9,842
Ireland	56,593	63,283	50,266	33,660	42,419
Netherlands	102,311	61,786	31,175	-----	-----
Poland	9,129	49,211	35,678	36,130	33,266
Portugal	8,066	23,887	37,828	22,145	30,806
Rumania	-----	-----	-----	-----	9,744
Spain	27,592	4,429	67,935	168,792	131,884
Switzerland	1,855	-----	-----	-----	886
United Kingdom	102,444	53,823	73,182	88,382	81,099
Yugoslavia	3,169	10,019	14,566	-----	17,470
Asia:					
Indochina	5,905	-----	-----		7,874
Indonesia	-----	-----	-----	-----	4,458
Malaya	-----	-----	-----	-----	709
French overseas territories	4,950	2,362	4,724	10,472	-----
Other countries	11,028	17,143	10,964	15,501	6,456
Total	598,190	684,405	592,281	552,505	658,141

[1] Compiled by John E. McDaniel, Division of Foreign Activities, Bureau of Mines, from Customs Returns of Algeria.

TABLE 18.—Exports of phosphate rock from French Morocco, 1950–54, by countries of destination, in long tons [1]

Country	1950	1951	1952	1953	1954
South America:					
Brazil	28,661	21,675	30,806	13,681	6,919
Chile	-----	-----	-----	14,074	19,320
Uruguay	4,218	4,884	6,397	6,348	12,775
Europe:					
Belgium-Luxembourg	294,546	281,439	198,713	178,762	306,827
Denmark	240,778	266,795	209,863	238,691	214,784
Finland	84,957	90,996	96,445	37,735	52,163
France	527,627	531,490	400,785	484,822	596,215
Germany	252,015	228,773	316,194	230,679	373,124
Hungary	21,948	11,644	-----	-----	-----
Ireland	34,808	29,007	34,674	53,324	61,730
Italy	229,523	527,902	470,451	526,169	650,021
Netherlands	330,811	296,081	308,438	80,184	260,166
Norway	45,550	38,200	50,362	51,838	76,483
Poland	99,258	173,973	94,541	119,030	134,591
Portugal	159,585	164,192	172,489	215,916	196,124
Spain	281,110	333,486	441,248	457,274	484,822
Sweden	196,847	310,530	232,953	225,109	285,165
Switzerland	25,550	34,873	15,924	17,194	24,841
United Kingdom	677,222	666,260	518,299	742,212	620,800
Yugoslavia	-----	-----	-----	-----	8,011
Asia:					
India	-----	-----	-----	-----	12,795
Japan	-----	-----	-----	-----	66,641
Taiwan	-----	-----	-----	-----	9,960
Africa: Union of South Africa	368,409	288,504	245,798	255,471	325,911
Other countries	94,846	46,374	-----	86,069	31,062
Total	3,998,269	4,347,078	3,844,380	4,034,582	4,831,250

[1] Compiled by John E. McDaniel, Division of Foreign Activities, Bureau of Mines, from Customs Returns of French Morocco.

Tunisia.—The washing plant at the Metlaoui mine near Gafsa, capable of processing 700,000 tons of ore per year, started operation during 1954. The SIAPE superphosphate plant at Sfax was not operating at capacity. This plant produced 44 percent B. P. L. triple superphosphate.

Prices of phosphate rock f. o. b. Tunisian ports at mid-1954 were as follows: 58–63 B. P. L., $6.62 per long ton; 63–65 B. P. L., $7.25 per long ton; and 65–68 B. P. L., $8.29 per long ton.[44]

Phosphate-rock exports from Tunisia increased 20 percent above those in the previous year. France and Italy were the major recipients, receiving 31 and 24 percent, respectively. About 5 percent of the exports went to Communist-dominated countries. Tunisian statistics group East and West Germany together.

Union of South Africa.—Construction of the concentrating plant at the Government-controlled FOSKOR operation in the Eastern Transvaal continued during the year. The plant was scheduled for completion in 1955, with a capacity of about 60,000 long tons. All the production was for the domestic superphosphate industry. Plans were announced for the construction of a 10,000-ton-per-year dicalcium phosphate plant by African Metals Corp., Ltd., at Kookfontein, using phosphatic raw material from the Saldanka Bay area or the FOSKOR deposit in the Transvaal.[45]

TABLE 19.—Exports of phosphate rock from Tunisia, 1950–54, by countries of destination, in long tons [1] [2]

Country	1950	1951	1952	1953	1954
North America: Canada	16, 238	2, 953	3, 936		9, 804
South America:					
Brazil	11, 023		31, 003	68, 924	76, 570
Chile	1, 969		15, 230	5, 413	
Uruguay			1, 699	2, 953	
Europe:					
Belgium	14, 270	106, 208	68, 009	35, 658	20, 700
Czechoslovakia	24, 182	25, 343	27, 263	55, 785	57, 714
Denmark			7, 323	7, 185	12, 573
Finland	41, 424	78, 264	58, 359	29, 231	29, 590
France	252, 927	549, 228	338, 739	433, 464	578, 738
Germany	92, 846	124, 544	131, 121	46, 602	79, 176
Greece	21, 800	103, 644	62, 857	70, 791	125, 504
Hungary	10, 757				4, 921
Italy	146, 433	419, 739	402, 293	469, 567	444, 446
Netherlands	36, 662	105, 564	69, 234	4, 144	131, 845
Poland	32, 484				33, 965
Portugal		8, 553	25, 909		10, 187
Spain	81, 837	236, 895	167, 504	87, 711	118, 523
Sweden	7, 972	2, 953	7, 765	5, 216	8, 445
Switzerland	3, 149	5, 684	935	1, 033	1, 230
United Kingdom and Ireland	110, 811	207, 839	583, 978	178, 864	100, 863
Yugoslavia	522	9, 987	7, 628	12, 799	10, 984
Asia:					
Indochina	5, 905		15, 944	17, 229	
Japan			9, 842	10, 285	
Turkey	6, 053	11, 318	15, 312	12, 554	30, 509
Africa:					
Madagascar			1, 968	492	
Union of South Africa		60, 973	69, 592		1, 000
Oceania: New Zealand	45, 279		17, 749	17, 619	
Other countries		5, 905	30	3, 502	49
Total	964, 543	2, 065, 594	2, 141, 222	1, 577, 021	1, 887, 336

[1] Compiled by John E. McDaniel, Division of Foreign Activities, Bureau of Mines, from Customs Returns of Tunisia.
[2] Figures include hyperphosphate.

[44] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 4, October 1954, pp. 66–68.
[45] Fertiliser and Feeding Stuffs Journal (London), vol. 41, No. 11, Nov. 24, 1954, p. 447.

Other African Countries.—The Société Pechiney closed its calcium phosphate operations because of increased costs but reported expansion of operations at the alumina-type phosphate open-pit mines near Thies, Senegal.[46] The Anglo-Transvaal Investment, Ltd., was investigating the Shawa apatite deposits southeast of Umtali, Southern Rhodesia.[47] The Sukulu apatite deposits near Tororo, Uganda, were estimated to contain more than 100,000 tons. Production started in this area in the early 1940's, entirely for domestic consumption.[48]

The exports of phosphate rock from Egypt, 1949–53, are given in table 20.

TABLE 20.—Exports of phosphate rock from Egypt, 1949–53, by countries of destination, in long tons [1]

Country	1949	1950	1951	1952	1953
Belgium-Luxembourg	37,069	20,487	-	-	(2)
Ceylon	26,884	27,899	33,939	33,909	[3] 31,749
Finland	-	18,014	36,985	23,325	(2)
Germany, West	-	-	8,986	37,156	(2)
Greece	5,860	-	9,183	11,732	(2)
India	2,950	46,524	12,199	28,498	(2)
Italy	39,885	113,535	57,523	38,976	(2)
Japan	-	224,170	179,759	173,593	(2)
Netherlands	18,199	9,549	-	-	(2)
New Zealand	8,199	15,230	-	-	(2)
Sweden	-	5,413	337	-	(2)
Union of South Africa	-	-	16,352	60,265	[3] 16,648
Yugoslavia	-	10,196	9,845	-	(2)
Other countries	4,277	985	4,153	8,675	[3] 324,732
Total	143,323	492,002	369,261	416,129	373,129

[1] Compiled by John E. McDaniel, Division of Foreign Activities, Bureau of Mines, from Customs Returns of Egypt.
[2] Data not available.
[3] Preliminary figures.

[46] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 2, August 1954, p. 64.
[47] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 2, August 1954, p. 64.
[48] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 3, March 1954, p. 66.

Platinum-Group Metals

By James E. Bell[1] and Kathleen M. McBreen[2]

THE PLATINUM-GROUP METALS were highlighted in 1954 by a growing production potential, declining prices for most metals, and continuing strong demand. Noteworthy also was the appearance in world markets of substantial quantities of platinum of Soviet origin. Total sales of platinum-group metals to domestic consumers were 9 percent greater in 1954 than in 1953, but total imports were 5 percent less. Demand for platinum for jewelry continued at a relatively low level, but this was more than offset by the expanding use of platinum as a catalyst for upgrading gasoline. The domestic refinery production of platinum-group metals (new and secondary combined) was 2 percent less in 1954 than in the preceding year.

TABLE 1.—Salient statistics of platinum-group metals in the United States, 1953–54, in troy ounces

	1953	1954
Production:		
Crude platinum from placers and byproduct platinum-group metals	[1] 26,072	[1] 24,235
Refinery production:		
New metal:		
Platinum	46,963	47,421
Palladium	6,347	4,605
Other	6,957	4,740
Total	60,267	56,766
Secondary metal:		
Platinum	29,547	31,330
Palladium	30,494	31,190
Other	4,816	3,179
Total	64,857	65,699
Consumption:		
Platinum	276,580	320,215
Palladium	231,525	234,537
Other	25,193	27,194
Total	533,298	581,946

	1953	1954
Stocks in hands of refiners, importers, and dealers, Dec. 31:		
Platinum	138,846	135,631
Palladium	110,211	86,770
Other	31,991	34,194
Total	281,048	256,595
Imports for consumption:		
Unrefined materials	[2] 48,525	53,287
Refined metals	[2] 585,563	548,325
Total	[2] 634,088	601,612
Exports:		
Ore and concentrates	30	29
Refined metals and alloys, including scrap	25,728	24,913
Manufactures (except jewelry)	(3)	(3)

[1] Includes Alaska. The production total of platinum-group metals for the year 1954 will be compared with the Bureau of the Census total for this commodity when it is available. Differences in the totals will be adjusted or explained.
[2] Revised figure.
[3] Beginning Jan. 1, 1952, quantity not recorded.

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

Platinum (new and secondary combined) was refined in the United States in 1954 at a rate 3 percent greater than in 1953, but imports of refined platinum were nearly the same. Domestic consumption as measured by sales increased 16 percent, while stocks of refiners and dealers declined 2 percent. The chemical industry was again the largest user, taking 67 percent of the total sold in 1954 compared with 58 percent in 1953. Platinum was purchased by the Government for stockpiling. The Commodity Credit Corporation of the Department of Agriculture bartered surplus food to friendly countries for additional platinum, and the metal so acquired also entered the Government stockpile. Stocks of refiners and dealers declined 2 percent.

Palladium (new and secondary combined) was refined in the United States in 1954 at a rate 3 percent below that of 1953, and imports of refined palladium declined 17 percent. Domestic consumption as measured by sales rose 1 percent. The electrical industry continued to provide the largest market, taking 66 percent of the total sales in 1954, the same as in 1953. Stocks of refiners and dealers decreased 21 percent.

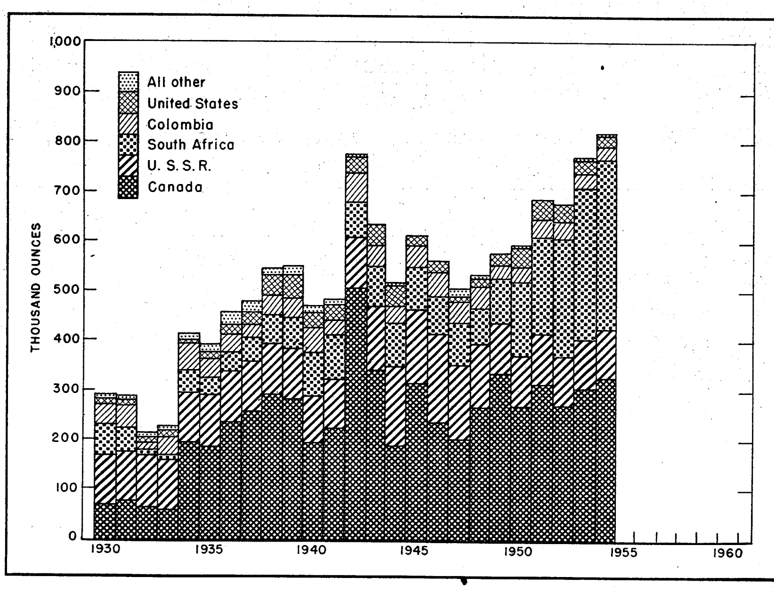

FIGURE 1.—World production of platinum-group metals, 1930–54.

Refining of iridium, rhodium, and ruthenium (new and secondary combined) in the United States in 1954 was 36, 7, and 56 percent, respectively, under the 1953 rates; that of osmium rose 5 percent. Imports of refined iridium and osmium dropped 74 and 66 percent, respectively, while imports of rhodium and ruthenium rose 7 and 85 percent, respectively. Consumption of the 4 metals together was 8 percent greater in 1954 than in 1953, and stocks of refiners and dealers increased 7 percent.

Under a project of the Defense Minerals Exploration Administration, a placer-platinum deposit in the Goodnews Bay district in Alaska was tested by drilling in 1954. Encouraging results were obtained in one area, and it was planned to continue the work in 1955.

Expansion and improvements of mining, milling, and matte-treatment facilities at properties of the Rustenburg Platinum Mines, Ltd., in the Union of South Africa increased the production capacity markedly, with the result that this company now ranks as the leading producer of platinum-group metals of the world.

Figure 1 shows the trends in world production of platinum-group metals since 1930.

GOVERNMENT REGULATIONS

The regulations established on March 23, 1953, by the Defense Materials System of the 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 1954.

By regulations of the Advisory Committee on Export Policy of the Department of Commerce, manufactures of platinum-group metals were among the products that required a validated license throughout 1954 for export to Soviet-bloc countries.

CRUDE PLATINUM PRODUCTION

Mine returns and refinery reports show a domestic production of 24,200 troy ounces of platinum-group metals in 1954 as against 26,100 ounces in the preceding year. This output includes crude platinum mined at placer-platinum deposits in the Goodnews Bay district in southwestern Alaska, byproduct crude platinum recovered from gold placer mining in California, and platinum-group metals contained in small quantities in some gold and copper ores and recovered as a byproduct in smelting and refining operations.

Purchases.—Buyers in the United States reported the purchase in 1954 of 58,800 ounces of crude platinum from Alaska, Colombia, and Union of South Africa. The corresponding quantity in 1953 was 59,400 ounces.

RECOVERY OF REFINED PLATINUM-GROUP METALS

New Metals Recovered.—Reports from refiners indicate recovery in the United States of 56,800 ounces of new platinum-group metals in 1954 compared with 60,300 ounces in 1953. Of the total new metals refined in 1954, 91 percent was recovered from crude platinum, both domestic and foreign, and 9 percent was recovered as a byproduct of gold and copper ores; comparable figures in 1953 were 86 and 14 percent, respectively.

Secondary Metals Recovered.—In the United States 65,700 ounces of platinum-group metals was recovered in 1954 from the refining of scrap, etc., compared with 64,900 ounces in 1953. Substantial quantities of wornout catalysts, spinnerets, laboratory ware, and other products are returned to refiners for refining or reworking. The platinum-group metals so recovered from these items (or their equivalent in refined metals) are returned to the consumers; they are not considered secondary production or included in the statistics of secondary metals.

TABLE 2.—New platinum-group metals recovered by refiners in the United States, 1945–49 (average), 1950–52, and 1953–54, by sources, in troy ounces

	Platinum	Palladium	Iridium	Osmium	Rhodium	Ruthenium	Total
1945–49 (average)	76,948	9,416	2,705	613	1,411	639	91,732
1950	56,757	11,819	2,351	1,295	433	474	73,129
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							
From domestic—							
Crude platinum	11,585	228	2,559	468	304	84	15,228
Gold and copper refining	1,199	3,989	3		12	1	5,204
Total	12,784	4,217	2,562	468	316	85	20,432
From foreign— Crude platinum; Nickel and copper refining	34,179	2,130	1,295	724	575	932	39,835
Total	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

TABLE 3.—Secondary platinum-group metals recovered in the United States, 1945–49 (average) and 1950–54, in troy ounces

	Platinum	Palladium	Iridium	Others	Total
1945–49 (average)	50,756	30,789	1,643	3,451	86,639
1950	33,894	21,167	1,064	1,988	58,113
1951	22,470	27,999	1,014	1,875	53,358
1952	28,628	25,540	1,030	3,403	58,601
1953	29,547	30,494	853	3,963	64,857
1954	31,330	31,190	734	2,445	65,699

CONSUMPTION AND USES

The platinum-group metals, formerly better known as materials used chiefly for jewelry and luxury wares, today find their greatest application in the chemical and electrical industries. In recent years consumption of these metals in the United States has equaled about two-thirds of the world output.

The industrial uses of the platinum-group metals arise from their activity as catalysts, chemical inertness, and high melting points; in addition, platinum and palladium are ductile and malleable and are extremely workable. 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 in 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 continued to expand. 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 platinum nozzles, whence it emerges in fine streams that are stretched to filaments of minute diameter. Platinum alloys are employed also for handling molten glass in the manufacture of light bulbs and optical glass.

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. Palladium is used in large quantities 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 high-tension magnetos. Spark plugs equipped with platinum-alloy electrodes have long life and resistance to fouling. Platinum and palladium alloys are widely employed in many types of instruments and in electronic tubes. The military importance of platinum lies in its 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, alloys of platinum and palladium are used extensively for dentistry in cast and wrought forms and as pins and anchorages. Platinum and palladium are used in special photographic papers.

Alloys of ruthenium 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, controlled-thickness electroplating of rhodium on most common metals, permitting manufacturers to make use of the resistance of pure rhodium to wear and corrosion on many production items.

Sales of platinum-group metals for domestic industrial consumption totaled 581,900 troy ounces in 1954, as against 533,300 ounces in 1953, a gain of 9 percent.

Sales of platinum to domestic consumers totaled 320,200 ounces in 1954, representing 55 percent of total sales of platinum-group metals; the corresponding figures for 1953 were 276,600 ounces and 52 percent. Sales to industry were as follows: Chemical 214,100 ounces (67 percent), electrical 51,900 ounces (16 percent), dental and medical 14,200 ounces (4 percent), jewelry and decorative 37,700 ounces (12 percent), and miscellaneous and undistributed 2,300 ounces (1 percent). Demand for platinum as a catalyst continued to be active, but demand for jewelry was under expectations.

Sales of palladium to domestic consumers in 1954 were 234,500 ounces, equivalent to 40 percent of total sales of platinum-group metals; the corresponding figures for 1953 were 231,500 ounces and 43 percent. Sales to industry were as follows: Chemical 15,000 ounces (6 percent), electrical 153,900 ounces (66 percent), dental and medical 28,700 ounces (12 percent), jewelry and decorative 27,400 (12 percent), and miscellaneous and undistributed 9,500 ounces (4 percent).

Sales of iridium, osmium, rhodium, and ruthenium together to domestic consumers in 1954 were 27,200 ounces, representing 5 percent of total sales of platinum-group metals; the equivalent figures for 1953 were 25,200 ounces and 5 percent. Sales of each of the 4 metals were as follows: Iridium 4,400 ounces, osmium 1,300, rhodium, 13,800, and ruthenium, 7,700.

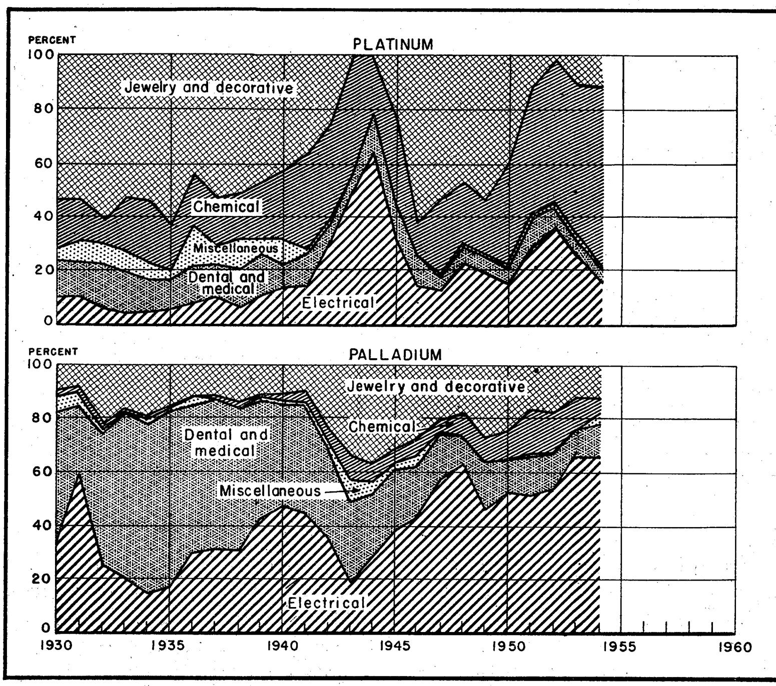

FIGURE 2.—Sales of platinum and palladium to various consuming industries in the United States, 1930–54, as percent of total.

TABLE 4.—Platinum-group metals sold to consuming industries in the United States, 1953–54, in troy ounces

Industry	Platinum	Palladium	Iridium, osmium, rhodium, and ruthenium	Total
1953				
Chemical	160, 622	24, 961	9, 752	195, 335
Electrical	67, 850	152, 136	5, 073	225, 059
Dental and medical	14, 451	26, 024	318	40, 793
Jewelry and decorative	31, 496	27, 583	5, 641	64, 720
Miscellaneous and undistributed	2, 161	821	4, 409	7, 391
Total	276, 580	231, 525	25, 193	533, 298
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

STOCKS

Stocks of platinum-group metals in all forms in the hands of refiners, dealers, and importers totaled 256,600 troy ounces on December 31, 1954, compared with 281,000 ounces on December 31, 1953, representing a drop of 9 percent.

TABLE 5.—Stocks of platinum-group metals held by refiners, importers, and dealers in the United States, December 31, 1950–54, in troy ounces

Year	Platinum	Palladium	Iridium, osmium, rhodium, and ruthenium	Total
1950	125,234	107,854	33,474	266,562
1951	138,977	138,099	36,815	313,891
1952	130,136	116,786	35,451	282,373
1953	138,846	110,211	31,991	281,048
1954	135,631	86,770	34,194	256,595

PRICES

Although the demand for platinum-group metals remained strong, the prices of most of them declined in 1954. Expansion of production facilities, particularly in the Union of South Africa, tended to a situation of supply in excess of demand. Platinum from Soviet sources also contributed to unsteadiness of the market.

Domestic retail prices of the platinum-group metals per fine troy ounce in 1954 were quoted as follows: Platinum was $93 to the middle of January, $92 to the middle of March, $87 to the latter part of December, and $84 thereafter. Palladium was $24 in the early part of January and $21 thereafter. Iridium was $170–$175 to the middle of March, $145–$150 to the middle of September, and $130–$135 thereafter. Osmium was $140–$150 to the middle of September and $140 thereafter. Rhodium was $125 to the middle of March, $118–$125 to the middle of September, and $125 thereafter. Ruthenium was $75–$80 to the middle of March, $70–$75 to early in October, $65–$70 to the middle of October, and $60–$65 thereafter.

Buyers in the United States reported purchases of domestic and foreign crude platinum in 1954 at $70 to $89 per ounce. This price range resulted chiefly from fluctuation in demand for refined metals and variations in the iridium content of crude platinum.

FOREIGN TRADE [3]

Imports.—Imports of platinum-group metals into the United States in 1954 totaled 601,600 ounces, a drop of 5 percent under the alltime record established in 1953. The principal sources were Canada (231,800 ounces), Colombia (43,900 ounces), France (42,000

[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.

ounces), Netherlands (25,200 ounces), Switzerland (83,000 ounces), and United Kingdom (147,100 ounces). The metals imported from France, Netherlands, and Switzerland were reported to be largely of Soviet origin.

Imports of unrefined metals in 1954 were 53,300 troy ounces as against 48,500 ounces in 1953; imports of refined metals totaled 548,300 ounces compared with 585,600 ounces. Imports of refined platinum were virtually the same in 1954 as in 1953; imports of palladium, iridium, and osmium were 17, 74, and 66 percent less, respectively, and imports of rhodium and ruthenium were 7 and 85 percent greater, respectively.

TABLE 6.—Platinum-group metals imported for consumption in the United States, 1945–49 (average) and 1950–54

[U. S. Department of Commerce]

Year	Troy ounces	Value	Year	Troy ounces	Value
1945–49 (average)	319,447	$12,972,942	1952	452,818	$25,533,898
1950	427,547	23,220,709	1953	[1] 634,088	[1] 39,447,072
1951	601,423	36,307,916	1954	601,612	[2] 35,284,842

[1] Revised figure.
[2] Owing to changes in tabulating procedures by the U. S. Department of Commerce, not strictly comparable to earlier years.

Exports.—Exports of refined platinum (including scrap) were 13,500 ounces in 1954, and exports of other platinum-group metals combined (including scrap) were 11,400 ounces. Corresponding figures for 1953 were 2,500 ounces and 23,200 ounces, respectively. Brazil was the largest buyer of platinum, taking 7,100 ounces, followed by United Kingdom, taking 3,600 ounces. Canada was the largest buyer of the other platinum-group metals with 5,900 ounces.

TABLE 7.—Platinum-group metals (unmanufactured) imported for consumption in the United States, 1953–54, 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
1953											
North America:											
Canada	[3] 840	409	367	60	106,986	103,594	400		8,386	655	[3] 221,697
Mexico			1								1
Netherlands Antilles			12								12
Total	840	409	380	60	106,986	103,594	400		8,386	655	221,710
South America:											
Colombia		[3] 38,733	[3] 360								[3] 39,093
Venezuela		12									12
Total		38,745	360								39,105
Europe:											
Belgium-Luxembourg					497						497
Denmark			63								63
France					12,344	6,113	(4)		85		[3] 18,542
Germany, West			21				200				221
Italy					100	3,983					4,083
Netherlands					[3] 70,893	49,091					[3] 119,984
Norway	(4)	[3] 1,419			1,989	425	349		[3] 610	[3] 753	[3] 5,545
Switzerland		321			[3] 4,837		240				[3] 5,398
U. S. S. R.						31,256					31,256
United Kingdom		4,007		82	[3] 142,886	32,618	[3] 454	583	3,218	1,918	[3] 185,766
Total	(4)	5,747	84	82	233,546	123,486	1,243	583	3,913	2,671	371,355
Asia:											
Bahrein					100						100
Lebanon		146									146
Total		146			100						246

Africa: Union of South Africa				1,667							1,667
Oceania: Australia				5							5
Grand total	[3] 840	[3] 45,047	[3] 824	1,814	340,632	227,080	1,643	583	[3] 12,299	[3] 3,326	[3] 634,088
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	41,329		1		2	7		4		43,898
Venezuela		58									58
Total	2,555	41,387		1		2	7		4		43,956
Europe:											
Austria			11								11
France		1,472	886		14,386	25,258					42,002
Germany, West			2,733			8,097					10,830
Netherlands					7,908	17,260					25,168
Norway	118	475			5,696	5,054	191		293	558	12,385
Switzerland					69,814	13,112	51				82,977
U. S. S. R.					4,166						4,166
United Kingdom				1,868	118,053	19,971	17	199	3,265	3,710	147,083
Total	118	1,947	3,630	1,868	220,023	88,752	259	199	3,558	4,268	324,622
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	43,355	4,230	2,988	339,490	188,839	432	199	13,197	6,168	601,612

[1] On the basis of detailed information received by the Bueau of Mines from importers, certain items recorded by the U. S. Department of Commerce as "ores and concentrates" and "sponge and scrap" have been reclassified and included with other groups in this table.
[2] U. S. Department of Commerce categories are in terms of metal content. It is believed, however, that in many instances gross weights are actually reported.
[3] Revised figure.
[4] Revised to none.

TABLE 8.—Platinum-group metals(unmanufactured) imported for consumption in the United States, 1953–54 [1]

[U. S. Department of Commerce]

Material	1953		1954	
	Troy ounces	Value	Troy ounces	Value
Unrefined materials:[2]				
Ores and concentrates of platinum metals	[3] 840	[3] $50,000	2,714	$191,426
Platinum grains and nuggets (including crude, dust, and residues)	[3] 45,047	[3] 3,423,958	43,355	2,725,343
Platinum sponge and scrap	[3] 824	70,211	4,230	[4] 366,519
Osmiridium	1,814	174,577	2,988	289,521
Total	[3] 48,525	3,718,746	53,287	[4] 3,572,809
Refined metals:				
Platinum	340,632	29,325,074	339,490	[4] 26,500,388
Palladium	227,080	4,548,460	188,839	[4] 3,467,875
Iridium	1,643	251,908	432	55,072
Osmium	583	67,126	199	[4] 20,025
Rhodium	[3] 12,299	[3] 1,322,971	13,197	1,336,047
Ruthenium	[3] 3,326	[3] 212,787	6,168	332,626
Total	[3] 585,563	[3] 35,728,326	548,325	[4] 31,712,033
Grand total	[3] 634,088	[3] 39,447,072	601,612	[4] 35,284,842

[1] On the basis of detailed information received by the Bureau of Mines from importers, certain items recorded by the U. S. Department of Commerce as "ores and concentrates" and "sponge and scrap" have been reclassified and included with other groups in this table.
[2] U. S. Department of Commerce categories are in terms of metal content. It is believed, however, that in many instances, gross weights are actually reported.
[3] Revised figure.
[4] Owing to changes in tabulating procedures by the U. S. Department of Commerce, not strictly comparable to earlier years.

TABLE 9.—Platinum-group metals exported from the United States, 1945–49 (average) and 1950–54 [1]

[U. S. Department of Commerce]

Year	Ores 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
1945–49 (average)	69	$2,837	14,927	$962,159	13,330	$499,362	8,896	$284,976
1950	82	265	12,753	994,362	24,946	802,970	12,640	521,575
1951	732	117,500	8,760	834,985	52,088	1,355,514	17,348	932,085
1952			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	13,470	1,148,050	11,443	287,400	(2)	1,800,826

[1] Quantities are gross weight.
[2] Beginning Jan. 1, 1952, quantity not recorded.

TABLE 10.—Platinum-group metals exported from the United States, 1953–54, by countries of destination [1]

[U. S. Department of Commerce]

Destination	Ores and concentrates		Platinum (bars, ingots, sheets, wire, sponge, and other forms, including scrap)		Palladium, rhodium, iridium, osmiridium, ruthemium, and osmium (metal and alloys, including scrap)		Platinum-group manufactures, except jewelry [2]
	Troy ounces	Value	Troy ounces	Value	Troy ounces	Value	Value
1953							
North America:							
Canada			1,036	$90,340	6,433	$157,682	$816,491
Cuba			57	5,552	230	7,131	1,470
Mexico			176	18,754	464	10,881	12,712
Other			26	2,702	5	153	1,803
Total			1,295	117,348	7,132	175,847	832,476
South America:							
Brazil			60	5,315	127	2,984	987
Chile			44	5,596	61	1,482	4,555
Colombia					386	9,093	25,223
Peru			57	5,236	67	2,350	6,763
Venezuela			96	9,490	313	7,211	4,129
Other			30	4,760	7	200	4,256
Total			287	30,397	961	23,320	45,913
Europe:							
France			52	6,230	21	3,080	3,634
Germany, West			600	55,000	13,019	304,264	
Italy			1	400	88	17,166	43,177
Spain					1,020	26,404	
Switzerland					321	7,054	856
United Kingdom	15	$290	249	22,481	95	14,313	598,162
Other	15	290	21	3,661			7,564
Total	30	580	923	87,772	14,564	372,281	653,393
Asia:							
Japan					398	15,641	1,400
Philippines			3	357	150	4,200	10,717
Other			6	499	1	150	6,193
Total			9	856	549	19,991	18,310
Africa			6	1,366			4,954
Oceania			2	114			
Grand total	30	580	2,522	237,853	23,206	591,439	1,555,046
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							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			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			55	2,360	28	1,050	25,876
Total			4,309	327,411	2,439	65,639	380,597
Asia:							
Japan			366	32,281	535	23,687	82,086
Other			29	3,782			74,955
Total			395	36,063	535	23,687	157,041
Africa			6	1,340			8,626
Oceania							4,720
Grand total	29	2,367	13,470	1,148,050	11,443	287,400	1,800,826

[1] Quantities are gross weight. [2] Beginning Jan. 1, 1952, quantity not recorded.

WORLD REVIEW

Canada.—Most of the output of platinum-group metals of Canada is obtained as a byproduct of nickel-copper mining in the Sudbury district in Ontario; a small quantity of crude platinum is recovered as a byproduct of gold placer mining in British Columbia. According to the Dominion Bureau of Statistics, the total production in Canada in 1954 was 149,100 ounces of platinum and 176,500 ounces of other platinum-group metals; the corresponding figures for 1953 were 137,500 and 166,000 ounces, respectively. The increase in output in 1954 reflected a stepped-up rate of production of nickel and copper in the Sudbury district and in consequence a greater production of byproduct platinum-group metals.

Deliveries of platinum-group metals by the International Nickel Co. of Canada, Ltd., were 263,200 in 1954 compared with 270,600 ounces in 1953.

Further successful exploration at a nickel-copper deposit containing significant quantities of platinum and palladium in the Kluane Lake district, Yukon Territory, discovered in 1952, was reported by the Hudson Bay Mining & Smelting Co., Ltd.[4]

Colombia.—The production of platinum-group metals in Colombia results from placer-mining operations (mostly by dredging) in the Choco district. The crude-platinum product for shipment averages about 85 percent platinum-group metals. The South American Gold & Platinum Co., which accounts for most of the output, recovered 25,300 ounces of crude platinum in 1954 as against 28,300 ounces in 1953. Production figures for other operators are not available.

Union of South Africa.—Platinum-group metals are recovered in the Union of South Africa from two sources—as an osmiridium byproduct of gold mining on the Rand and as the principal product of mining operations on the Merensky Reef, a horizon of the ultrabasic Bushveld igneous complex in the Transvaal.

In recent years the production of osmiridium on the Rand has averaged around 6,000 ounces annually. The composition of the osmiridium is variable, but the metals contained range approximately within the limits given below:

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

[4] Hudson Bay Mining & Smelting Co., Ltd., Annual Report to Stockholders: 1954.

TABLE 11.—World production of platinum-group metals, 1945–49 (average) and 1950–54, in troy ounces [1]

(Compiled by Pauline Roberts)

Country	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Canada:						
Platinum: Placer platinum and from refining nickel-copper matte	[2] 139,953	124,571	153,483	122,317	137,545	149,145
Other platinum-group metals: From refining nickel-copper matte	[2] 203,430	148,741	164,905	157,407	166,018	176,528
United States: Placer platinum and from domestic gold and copper refining	23,965	37,855	36,951	34,409	26,072	24,235
Total	367,348	311,167	355,339	314,133	329,635	349,908
South America: Colombia: Placer platinum	36,170	26,445	[3] 32,000	[3] 33,700	28,977	25,266
Europe: U. S. S. R.: Placer platinum and from refining nickel-copper ores (estimate)	140,000	100,000	100,000	100,000	100,000	100,000
Asia: Japan:						
Palladium from refineries	177	59	23	85	71	[3] 70
Platinum from refineries		151	245	484	987	1,347
Total	177	210	268	569	1,058	1,417
Africa:						
Belgian Congo: Palladium from refineries	63	----------	----------	----------	----------	[4] 176
Ethiopia: Placer platinum	594	641	266	100	566	230
Sierra Leone: Placer platinum	140	----------	----------	----------	----------	----------
Union of South Africa:						
Platinum-group metals from platinum ores	24,223	144,217	190,898	232,521	299,177	338,162
Concentrates (platinum-group metal content from platinum ores)	52,278					
Osmiridium from gold ores	6,213	6,914	6,359	6,141	6,966	6,266
Total	83,511	151,772	197,523	238,762	306,709	344,834
Oceania:						
Australia:						
Placer platinum	([5])	16	8	----------	----------	23
Placer osmiridium	87	48	33	51	59	17
New Guinea	[6] 4	----------	5	2	6	5
New Zealand: Placer platinum	3	----------	8	4	2	----------
Papua: Placer platinum	----------	([5])	[7] 2	5	----------	4
Total	94	64	56	62	67	49
World total (estimate)	625,000	600,000	675,000	700,000	775,000	825,000

[1] This table incorporates a number of revisions of data published in previous Platinum chapters.
[2] Includes certain adjustments in 1945 to account for metals produced in Canada in 1938–44 but are not included in the statistics for those years.
[3] Estimate.
[4] Includes platinum.
[5] Less than 0.5 ounce.
[6] Average for 1 year only, as 1949 was the first year for which commercial production was reported.
[7] Year ended June 30 of year stated.

All mining operations on the Merensky Reef were carried on by Rustenburg Platinum Mines, Ltd., a merger of several former producers. The mining, milling, and treatment plants of this company have been expanded steadily for several years, and in 1954 the rated annual capacity was 1,500,000 tons of ore. The potential annual output of this company was around 360,000 ounces of platinum-group metals; gold, copper, and nickel are recovered as byproducts. A matte smelter owned jointly by Rustenburg Platinum Mines, Ltd., and Johnson, Matthey & Co., Ltd., was completed in 1954. The purpose of this plant is to reduce the bulk of matte shipped for refining to England, where the platinum-group metals contained in the matte are recovered.

According to the Department of Mines, the production of platinum-group metals in the Union of South Africa was 338,200 ounces in 1954 compared with 299,200 in 1953. The 1954 output exceeded that of Canada, and the Union of South Africa thus attained the rank of the leading producer of platinum-group metals. The average analysis of 270,900 ounces of platinum-group metals exported from the Union in 1954 was reported as follows:[5] Platinum 78.18 percent, palladium 13.81, osmium and osmiridium 0.03, rhodium 2.66, ruthenium 1.62, and gold 3.70.

The following is excerpted from an unpublished report by B. R. Frisbie, Regional Minerals Officer, U. S. Department of State (July 1955):

Production Methods.—The Merensky Reef over the area being mined by Rustenburg Platinum Mines is uniquely consistent in value. The Reef itself, which is about 12 inches thick and dipping very flatly, contains approximately 10 to 12 dwts. of platinum-group metals per ton with a gradation of value into the hanging wall and into the foot wall. Mining practice, because of the uniformity of value throughout, is relatively simple. Scraper-ways are driven just below the Reef on dip at 500-foot intervals. The ore between scraper-ways is mined in blocks approximately 250 feet long on strike by 35 feet on dip. Mining is by cut and fill, and the mining width is kept to a maximum of 30 inches in which a portion of both the hanging and foot walls are removed. Waste filling of the stoped-out area is around 40 percent. Ore is trammed in small one-half-ton mine cars to the scraper-ways, where it is dumped and then carried by scraper to a haulage level below stoping operations. The maximum depth of operations at present is about 1,000 feet. Ore is hoisted through a number of shafts and transported to the main concentrator. Run-of-mine material is crushed and sent over a sorting belt, where approximately 800 tons of waste and very low grade material is removed daily. From the sorting plant the material is further crushed and ground to approximately 50 to 55 percent minus-200-mesh. All of the crushed and ground material is put over corduroy cloths, where approximately 30 percent of the platinum-group metals content is recovered. This product from the corduroy cloths consists of platinum sulphides and is referred to in statistics as "platinum mineral concentrates." There is no free metallic platinum found in the ore. The platinum mineral concentrates are shipped by air to England for smelting and refining. The tails from the corduroy cloths are then put through flotation cells, both Denver-sub A and Agitair. The flotation product, which consists of copper sulphides, nickel sulphides, and platinum-group metals, is then sent to the smelter. Smelting is in a blast furnace. Concentrates require briquetting before smelting. The matte from the smelter is treated further in a Great Falls-type convertor and blown to a high-grade copper-nickel matte.

[5] Pretoria, Union of South Africa, Industrial Minerals Quarterly Report. Fourth Quarter 1954, p. 23.

Distribution of Production.—The two products from Rustenburg Platinum Mines, i. e. platinum mineral concentrates (platinum-group metals sulphides) and matte are handled somewhat differently. The former are dried and shipped directly by air to the Johnson Matthey plant in Great Britain. Twenty-five percent of the matte produced is treated further in the plant of Matte Smelters (Pty.), Ltd., on the property. The remaining 75 percent is shipped to Great Britain for smelting and refining. Matte Smelters (Pty.), Ltd., produces an electrolytic copper and electrolytic nickel and an "enriched" matte. This enriched matte is principally the platinum-group metals remaining after the separation of the copper-nickel. The enriched matte is also flown to England for refining. The capacity of Matte Smelters (Pty.), Ltd., will only allow for treating 25 percent of the total matte produced by Rustenburg Platinum Mines, Ltd. (the Rustenburg section smelts all the concentrates from the Union section), and it is not anticipated that Matte Smelters will increase its capacity. It seems as though refinery capacity of Johnson Matthey in Great Britain was insufficient to treat the total production of Rustenburg Platinum Mines and therefore Matte Smelters (Pty.), Ltd., was formed in South Africa merely to treat that amount of matte which the plant in Great Britain was unable to treat. It is not anticipated that Matte Smelters (Pty.), Ltd., will ever produce refined platinum-group metals. This last step is reserved for Johnson Matthey in Great Britain.

Mill heads, before sorting, contain approximately 5 dwts. platinum-group metals per ton. Thirty percent of this content is removed on corduroy cloths. The flotation concentrate contains approximately 90 dwts. platinum-group metals per ton. The matte from the Great Falls convertor contains approximately 900 dwts. platinum-group metals per ton. An average analysis of the convertor matte is as follows:

45 percent nickel,
30 percent copper.

* * * * * * *

U. S. S. R.—The appearance of substantial quantities of platinum of Soviet origin on world markets in 1953 and 1954, after a lack of such offerings extending over several years, was a matter of much interest to other platinum producers. Views on supplies of Russian platinum are quoted below:[6]

Lack of information regarding the current level of platinum production in the Soviet Union makes it difficult to determine whether the Russian selling is likely to be maintained on the present scale or whether the recent disposals have included a distinct element of stock disposal. On the whole, the latter is believed to be the case, partly owing to the way in which the material has been marketed and partly owing to the fact that only a few months ago Russia had sold little or nothing on the world market for a lengthy period and could therefore be presumed to have accumulated some quite substantial stocks. Although her internal requirements are undoubtedly rising as the industrialisation of the Soviet Union progresses, it is doubted whether they yet equal the probable production which, in the absence of any accurate data, might be guessed as in the neighbourhood of 100,000 oz. per year.

[6] Metal Bulletin (London), No. 3918, Aug. 17, 1954, p. 24.

Potash

By E. Robert Ruhlman [1] and Gertrude E. Tucker [2]

INCREASED domestic production and lower imports of potash in 1954 made available in the United States about 2 million short tons of K_2O equivalent, the same as in 1953. Imports from East Germany, West Germany, France, and Spain were being investigated by the United States Treasury Department and the Tariff Commission under the Antidumping Act, 1921, as amended.

TABLE 1.—Salient statistics of the potash industry in the United States, 1945–49 (average) and 1950–54

	1945–49 (average)	1950	1951	1952	1953	1954
Production of potassium salts (marketable)......short tons..	1,875,384	2,242,647	2,474,870	2,866,462	3,266,429	3,322,395
Approximate equivalent K_2O..........short tons..	1,018,841	1,287,724	1,420,323	1,665,113	1,911,891	1,948,721
Sales of potassium salts by producers..........short tons..	1,887,062	2,221,920	2,451,913	2,757,252	2,965,986	3,270,006
Approximate equivalent K_2O..........short tons..	1,023,200	1,276,164	1,408,408	1,598,354	1,731,607	1,918,157
Value at plant [1]............	$38,220,000	$44,938,000	$51,007,000	$59,852,000	$65,403,000	$71,819,000
Average per ton............	$20.25	[2] $20.22	[2] $20.80	[2] $21.71	[2] $22.05	$21.96
Imports of potash materials short tons..	36,091	381,490	574,361	357,437	[2] 250,557	225,230
Approximate equivalent K_2O..........short tons..	16,528	200,529	313,617	188,441	[2] 133,587	119,220
Value............	$2,711,733	$13,993,974	$18,543,112	$12,714,434	[2] $9,952,663	$8,387,265
Exports of potash materials short tons..	124,822	117,137	124,211	101,200	88,208	117,386
Approximate equivalent K_2O [3]..........short tons..	68,124	65,047	68,654	56,281	49,109	66,476
Value............	$7,752,174	$5,534,176	$7,593,646	$4,836,659	$3,936,415	$5,463,452
Apparent consumption of potassium salts [4] short tons..	1,798,331	2,486,273	2,902,063	3,013,489	[2] 3,128,335	3,377,850
Approximate equivalent K_2O..........short tons..	971,605	1,411,646	1,653,371	1,730,514	[2] 1,816,085	1,970,901

[1] Revised for 1945–53 and partly estimated.
[2] Revised figure.
[3] Estimate by Bureau of Mines.
[4] Quantity sold by producers, plus imports, minus exports.

PRODUCTION AND SALES [3]

The domestic production of marketable potassium salts reached a new high in 1954, a 2-percent increase above the corresponding 1953 figure and more than 109 percent over the production 10 years ago. The sales of domestic marketable salts increased 10 percent in 1954 from 1953, and total value of domestic potash sales rose 10 percent.

[1] Commodity-industry analyst.
[2] Statistical assistant.
[3] The marketable production total of potassium salts for 1954 is equal to the prepared potassium salts total shown in Bureau of the Census Preliminary Report MI-14-7-4.

Production of high-analysis materials (60–62 percent K_2O minimum, including refined KCl and 93–96 percent KCl), including some low-grade muriate and manure salts, was 91 percent of the total potassium salts produced in the United States in 1954. Production of the lower grade muriate (48–50 percent K_2O minimum) was stopped during the year. The output of manure salts, sulfate of potash, and sulfate of potash-magnesia increased in 1954.

California, New Mexico, and Utah supplied nearly all the reported production of domestic marketable potassium salts, over 90 percent coming from the Permian deposits of southeastern New Mexico.

TABLE 2.—Potassium salts produced in the United States, 1945–49 (average) and 1950–54, by grades, in short tons

Grade	1945–49 (average)	1950	1951	1952	1953	1954
Muriate of potash:						
60–62 percent K_2O minimum [1]	1,371,134	1,846,459	2,047,793	2,468,436	2,926,398	3,033,185
48–50 percent K_2O minimum	136,641	151,547	155,797	150,959	81,801	
Manure salts	165,186	21,532	19,775	8,409	4,628	
Sulfate of potash and sulfate of potash-magnesia	202,423	223,109	251,505	238,658	253,602	289,210
Total	1,875,384	2,242,647	2,474,870	2,866,462	3,266,429	3,322,395

[1] Includes refined potash, and some 93–96 percent KCl, 1946–54.

TABLE 3.—Potassium salts produced, sold, and in producers' stocks in the United States, 1945–49 (average) and 1950–54

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 [1]	Potassium salts (short tons)	Equivalent potash (K_2O) (short tons)
1945–49 (average)	7	1,875,384	1,018,841	7	1,887,062	1,023,200	$38,220,000	46,157	21,445
1950	7	2,242,647	1,287,724	7	2,221,920	1,276,164	44,938,000	39,640	20,620
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	[2] 471,939	[2] 279,168
1954	10	3,322,395	1,948,721	10	3,270,006	1,918,157	71,819,000	524,328	309,732

[1] Revised for 1945–53 and partly estimated.
[2] Stock adjustment.

The plant locations of potash-producing companies in the United States in 1954, 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.

TABLE 4.—Production and sales of potassium salts in New Mexico, 1945–49 (average) and 1950–54, 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 [2]
1945–49 (average)	4, 575, 328	958, 040	1, 596, 742	855, 916	1, 609, 485	860, 739	$32, 120, 000
1950	5, 802, 004	1, 198, 021	1, 904, 565	1, 086, 996	1, 878, 094	1, 072, 772	37, 108, 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

[1] Sylvite and langbeinite.
[2] Revised for 1945–53 and partly estimated.

Mine production of crude potassium salts in the Carlsbad region of New Mexico reached a new high of over 9.9 million short tons, a 10-percent increase over 1953. The calculated grade (K_2O equivalent) of the crude salts mined decreased in 1954 to 19.90 percent compared with 20.97 percent in 1953.

All 5 producing companies in the Carlsbad region—Duval Sulphur & Potash Co., International Minerals & Chemical Corp., Potash Company of America, Southwest Potash Corp., and United States Potash Co., Inc.—mined sylvinite (potassium and sodium chlorides), and 1—International Minerals & Chemical Corp.—also mined langbeinite (potassium-magnesium sulfate). All 5 companies processed sylvinite, to yield 60 percent or higher grade muriate. Potassium sulfate and potassium-magnesium sulfate were produced from langbeinite by the International Minerals & Chemical Corp. in its refinery near Carlsbad.

The Potash Company of America formed a Canadian subsidiary to continue the exploration work in Saskatchewan.[4] A conveyor-belt system for the company Carlsbad mine was ordered and scheduled to be in operation in 1955. The conveyor is to be 7¼ miles long.[5]

Freeport Sulphur Co. and Pittsburgh Consolidation Coal Co. were discussing a joint venture to develop the potash deposits disclosed by Freeport's drilling program. No decision was announced by the end of 1954.[6] The National Farmers Union and Kerr-McGee Oil Industries, Inc., agreed on joint development of the union potash deposits near Carlsbad.[7]

The American Potash & Chemical Corp. acquired a 48.2-percent interest in the Western Electrochemical Co. This company manufactures potassium chemicals at Henderson, Nev. A new chemical laboratory at Trona was completed during 1954, and the chemical-grade potash plant was rebuilt and expanded.

It was reported that the Potash Chemical Co. was drilling carnallite and sylvinite deposits south of Green River in Grand County,

[4] Mining World, vol. 16, No. 6, May 1954, p. 33.
[5] Engineering and Mining Journal, vol. 155, No. 11, November 1955, p. 148.
[6] Oil, Paint and Drug Reporter, vol. 166, No. 16, Oct. 18, 1954, p. 4.
[7] Mining Congress Journal, vol. 40, No. 12, December 1954, p. 88.

Utah.[8] The Calunite Corp. announced plans for mining alunite deposits near Marysvale, Utah. After processing, the alunite will be added to a fertilizer containing available nitrogen, phosphorus, and potash.[9]

CONSUMPTION AND USES

The apparent consumption of K_2O in 1954 (producers' sales plus imports minus exports) was 9 percent greater than in 1953. 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 were 97 percent of apparent consumption compared with 95 percent in 1953 and 85 percent in 1951.

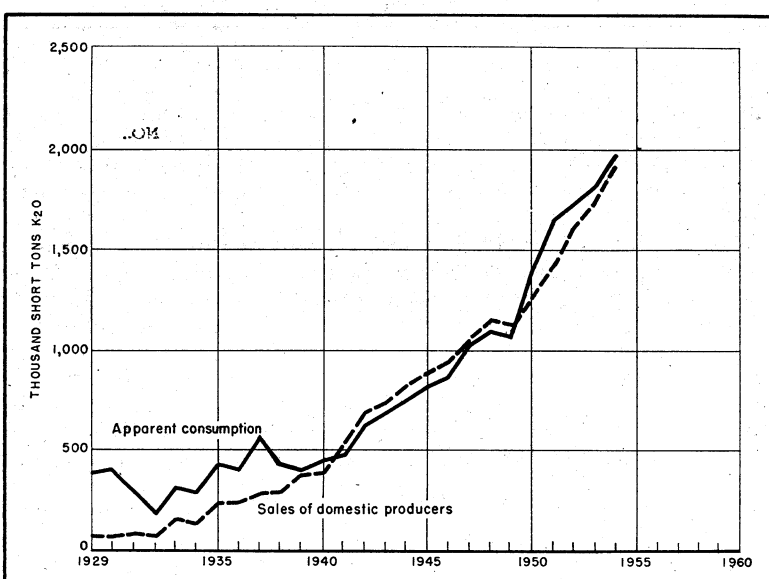

FIGURE 1.—Comparison of apparent domestic consumption of potash (K_2O) and sales of domestic producers of potash in the United States, 1929–54.

According to the American Potash Institute (press notice, April 18, 1955):

- Deliveries of potash in North America during 1954 amounted to 3,522,213 tons of salts containing an equivalent of 2,059,643 tons K_2O, again a new record high according to the American Potash Institute. This was an increase of 178,259 tons K_2O or 9% over 1953. Deliveries by the seven leading domestic producers were 1,909,255 tons K_2O, an increase of 11% over last year. Imports were 150,388 tons K_2O, a 5% decrease under last year.

Deliveries for agricultural purposes in the continental United States for 1954 were 1,834,810 tons K_2O, an increase of 171,568 tons over 1953. Canada received 76,265 tons K_2O, Cuba 5,113 tons, Puerto Rico 21,017 tons, and Hawaii 18,252 tons. Exports to other countries amounted to 12,377 tons K_2O.

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8 Engineering and Mining Journal, vol. 155, No. 8, August 1954, p. 145.
9 Mining Congress Journal, vol. 40, No. 9, September 1954, p. 67.

In this country agricultural potash was delivered in 45 states and the District of Columbia. Illinois with over 216,000 tons K_2O was the leading state followed in order by Ohio, Indiana, Georgia, Virginia, and Florida, 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 93% of the total K_2O delivered for agricultural purposes, sulphate of potash and sulphate of potash magnesia over 7%, and manure salts an insignificant percentage of deliveries.

Deliveries for chemical purposes in 1954 were 136,548 tons of muriate of potash containing an equivalent of 85,921 tons K_2O, and 11,638 tons of sulphate of potash containing 5,888 tons K_2O. The total chemical deliveries of 91,809 tons K_2O were 4% of all potash deliveries, and 9,687 tons or 9% less than in 1953.

The deliveries of agricultural and chemical potash in North America, 1943–54, are shown in figure 2, and the deliveries by States in 1954 are given in table 6.

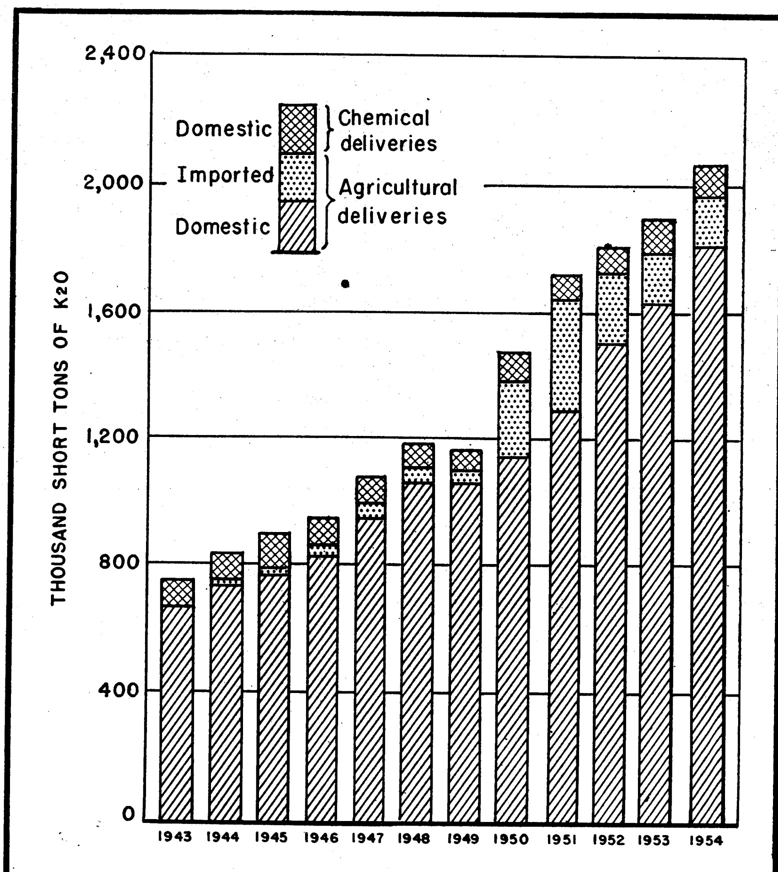

FIGURE 2.—Potash deliveries by use groups in North America, 1943–54 (American Potash Institute).

TABLE 5.—Apparent consumption[1] of potassium salts in the United States, 1945–49 (average) and 1950–54, in short tons

Year	Potassium salts	Approximate equivalent K_2O	Year	Potassium salts	Approximate equivalent K_2O
1945–49 (average)	1,798,331	971,605	1952	3,013,489	1,730,514
1950	2,486,273	1,411,646	1953[2]	3,128,335	1,816,085
1951	2,902,063	1,653,371	1954	3,377,850	1,970,901

[1] Quantity sold by producers, plus imports, minus exports.
[2] Revised figure.

TABLE 6.—Deliveries of potash salts in 1954, by States of destination, in short tons of K_2O

[American Potash Institute]

State	Agricultural potash	Chemical potash	State	Agricultural potash	Chemical potash
Alabama	60,505		Montana	59	
Arizona	554		Nebraska	2,099	7
Arkansas	42,185	20	Nevada		999
California	13,479	5,169	New Hampshire		20
Colorado	628		New Jersey	38,970	1,862
Connecticut	4,814	150	New Mexico	50	
Delaware	8,051	609	New York	31,040	59,947
District of Columbia	442		North Carolina	93,153	32
Florida	104,231	194	North Dakota	2,468	
Georgia	126,701	180	Ohio	174,726	2,628
Idaho	415		Oklahoma	4,168	238
Illinois	216,641	1,938	Oregon	3,005	160
Indiana	143,952	738	Pennsylvania	35,743	1,082
Iowa	44,055	320	Rhode Island	1,664	
Kansas	2,802	200	South Carolina	60,521	
Kentucky	45,510	179	South Dakota	122	
Louisiana	28,476	161	Tennessee	76,306	
Maine	11,048	50	Texas	34,905	5,107
Maryland	72,898	939	Utah	191	81
Massachusetts	12,327	75	Vermont	461	
Michigan	48,469	776	Virginia	106,874	200
Minnesota	43,231		Washington	5,491	84
Mississippi	29,708	24	West Virginia	1,249	5,352
Missouri	47,028	888	Wisconsin	53,395	76
			Total	1,834,810	90,485

STOCKS

Stocks (K_2O equivalent) reported by producers at the end of 1954 were 11 percent higher than the 1953 figure. Year-end stocks in the potash industry are not entirely unsold output but include high inventories in anticipation of large orders for the spring planting season which begins in February. Producers' stocks on hand at year end for 1945–49 (average) and 1950–54 are included in table 3.

PRICES

The domestic producers of potash discontinued seasonal discounts on price schedules for the 1954–55 season. Various prices were quoted according to date of order and schedule of delivery.

The American Potash & Chemical Corp. issued its price schedule for agricultural-grade Trona potash for the 1954–55 season on May 19, 1954. 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, was quoted at 44.5, 49.0, and 53.0 cents per unit K_2O for contracts made before July 1, 1954, between July 1 and November 30, 1954, and between December 1 and May 31, 1955, respectively. 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 3 periods as 74.5, 81.5, and 88.5 cents per unit K_2O.

Price schedules for New Mexico potash for agricultural purposes for 1954–55 were issued in May and June 1954, as shown in table 7.

In addition to the f. o. b. Carlsbad prices, International Minerals & Chemical Corp. and Duval Sulphur & Potash Co. quoted f. o. b. port prices at selected Atlantic and Gulf ports as follows: 60.3, 64, and 67.5 cents per unit of K_2O for the 3 periods shown in table 7 for I. M. & C. C., and 61.5 and 65 cents per unit of K_2O for the 2 periods shown in table 7 for D. S. & P. C.

TABLE 7.—Prices of agricultural potash quoted by producers, f. o. b. Carlsbad, N. Mex., for 1954–55 season, in bulk, minimum carlots of 40 tons

Salt	Grade	Brand	Producer	Cents per unit K_2O		
				Period 1	Period 2	Period 3
Muriate of potash [1]	62–63 percent K_2O	Sunshine State	U. S. P	36	39.5	43
Do [1]	60 percent K_2O minimum, standard.	Red Muriate	P. C. A	37.5	40.5	43
Do [2]	do	International	I. M. & C. C.	36	39.5	43
Do [3, 4]	do	High-K	S. W. P. C.	36	38	-------
Do [3, 5]	do	Duval Muriate of Potash.	D. S. & P. C.	36.6	40	-------
Do [1, 6]	60 percent K_2O granular	Red Muriate	P. C. A	37.8	40.8	45
Do [1, 7]	59–61 percent K_2O granular	Sunshine State	U. S. P	37	40.5	44
Do [1, 8]	50 percent K_2O minimum	International	I. M. & C. C.	35.3	38.6	42
Manure salts [1]	22 percent K_2O minimum	Red Muriate	P. C. A	17.65	17.65	17.65
Do [1]	Run-of-mine 20 percent K_2O minimum.	Sunshine State	U. S. P	17	19	21
Do [3]	Run-of-mine 22 percent K_2O minimum.	High-K	S. W. P. C.	17.65	18.6	-------
Do [1]	Run-of-mine 20 percent K_2O minimum.	International	I. M. & C. C.	17	19	21
Sulfate of potash	49–51 percent K_2O minimum.	do	do	63	68.5	74.5
Sulfate of potash-magnesia	22 percent K_2O 18 percent MgO.	Sul Po-mag	do	[9] $13.45	[9] $14.75	[9] $16.00

[1] Prices under period 1 applied to contracts made before July 1, 1954; period 2, contracts made between July 1–Nov. 30, 1954; period 3, contracts made between Dec. 1, 1954 through May 1955.
[2] International Minerals & Chemical Corp. quoted muriate of potash, 60 percent K_2O minimum, in 5-ply bags, 100 lb. each at $25.85, $28.00, and $30.05 per ton for the 3 periods, respectively.
[3] Prices under period 1 apply to orders accepted before June 30, 1954; period 2 orders accepted after June 30, 1954. Shipments to be made in equal monthly installments.
[4] Southwest Potash Corp. quoted muriate of potash, 60 percent K_2O minimum, in 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 multiwall bags, 100 lb. each, at $26.50 and $28.00 per ton, respectively.
[6] Potash Company of America quoted muriate of potash, 60 percent K_2O, granular, in multiwall bags, at $27.00, $28.80, and $31.25 per ton for the 3 periods, respectively.
[7] United States Potash Co. quoted muriate of potash, granular, 60 percent K_2O minimum, in 5-ply bags, 100 lb. each, at $26.50, $28.60, and $30.70, respectively.
[8] International Minerals & Chemical Corp. quoted muriate of potash, 50–52 percent K_2O, in 5-ply bags, 100 lb. each, at $22.25, $24.05 and $25.70, respectively.
[9] Per short ton.

FOREIGN TRADE [10]

Imports.—The downward trend of imports of fertilizer and chemical potash materials continued in 1954 and were 62 percent (K_2O) less than in 1951, the last high year. The average declared value per ton

[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.

of imports of fertilizer-grade potash materials at the port of shipment was $29.59, more than $1.50 less than in 1953. Details on imports by country of origin are given in table 9. The principal supplying countries were West Germany, East Germany, France, and Spain.

The average K_2O content of potash imports remained about the same as in 1953.

The Potash Import & Chemical Corp. was formed in New York as the exclusive agent for West German potash.[11]

TABLE 8.—Potash materials imported for consumption in the United States, 1953–54

[U. S. Department of Commerce]

Material	Approximate equivalent as potash (K_2O) (percent)	1953 Short tons	1953 Approximate equivalent as potash (K_2O) Short tons	1953 Approximate equivalent as potash (K_2O) Percent of total	1953 Value	1954 Short tons	1954 Approximate equivalent as potash (K_2O) Short tons	1954 Approximate equivalent as potash (K_2O) Percent of total	1954 Value
Used chiefly in fertilizers:									
Muriate (chloride)	[1] 59.0	175,545	[2] 103,572	[2] 77.5	$4,579,131	147,344	86,933	72.9	$3,746,611
Potassium nitrate, crude	40.0	15,941	6,376	[2] 4.8	852,590	732	293	.2	70,777
Potassium-sodium nitrate mixtures, crude	14.0	12,516	1,752	1.3	626,149	13,228	1,852	1.6	599,230
Potassium sulfate, crude	50.0	[2] 35,238	[2] 17,619	[2] 13.2	[2] 1,400,368	53,623	26,812	22.5	1,943,206
Total fertilizer		[2] 239,240	[2] 129,319	96.8	[2] 7,458,238	214,927	115,890	97.2	6,359,824
Used chiefly in chemical industries:									
Bicarbonate	46.0	11	5		3,080	38	17		9,266
Bitartrate:									
Argols	20.0	[2] 5,530	[2] 1,106		462,613	6,139	1,228		620,536
Cream of tartar	25.0	512	128		177,880	361	90		122,081
Carbonate	61.0	1,544	942		178,901	18	11		1,852
Caustic	80.0	179	143		65,830	191	153		48,516
Chlorate and perchlorate	36.0	101	36		26,182	121	44		29,021
Chromate and dichromate	40.0	1	(3)	3.2	432			2.8	
Cyanide	70.0	1,404	983		1,033,185	838	587		559,609
Ferricyanide	42.0	287	121		192,239	241	101		152,266
Ferrocyanide	44.0	449	198		173,877	701	308		258,890
Nitrate	46.0	1,005	462		106,378	867	399		95,940
Permanganate	29.0	15	4		6,932	10	3		2,763
Rochelle salts	22.0								
All other	50.0	279	140		66,896	778	389		126,701
Total chemical		[2] 11,317	[2] 4,268	3.2	2,494,425	10,303	3,330	2.8	2,027,441
Grand total		[2] 250,557	[2] 133,587	100.0	[2] 9,952,663	225,230	119,220	100.0	8,387,265

[1] Percent changed to conform to higher grade material being imported.
[2] Revised figure.
[3] Less than 1 ton.

The United States Treasury Department, at the request of most of the major producers, investigated the charge that East German potash was being "dumped" on the United States market at less than fair value.[12]

[11] Oil, Paint and Drug Reporter, vol. 166, No. 3, July 19, 1954, p. 5.
[12] Chemical Week, vol. 74, No. 18, May 8, 1954, pp. 30–32.
Oil, Paint and Drug Reporter, vol. 165, No. 18, May 3, 1954.

The Treasury Department, after determining that East German potash was being sold in the United States at less than the fair value, referred the case to the United States Tariff Commission, which will determine if these sales were injuring or were likely to injure the domestic industry. The Treasury Department also initiated similar investigations of French and West German imports.[13]

TABLE 9.—Potash materials imported for consumption in the United States, 1953–54, 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 or wine lees (20)	Bitartrate: Cream of tartar (25)	Carbonate (61)	Caustic (hydroxide) (80)	Chlorate and perchlorate (36)	Cyanide (70)	Muriate (chloride) [1] (59)	Potassium nitrate, crude (40)	Potassium sodium nitrate mixtures, crude (14)	Potassium sulfate, crude (50)	All other [2]	Total: Short tons	Total: Value
1953													
North America:													
Canada	----	----	----	(3)	1	----	2	4	----	----	----	7	$307
South America:													
Chile	----	----	----	----	41	----	----	----	12, 516	----	----	12, 557	637, 485
Europe:													
Belgium-Luxembourg	----	----	----	(3)	----	12	----	----	----	100	206	318	160, 297
Czechoslovakia	----	----	----	----	----	62	----	----	----	----	----	62	41, 494
France	1, 605	1	11	11	----	77	37, 726	----	----	10, 843	72	50, 346	1, 742, 271
Germany:													
East	----	----	----	----	----	----	49, 018	----	----	[4] 1, 102	[4] 11	[4] 50, 131	[4] 1,443,180
West	----	----	1, 533	20	----	689	45, 048	15, 937	----	23, 193	[4] 1,050	[4] 87, 470	[4] 3,643,730
Italy	469	283	----	----	----	4	----	----	----	----	(5)	[4] 756	[4] 154, 109
Netherlands	----	----	----	----	----	17	----	----	----	----	681	698	229, 258
Portugal	209	----	----	----	----	----	----	----	----	----	----	209	17, 423
Spain	----	199	----	----	----	----	42, 592	----	----	----	----	42, 791	1, 058, 952
Sweden	----	28	----	148	37	----	----	----	----	----	----	213	79, 610
Switzerland	----	1	----	----	22	----	----	----	----	----	----	23	5, 709
United Kingdom	----	----	----	(3)	----	543	1, 159	----	----	----	27	1, 729	474, 798
Total	2, 283	512	1, 544	179	59	1, 404	175, 543	15, 937	----	[4] 35,238	[4] 2,047	[4] 234,746	[4] 9,050,831
Africa:													
Algeria	2, 743	----	----	----	----	----	----	----	----	----	----	2, 743	230, 245
French Morocco	[4] 220	----	----	----	----	----	----	----	----	----	----	[4] 220	17, 033
Tunisia	284	----	----	----	----	----	----	----	----	----	----	284	16, 762
Total	[4] 3,247	----	----	----	----	----	----	----	----	----	----	[4] 3, 247	264, 040
Grand total	[4] 5,530	512	1, 544	179	101	1, 404	175, 545	15, 941	12, 516	[4] 35,238	[4] 2, 047	[4] 250,557	[4] 9,952,663

[13] Wall Street Journal, vol. 144, No. 118, Dec. 16, 1954, p. 11.

TABLE 9.—Potash materials imported for consumption in the United States, 1953–54, 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 [2]	Total	
	Argols or wine lees (20)	Cream of tartar (25)	(61)	(80)	(36)	(70)	[1] (59)	(40)	(14)	(50)		Short tons	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

[1] Percent changed to conform to higher grade material being imported.
[2] Approximate equivalent as potash (K_2O)—1953: [1] 42 percent; 1954: 43 percent.
[3] Less than 1 ton.
[4] Revised figure.
[5] Revised to none.

Exports.—Exports of potash materials in 1954 increased 33 percent over 1953. About 92 percent of the exports went to countries in the Western Hemisphere. Canada, Brazil, Cuba, and Mexico were the major recipients of the potash exports.

TABLE 10.—Potash materials exported from the United States, 1945–49 (average) and 1950–54

[U. S. Department of Commerce]

Year	Fertilizer		Chemical		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1945–49 (average)	103, 956	$3, 307, 726	20, 866	$4, 444, 448	124, 822	$7, 752, 174
1950	107, 972	3, 813, 000	9, 165	1, 721, 176	117, 137	5, 534, 176
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

TABLE 11.—Potash materials exported from the United States, 1953–54, by countries of destination

[U. S. Department of Commerce]

Country	Fertilizer				Chemical			
	1953		1954		1953		1954	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
North America:								
Canada	69,333	$2,397,369	74,089	$2,642,484	3,379	$539,115	3,634	$603,758
Costa Rica			512	25,888	30	7,916		
Cuba	9,063	299,732	8,207	263,294	145	38,340	145	43,020
Dominican Republic	25	1,619	670	22,750	5	1,339	5	1,190
El Salvador	150	4,513	350	14,729	18	6,058	5	1,330
Guatemala					75	18,142	41	10,771
Honduras					6	2,135	5	1,075
Mexico	2,227	71,999	4,525	138,557	193	61,585	322	103,440
Other North America	33	2,105	80	5,550	17	7,293		
Total	80,831	2,777,337	88,433	3,113,252	3,868	681,923	4,157	764,584
South America:								
Argentina			177	7,251	25	25,000	15	4,788
Brazil	668	36,252	16,325	741,692	43	40,962	1,304	320,895
Chile					81	21,988	13	3,725
Colombia	150	4,860	200	7,848	218	54,729	94	27,698
Ecuador	33	1,107	55	1,937	18	5,156	28	8,072
Peru			220	4,917	20	8,355	6	2,470
Venezuela	325	18,939	589	26,796	132	35,706	86	27,071
Other South America					12	6,342	15	11,283
Total	1,176	61,158	17,566	790,441	549	198,238	1,561	406,002
Europe:								
Belgium-Luxembourg					35	10,261	14	8,843
Germany, West							82	20,188
Italy					59	19,625		
Netherlands			3,307	152,000				
Norway					3	814	3	1,136
Portugal					9	3,664		
Sweden			165	7,260	(1)	110	172	11,842
Switzerland					5	2,550	1	592
United Kingdom					10	22,302	8	18,730
Other Europe					(1)	138	5	1,898
Total			3,472	159,260	121	59,464	285	63,229
Asia:								
India					43	4,372	7	6,743
Japan			10	612				
Korea, Republic of					(1)	164	33	9,167
Pakistan					7	6,308	1	990
Philippines	1,387	54,414	1,663	67,779	133	41,723	85	29,146
Other Asia	16	887	40	2,183	27	11,555	17	5,992
Total	1,403	55,301	1,713	70,574	210	64,122	143	52,038
Africa:								
Union of South Africa					35	27,547	51	39,481
Other Africa	2	150			1	1,566	(1)	540
Total	2	150			36	29,113	51	40,021
Oceania:								
Australia					11	9,067	5	4,051
New Zealand					1	542		
Total					12	9,609	5	4,051
Grand total	83,412	2,893,946	111,184	4,133,527	4,796	1,042,469	6,202	1,329,925

[1] Less than 1 ton.

TECHNOLOGY

Expansion of the potash industry in the Carlsbad area has resulted in the use of new and different types of mining equipment. Two-boom, two-operator, hydraulic jumbo drills speed up the drilling cycle and were replacing auger-type post-mounted coal drills. Continuous mining machines were used in 1954 in four of the mines. Diesel equipment included shuttle cars, bulldozers, diesel-electric locomotives, and jeeps. Belt conveyors were reported in several mines. One mine used all conveyor haulage and another announced plans to install a conveyor over 7 miles long. Higher voltage primary power-distribution systems were installed.[14]

As a result of the increasing quantities of impurities in potash ores, a new flotation process was devised. This process used only an amine reagent, no starches, and was reported to have a high tolerance for impurites in the brine.[15]

The potassium sulfate plant of Potash Company of America at Dumas, Tex., operating since 1951, was producing more than the 60 tons per day rated capacity in May 1954. This plant utilized the Hargreaves process to produce potassium sulfate and hydrochloric acid from potassium chloride and hydrogen sulfide from natural gas. The recovery efficiencies at this plant were reported to exceed 95 percent.[16]

Research on the recovery of potash fertilizer from sea bitterns was reported by the National Chemical Laboratory, Poona, India. A product was obtained from laboratory-scale experiments containing 4 percent available K_2O and 22 percent available nitrogen, with light basic magnesium carbonate and light magnesia as byproducts.[17]

The various means of expressing analyses of fertilizers were reported confusing to consumers. A few European countries require the potash content to be expressed as percent of K, but most areas use percent of K_2O, KCl, and K_2SO_4. It was recommended that a unified basis of reporting content be adopted, preferably N (nitrogen), P (phosphorus), and K (potassium).[18]

After considerable experimentation by Norsk Hydro in Norway and N. V. Maatschappij tot Exploitatie Van Kooksovengassen in the Netherlands, a joint company, A/S Norduco, Oslo, was formed to perfect a method of recovering potash from sea water. The addition of an organic reagent causes the precipitation of the potassium which then can be recovered as potassium nitrate.[19]

WORLD REVIEW

NORTH AMERICA

Canada.—Compana, Ltd., of Calgary, Alberta, obtained an exploration permit covering 100,000 acres of land in the Unity area of Saskatchewan. Duval Sulphur & Potash Co., a potash producer in the Carlsbad area of the United States, also received exploration permits for potash in 4 areas of Saskatchewan—1 near Saskatoon, 1 at Humboldt, 1 in the Yorktown area, and 1 between Humboldt and Saskatoon.[20]

[14] Bruhn, H. H., and Miller, E. H., Permian Basin Potash-Mining Methods: Min. Eng., vol. 6, No. 6, June 1954, pp. 608–612.
Chafetz, A. B., and Skinner, E. C., Late Developments in Mining at Carlsbad: Min. Con. Jour., vol. 40, No. 4, April 1954, pp. 71–74, 105.
Nordyke, Lewis, Potash in the Carlsbad Basin: Explosives Eng., vol. 32, No. 5, September–October 1954, pp. 135–141, 155.
[15] Mining Engineering, vol. 6, No. 7, July 1954, p. 678.
[16] Chemical Engineering, vol. 61, No. 5, May 1954, pp. 132, 134.
[17] South African Mining and Engineering Journal, vol. 55, No. 3202, June 26, 1954, p. 685.
[18] Crowther, E. M., The Production and Use of Fertilizers: Chem. and Ind. (London), No. 2, Nov. 13, 1954, pp. 1400–1415.
[19] Chemical Age (London), vol. 70, No. 1805, Feb. 13, 1954, p. 420.
Fertiliser and Feeding Stuffs Journal (London), vol. 40, No. 9, Apr. 28, 1954, pp. 369, 371.
[20] Wall Street Journal, vol. 144, No. 93, Nov. 10, 1954, p. 11.

TABLE 12.—World production of potassium salts and equivalent K_2O, by countries,[1] 1945–49 (average) and 1950–54, in short tons [2]

(Compiled by Helen L. Hunt)

Country [1]	1945–49 (average), equivalent K_2O	1950		1951		1952		1953		1954	
		Potassium salts	Equivalent K_2O	Potassium salts	Equivalent K_2O	Potassium salts	Equivalent K_2O	Potassium salts	Equivalent K_2O	Potassium salts	Equivalent K_2O
North America: United States	1,018,841	2,242,647	1,287,724	2,474,870	1,420,323	2,866,462	1,665,113	3,266,429	1,911,891	3,322,395	1,948,721
South America: Chile	[3] 1,556	(4)	1,590	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Europe:											
France (Alsace)	624,819	6,458,811	994,575	6,404,422	960,730	6,899,879	1,022,542	6,448,514	1,136,261	7,428,688	1,361,132
Germany:											
East	1,337,736 (East and West)	(4)	1,378,990	(4)	1,806,686	(4)	1,987,465	(4)	2,105,412	(4)	[5] 2,100,000
West		9,840,563 (East and West)	1,206,242	11,957,330	1,459,363	13,872,902	1,712,659	13,874,585	1,738,244	17,169,581	2,134,072
Spain	199,508	1,117,007	178,154	1,058,884	190,556	1,340,008	199,613	1,375,882	202,764	1,343,936	231,260
Asia:											
India	2,665	6,161	3,024	5,838	2,912	9,391	4,704	3,111	1,567	(4)	(4)
Israel	35,002	------	------	------	------	------	------	5,692	3,415	[5] 20,200	[5] 12,000
Japan	104	3,743	224	4,296	[5] 250	2,881	173	4,719	283	6,487	454
Africa: Eritrea	45	612	291	4,299	2,094	2,888	1,323	(4)	(4)	(4)	(4)
Oceania: Australia	850	1,461	126	503	37	352	26	------	------	------	------
World total (estimate) [1]	3,400,000	------	5,300,000	------	6,100,000	------	6,900,000	------	7,400,000	------	8,100,000

[1] In addition to countries listed, China, Ethiopia, Italy, Korea, and U. S. S. R., are reported to produce potash salts, but statistics of production are not available; estimates by senior author of chapter included in total.

[2] This table incorporates a number of revisions of data published in previous Potash chapters.

[3] Average for 1947–49.

[4] Data not available; estimate by author of chapter included in total.

[5] Estimate.

Early in 1954 the Potash Company of America formed a wholly owned Canadian subsidiary, Potash Company of America, Ltd., to continue the exploration and possible development of the potash deposits about 15 miles east of Saskatoon. Plans to sink a 20-foot circular shaft to the potash beds 3,400 feet below the surface were announced. Holes were being drilled around the shaft site to a depth of 3,000 feet in preparation for freezing to permit sinking through the poorly consolidated sediments.[21]

Shaft sinking at Unity by Western Potash Corp. was resumed at the end of March and reached a depth of 1,169 feet by the middle of November. On December 13 all underground work was suspended indefinitely. Other progress during the year included: Additional diamond drilling in the Vera area, installation of a new and larger hoist, widening of the shaft in the quicksand formation near the surface, and enlargement of the headframe.[22] Recent reserve calculations, based on a minimum thickness of 5 feet and an average grade of 23.4 percent K_2O, were 17.4 million short tons of K_2O. The available tonnage was not given and will depend on the mining and refining methods.[23]

EUROPE

France.—French potash (K_2O) production rose 20 percent above 1953. The Société des Mines de Kali Sainte-Thérese and the Government-owned Mines Domaniales continued to be the only producing companies. All sales were handled by Société Commerciale des Potasses d'Alsace.[24]

The quantity of potash materials exported from France in 1953 was 17 percent more than in 1952. Data for 1954 are not available. European countries received 61 percent of the potash exports. Exports to the United States were 5 percent of the total.

Netherlands.—It was reported that a pilot plant was constructed near Amsterdam to produce potash from sea water (described in the section on Technology).[25]

Germany, East.—Estimated production of crude potash salts from the mines of East Germany is given in table 12, World production of potassium salts. The estimated production of marketable potassium salts (K_2O equivalent) for 1950–54 was as follows: 1950, 1,300,000; 1951, 1,500,000; 1952, 1,400,000; 1953, 1,500,000; and 1954, 1,500,000 short tons K_2O.

Germany, West.—The West German potash industry experienced more competition from the East German producers and were concerned as to future conditions. Burbach-Kaliwerke A. G., one of the leading producers, announced plans for additional mechanization to lower the production costs.[26] During the latter part of the year, sales for export increased considerably and domestic deliveries had to be curtailed to meet the export orders.[27]

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21 Canadian Mining Journal, vol. 75, No. 12, December 1954, p. 102.
Pit and Quarry, vol. 46, No. 12, June 1954, p. 62.
22 DeWolf, E. G., Western Potash Corp. Ltd., Letter to Bureau of Mines, June 13, 1955.
23 Fertiliser and Feeding Stuffs Journal (London), vol. 41, No. 12, Dec. 8, 1954, p. 503.
24 Fertiliser and Feeding Stuffs Journal, vol. 41, No. 4, Aug. 18, 1954, p. 144.
25 Rock Products, vol. 57, No. 12, December 1954, p. 33.
26 Chemical Age (London), vol. 70, No. 1805, Feb. 13, 1954, p. 429; No. 1818, May 15, 1954, p. 1111.
27 Chemical and Engineering News, vol. 32, No. 42, Oct. 18, 1954, p. 4193.

TABLE 13.—Exports of potash materials from France, 1949–53, by countries of destination, in short tons [1]

(Compiled by John E. McDaniel)

Country	1949	1950	1951	1952	1953
North America:					
Canada	37,099	27,240	21,911	20,975	34,167
Cuba		10,366	6,232	9,019	
United States	26,307	55,506	74,219	70,363	54,789
South America:					
Argentina	747		380	147	
Brazil	8,752	20,737	18,337	16,892	45,897
Colombia	2,067		11,822	3,142	
Europe:					
Austria	250	18,432	18,632	14,323	6,618
Belgium-Luxembourg	234,253	168,595	105,769	185,555	144,394
Denmark	9,674	57,553	27,788	16,905	12,603
Finland	13,700		9,796	10,196	3,674
Italy	29,839	34,794	33,367	19,441	24,707
Netherlands	207,934	245,988	195,322	227,490	208,256
Norway	40,370	29,862	12,486	17,653	11,344
Sweden	33,838	49,522	21,677	26,731	76,245
Switzerland	38,734	30,889	29,883	27,570	32,367
United Kingdom	167,711	208,150	170,904	131,832	172,374
Yugoslavia	55	252	7,186	5,022	9,480
Asia:					
Ceylon	6,625	13,197	21,158	9,762	23,626
China		6,568	7,379		
India and Burma	4,177	2,675	7,203		5,075
Japan	23,686	86,234	50,007	60,130	155,649
Philippines			3,178		
Africa: Algeria	21,302	21,939	25,224	16,359	17,186
Oceania: Australia and New Zealand	22,099	27,925	20,583	32,818	9,650
Other countries	39,940	70,606	67,283	59,201	101,422
Total	969,159	1,187,030	967,726	981,526	1,149,523

[1] Compiled from Customs Returns of France. Figures include salts, carbonate, chloride and nitrate of potash.

Production of crude potash salts from the mines of West Germany is given in table 12, World production of potassium salts. The production of marketable potassium salts, comparable with the United States figures for 1950–54 was as follows: 1950, 998,777; 1951, 1,210,600; 1952, 1,443,496; 1953, 1,456,400; and 1954, 1,780,400 short tons (K_2O equivalent). The percentage recovery of the K_2O from the crude ore was about 83 percent. Approximately 10 percent of the total sales of potash was as crude salts (less than 20 percent K_2O) and the remaining 90 percent was refined salts (more than 20 percent K_2O).

The quantity of potash materials exported from West Germany was 8 percent greater in 1954 than 1953. European countries received 68 percent of the exports and Japan and the United States 14 and 6 percent, respectively.

Poland.—The potash deposits in the northeast foothills of the Carpathian Mountains are part of Soviet Ukraine. Exploration in the Klodawa region of Central Poland has disclosed potash deposits that were being developed. Production was scheduled for 1955.[28]

[28] Fertiliser and Feeding Stuffs Journal (London), vol. 40, No. 12, June 9, 1954, p. 500.

TABLE 14.—Exports of potash materials from West Germany, 1950–54, by countries of destination, in short tons [1]

(Compiled by John E. McDaniel)

Country	1950	1951	1952	1953	1954
North America:					
Canada	6,393	7,220	6,425	21,643	24,465
Puerto Rico			11,657	1,654	3,031
United States	84,088	204,934	85,224	51,445	91,057
South America: Brazil		12,196	1,929	8,295	25,874
Europe:					
Austria			11,910	38,832	48,345
Belgium-Luxembourg	8,958	19,260	145,505	162,527	148,544
Denmark	1,246	57,022	150,733	218,357	251,995
Greece	7,738	13,240			3,318
Ireland	1,334	19,395	11,947	19,130	36,079
Italy	10,003	14,904	8,406	28,417	21,763
Netherlands	311	7,253	211,586	216,998	236,468
Portugal		1,819	2,204		
Sweden	278		11,791	62,543	56,082
Switzerland	7,170	3,685	18,221	20,947	19,287
United Kingdom	106,000	114,091	126,588	259,961	193,729
Yugoslavia				8,965	19,931
Asia:					
Ceylon	2,812	4,795	831	1,036	3,416
Formosa		19,324			1,323
India	21	5,998	685	2,174	5,322
Indonesia	4,641	1,651		2,016	1,542
Japan	140,007	94,392	54,758	200,862	210,706
Korea	2,615		7,167		9,331
Turkey	165	1,213	3,582	9,733	9,370
Africa: Union of South Africa and Federation of Rhodesia	2,055	13,150	11,279	18,650	15,987
Oceania: Australia and New Zealand			5,387	8,203	27,030
Other countries	19,055	18,724	27,277	44,531	60,088
Total	404,890	634,266	915,092	1,406,919	1,524,083

[1] Compiled from Customs Returns of West Germany. 1950 and 1951 include chloride and sulfate only. 1952 through 1954 include crude salts, chloride, sulfate, magnesium sulfate, and beet ash.

Spain.—Production by the 4 major producers (listed in Minerals Yearbook, 1953) was 14 percent greater than in 1953.

Further exploration of the newly discovered potash deposits near Pamplona in Navarra has increased the estimated reserves to 88 million short tons of K_2O.[29] Potasas Españolas S. A. continued to be the marketing agency for Spanish potash and made a barter agreement with Japan for 45,000 tons of potash in exchange for steel products.[30]

The quantity of potash materials exported from Spain (table 15) increased 16 percent in 1953 above 1952. Data for 1954 are not available. European countries received 65 percent and the United States 15 percent.

United Kingdom.—No decision was announced during 1954 concerning development of the extensive potash deposits in North Yorkshire. Imperial Chemical Industries, Ltd., and Fisons, Ltd., have been investigating these deposits for several years. An experimental brinewell was operated for a year and announced as unsatisfactory.[31] The Cookson Produce & Chemical Co., Ltd., was appointed exclusive distributor in the United Kingdom and Eire for West German potash from the Deutsche Waren-Vertriebsgesellschaft

[29] Engineering and Mining Journal, vol. 155, No. 11, November 1954, p. 194.
[30] Chemical Age (London), vol. 70, No. 1805, Feb. 13, 1954, p. 434.
[31] Chemical and Engineering News, vol. 32, No. 34, Aug. 23, 1954, pp. 3364–3366.

m. b. H.[32] Interest continued in seaweed as a source of potash for fertilizer and feed supplements. A recent development was the production of liquid fertilizer from seaweed.[33]

TABLE 15.—Exports of potash materials from Spain, 1949–53, by countries of destination, in short tons [1]

(Compiled by John E. McDaniel)

Country	1949	1950	1951	1952	1953
North America: United States	---	32,419	88,274	43,497	40,339
Europe:					
Belgium-Luxembourg	73,361	48,715	48,064	54,456	74,689
Ireland	---	5,500	5,368	5,557	5,243
Italy	2,381	---	14,946	10,367	14,545
Netherlands	18,421	5,907	4,189	10,086	9,199
Norway	15,653	11,473	13,297	9,190	8,047
Portugal	11,356	8,859	10,979	8,736	7,021
Sweden	---	4,409	---	---	---
United Kingdom	57,783	63,262	39,222	46,878	59,800
Asia:					
China	---	---	5,115	10,023	2,645
Japan	39,793	20,139	43,216	21,253	55,191
Korea	43,069	---	---	5,376	---
Other countries	2,423	5,574	2,954	13,149	---
Total	264,240	206,257	275,624	238,568	276,719

1 Compiled from Customs Returns of Spain.

ASIA

Israel.—Potash production by The Dead Sea Works, Ltd., reached nearly 3,000 short tons per month, all from accumulated carnallite left in the evaporating pans since 1948.[34] New evaporating pans were under construction to increase the plant capacity. The finished product was transported to Haifa by combination truck and rail. Semitrailer diesel trucks with 25- to 30-ton loads were used.[35] Fertilizers & Chemicals, Ltd., announced plans to build a potassium sulfate plant and will use Dead Sea muriate as raw material.[36]

Jordan.—Investigations were initiated during the year regarding the establishment of a potash industry at the north end of the Dead Sea. No decision was announced.[37]

32 Fertiliser and Feeding Stuffs Journal (London), vol. 40, No. 13, June 23, 1954, p. 555.
33 Fertiliser and Feeding Stuffs Journal (London), vol. 40, No. 5, Mar. 3, 1954, p. 1922.
34 Engineering and Mining Journal, vol. 155, No. 9, September 1954, pp. 220, 222.
35 Commercial America, vol. 51, No. 6, December 1954, pp. 20–21.
36 Chemical Age (London), vol. 70, No. 1816, May 1, 1954, p. 1009.
37 Chemical Age (London), vol. 70, No. 1818, May 15, 1954, p. 1114.

Pumice and Pumicite

By Oliver S. North [1] and Annie L. Marks [2]

THE OUTPUT of pumice, pumicite, volcanic cinders, and scoria continued to increase as a group in 1954 owing to an increment in the large tonnage, low-priced materials, volcanic cinders and scoria, used principally as railroad ballast. The production of pumice as a lightweight aggregate declined slightly, especially in Rocky Mountain States that shipped into midwestern areas as competition from manufactured lightweight aggregates cut into the market.

DOMESTIC PRODUCTION

Fifteen States and the Territory of Hawaii reported production of pumice and pumicite (including volcanic cinders and scoria) during 1954. These materials were produced at 85 pits by 76 companies, individuals, or agencies of State or county governments. Output was 22 percent higher than in 1953, mainly because of large-tonnage use of volcanic cinders and scoria as railroad ballast, while the increase in total value was 18 percent.

California was the largest pumice-producing State in 1954, with 30 operating units reporting, followed in order by New Mexico with 11, Wyoming with 3, Territory of Hawaii with 2, Idaho with 4, and Colorado with 2. Only open pit mining methods were reported.

Output of pumice and pumicite (including volcanic cinders and scoria in 1953–54) is shown in tables 1 and 2.

TABLE 1.—Pumice and pumicite sold or used by producers in the United States, 1945–49 (average) and 1950–54

Year	Short tons	Value	Year	Short tons	Value
1945–49 (average)	448,787	$1,905,932	1952	597,044	$2,266,981
1950	719,356	2,661,052	1953 [2]	1,348,136	2,526,040
1951 [1]	749,942	2,752,907	1954 [3]	1,647,397	2,974,318

[1] Includes Alaska.
[2] Includes Hawaii. Includes 699,831 short tons of volcanic cinders, valued at $565,846.
[3] Includes Hawaii. Includes 690,056 short tons of volcanic cinders, valued at $475,424.

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

TABLE 2.—Pumice and pumicite sold or used by producers in the United States, 1952–54, by States

State	1952		1953		1954	
	Short tons	Value	Short tons	Value	Short tons	Value
Arizona	(1)	(1)	(1)	(1)	80,883	$125,927
California	129,780	$793,716	433,105	$647,910	566,664	651,638
Idaho	88,085	141,253	85,224	159,833	94,434	183,924
Kansas	(1)	(1)	(1)	(1)	23,433	92,899
Montana			(1)	(1)	175	920
New Mexico	217,482	755,139	528,649	759,840	363,926	1,060,096
Oregon	59,578	201,809	73,080	173,822	67,852	177,515
Utah	(1)	(1)	(1)	(1)	3,588	3,788
Washington	3,604	8,089	(1)	(1)	(1)	(1)
Wyoming	2,851	10,918	648	1,898	(1)	(1)
Other States [2]	95,664	356,057	227,430	782,737	446,442	677,611
Total	597,044	2,266,981	[3] 1,348,136	[3] 2,526,040	[4] 1,647,397	[4] 2,974,318

[1] Included with "Other States" to avoid disclosure of individual company operations.
[2] Includes States indicated by footnote 1, and Colorado, Hawaii (1953–54), Nebraska, Nevada, Oklahoma, and Texas.
[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.

Mine and Plant Developments.—The new pumice-processing plant of Pumice, Inc., Ammon, Idaho, was described in an article.[3] Pumice from pits east of Ammon is trucked to the stockpile at the plant. Concrete-block aggregate is produced in high-speed rolls. The minus-20-mesh fines fraction produced by the rolls is ball-milled to produce minus 325-mesh pozzolana for concrete. Other products of the plant are fractions prepared for use as an ingredient in insecticides, as a soil conditioner, as insulating loose fill, as traction granules for slippery pavement, and as a constituent of a ready-mixed, packaged stucco.

The geology and mineral resources of Hughes and Okfuskee Counties, Okla., were described.[4] In both counties sizable deposits of volcanic ash are associated with high terrace clay and sand deposits. Two small strip mines were said to be operating sporadically near Dustin, Hughes County; their output reportedly was used in sweeping compounds, for paint filler, and for abrasive purposes.

A pumice deposit 26 air miles from Ketchikan was reportedly staked, with a view to its possible commercialization as a building material.[5]

An open-pit pumice operation reportedly began near Bellevue, Blaine County, Idaho.[6] The Sunite Sales and Manufacturing Co., Elko, Nev., planned to use the material as lightweight aggregate with gypsum in flagstone, roofing tile, and prefabricated houses.

[3] Utley, H. F., Idaho Firm Adds Processing Plant to Produce Natural Pozzolan: Pit and Quarry, vol. 47, No. 5, November 1954, pp. 75–76, 86.
[4] Weaver, O. D., Jr., Geology and Mineral Resources of Hughes County, Okla.: Oklahoma Geol. Surv. Bull. 70, 1954, 150 pp.
Ries, E. R., Geology and Mineral Resources of Okfuskee County, Okla.: Oklahoma Geol. Surv. Bull. 71, 1954, 120 pp.
[5] Mining World (news item), vol. 16, No. 7, June 1954, p. 80.
[6] Rock Products (news item), vol. 57, No. 6, June 1954, p. 69.

CONSUMPTION AND USES

The physical structure of pumice and pumicite makes them effective acoustical and heat-insulating materials. The low density of pumice combined with other advantageous properties, makes it especially useful as lightweight aggregate.

During 1954 the concrete aggregates and admixtures markets used 43 percent of the pumice and pumicite output reported, abrasives 1 percent, and other uses 56 percent. Other uses included 766,600 short tons of volcanic cinder and scoria (47 percent of the total) valued at 44 cents per ton, that was used as railroad ballast. The use of pumice and pumicite in 1954 for concrete aggregate and admixtures decreased 1 percent in tonnage but increased 4 percent in value compared with 1953.

Competition with other lightweight aggregates, and the freight charges to more distant points, tended to restrict the marketing of pumice and pumicite for lightweight concrete applications to areas relatively near its production point. On the eastern seaboard imported pumice found a market in Providence, R. I.; Salisbury, Md.; and Del Ray Beach, Fla., in competition with domestic pumice and other lightweight materials.

The tonnage used for abrasive purposes declined 29 percent from 1953. Other minor quantities of pumice, pumicite, volcanic cinders, and scoria were sold for use in insecticides, insulation, filtration, brick manufacture, absorbents, and soil conditioner and for road surfacing and ice control.

Table 3 shows the uses of these materials, while table 4 lists the quantities sold in crude and prepared form.

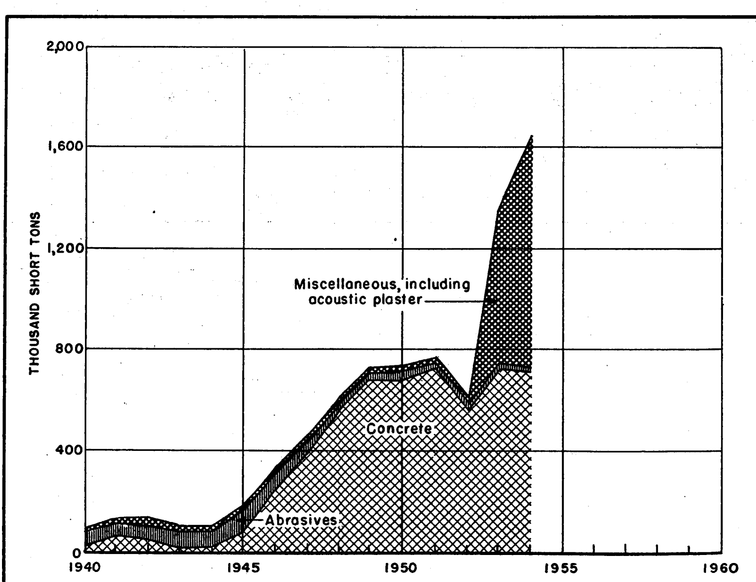

FIGURE 1.—Trends by uses, 1940–54.

TABLE 3.—Pumice and pumicite sold or used by producers in the United States, 1952–54, by uses

Use	1952		1953		1954	
	Short tons	Value	Short tons	Value	Short tons	Value
Abrasive:						
Cleansing and scouring compounds and hand soaps	17,308	$177,609	19,816	$140,900	9,641	$322,220
Other abrasive uses	5,121	248,977	3,172	83,673	6,681	99,995
Acoustic plaster	3,934	100,097	7,506	171,336	4,712	158,505
Concrete admixture and concrete aggregate	553,899	1,525,331	713,931	1,649,993	705,951	1,709,892
Other uses [1]	16,782	214,967	603,711	480,138	920,412	683,706
Total	597,044	2,266,981	[2] 1,348,136	[2] 2,526,040	[3] 1,647,397	[3] 2,974,318

[1] Insecticide, insulation, brick manufacture, filtration, railroad ballast, roads (surfacing and ice control), absorbents, soil conditioner, and miscellaneous uses.
[2] Includes 699,831 short tons of volcanic cinders, valued at $565,846.
[3] Includes 690,056 short tons of volcanic cinders, valued at $475,424.

PRICES

As reported in Oil, Paint and Drug Reporter, the quotations on domestic and imported pumice remained the same as in the previous year and were as follows: Domestic, common, ground, coarse to fine, in bags, ton lots, 3⅝ to 4¼ cents a pound; smaller lots, 3⅞ to 4½ cents a pound. Italian, silk-screen, coarse, bags, ton lots, 6½ cents a pound; fine, bags, ton lots, 4 cents a pound; sun-dried, coarse, bags, ton lots, 2½ to 4 cents a pound; fine, bags, ton lots, 2½ to 4 cents a pound. The E&MJ Metal and Mineral Markets quoted prices of pumice, f. o. b., New York or Chicago, in barrels, powdered, 3 to 5 cents per pound; and lump, 6 to 8 cents.

The value of pumice and pumicite at the mine in 1954 for the 76 producers reporting to the Bureau of Mines is shown in table 4.

TABLE 4.—Crude and prepared pumice and pumicite[1] sold or used by producers in the United States in 1954

	Short tons	Value	
		Total	Average per ton
Crude	653,814	$525,684	$0.80
Prepared	993,583	2,448,634	2.46
Total	1,647,397	2,974,318	1.81

[1] Includes 690,056 short tons of volcanic cinders valued at $475,424.

Average domestic values per ton at the mine for the preceding 4 years were: 1953, $1.87; 1952, $3.80; 1951, $3.67; and 1950, $3.70.

FOREIGN TRADE [7]

Imports of crude or unmanufactured pumice into the United States during 1954 totaled 20,951 short tons valued at $117,136 or $5.59 a ton. Wholly or partly manufactured pumice imports were 950 short tons valued at $20,541 or $21.62 a ton. Other types of pumice not otherwise specified valued at $6,720 also were imported. The larger part of the crude pumice came from Greece, while Italy supplied the manufactured pumice and about one-fourth of the crude pumice.

The duties on imported pumice were: 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 and pumicite[1] imported for consumption in the United States, 1953–54, 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							
	1953		1954		1953		1954		1953		1954	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Europe:												
Azores							7	$313				
Greece	24,907	$90,591	13,306	$44,614								
Italy	7,311	65,395	7,123	63,645	494	$10,093	515	8,564	943	$19,966	950	$20,541
Total	32,218	155,986	20,429	108,259	494	10,093	522	8,877	943	19,966	950	20,541
Asia: Japan									(2)	9		
Grand total	32,218	155,986	20,429	108,259	494	10,093	522	8,877	943	19,975	950	20,541

[1] Exclusive of "manufactures, n. s. p. f."
[2] Less than 1 ton.

TABLE 6.—Pumice and pumicite imported for consumption in the United States, 1945–49 (average) and 1950–54

[U. S. Department of Commerce]

Class	1945–49 (average)		1950		1951		1952		1953		1954	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Crude or unmanufactured	6,127	$59,410	19,268	$125,726	15,752	$182,737	21,986	$135,305	32,712	$166,079	20,951	$117,136
Wholly or partly manufactured	663	16,066	982	18,356	750	18,041	478	9,792	943	19,975	950	20,541
Manufactures, n. s. p. f.		192		953		2,591		6,301		5,415		6,720
Total		75,668		145,035		203,369		151,398		191,469		144,397

TECHNOLOGY

Patents.—Two patents cited the use of pumice as a solid carrier for herbicides. In one it was claimed to be useful in herbicide oil-in-water emulsions.[8] The other describes a dry herbicide made by impregnating with a herbicidal agent dry pumice aggregate sized to minus-¼-inch to plus-50-mesh; the pumice must have a water absorption factor of at least 25 percent.[9] It was claimed that this composition can be used effectively for dusting large acreages from airplanes.

According to a patent, finely ground pumice is a satisfactory contact material for chemical reactions accomplished under conditions of high temperature and short contact time.[10]

A patent covered the use of pumice as the nonadsorbent component in a granular cupric chloride catalyst employed to sweeten cracked naphthas that contain objectionable percentages of mercaptans.[11]

The use of pumicite, particularly the so-called Fresno or Friant pumicite, as an impregnating material in abrasive papers and cloths was patented.[12] The extremely fine pumice is sprayed onto the pulp on the moving felt mat, where it will be thoroughly mixed and distributed in the pulp flow. The pulp then goes through the usual processing and finishing stages. Papers and cloths so prepared were said to be useful for cleaning windshields and polishing bumpers, silverware, home fixtures, etc.

A patent was issued on the use of pulverized pumice as the inert filler in a composition comprising also gum arabic, a resin, and a hydraulic binder, such as gypsum or portland cement.[13] The resulting material was claimed to be useful for a variety of structural purposes, for exterior and interior decoration, and for the manufacture of "hard" merchandise, such as furniture.

A method for manufacturing heat-insulating molded panels from any of several lightweight minerals, including pumice, was patented.[14] The light weight of the product is maintained principally by foaming the mixture; the dry, absorbent aggregates are added mainly to take up the excess moisture therein.

Another patent described conversion of several siliceous materials, including pumice and pumicite, to more chemically reactive forms having properties that make them suitable for manufacturing lightweight heat-insulating materials having good strength.[15] This object is accomplished by reacting the silica-containing material with an alkaline-earth silicate-producing compound such as lime and acidifying the resulting composition.

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8 Schlesinger, A. H. (assigned to Monsanto Chemical Co., St. Louis, Mo.), Prevention of Plant Growth with Arylic Sulfides: U. S. Patent 2,695,224, Nov. 23, 1954.

9 Leppla, P. W. (assigned to Great Lakes Carbon Corp., New York, N. Y.), Methods and Compositions for Killing Weeds: U. S. Patent 2,695,840, Nov. 30, 1954.

10 Keith, P. C. (assigned to The M. W. Kellogg Co., Jersey City, N. J.), Method of Effecting Chemical Conversions: U. S. Patent 2,675,294, Apr. 13, 1954.

11 Krause, J. H. (assigned to Standard Oil Co., Chicago, Ill.), $CuCl_2$ Sweetening of Cracked Naphthas: U. S. Patent 2,695,263, Nov. 23, 1954.

12 Carper, E. R., Article of Manufacture for Cleaning and Polishing Hard Surfaces: U. S. Patent 2,682,460, June 29, 1954.

13 Bouvier, G. S., and Clair, R. P., Building Material Comprising a Hydraulic Binder, Gum Arabic, and a Resin: U. S. Patent 2,691,003, Oct. 5, 1954.

14 Willson, C. D., Making Molded Panels: U. S. Patent 2,674,775, Apr. 13, 1954.

15 Shea, F. L., Jr., and Hsu, H. L. (assigned to Great Lakes Carbon Corp., Morton Grove, Ill.), Siliceous Composition and Method for Manufacturing the Same: U. S. Patent 2,698,256, Dec. 28, 1954.

Processing.—Lightweight pumice particles distributed through a sand to be used for concrete work can be removed from sand either by jigging or sink-float methods.[16] The same methods could be used to purify pumice and pumicite.

Use.—The various types of natural pozzolanic materials, including pumice and pumicite, that are used in concretes were discussed and evaluated.[17] Details of processing the materials were given.

The relative resistance to cracking of portland-cement exterior stuccos made with various heavy and lightweight mineral aggregates was investigated.[18] Pumice was used in two of the test panels. All panels showed some early cracking, but those made with the lightweight aggregates were most susceptible. Further research, under carefully controlled conditions, of a wider range of mixes—particularly mixes containing a larger proportion of aggregate—was recommended. Also, it was thought that portland cement might be too brittle for best results and that the adaptability of brick mortar should be tested.

There was a discussion of a previously published article relating to alkali reactivity of certain natural aggregates.[19] The purpose of the discussion was to clarify the difference in the effect on concrete of reactivity of opaline silicas and volcanic glasses used as aggregate and the same materials used for pozzolanic advantages. It was stated that pumice and pumicite used as a pozzolan are in the form of very finely divided particles and that the reaction is so immediate, rapid, and dispersed that only insignificant pressures, if any, are produced in the concrete. Also, when pumice is used in important proportions as aggregate, the gel produced by the reaction is absorbed in the voids that are available in large number without damage to the concrete. It was said that harmful alkali reactivity may occur when pumice is used in fairly large particle sizes, in the proportion of roughly 15 percent of the total aggregate.

The cementitious phases of autoclaved concrete products made from different raw materials, including pumice fines were investigated.[20] Results indicated that pumice with lime or cement forms a series of hydrates similar to those formed using quartz instead of pumice. However, the composition of the pumice series extended to values above 1.3 mols of CaO per mol of SiO_2 (called the C/S ratio), compared to a maximum C/S ratio of 1.3 when quartz is the siliceous raw material used.

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[16] Rogers, J., and Sanderson, F. L., Separation of Pumice from Sand: New Zealand Eng. (Wellington), vol. 9, No. 4, April 1954, pp. 106–109.

[17] Bauer, W. G., Technical Considerations in Natural Pozzolan Production: Pit and Quarry, vol. 47, No. 4, October 1954, pp. 41–42, 44–46; No. 5, November 1954, pp. 83–86.

[18] Plastering Industries, Must "Roll With the Punch" for Best Portland Cement (Exterior Stuccos): Vol. 33, No. 1, February 1954, pp. 10–11.

[19] Holland, W. Y., and Cook, R. H., Alkali Reactivity of Natural Aggregates in Western United States (Discussion by D. H. Reynolds and W. L. Merritt): Min. Eng., vol. 6, No. 11, November 1954, pp. 1114–1116.

[20] Kalousek, G. L., Studies on the Cementitious Phases of Autoclaved Concrete Products Made of Different Raw Materials: Jour. Am. Concrete Inst., vol. 25, No. 5, January 1954, pp. 365–378.

WORLD REVIEW

ASIA

Indonesia.—Plans were afoot to extract pumice from the crater of the Anak Krakatau, in Sunda Strait, for use in manufacturing hollow building brick.[21] The start of mining was said to have been delayed by volcanic activity in the crater.

OCEANIA

New Zealand.—It was reported that agricultural scientists had reclaimed, for farming purposes, large sections of the widespread "pumice lands" of North Island, N. Z.[22] Pumice soils of the area derived from different ash showers vary in texture and moisture-holding capacity and formerly were considered suitable for forestry only. However, results of careful grassing and fertilizing indicated that immense acreages of pumice-underlaid wasteland may be successfully farmed in the future.

TABLE 7.—World production of pumice, by countries,[1] 1949–54, in short tons[2]

(Compiled by Helen L. Hunt)

Country [1]	1949	1950	1951	1952	1953	1954
Egypt	496	397	1,102	441	761	441
France:						
Pumice	16,314	15,653	17,637	13,371	13,691	11,574
Pozzolana	48,391	73,193	114,310	188,275	209,439	259,043
Greece [3]	51,809	58,422	71,650	34,133	91,271	[4] 73,000
Italy:						
Pumice	54,098	78,536	88,057	95,017	139,291 (Pumice and Pumicite)	141,039 (Pumice and Pumicite)
Pumicite	30,644	35,660	48,502	53,517		
Pozzolana	745,693	931,066	1,324,789	1,379,936	1,392,703	1,399,650
New Zealand	14,699	10,882	9,827	10,765	2,254	9,916
Spain	1,085	465	1,229	732	612	----------
United States (sold or used by producers)	716,742	719,356	749,942	597,044	[5] 1,348,136	[5] 1,647,397
Total (estimate) [1]	1,700,000	2,000,000	2,500,000	2,400,000	3,200,000	3,600,000

[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 and Pumicite chapters.
[3] These figures include the following tonnages of Santorini earth: 1949, 38,581 tons; 1950, 41,888 tons; 1951, 49,604 tons; 1952, 20,424 tons; 1953, 44,092 tons; 1954, 38,600 tons (estimate).
[4] Estimate.
[5] Includes in 1953: 560,502 tons, and in 1954: 690,056 tons of volcanic cinder and scoria, used for railroad ballast or similar purposes, not previously included in this chapter.

[21] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 3, September 1954, p. 67.
[22] Smallfield, P. W., Pumice Land Development in Central North Island: New Zealand Jour. Agriculture (Wellington), vol. 88, No. 5, May 15, 1954, pp. 418–422.
Grindrod, J., The Development of New Zealand's Pumice Lands: World Crops (London), vol. 6, No. 6, June 1954, pp. 232–234.

Quartz Crystal (Electronic Grade)

By Robert D. Thomson [1] and Gertrude E. Tucker [2]

CONSUMPTION of raw quartz crystal and production of piezoelectric units in 1954 decreased 66 and 47 percent, respectively, owing to a decline in military requirements. Domestic production remained negligible. Imports of quartz crystal, 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 1954 was the lowest since 1950. Quartz-crystal cutters in the United States reported using 265,300 pounds less than in 1953, a decrease of 66 percent. The biggest factor in this decrease was the declining production for military equipment. Raw quartz was purchased 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 companies used crystals ranging from 200 to 500 grams.

Production of piezoelectric units in 1954 decreased 47 percent compared with 1953. The average number of units obtained per pound of raw quartz increased from 18.1 to 28.8 in 1954, the highest yield ever reported to the Bureau of Mines by producing companies. The increased yield was believed to be attributable to the preponderance of small units produced and the use of larger crystals. Use distribution for the finished piezoelectric units produced in 1954 was: Oscillator plates, 96.25 percent; telephone resonators, 3.70 percent; filter plates, 0.01 percent; and 0.04 percent for miscellaneous uses.

Quartz-crystal cutters and producers of quartz piezoelectric units were located in 22 States and the Territory of Hawaii (see table 1). Pennsylvania consumed about 35 percent of the raw quartz and produced 31 percent of the piezoelectric units. Forty of the quartz consumers also produced piezoelectric units.

Production of synthetic quartz crystal continued on a pilot-plant basis. Yield of crystals was reported to be high, but cost figures for comparison with the processing of natural quartz were not available.

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

TABLE 1.—Consumption of electronic-grade quartz and production of piezoelectric units in the United States in 1954, by States

State	Consumption of electronic-grade quartz [1]		Production of piezoelectric units [2]	
	Consumers	Pounds consumed	Producers	Units produced
California	7	7,600	10	185,000
Connecticut, Massachusetts, and New York	6	4,600	7	230,500
Hawaii	1	400	1	8,100
Illinois	3	8,600	} 4	393,800
Iowa	1	1,200		
Kansas, Missouri, and Nebraska	5	40,400	6	1,088,100
Louisiana and Texas	1	(3)	4	[4] 2,800
Maryland, North Carolina, and Virginia	3	5,800	3	75,100
New Jersey	4	9,900	} 6	[4] 525,300
Ohio	2	(5)		
Oklahoma			1	24,900
Pennsylvania	7	46,400	8	1,207,800
Other States	2	[6] 9,000	3	[7] 115,200
Total	42	133,900	53	3,856,600

[1] Includes a small quantity of reworked scrap previously reported as consumption.
[2] For radio oscillators, telephone resonators, filters, and miscellaneous purposes.
[3] Consumption in Texas, only; not separately reported by State and included under "Other States."
[4] A quantity produced in Texas and reported with production for Ohio, included with New Jersey and Ohio.
[5] Included with "Other States," to avoid revealing individual company operations.
[6] Includes Florida, Ohio, Texas, and Wisconsin.
[7] Includes Florida, Georgia, and Washington.

PRICES

There were no important changes in resale prices of quartz crystal sold domestically in 1954 compared with 1953. Best quality crystals weighing 201–300 grams sold for about $12 per pound in 1954. The price of selected 301–500 grams, class 1, crystals ranged from $17 to $18 per pound. Larger crystals brought higher prices, some 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 1953 and 1952. The Tabela for 1952 was published in the "Radio-Grade Quartz" chapter of the 1952 Minerals Yearbook.

FOREIGN TRADE [3]

Imports of optical- and electronic-grade quartz crystal decreased 45 percent in 1954 compared with 1953 and were the lowest since 1950. Brazil continued to be the principal source of supply, furnishing 98 percent of the imports. Imports from France, Madagascar, and Canada totaled 13,679, 3,120, and 244 pounds, respectively.

Exports of quartz crystal in 1954 were valued at $41,195 and reexports at $695,439. The term "export" refers to any 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 which entered the United States as imports and were exported in the same

[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.

condition. Valuation of exports and reexports is based on the actual selling price or cost if not sold, while 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.

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, 1945–49 (average) and 1950–54

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
1945–49 (average)	668,500	$3,193,400	$4.78	277,700	4,775,400	17.2
1950	241,200	785,900	3.26	114,300	1,614,000	14.1
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	3,856,600	28.8

[1] Figures for 1945–49 (average) and 1950–52 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.

TECHNOLOGY

From 1946 to 1952, A. C. Walker of Bell Telephone Laboratories conducted experiments on the synthesis of quartz crystal. The main objectives of the investigation were: (1) Evaluation of the merits of temperature difference growth method and constant temperature method, (2) establishment of optimum temperature and pressure conditions, and (3) determination of the effects of impurities in solution on the form and quality of the synthetic quartz crystal. Certain results of the investigation and details of autoclave design were published in the technical literature.[4]

Early in 1954 Brush Laboratories Co., at its pilot plant in Cleveland, Ohio, reported growing a 2-pound quartz crystal on a natural quartz seed in 78 days. The synthetic crystal was grown at 600° F. and a pressure of 5,000 pounds per square inch. An 18-percent solution of sodium carbonate was the medium for growing the crystal.[5]

The index of refraction of fused quartz was determined by the National Bureau of Standards for 24 wave lengths ranging from 0.34669 to 3.5078 microns. Seven prisms were studied using the minimum-deviation method.[6]

Measuring the resonant and antiresonant frequencies, the low-frequency capacitance, and the resistance at resonance were found to be the simplest and most accurate methods for determining the piezoelectric, elastic, and dielectric coefficients of crystals and ceramics when the ratio of energy input to energy output divided by the

[4] Walker, A. C., Hydrothermal Growth of Quartz Crystals: Ind. Eng. Chem., vol. 46, No. 8, August 1954, pp. 1670–1676.
[5] Science News Letter, Largest Artificial Quartz Crystal Weighs 2 Pounds: Vol. 65, No. 6, Feb. 6, 1954, p. 91.
[6] Rodney, W. S., and Spindler, R. J., Index of Refraction of Fused-Quartz Glass for Ultraviolet, Visible, and Infrared Wavelengths: Jour. Res. Nat. Bur. of Standards, vol. 53, No. 3, September 1954, pp. 185–189.

reactance (Q/r) is high. Quasistatic methods proved useful for crystals having a low Q/r ratio.[7]

United States patents were issued during the year for growing crystalline silica below pH 13 at about 300°–550° C. and 1,200 p. s. i.,[8] and for new apparatus to produce synthetic quartz crystal.[9]

WORLD REVIEW

Brazil.—During the first half of 1954 exports of piezoelectric quartz from Brazil totaled 340,538 pounds and exports of lasca (fusing grade) totaled 366,354 pounds. Figures for the complete year were not published, but shipments for the first half of 1954 are shown in table 3.

TABLE 3.—Exports of quartz crystal from Brazil during first half of 1954, by grade and countries of destination [1]

Country of destination	Piezoelectric grade (pounds)	Lasca grade (pounds)
United States	278,227	199,433
England	17,117	160,307
Japan	45,194	
Holland		6,614
Total	340,538	366,354

[1] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 4, April 1955, p. 57.

[7] Mason, W. P., and Jaffe, Hans, Methods for Measuring Piezoelectric, Elastic, and Dielectric Coefficients of Crystals and Ceramics: Proc. Inst. Radio. Eng., vol. 42, 1954, pp. 921–930.

[8] Broge, E. C., and Iler, R. K., Process for Growing Quartz Crystals: U. S. Patent 2,680,677, June 8, 1954.

[9] Ottosson, O. L., Apparatus for Growing Crystals: U. S. Patent 2,683,080, July 6, 1954.
Sobek, A. R., and Hale, D. R., Growing Single Crystals of Quartz: U. S. Patent 2,675,303, Apr. 13, 1954.

Salt

By Robert T. MacMillan[1] and Annie L. Marks[2]

THE TONNAGE of salt produced in the United States in 1954 was second only to the record reached in 1953. A decline in production of salt in brine more than offset slight gains in evaporated and rock salt during the year, so the total salt output in 1954 was less than 1 percent lower than in 1953.

TABLE 1.—Salient statistics of the salt industry in the United States, 1945–49 (average) and 1950–54 [1]

	1945–49 (average)	1950	1951	1952	1953	1954
Sold or used by producers:						
Dry salt:						
Evaporated (manufactured) short tons	3,216,502	3,329,288	3,654,808	3,641,885	3,702,305	3,731,087
Rock salt do	3,592,657	3,927,267	4,662,194	4,567,531	4,478,655	4,824,708
Total do	6,809,159	7,256,555	8,317,002	8,209,416	8,180,960	8,555,795
Value	$42,209,931	$51,795,728	$58,425,022	$59,757,322	$65,407,021	$73,405,616
Average per ton	$6.20	$7.14	$7.02	$7.28	$7.99	$8.58
In brine:						
Short tons	8,901,976	9,373,254	11,890,129	11,335,798	12,608,043	12,113,608
Value	$7,585,409	$8,115,615	$11,309,978	$11,252,767	$12,869,646	$32,180,276
Total salt:						
Short tons	15,711,135	16,629,809	20,207,131	19,545,214	20,789,003	20,669,403
Value [2]	$49,795,340	$59,911,343	$69,735,000	$71,010,089	$78,276,667	$105,585,892
Imports for consumption:						
Short tons	4,529	7,869	4,329	7,056	137,308	160,770
Value	$45,453	$58,819	$46,831	$44,230	$473,472	[3] $878,961
Exports:						
Short tons	289,223	190,377	439,114	349,971	249,521	380,609
Value	$3,323,727	$1,776,062	$3,501,904	$3,458,363	$2,327,656	$3,053,702
Apparent consumption: [4] short tons	15,426,442	16,447,301	19,772,346	19,202,299	20,676,790	20,449,564

[1] Includes Hawaii (1952–54 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] Quantity sold or used by producers, plus imports, minus exports.

DOMESTIC PRODUCTION

Michigan maintained its leading position as a salt producing State, followed by New York and Louisiana. Texas edged Ohio for fourth place; Ohio and California ranked fifth and sixth in salt production, respectively. Decreased production was noted mainly in Ohio and Michigan.

Salt was produced in 1954 at 83 facilities in the United States, Hawaii, and Puerto Rico. Of these, 8 facilities had an annual production of over 1 million tons each; their combined production

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

was over half of the United States total; 4 had a production between 500,000 and 1 million tons; 30 produced between 100,000 and 500,000 tons. Of the 41 facilities which produced less than 100,000 tons of salt, 24 produced less than 10,000 tons.

In the Internal Revenue Code of 1954 sodium chloride was included with the natural deposits accorded a 10 percent depletion rate.[3]

TABLE 2.—Salt sold or used by producers in the United States, 1952–54, by States

State	1952			1953			1954		
	Quantity		Value	Quantity		Value	Quantity		Value
	Short tons	Percent of total		Short tons	Percent of total		Short tons	Percent of total	
California	1,148,693	6	$4,880,392	1,123,365	5	$6,263,059	1,185,844	6	$6,126,194
Kansas	911,744	5	6,850,027	905,227	4	7,480,556	876,667	4	7,778,406
Louisiana	2,553,448	13	7,807,693	3,061,234	15	9,189,526	3,088,686	15	11,101,456
Michigan	4,778,347	24	21,446,382	5,127,387	25	22,171,988	5,063,633	24	29,396,812
New Mexico	(1)	------	(1)	62,087	(2)	216,364	50,669	(2)	333,255
New York	3,417,443	17	16,746,462	3,322,659	16	17,351,111	3,412,636	17	22,754,118
Ohio	2,827,455	14	5,991,626	3,040,237	15	7,484,795	2,748,993	13	12,358,521
Puerto Rico	12,676	(2)	122,158	13,692	(2)	131,490	8,758	(2)	98,110
Texas	2,640,209	14	4,402,032	2,845,190	14	5,010,624	2,864,312	14	9,310,339
Utah	136,125	1	522,721	154,088	1	772,035	166,506	1	1,020,061
West Virginia	392,519	2	1,438,490	419,907	2	1,490,592	471,516	2	2,885,696
Other States [3]	726,555	4	802,106	713,930	3	714,527	731,183	4	2,422,924
Total	19,545,214	100	71,010,089	20,789,003	100	78,276,667	20,669,403	100	105,585,892

[1] Included with "Other States" to avoid disclosure of individual company operations.
[2] Less than 1 percent.
[3] Includes Alabama, Hawaii, Nevada, New Mexico (1952 only), Oklahoma, and Virginia.

TABLE 3.—Salt sold or used by producers in the United States,[1] 1953–54, by methods of recovery

Method of recovery	1953		1954	
	Short tons	Value	Short tons	Value
Evaporated:				
Bulk:				
Open pans or grainers	432,126	$8,722,732	397,391	$9,344,207
Vacuum pans	2,028,283	23,746,727	2,028,947	26,410,712
Solar	948,882	4,556,171	1,020,473	4,402,010
Pressed blocks	293,014	4,603,864	284,276	4,929,057
Rock:				
Bulk	4,416,408	22,924,006	4,765,093	27,308,023
Pressed blocks	62,247	853,521	59,615	1,011,607
Salt in brine (sold or used as such)	12,608,043	12,869,646	12,113,608	32,180,276
Total	20,789,003	78,276,667	20,669,403	105,585,892

[1] Includes production in Hawaii and Puerto Rico.

CONSUMPTION AND USES

Salt is an essential article of diet, but only a small percentage of the total salt consumed was used in this way. By far the greatest use of salt was in the production of soda ash (sodium carbonate),

[3] Internal Revenue Code of 1954, Public Law 591, 83d Cong., 2d Sess., p. 208.

TABLE 4.—Evaporated salt sold or used by producers in the United States, 1952–54, by States

State	1952		1953		1954	
	Short tons	Value	Short tons	Value	Short tons	Value
Kansas	358,887	$4,775,741	370,569	$5,285,805	356,045	$5,474,151
Louisiana	111,713	1,134,991	121,410	1,580,290	124,558	1,831,480
Michigan	847,873	11,260,605	820,660	11,912,341	816,736	13,449,085
New York	508,317	6,674,698	532,924	7,832,362	529,602	8,734,524
Ohio	461,289	4,189,883	498,438	5,175,816	482,906	5,361,838
Puerto Rico	12,676	122,158	13,692	131,490	8,758	98,110
Texas	97,663	1,259,164	111,851	1,910,250	107,946	1,799,139
Other States [1]	1,243,467	6,218,217	1,232,761	7,801,140	1,304,536	8,337,659
Total	3,641,885	35,635,457	3,702,305	41,629,494	3,731,087	45,085,986

[1] Includes California, Hawaii, Nevada, New Mexico, Oklahoma, Utah, and West Virginia.

TABLE 5.—Rock salt sold by producers in the United States, 1945–49 (average) and 1950–54

Year	Short tons	Value	Year	Short tons	Value
1945–49 (average)	3,592,058	$15,093,059	1952	4,567,531	$24,121,865
1950	3,927,267	19,435,431	1953	4,478,655	23,777,527
1951	4,662,194	23,589,552	1954	4,824,708	28,319,630

TABLE 6.—Pressed-salt blocks sold by original producers of the salt in the United States, 1945–49 (average) and 1950–54

Year	From evaporated salt		From rock salt		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1945–49 (average)	268,939	$2,867,058	74,522	$675,873	343,461	$3,542,931
1950	265,835	3,465,935	63,081	704,600	328,916	4,170,535
1951	284,261	3,936,356	70,597	787,943	354,858	4,724,299
1952	278,455	3,862,723	67,822	836,593	346,277	4,699,316
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

which in turn had a multitude of uses. Large quantities of salt also were utilized in manufacturing chlorine, bleaches, and other chemicals, as well as in water treatment, meat packing, feed mixing, and the many other categories listed in table 7.

After consultation with members of the industry, changes were made by the Bureau of Mines in the methods of reporting information on salt uses as shown in table 7. Use classifications were changed or reworded to describe more accurately the consumption pattern of salt. In revising the use classification more emphasis was put on determination of the quantities sold to specific consuming industries. This minimizes problems previously encountered in reporting such classifications as refrigeration and water treatment, which are very difficult to determine because sales for these purposes often are not clearly identified. Greater uniformity and accuracy of the data was expected to result from the new method of reporting. Both the old and the new breakdowns according to uses are shown in table 7.

TABLE 7.—Salt sold or used by producers in the United States, 1953–54, by classes and consumers or uses, in thousand short tons

Use [1]	1953			
	Evaporated	Rock	Brine	Total
Chlorine, bleaches, chlorates, etc.	590	1,018	4,457	6,065
Soda ash	(2)		7,846	[2] 7,846
Dyes and organic chemicals	47	55		102
Soap (precipitant)	38	10		48
Other chemicals	130	515	(2)	[2] 645
Textile processing	28	104	(2)	[2] 132
Hides and leather	103	156	(2)	[2] 259
Meat packing	345	409		754
Fish curing	18	10		28
Butter, cheese, and other dairy products	71	6		77
Canning and preserving	163	53		216
Other food processing	251	9		260
Refrigeration	79	156		235
Livestock, agriculture and general farm use [3]	732	298		1,030
Highways, railroads and other dust and ice control	20	721		741
Table and other household use	453	68		521
Water treatment	294	338	(2)	[2] 632
Metallurgy	44	80		124
Undistributed [4]	296	473	305	1,074
Total	3,702	4,479	12,608	20,789

Consumer or use [1]	1954			
	Evaporated	Rock	Brine	Total
Chlorine	593	1,076	4,395	6,064
Soda ash	(2)		(2)	7,384
Textile and dyeing	51	130		181
Soap (including detergents)	32	8		40
All other chemicals	(2)	444	(2)	671
Meat packers, tanners, and casing manufacturers	(2)	551	(2)	975
Fishing	23	10		33
Dairy	74	4		78
Canning	156	33		189
Baking	27	3		30
Flour processors (including cereal)	(2)	(2)		9
Other food processing	201	21		222
Ice manufacturers and cold storage companies	(2)	76	(2)	139
Feed dealers	216	177		393
Feed mixers	513	129		642
Metals	56	73		129
Ceramics (including glass)	(2)	(2)		13
Rubber	(2)	(2)	(2)	91
Oil	(2)	51	(2)	95
Paper and pulp	(2)	86	(2)	115
Water softener manufacturers and service companies.	(2)	320	(2)	564
Grocery stores	542	150		692
Railroads	30	88		118
Bus and transit companies	(2)	(2)		26
State, counties and other political subdivisions (except Federal).	(2)	1,104	(2)	1,140
U. S. Government	13	18		31
Miscellaneous	(2)	164	(2)	605
Undistributed [4]	1,204	109	7,718	
Total	3,731	4,825	12,113	20,669

[1] Owing to revision in use pattern 1953-54 figures known not to be comparable.
[2] Included with "Undistributed" to avoid disclosure of individual company operations.
[3] Livestock salt is about 93 percent of the total.
[4] Comprises miscellaneous uses (1953 only) and 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, 1953–54, by States of destination, in short tons

Destination	1953		1954	
	Evaporated	Rock	Evaporated	Rock
Alabama	21, 750	92, 024	21, 579	85, 738
Arizona	17, 312	9, 676	15, 404	10, 390
Arkansas	13, 328	58, 991	13, 406	69, 625
California	466, 991	96, 581	477, 522	84, 540
Colorado	51, 080	30, 593	53, 018	22, 073
Connecticut	14, 363	19, 830	13, 968	20, 514
Delaware	6, 220	7, 600	6, 272	7, 187
District of Columbia	5, 566	1, 780	5, 534	2, 618
Florida	12, 387	39, 466	13, 557	40, 554
Georgia	26, 728	57, 899	25, 046	62, 617
Idaho	20, 192	2, 065	20, 144	1, 490
Illinois	228, 677	286, 376	221, 431	309, 568
Indiana	112, 196	87, 337	114, 748	92, 358
Iowa	123, 392	111, 614	119, 146	115, 002
Kansas	57, 889	209, 734	51, 408	209, 108
Kentucky	32, 565	132, 178	30, 231	107, 940
Louisiana	19, 803	133, 564	19, 206	135, 035
Maine	11, 808	80, 520	12, 538	88, 478
Maryland	43, 474	79, 131	40, 156	81, 032
Massachusetts	54, 584	91, 928	53, 049	88, 998
Michigan	128, 820	185, 364	127, 233	284, 094
Minnesota	118, 924	80, 804	125, 085	98, 383
Mississippi	11, 141	28, 385	10, 158	33, 090
Missouri	74, 397	71, 961	71, 481	70, 381
Montana	21, 505	2, 359	22, 187	2, 472
Nebraska	64, 430	65, 777	64, 409	64, 972
Nevada	6, 074	100, 752	6, 600	108, 838
New Hampshire	5, 019	74, 753	4, 280	86, 765
New Jersey	111, 886	125, 786	113, 915	123, 572
New Mexico	12, 067	58, 297	8, 178	34, 993
New York	195, 735	762, 257	188, 864	813, 485
North Carolina	58, 062	95, 483	58, 182	93, 368
North Dakota	13, 346	4, 862	14, 968	16, 180
Ohio	212, 309	263, 670	216, 063	284, 904
Oklahoma	33, 397	27, 215	31, 564	27, 909
Oregon	186, 582	258	183, 274	239
Pennsylvania	140, 615	132, 042	135, 969	135, 563
Rhode Island	9, 174	12, 444	10, 606	11, 236
South Carolina	14, 442	22, 413	12, 915	23, 159
South Dakota	25, 442	14, 965	25, 990	16, 960
Tennessee	36, 600	78, 734	39, 688	79, 833
Texas	102, 744	175, 215	95, 892	250, 811
Utah	45, 102	(1)	49, 489	(1)
Vermont	6, 264	32, 717	6, 214	39, 685
Virginia	77, 199	82, 184	86, 669	77, 729
Washington	236, 995	624	239, 401	----------
West Virginia	175, 190	88, 433	171, 210	57, 817
Wisconsin	147, 695	60, 966	136, 766	75, 132
Wyoming	11, 304	2, 653	13, 685	1, 101
Other [2]	79, 540	198, 395	132, 789	277, 172
Total	3, 702, 305	4, 478, 655	3, 731, 087	4, 824, 708

[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 prices of rock salt and table salt were steady throughout the year. Rock salt in bags, carlots, works, was quoted at $0.98 per hundred pounds and table salt (vacuum common), same basis, was quoted at $1.12 per hundred pounds. The average value of dry salt reported by producers to the Bureau of Mines increased from $7.99 in 1953 to $8.58 in 1954. The average value reported for salt in brine rose sharply from just under $1 per ton in the preceding 5-year period to $2.66 per ton in 1954. This did not indicate a major increase in brine-salt prices but reflected primarily a change in reporting practice. Because much of the salt

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produced as brine was consumed by the producing companies, relatively few sales transactions occurred. Heretofore, values assigned by many producers have been far below market value. In the 1954 canvass a general effort was made to obtain reasonable local market valuations for salt in brine. Consequently, the average value for 1954 was much higher than for the previous year.

FOREIGN TRADE [4]

In 1954 imports of salt into the United States were less than 1 percent of the domestic consumption and were chiefly from Bahamas Islands and the Dominican Republic. Imports from Canada were less than half of the 1953 figure.

Exports of salt from the United States totaled somewhat more than twice the import figure and were distributed among a number of countries throughout the world but chiefly those in North and Central America. Increased shipments to Canada and Japan accounted mainly for the increase in exports in 1954 compared with the previous year.

TABLE 9.—Salt imported for consumption in the United States, 1953–54, by countries

[U. S. Department of Commerce]

Country	1953		1954	
	Short tons	Value	Short tons	Value
North America:				
Bahamas	133,263	$439,713	140,835	$794,123
Canada	2,123	24,882	875	13,104
Dominican Republic			18,989	71,166
Jamaica	1,011	3,612		
Mexico	911	5,195	71	568
Total	137,308	473,402	160,770	[1] 878,961
Europe: Netherlands	(2)	68		
Asia: Taiwan	(2)	2		
Grand total	137,308	473,472	160,770	[1] 878,961

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

TABLE 10.—Salt imported for consumption in the United States, 1945–49 (average) and 1950–54, 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
1945–49 (average)	1,333	$22,130	2,761	$21,772	435	$1,551
1950	3,395	43,567	4,474	15,252		
1951	2,991	37,245	1,338	9,586		
1952	2,488	29,538	4,568	14,692		
1953	2,550	26,428	134,758	447,044		
1954	946	[1] 13,672	159,824	865,289		

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

[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 11.—Salt exported from the United States, 1953–54, by countries

[U. S. Department of Commerce]

Country	1953		1954	
	Short tons	Value	Short tons	Value
North America:				
Canada	228,746	$1,667,114	299,616	$2,113,283
Central America:				
Canal Zone	734	43,737	515	29,372
Costa Rica	155	6,498	250	11,179
El Salvador	196	7,547	223	9,814
Guatemala	88	3,486	153	6,857
Honduras	225	6,763	190	6,162
Nicaragua	307	7,695	154	3,700
Mexico	5,175	175,169	5,689	180,109
West Indies:				
Cuba	9,495	248,590	9,885	279,577
Dominican Republic	229	21,020	174	16,947
Netherland Antilles	314	26,091	420	29,561
Other North America	152	5,703	145	7,716
Total	245,816	2,219,413	317,414	2,694,277
South America	103	10,209	140	15,076
Europe	(1)	1,109	7	2,190
Asia:				
Japan	13	2,102	60,866	271,500
Philippines	3,369	77,034	1,889	51,659
Other Asia	47	7,893	143	7,379
Total	3,429	87,029	62,898	330,538
Africa	11	1,040	30	3,381
Oceania	162	8,856	120	8,240
Grand total	249,521	2,327,656	380,609	3,053,702

[1] Less than 1 ton.

TABLE 12.—Salt shipped to possessions and other areas administered by the United States,[1] 1952–54

[U. S. Department of Commerce]

Territory	1952		1953		1954	
	Short tons	Value	Short tons	Value	Short tons	Value
American Samoa	7	$1,822	3	$138	31	$1,406
Guam	92	6,678	68	6,099	55	4,964
Puerto Rico	8,378	555,474	8,827	618,488	9,489	768,551
Virgin Islands	69	6,645	82	6,813	75	7,565
Total	8,546	570,619	8,980	631,538	9,650	782,486

[1] Salt is also shipped to the Territories of Alaska and Hawaii, but no record has been kept of these shipments since March 1948.

TECHNOLOGY

An improved method for drying salt was reported to be in operation at the Carey Salt Co., Hutchinson, Kans.[5] The salt was dried from an initial 3 percent to 0.03 percent moisture content in a fluidized-bed drier with a saving of two-thirds the fuel required for conventional kiln drying. It was also claimed that the fluidized-bed drier required less floor space and less manpower and caused less crystal degradation than kiln drying.

[5] Chemical Engineering, Fluidized Crystal Drier Pays Off: Vol. 61, No. 1, January 1954, pp. 166–168.

The wet salt was fed into the top of an 8-foot-diameter, cylindrical chamber, where it was fluidized by an upwardly moving stream of heated gases from a gas furnace. After drying, the fluidized salt flowed downward to a second fluidizing chamber situated below the first. Here the salt was air-cooled, and the heat was utilized in preheating the air required by the furance.

A patent was issued relating to a process for increasing the formation of sodium chloride crystals of the hopper type from evaporating brine.[6] By adding to the brine certain surface active compounds such as polyoxyethylene sorbitan monolaurate, improvements in the rate of crystal formation were claimed.

A method for decreasing the concentration of the sulfate ion in saturated salt brine was described in a recent patent.[7] According to claims, the concentration of the SO_4 ion in a saturated NaCl brine is reduced by precipitation of $CaSO_4$ following the addition of $CaCl_2$ to the brine and 2 to 3 hours of agitation.

A 1,000-foot shaft-sinking operation at the Ojibway salt property of the Canadian Rock Salt Co. was described in an article.[8] Inflow of water at several levels down to 710 feet was controlled by placing pipes containing a refrigerant in holes bored at intervals on the circumference of a 30-foot circle surrounding the shaft. The ground was thus frozen to a depth of 720 feet, eliminating the flow of water while the shaft was being lined with waterproof concrete.

The structure and theory of formation of the Jefferson Island salt dome was discussed in an article.[9] Salt domes are described as intrusive masses of compact halite grains associated with varying amounts of disseminated, sand-size anhydrite grains concentrated in complexly folded bands.[10]

Salt domes are thought to be formed by the deformation under pressure of original bedded deposits of salt formed by the evaporation of ancient saline seas and lakes. The plasticity of halite, together with its low specific gravity, has allowed it under certain circumstances to be forced upward through zones of weakness in the overlying strata. Thus columnar structures of salt or salt domes are formed that may extend several thousand feet in height and cross section. Surface features may or may not indicate the presence of underlying salt domes; most have been located by geophysical methods and proved by drilling. There were 235 salt domes reported to exist in the Gulf Coast area from Alabama to Mexico. Occurrence of such domes in Germany, Spain, Rumania, and Iran was also reported.

Both petroleum and sulfur have often been found associated with salt domes. Petroleum has been found trapped in the strata bordering the salt plug; sulfur has been found associated with caprock, which overlies the salt dome.

[6] Gilkey, W. K., and Shuman, A. C., (assigned by mesne assignments to Diamond Crystal Salt Co.), Sodium Chloride: U. S. Patent 2,655,438, Oct. 13, 1953.
[7] Hirsch, A., (assigned to Diamond Alkali Co.), Purifying Sodium Chloride Brine: U. S. Patent 2,683,649, July 13, 1954.
[8] Northern Miner, Toronto, Rock-Salt Mine Shaft Deepens: Vol. 41, No. 22, Aug. 19, 1954, p. 2.
[9] Balk, Robert, Salt Structure of Jefferson Island Salt Dome, Iberia and Vermilion Parishes, La.: Bull. Am. Assoc. Petrol. Geol., vol. 37, No. 11, November 1953, pp. 2455–2474.
[10] Taylor, R. E., Geology and Mineralogy of Salt and Cap Rock of U. S. Gulf Coast Salt Domes: Econ. Geol., vol. 49, No. 7, November 1954, pp. 805–806.

Underwater salt domes have been suggested for storing oil.[11] According to the plan suggested, a cavity would be dissolved in the central part of the dome by introducing water through a pipe and removing the brine. When the cavity had grown to the size desired, the residual brine would be displaced with oil, which (being less dense) would float above residual brine. Savings in construction costs and great safety were claimed for such a reservoir.

WORLD REVIEW

NORTH AMERICA

Canada—The Canadian production of salt (963,357 short tons in 1954) was approximately the same as the 1953 output; imports increased 20½ percent.[12] Underground deposits accounted for all Canadian output of salt. Most was produced by evaporating brine obtained by pumping water into the deposits.

TABLE 13.—World production of salt by countries,[1] 1945–49 (average) and 1950–54, in short tons [2]

(Compiled by Helen L. Hunt)

Country [1]	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Canada	687,251	858,851	963,557	973,207	959,898	963,357
Costa Rica	7,713	9,259	6,002	2,500	4,289	4,519
Guatemala	10,899	12,679	13,295	13,199	16,736	12,804
Honduras	3,322	4,847	5,126	5,291	[3] 11,500	[3] 11,000
Mexico	146,821	162,040	181,881	189,597	246,763	246,917
Nicaragua	8,958	12,315	13,546	14,568	15,400	16,035
Panama	4,760	5,511	6,532	7,155	4,764	7,692
Salvador	20,807	[3] 17,600	[3] 30,000	[3] 19,800	38,250	41,100
United States:						
Rock salt	3,592,658	3,927,267	4,662,194	4,567,531	4,458,393	4,824,708
Other salt	12,118,478	12,702,542	15,544,937	14,977,421	16,330,610	15,844,695
West Indies:						
British:						
Bahamas	57,392	67,200	57,100	89,600	165,000	149,357
Leeward Islands: Antigua (exports)	6,397	6,181	7,710	6,553	5,937	4,664
Turks and Caicos Islands	33,769	67,197	23,520	18,368	11,046	[3] 11,000
Cuba	60,749	65,330	55,410	61,734	56,232	[3] 56,000
Dominican Republic:						
Rock salt	2,124	2,540	2,502	2,869	4,183	47,239
Other salt	14,746	15,146	8,920	18,457	15,064	15,948
Haiti	[3] 8,800	[3] 28,000	[3] 28,000	33,500	33,500	33,500
Netherland Antilles	1,366	3,300	[3] 3,300	2,920	[3] 3,300	[3] 3,300
Total [3]	16,787,000	17,968,000	21,614,000	21,004,000	22,381,000	22,294,000
South America:						
Argentina	455,499	330,000	460,000	540,000	498,775	[3] 550,000
Brazil	703,084	875,434	1,371,763	860,483	839,192	[3] 880,000
Chile:						
Rock salt	51,976	51,487	53,933	56,262	39,129	50,000 (rock and other salt combined)
Other salt	27,545	1,038	384	1,076	1,345	
Colombia:						
Rock salt	105,792	117,857	121,348	184,778	163,836	190,117
Other salt	40,050	38,630	30,937	42,109	52,208	33,413
Ecuador	27,582	20,978	36,064	44,553	15,831	[3] 22,000
Peru	64,129	73,305	75,502	87,758	84,860	[3] 83,000
Venezuela	64,213	62,213	42,902	127,923	80,012	91,948
Total [3]	1,556,000	1,588,000	2,210,000	1,962,000	1,792,000	1,917,000

See footnotes at end of table.

[11] Oil and Gas Journal, vol. 52, Aug. 17, 1953, p. 84.
[12] Collings, R. K., Salt in Canada, 1954 (Prelim.): Department of Mines and Technical Surveys, Ottawa, 4 pp.

TABLE 13.—World production of salt by countries,[1] 1945–49 (average) and 1950–54, in short tons [2]—Continued

Country [1]	1945–49 (average)	1950	1951	1952	1953	1954
Europe:						
Austria:						
Rock salt	1,648	1,196	763	1,261	1,349	1,409
Other salt	243,035	360,925	399,360	368,255	365,485	394,661
Bulgaria	[3] 74,000	(4)	(4)	(4)	(4)	(4)
Czechoslovakia	[3] 8,800	(4)	(4)	(4)	(4)	(4)
France:						
Rock salt and salt from springs	1,946,430	2,460,667	2,848,109	2,254,734	2,432,301	2,666,666
Other salt	628,539	742,268	474,809	723,115	618,506	545,643
Germany, West:						
Rock salt	1,610,066 (rock and brine)	2,519,549	2,824,118	2,674,205	3,522,953	3,141,310
Brine salt		304,775	310,306	305,654	410,900	342,336
Greece	84,875	112,798	90,868	96,480	94,080	[3] 90,000
Italy:						
Rock salt and brine salt	621,829	822,492	1,226,707	835,005	1,431,036	[3] 676,000
Other salt	942,298	631,430	438,852	715,903	1,104,277	498,160
Malta	2,218	2,014	4,234	1,679	4,103	3,618
Netherlands	241,320	451,484	535,039	457,250	503,664	563,835
Poland [3]	575,000	1,100,000	1,100,000	1,100,000	1,100,000	1,100,000
Portugal:						
Rock salt	61	46	43	50	54	60
Other salt (exports)	31,609	33,913	32,379	25,301	3,325	2,513
Rumania	349,800	(4)	(4)	(4)	(4)	(4)
Spain:						
Rock salt	294,913	339,763	405,440	413,650	434,098	439,200
Other salt	636,122	993,815	984,690	722,014	1,093,819	1,172,201
Switzerland	109,067	103,617	125,663	120,482	112,877	128,419
U. S. S. R. [3]	5,500,000	5,500,000	6,100,000	6,600,000	6,800,000	7,200,000
United Kingdom:						
Great Britain:						
Rock salt	35,675	45,920	60,480	50,400	48,160	(4)
Other salt	3,826,917	4,692,809	5,173,290	4,363,529	4,495,689	(4)
Northern Ireland	14,276	14,330	14,607	12,321	[3] 11,000	12,143
Yugoslavia	106,968	144,403	105,432	163,559	136,045	[3] 110,000
Total [3]	18,000,000	22,200,000	24,100,000	22,900,000	25,700,000	24,500,000
Asia:						
Aden	228,934	286,570	340,819	421,209	269,274	(4)
Afghanistan	[3] 40,300	38,581	27,268	26,125	[3] 30,020	(4)
Burma	46,175	23,652	70,862	65,385	69,909	107,456
Ceylon	47,695	72,855	40,774	54,250	65,970	57,500
China [3]	2,200,000	3,300,000	3,300,000	3,900,000	4,400,000	6,100,000
Cyprus	4,200	4,556	12,344	----------	2,196	5,249
India:						
Rock salt	118,132	5,655	6,096	6,711	3,913,201 (rock and other)	3,351,022
Other salt	2,223,412	2,929,777	3,056,975	3,158,592		
Indochina (Vietnam)	73,827	83,469	103,516	146,530	117,947	116,899
Indonesia	198,956	413,366	529,761	356,046	293,214	143,300
Iran [3] [5]	29,000	110,000	220,000	240,000	240,000	220,000
Iraq	13,173	13,074	18,191	21,272	20,612	[3] 20,000
Israel	[6] 16,930	8,818	10,858	13,816	23,141	26,511
Japan	330,098	460,924	474,440	477,521	507,944	468,261
Jordan	(6)	(4)	2,989	8,132	7,778	[3] 11,000
Korea, Republic of	137,787	192,776	93,207	224,722	212,400	198,558
Lebanon [3]	5,400	7,200	7,700	7,700	9,900	17,000
Pakistan:						
Rock salt [5]	[7] 117,519	162,226	154,796	143,662	161,855	(4)
Other salt [5]	[7] 119,724	212,401	253,505	188,379	151,745	(4)
Philippines	57,276	62,041	57,629	18,486	52,690	52,990
Portuguese India	16,258	19,409	34,808	23,567	17,606	(4)
Syria	17,457	21,128	4,408	17,653	21,479	14,330
Taiwan (Formosa)	235,504	192,974	302,877	343,602	178,536	406,232
Thailand (Siam) [3]	149,700	220,000	275,000	275,000	275,000	330,000
Turkey:						
Rock salt	291,424 (rock and other)	25,482	24,977	34,759	29,962	28,660
Other salt		316,425	275,568	321,423	354,020	458,561
Yemen	----------	----------	----------	----------	110,000	110,000
Total [3]	6,700,000	9,200,000	9,700,000	10,500,000	11,500,000	12,900,000

See footnotes at end of table.

TABLE 13.—World production of salt by countries,[1] 1945–49 (average) and 1950–54, in short tons [2]—Continued

Country [1]	1945–49 (average)	1950	1951	1952	1953	1954
Africa:						
Algeria	80,895	83,396	107,234	90,768	66,139	108,434
Anglo-Egyptian Sudan	44,469	44,924	50,943	58,765	60,473	[3] 55,000
Angola	53,947	44,614	49,228	63,394	63,923	60,810
Belgian Congo	908	606	643	683	893	928
Canary Islands	12,216	6,693	17,338	16,800	18,872	(4)
Cape Verde Islands	14,207	21,792	26,572	19,941	11,715	23,326
Egypt	[8] 348,361	594,163	757,329	549,384	418,878	496,552
Eritrea	50,646	192,904	198,416	170,858	209,439	[3] 210,000
Ethiopia: Rock salt	[3] 11,000	[3] 11,000	[3] 11,000	[3] 11,000	16,211	[3] 22,000
French Equatorial Africa	[3] 2,000	4,000	4,300	4,700	4,500	6,800
French Morocco:						
Rock salt	8,341	19,300	4,860	} 44,000	44,968	35,373
Other salt	36,671	50,719	51,859			
French Somaliland	56,063	88,000	60,800	71,000	67,202	63,389
French West Africa [3]	57,000	73,000	73,000	55,000	40,000	24,000
Italian Somaliland [3]	1,300	1,700	2,200	5,500	5,000	5,500
Kenya	17,817	20,637	21,374	18,760	23,392	21,051
Libya:						
Cyrenaica	340	----------	[3] 800	----------	----------	[3] 2,200
Tripolitania	3,825	9,921	13,228	13,228	12,125	16,535
Mauritius	4,134	2,873	3,748	2,425	2,646	3,417
Mozambique:						
Rock salt	68	68	97	114	121	109
Other salt	12,193	10,891	9,510	11,466	11,891	(4)
South-West Africa:						
Rock salt	3,630	4,316	5,187	7,592	5,176	5,403
Other salt	12,038	14,223	43,960	36,661	40,262	42,792
Spanish Morocco [3]	275	275	275	275	275	275
Tanganyika	13,219	13,749	17,480	21,225	22,159	23,823
Tunisia	104,237	108,876	161,496	103,066	153,675	180,000
Uganda	5,097	8,171	8,674	4,528	8,419	8,052
Union of South Africa	[9] 165,811	117,281	165,121	154,956	140,610	172,185
Total [3]	1,130,000	1,565,000	1,885,000	1,550,000	1,460,000	1,630,000
Oceania:						
Australia	238,151	296,800	336,001	310,240	347,201	[3] 425,000
New Zealand	----------	----------	----------	784	----------	1,680
Total	238,151	296,800	336,001	311,024	347,201	[3] 427,000
World total (estimate) [1]	44,400,000	53,000,000	60,000,000	58,000,000	63,200,000	63,700,000

[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.
[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 with Israel.
[7] Average for 1947–49.
[8] Exports.
[9] Year ended June 30 of year stated.

The Canadian Rock Salt Co., a subsidiary of the Canadian Salt Co. Ltd., was reported to have finished sinking a shaft to high-purity salt beds about 1,000 feet below the surface at Ojibway, Ontario. Production of rock salt from this deposit was expected to begin early in 1955.

A large body of salt at an average depth of 400 feet was discovered near Pugwash, Nova Scotia. The Malogash Salt Co. Ltd., a subsidiary of the Canadian Salt Co. Ltd., planned to mine this salt by means of a 500-foot shaft.

Ontario was the chief salt producer in 1954, accounting for 76 percent of the total production. Nova Scotia produced about 15 percent, and the remaining production was divided among Saskatchewan, Alberta and Manitoba.

Jamaica.—No salt was produced in Jamaica in 1953; however, two deposits were being prepared for exploitation in 1954. In Turks and Caicos Island, a dependency of Jamaica, the 270-year-old salt industry met serious competition from recently developed salt concessions on nearby Inagua Island where a firm was producing a large annual tonnage of sea salt. As Turks and Caicos Island has no deep-water port, the islanders have been advised not to depend on the salt industry for their livelihood.[13]

Panama.—The 1954 sea-salt production was about 60 percent higher than in 1953; sales increased only 16 percent in the same period. Resolution 54 was passed in December 1954 by the Board of Directors of the Instituto de Fomento Economico limiting the 1955 production to 7 quintals (770 pounds) per flat for human consumption and 2 quintals (220 pounds) per flat for cattle. From approximately 24,700 authorized flats a total allowable production of 12,210 short tons was calculated.[14]

SOUTH AMERICA

Brazil.—Known rock salt deposits of Brazil were said to be at depths too great for profitable mining.[15] The bulk of Brazilian salt has been produced on the dry northern coast of the country by evaporation of sea water. There is also an important salt industry at Cabo Frio in the State of Rio de Janiero.

Ecuador.—The Government of Ecuador was reported to have engaged the services of a Swiss firm to install a salt refinery at Salinas capable of producing 40,000 tons of refined, iodized salt annually.[16]

Peru.—The Peruvian Salt Monopoly purchased from the United States modern salt-refining equipment of the thermocompression type. The expected increase in capacity was believed to be ample for domestic needs.[17]

Venezuela.—The 1954 production of salt from the Lagunas Araya, Cumaranga and Coche was the largest ever recorded. Studies have been made in regard to building a salt refinery at Araya. Mechanization of the various salt lagoons was planned.[18]

EUROPE

Austria.—Modernization of the salt industry of Austria, including a change to the thermocompression system, was reported to be in progress. A 50- to 90-percent increase in output was predicted.[19]

Greece.—Expansion of the Missolonghi salt works was planned to provide more salt for export and for the manufacture of caustic soda for use in the local production of bauxite.[20]

[13] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 1, January 1955, p. 54.
[14] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 2, February 1955, pp. 53–54.
[15] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 4, April 1955, pp. 57–58.
[16] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 1, July 1954, p. 54.
[17] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 4, April 1954, p. 61.
[18] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 4, April 1955, pp. 58–59.
[19] Chemical Age (London), vol. 70, No. 1823, June 19, 1954, p. 1364.
[20] Chemical Age (London), vol. 71, No. 1839, Oct. 9, 1954, p. 786.

ASIA

Ceylon.—It was reported that the lack of port facilities near the salt-producing areas was a factor in the high cost of Ceylon salt on the international market. The salt department was unable to market an estimated 20,000 tons, which was in excess of domestic requirements.[21]

India.—The Central Salt Research Institute, twelfth in a series of national research laboratories, was opened at Bhavnagar on April 10, 1954. The institute was to help the salt industry to improve the quality of its product and conduct research on the production and utilization of the products and byproducts of the salt industry.[22]

The Indian Production Minister announced that, beginning March 1, 1955, the area on which small producers of salt were permitted to operate free of the provisions of the Central Excises and Salt Act, 1944, would be reduced from 10 to 2½ acres.[23]

Japan.—Japanese dependence on foreign salt imports was expected to be reduced by the construction of two new salt plants. Plans were made for constructing a large salt plant at Onohama at a cost of $880,000 and another on Yakushima Island. One plant was expected to be in operation in 1954.[24]

Taiwan (Formosa).—A 1954 production goal of 300,000 metric tons of sea salt was set by the Industrial Development Commission. This was nearly twice the 1953 output, which was low because of unfavorable weather conditions. Production in the first quarter of 1954 was somewhat greater than in the corresponding months of 1953. The annual consumption of salt in Formosa was estimated at 75,000 metric tons, leaving a considerable tonnage for export.[25]

AFRICA

Egypt.—The right to produce salt from the deposits of Mex and Baltim was assigned to the new Egyptian General Salt Co. by the Deputy Minister of Commerce and Industry effective September 1, 1954.[26]

Both deposits are on the Mediterranean coast, the former near Alexandria and the latter between the Rosetta and Damietta mouths of the Nile. The salt was obtained by solar evaporation.

Tanganyika.—In addition to coastal production, salt was produced at Ivuna in the Mbeya district and at Uvinza in the Kigoma district. The salt works at Uvinza supplied the surrounding region including the Belgian Congo. Production in 1954 was a new high record.[27]

Tunisia.—Sea-salt production was 18 percent greater in 1954 than in 1953. Exports to Japan in 1954 accounted for most of the increase in production.[28]

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21 Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 6, June 1954, p. 58.
22 Chemical Age (London), vol. 70, No. 1816, May 1, 1954, p. 988.
23 Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 1, July 1954, pp. 54–55.
24 Chemical and Engineering News, vol. 32, No. 15, Apr. 12, 1954, p. 1484.
25 Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 1, July 1954, pp. 55–56.
26 Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 4, October 1954, pp. 69–70.
27 Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 4, April 1955, p. 58.
28 Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 5, May 1955, p. 64.

Union of South Africa.—A large salt pan was found 24 miles north of Cape Cross in Southwest Africa. Although its exact size had not been determined, it was thought to extend over 40 square miles.[29]

A new, modern, salt-refining plant at the mouth of the Coega River near Port Elizabeth was expected to be in production in 1954.[30]

OCEANIA

New Zealand.—Unusually favorable weather conditions aided the production of sea salt at the Dominion Salt Co. evaporating ponds at Lake Grassmere near Blenheim in the South Island. Five evaporating ponds covering 90 acres were reported to have deposited some 8,000 tons.[31]

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29 Chemical Age (London), vol. 71, No. 1838, Oct. 2, 1954, p. 731.
30 Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 3, September 1954 ,p. 70.
31 Chemical Age, vol. 71, No. 1827, July 17, 1954, p. 139.

Sand and Gravel

By Wallace W. Key[1] and Dorothy T. Shupp[2]

SAND AND GRAVEL was the largest mineral industry tonnage-wise in 1954 and it anticipated the prospective large demands of the proposed National Road Building Program.

DOMESTIC PRODUCTION[3]

The output of sand and gravel in 1954 was a record 561 million short tons valued at $504 million. Both expanding requirements and improved coverage of the industry contributed to the 27-percent increase over the tonnage reported in 1953. This was the fifth year in succession in which a new output record was attained. Production of all grades increased, except railroad ballast and some of the in-

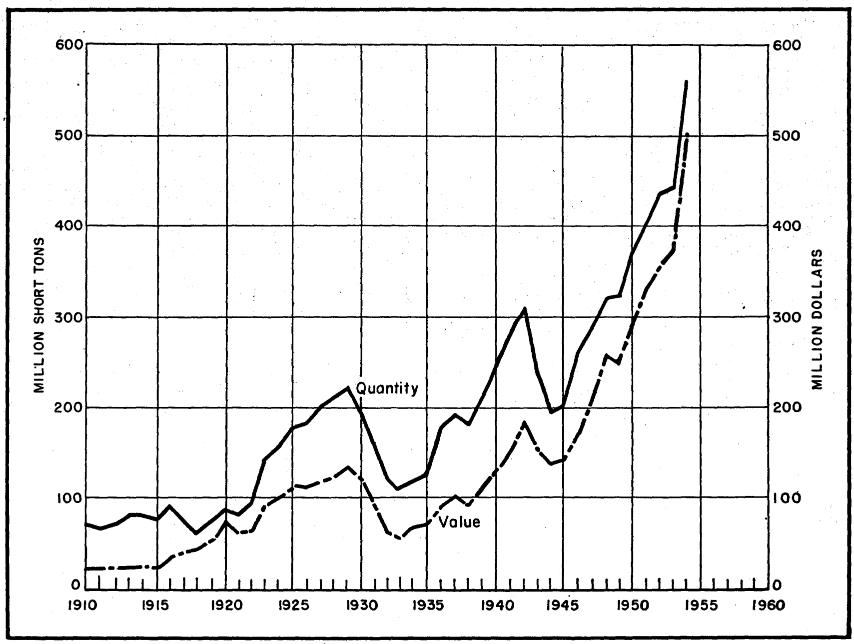

FIGURE 1.—Production of sand and gravel in the United States, 1910–54.

[1] Commodity-industry analyst.
[2] Statistical clerk.
[3] The production data, for 1954 were collected jointly with the Bureau of Census, U. S. Department of Commerce. Production totals will be compared with Census totals when they become available. Differences will be adjusted or explained.

TABLE 1.—Sand and gravel sold or used by producers in the United States,[1] 1953–54, by class of operations and uses

	1953			1954			Percent of change in—	
	Short tons	Value		Short tons	Value		Tonnage	Average value
		Total	Average		Total	Average		
COMMERCIAL OPERATIONS								
Sand:[2]								
Glass	6,192,389	$17,491,358	$2.82	5,809,929	$16,346,356	$2.81	−6	-----
Molding	7,895,391	15,731,809	1.99	6,319,510	12,779,604	2.02	−20	+2
Building	[3] 77,811,720	[3] 68,984,790	.89	100,476,105	92,301,076	.92	+29	+3
Paving	[3] 44,344,728	[3] 38,537,892	.87	51,555,983	45,527,752	.88	+16	+1
Grinding and polishing[4]	1,492,348	3,375,362	2.26	1,343,642	3,835,698	2.85	−10	+26
Fire or furnace	501,304	894,949	1.79	466,857	906,281	1.94	−7	+8
Engine	1,680,459	[3] 1,809,383	1.08	1,374,963	1,700,574	1.24	−18	+15
Filter	384,619	839,450	2.18	581,458	1,051,653	1.81	+51	−17
Railroad ballast	1,179,797	554,680	.47	970,040	507,943	.52	−18	+11
Other	4,095,864	4,993,388	1.22	8,416,446	14,472,743	1.72	+105	+41
Total commercial sand	[3] 145,578,619	[3] 153,213,061	1.05	177,314,933	189,429,680	1.07	+22	+2
Gravel:[5]								
Building	[3] 64,609,906	[3] 70,874,698	1.10	88,793,195	103,304,001	1.16	+37	+5
Paving	[3] 80,792,307	[3] 75,012,696	.93	110,343,622	108,668,952	.98	+37	+5
Railroad ballast	10,505,285	6,504,889	.62	8,391,160	5,612,357	.67	−20	+8
Other	7,410,234	6,554,541	.88	12,090,161	9,344,019	.77	+63	−13
Total commercial gravel	[3] 163,317,732	[3] 158,946,824	.97	219,618,138	226,929,329	1.03	+34	+6
Total commercial sand and gravel	[3] 308,896,351	[3] 312,159,885	1.01	396,933,071	416,359,009	1.05	+29	+4
GOVERNMENT-AND-CONTRACTOR OPERATIONS[6]								
Sand:								
Building	1,077,951	1,196,638	1.11	1,201,636	1,299,055	1.08	+11	−3
Paving	13,924,647	5,926,093	.43	19,748,502	8,825,611	.45	+42	+5
Total Government-and-contractor sand	15,002,598	7,122,731	.47	20,950,138	10,124,666	.48	+40	+2
Gravel:								
Building	9,044,500	5,936,889	.66	10,965,519	6,417,912	.59	+21	−11
Paving	107,455,776	49,575,255	.46	131,978,907	71,225,162	.54	+23	+17
Total Government-and-contractor gravel	116,500,276	55,512,144	.48	142,944,426	77,643,074	.54	+23	+13
Total Government-and-contractor sand and gravel	131,502,874	62,634,875	.48	163,894,564	87,767,740	.54	+25	+13
ALL OPERATIONS								
Sand	[3] 160,581,217	[3] 160,335,792	1.00	198,265,071	199,554,346	1.01	+23	+1
Gravel	[3] 279,818,008	[3] 214,458,968	.77	362,562,564	304,572,403	.84	+30	+9
Grand total	[3] 440,399,225	[3] 374,794,760	.85	560,827,635	504,126,749	.90	+27	+6

[1] Includes Territories of the United States, possessions, and other areas administered by the United States.
[2] Includes sand produced by railroads for their own use—1953: 338,772 tons valued at $73,422; 1954: 263,206 tons, $65,484.
[3] Revised figure.
[4] Includes blast sand as follows—1953: 651,149 tons valued at $2,156,691; 1954: 589,021 tons, $2,513,731.
[5] Includes gravel produced by railroads for their own use—1953: 5,553,079 tons valued at $2,476,789; 1954: 3,980,749 tons, $1,860,460.
[6] Approximate figures for States, counties, municipalities, and other Government agencies directly or under lease.

dustrial sands, such as glass, molding, and engine sand. Forty-four States reported higher outputs of sand and gravel in 1954. Paving sand and gravel constituted 56 percent of the total. Building construction utilized 36 percent, while molding, glass, engine, grinding and polishing, filter, and fire and furnace sands, listed in order of quantity, together constituted 3 percent of the total. Railroad ballast and miscellaneous constituted the remaining 5 percent.

California led in output, as in the previous year, producing more than twice as much as any other State. Michigan was second and New York third, followed by Texas, Ohio, Illinois, Wisconsin, Minnesota, South Dakota, and Washington, in that order.

TABLE 2.—Sand and gravel sold or used by producers in the United States,[1] 1945–49 (average) and 1950–54

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)
1945–49 (average)	102, 517	87, 478	172, 620	116, 129	275, 137	203, 607
1950	138, 900	126, 311	231, 555	168, 729	370, 455	295, 040
1951	149, 590	145, 148	251, 044	188, 566	400, 634	333, 714
1952	[2] 156, 203	[2] 148, 855	279, 419	204, 672	[2] 435, 622	[2] 353, 527
1953	[2] 160, 581	[2] 160, 336	[2] 279, 818	[2] 214, 459	[2] 440, 399	[2] 374, 795
1954	198, 265	199, 554	362, 563	304, 573	560, 828	504, 127

[1] Includes Territories of the United States, 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 1954, by States

State	Short tons	Value	State	Short tons	Value
Alabama	3, 966, 345	$3, 450, 858	Nebraska	8, 547, 876	$6, 992, 314
Alaska	6, 639, 638	6, 301, 939	Nevada	3, 531, 291	2, 956, 537
American Samoa	1, 800	675	New Hampshire	2, 240, 548	1, 094, 474
Arizona	3, 764, 080	3, 067, 076	New Jersey	10, 005, 325	14, 704, 474
Arkansas	6, 611, 860	6, 566, 806	New Mexico	6, 519, 339	8, 340, 251
California	70, 524, 612	68, 138, 578	New York	30, 082, 333	29, 756, 301
Colorado	13, 552, 406	9, 026, 993	North Carolina	7, 441, 200	5, 508, 284
Connecticut	4, 846, 282	4, 314, 557	North Dakota	7, 105, 466	2, 219, 747
Delaware	971, 647	752, 528	Ohio	25, 827, 220	27, 873, 469
Florida	3, 468, 842	2, 661, 152	Oklahoma	5, 424, 131	4, 265, 031
Georgia	2, 703, 281	2, 466, 352	Oregon	13, 157, 239	14, 149, 380
Hawaii	119, 121	318, 754	Pennsylvania	14, 218, 444	20, 595, 990
Idaho	6, 717, 700	4, 568, 919	Puerto Rico	374, 690	833, 654
Illinois	24, 443, 055	26, 164, 387	Rhode Island	1, 013, 014	979, 470
Indiana	14, 405, 098	11, 879, 316	South Carolina	2, 813, 750	2, 550, 260
Iowa	12, 199, 656	9, 276, 530	South Dakota	19, 110, 358	7, 840, 393
Kansas	10, 421, 554	7, 194, 171	Tennessee	5, 155, 185	6, 141, 139
Kentucky	4, 729, 606	4, 401, 793	Texas	26, 315, 635	24, 840, 811
Louisiana	7, 910, 152	9, 686, 635	Utah	5, 327, 969	3, 592, 286
Maine	7, 460, 620	2, 538, 143	Vermont	1, 481, 549	1, 110, 996
Maryland	10, 097, 800	12, 171, 613	Virginia	7, 115, 403	8, 657, 871
Massachusetts	9, 640, 274	8, 366, 409	Washington	16, 044, 687	13, 595, 014
Michigan	32, 040, 639	25, 516, 169	West Virginia	4, 073, 991	8, 351, 153
Minnesota	23, 848, 856	16, 318, 520	Wisconsin	23, 978, 722	17, 396, 438
Mississippi	5, 441, 837	4, 286, 871	Wyoming	4, 163, 660	2, 681, 527
Missouri	9, 891, 305	10, 203, 481			
Montana	13, 340, 544	7, 460, 260	Total	560, 827, 635	504, 126, 749

TABLE 4.—Sand and gravel sold or used by producers in the United States in 1954, by States, uses, and class of operations

(Commercial unless otherwise indicated)

State	Sand							
	Glass		Molding		Building			
					Commercial		Government-and-contractor	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Alabama	-	-	65,982	$112,357	597,276	$533,699	-	-
Alaska	-	-	-	-	39,330	124,323	[1]	[1]
American Samoa	-	-	-	-	-	-	750	$325
Arizona	-	-	-	-	558,783	573,999	1,000	4,000
Arkansas	[1]	[1]	[1]	[1]	632,011	635,880	-	-
California	[1]	[1]	63,666	285,123	15,092,777	15,114,218	215,532	180,206
Colorado	-	-	[1]	[1]	1,171,426	1,147,068	[1]	[1]
Connecticut	-	-	[1]	[1]	1,220,105	1,135,119	-	-
Delaware	-	-	-	-	352,663	307,748	-	-
Florida	-	-	-	-	2,416,450	1,669,327	-	-
Georgia	[1]	[1]	[1]	[1]	1,483,216	962,925	-	-
Hawaii	-	-	-	-	97,000	235,000	18,011	70,019
Idaho	-	-	-	-	222,874	267,017	1,572	2,410
Illinois	[1]	[1]	731,664	1,985,273	5,775,150	4,267,837	-	-
Indiana	[1]	[1]	468,708	571,795	2,789,461	2,030,637	-	-
Iowa	[1]	[1]	131,065	277,937	2,256,138	1,826,013	-	-
Kansas	[1]	[1]	102,000	51,080	3,088,344	2,106,670	1,127	425
Kentucky	-	-	[1]	[1]	1,582,347	1,579,089	50,000	1,250
Louisiana	-	-	[1]	[1]	993,717	1,008,189	-	-
Maine	-	-	-	-	144,766	121,261	16,200	520
Maryland	[1]	[1]	[1]	[1]	2,491,035	2,960,638	1,200	120
Massachusetts	-	-	75,659	220,133	2,358,350	2,089,256	19,437	46,080
Michigan	[1]	[1]	1,117,737	1,273,601	4,710,204	3,528,755	8,284	1,355
Minnesota	[1]	[1]	[1]	[1]	2,993,532	2,424,008	10,800	2,700
Mississippi	[1]	[1]	[1]	[1]	628,198	399,377	-	-
Missouri	467,622	$1,079,192	101,367	235,497	2,985,174	2,392,446	6	6
Montana	-	-	-	-	306,873	554,699	31,090	46,582
Nebraska	-	-	13,319	8,744	692,468	579,345	5,000	3,750
Nevada	[1]	[1]	47,420	122,753	343,716	519,310	100	50
New Hampshire	-	-	-	-	210,299	197,147	-	-
New Jersey	658,726	1,815,581	1,362,920	3,195,493	2,713,056	2,506,220	-	-
New Mexico	-	-	-	-	486,904	602,451	15,000	20,000
New York	[1]	[1]	271,477	720,879	10,280,834	9,468,050	17,195	4,157
North Carolina	-	-	-	-	1,478,833	951,481	7,800	3,900
North Dakota	-	-	-	-	213,035	212,784	-	-
Ohio	[1]	[1]	334,537	968,418	6,003,104	6,314,504	-	-
Oklahoma	[1]	[1]	[1]	[1]	1,312,967	1,071,138	-	-
Oregon	-	-	1,183	6,980	911,899	1,124,155	[1]	[1]
Pennsylvania	[1]	[1]	233,446	539,778	3,598,674	4,715,867	-	-
Puerto Rico	[1]	[1]	-	-	17,000	17,000	-	-
Rhode Island	-	-	[1]	[1]	242,925	227,596	-	-
South Carolina	[1]	[1]	-	-	1,082,688	514,642	-	-
South Dakota	-	-	-	-	425,250	370,569	[1]	[1]
Tennessee	28,675	78,026	247,094	651,280	1,000,757	1,327,130	-	-
Texas	285,360	555,916	76,757	192,941	5,319,839	4,859,153	-	-
Utah	-	-	[1]	[1]	742,381	599,199	-	-
Vermont	-	-	[1]	[1]	68,406	55,011	-	-
Virginia	[1]	[1]	[1]	[1]	834,517	917,268	-	-
Washington	[1]	[1]	3,655	13,234	2,074,404	1.957,787	330,170	298,036
West Virginia	[1]	[1]	[1]	[1]	678,829	904,038	-	-
Wisconsin	110,844	187,270	566,659	820,160	2,698,027	2,184,277	20,882	7,472
Wyoming	-	-	-	-	58,093	109,756	629	2,358
Undistributed [1]	4,258,702	12,630,371	303,195	526,148	-	-	429,851	603,334
Total	5,809,929	16,346,356	6,319,510	12,779,604	100,476,105	92,301,076	1,201,636	1,299,055

[1] Figures that may not be shown separately are combined as "Undistributed."

TABLE 4.—Sand and gravel sold or used by producers in the United States in 1954, by States, uses, and class of operations—Continued

State	Sand—Continued							
	Paving				Grinding and polishing [2]		Fire or furnace	
	Commercial		Government-and-contractor					
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Alabama	589,537	$535,329	134,833	$58,276	(1)	(1)		
Alaska	21,894	75,257	(1)	(1)				
American Samoa			1,050	350				
Arizona	149,598	172,317	35,622	21,315				
Arkansas	644,048	573,568						
California	5,327,995	4,711,404	3,579,968	2,170,763	141,790	$654,741	(1)	(1)
Colorado	123,253	99,278	289,875	108,561				
Connecticut	777,120	736,727	112,280	16,676	(1)	(1)	(1)	(1)
Delaware	(1)	(1)	85,760	17,657				
Florida	488,792	352,099	35,600	13,300	(1)	(1)		
Georgia	583,030	423,591			(1)	(1)		
Hawaii			4,110	13,735				
Idaho	43,946	38,023	289,156	65,562				
Illinois	2,070,194	1,548,895	200,861	113,102	(1)	(1)	(1)	(1)
Indiana	2,463,947	1,549,310	95,685	74,706				
Iowa	1,507,739	1,170,166	277,831	89,837	(1)	(1)		
Kansas	2,109,130	1,470,508	700,146	341,985	(1)	(1)		
Kentucky	668,235	636,094	222,768	61,787				
Louisiana	1,485,915	1,463,915	201,423	80,569				
Maine	71,268	48,913	238,380	72,609				
Maryland	1,880,497	2,380,475	24	2				
Massachusetts	1,272,819	1,039,583	97,357	86,361	(1)	(1)		
Michigan	3,002,364	2,365,766	523,099	196,424	(1)	(1)		
Minnesota	887,763	638,583	92,205	49,247	(1)	(1)		
Mississippi	702,583	572,223	50,323	19,009				
Missouri	873,781	781,673	54,655	42,690	(1)	(1)	(1)	(1)
Montana	(1)	(1)	127,482	24,684				
Nebraska	333,192	232,554	351,720	171,880				
Nevada	(1)	(1)	13,513	6,834	(1)	(1)		
New Hampshire	124,366	92,747	237,582	42,524				
New Jersey	1,952,931	1,702,822			121,912	465,938	(1)	(1)
New Mexico	66,405	134,349	324,413	576,574	(1)	(1)		
New York	4,577,719	4,616,755	171,499	49,391	(1)	(1)	(1)	(1)
North Carolina	455,292	276,341	2,110,346	637,988				
North Dakota	56,570	52,338						
Ohio	4,296,049	4,063,799	126,123	15,244	(1)	(1)	(1)	(1)
Oklahoma	988,531	721,213	466,922	95,447	(1)	(1)		
Oregon	323,816	302,364	(1)	(1)				
Pennsylvania	2,151,463	2,852,955	(1)	(1)	(1)	(1)	206,295	$442,361
Puerto Rico	33,000	31,000	3,602	7,062				
Rhode Island	166,175	131,560					(1)	(1)
South Carolina	211,470	130,233	38,589	8,058	(1)	(1)	(1)	(1)
South Dakota	124,074	107,105	5,031,892	1,728,926				
Tennessee	833,913	787,000	10,078	407	(1)	(1)	4,120	10,280
Texas	2,620,605	2,091,365	418,345	72,761	(1)	(1)		
Utah	448,981	312,145	100,582	88,877	(1)	(1)	20,000	26,000
Vermont	115,950	80,595	101,933	56,975				
Virginia	1,970,389	1,623,089	89,795	24,591				
Washington	560,355	423,122	99,888	64,799	(1)	(1)		
West Virginia	660,624	709,287			(1)	(1)		
Wisconsin	649,063	570,270	1,110,219	444,095	(1)	(1)		
Wyoming	14,227	22,285						
Undistributed [1]	75,375	76,762	1,490,968	993,971	1,079,940	2,715,019	236,442	427,640
Total	51,555,983	45,527,752	19,748,502	8,825,611	1,343,642	3,835,698	466,857	906,281

[1] Figures that may not be shown separately are combined as "Undistributed."
[2] Includes 589,021 tons of blast sand valued at $2,513,731.

TABLE 4.—Sand and gravel sold or used by producers in the United States in 1954, by States, uses, and class of operations—Continued

State	Sand—Continued							
	Engine [3]		Filter		Railroad ballast [4]		Other [5]	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Alabama	74,754	$37,333			43,352	$15,210	(1)	(1)
Alaska	(1)	(1)					(1)	(1)
American Samoa								
Arizona	(1)	(1)					(1)	(1)
Arkansas	(1)	(1)	(1)	(1)			(1)	(1)
California	66,006	98,548	(1)	(1)			138,762	$405,455
Colorado	11,478	13,557			(1)	(1)	(1)	(1)
Connecticut			(1)	(1)			(1)	(1)
Delaware	(1)	(1)					(1)	(1)
Florida	(1)	(1)	(1)	(1)	(1)	(1)	172,885	166,508
Georgia	(1)	(1)			(1)	(1)	110,184	152,834
Hawaii								
Idaho	75	75					(1)	(1)
Illinois	81,005	80,026	24,940	$51,884	(1)	(1)	1,095,094	4,511,807
Indiana	76,905	57,480	(1)	(1)			98,808	61,774
Iowa	21,898	29,247	(1)	(1)	59,821	24,122	59,869	47,373
Kansas	123,928	109,961	(1)	(1)	191,612	116,379	594,455	292,059
Kentucky	103,974	107,706	(1)	(1)	(1)	(1)	(1)	(1)
Louisiana	(1)	(1)	(1)	(1)	(1)	(1)	156,794	389,588
Maine	(1)	(1)	(1)	(1)			(1)	(1)
Maryland	(1)	(1)					(1)	(1)
Massachusetts	14,209	13,950	1,200	2,400			105,588	66,996
Michigan	33,424	25,798	(1)	(1)	(1)	(1)	527,855	487,694
Minnesota	(1)	(1)	(1)	(1)	1,917	568	94,289	63,820
Mississippi	(1)	(1)			4,850	1,455	34,339	17,709
Missouri	27,239	46,169	23,453	33,922	8,910	1,782	139,381	532,184
Montana							(1)	(1)
Nebraska			1,242	2,484	10,050	4,229	36,423	26,299
Nevada							(1)	(1)
New Hampshire	(1)	(1)	(1)	(1)			(1)	(1)
New Jersey	(1)	(1)	(1)	(1)			710,429	1,689,567
New Mexico	(1)	(1)					(1)	(1)
New York			28,176	36,726	(1)	(1)	1,452,726	564,453
North Carolina			608	1,216	(1)	(1)	(1)	(1)
North Dakota							5,813	10,606
Ohio	(1)	(1)	47,607	88,354	(1)	(1)	317,610	433,590
Oklahoma	26,026	18,212					(1)	(1)
Oregon	(1)	(1)	(1)	(1)	(1)	(1)	75,100	72,109
Pennsylvania	168,584	398,243	(1)	(1)			164,733	735,172
Puerto Rico								
Rhode Island							(1)	(1)
South Carolina	(1)	(1)	(1)	(1)	(1)	(1)	30,546	40,720
South Dakota			(1)	(1)				
Tennessee	(1)	(1)	(1)	(1)			(1)	(1)
Texas	(1)	(1)	(1)	(1)	52,970	40,636	400,182	340,261
Utah	(1)	(1)			(1)	(1)	69,298	36,694
Vermont	(1)	(1)					98,925	62,250
Virginia	(1)	(1)			(1)	(1)	168,887	125,133
Washington	29,959	15,301			(1)	(1)	43,142	46,917
West Virginia	157,771	292,833			(1)	(1)	(1)	(1)
Wisconsin	(1)	(1)	7,415	3,402	(1)	(1)	366,447	174,868
Wyoming								
Undistributed [1]	357,728	356,135	446,817	831,265	596,558	303,562	1,147,882	2,918,303
Total	1,374,963	1,700,574	581,458	1,051,653	970,040	507,943	8,416,446	14,472,743

[1] Figures that may not be shown separately are combined as "Undistributed."
[3] Includes 41,294 tons of engine sand valued at $25,147, produced by railroads for their own use.
[4] Includes 137,981 tons of ballast sand valued at $25,951, produced by railroads for their own use.
[5] Includes 83,931 tons of sand valued at $14,386, used by railroads for fills and similar purposes. Also includes 721,354 tons ground sand valued at $6,079,167. See table 11 for ground sand.

TABLE 4.—Sand and gravel sold or used by producers in the United States in 1954, by States, uses, and class of operations—Continued

State	Gravel							
	Building				Paving			
	Commercial [6]		Government-and-contractor		Commercial		Government-and-contractor	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Alabama	799, 590	$858, 342	-----	-----	954, 965	$960, 351	318, 335	$38, 704
Alaska	82, 158	243, 906	(1)	(1)	164, 350	364, 726	3, 070, 697	3, 333, 743
American Samoa	-----	-----	-----	-----	-----	-----	-----	-----
Arizona	792, 244	880, 835	51, 187	$42, 121	686, 296	705, 371	1, 086, 592	304, 711
Arkansas	389, 031	428, 712	-----	-----	1, 978, 594	2, 251, 567	2, 500, 383	1, 875, 152
California	16, 673, 759	18, 217, 166	2, 497, 925	2, 269, 338	12, 036, 903	12, 937, 697	13, 440, 264	8, 277, 710
Colorado	1, 334, 215	1, 553, 975	(1)	(1)	1, 125, 630	1, 406, 600	9, 358, 417	4, 588, 532
Connecticut	863, 410	1, 102, 090	330	99	694, 015	780, 833	940, 095	283, 017
Delaware	32, 298	50, 219	-----	-----	352, 997	274, 010	-----	-----
Florida	(1)	(1)	-----	-----	(1)	(1)	-----	-----
Georgia	(1)	(1)	-----	-----	(1)	(1)	4, 750	3, 400
Hawaii	-----	-----	-----	-----	-----	-----	-----	-----
Idaho	328, 821	419, 731	23, 009	25, 897	1, 871, 061	1, 506, 075	3, 679, 690	2, 091, 089
Illinois	4, 895, 015	4, 280, 922	-----	-----	5, 707, 606	4, 271, 289	1, 545, 804	953, 448
Indiana	3, 173, 105	3, 139, 370	-----	-----	3, 766, 901	3, 458, 007	496, 167	178, 964
Iowa	1, 361, 033	1, 807, 443	20, 284	6, 085	3, 356, 853	2, 530, 925	2, 727, 248	989, 788
Kansas	704, 843	752, 924	21, 252	7, 031	1, 177, 341	970, 890	1, 358, 080	479, 065
Kentucky	1, 213, 335	1, 255, 568	-----	-----	387, 942	430, 297	202, 731	75, 255
Louisiana	1, 400, 292	1, 774, 534	-----	-----	3, 406, 236	4, 765, 032	67, 500	13, 500
Maine	254, 380	196, 032	4, 050	180	415, 033	287, 623	6, 160, 831	1, 770, 540
Maryland	2, 288, 800	3, 873, 105	-----	-----	2, 203, 755	2, 540, 988	917, 118	82, 486
Massachusetts	2, 136, 630	2, 520, 786	22, 300	38, 980	1, 461, 241	1, 310, 078	1, 115, 875	395, 313
Michigan	4, 131, 930	4, 357, 628	788, 115	373, 108	11, 231, 436	9, 072, 018	4, 752, 218	2, 444, 213
Minnesota	2, 318, 437	3, 249, 287	102, 942	41, 177	3, 677, 918	3, 053, 817	12, 329, 185	5, 944, 583
Mississippi	680, 532	673, 979	-----	-----	2, 458, 278	2, 272, 363	183, 055	88, 441
Missouri	2, 138, 096	2, 317, 688	20, 250	11, 250	1, 711, 807	1, 685, 143	973, 063	558, 115
Montana	467, 857	636, 984	4, 380, 213	1, 481, 352	832, 731	793, 909	6, 350, 435	3, 396, 995
Nebraska	1, 429, 103	1, 202, 923	3, 446	1, 763	4, 571, 888	4, 001, 378	1, 094, 008	745, 605
Nevada	384, 400	574, 959	2, 000	1, 500	150, 927	102, 657	2, 419, 554	1, 048, 854
New Hampshire	218, 062	319, 728	-----	-----	211, 171	265, 354	1, 192, 527	135, 867
New Jersey	1, 603, 660	2, 475, 957	-----	-----	562, 041	559, 163	-----	-----
New Mexico	543, 377	638, 011	7, 157	3, 630	137, 613	232, 380	4, 825, 441	6, 058, 898
New York	6, 611, 586	9, 089, 761	73, 219	6, 417	3, 865, 249	3, 964, 047	1, 968, 399	762, 743
North Carolina	462, 837	695, 868	16, 000	14, 625	1, 675, 862	2, 015, 151	821, 865	565, 341
North Dakota	227, 025	328, 496	1, 600	80	164, 533	123, 261	5, 662, 963	723, 805
Ohio	5, 167, 568	5, 625, 946	-----	-----	6, 890, 688	7, 612, 778	134, 757	100, 849
Oklahoma	171, 394	192, 279	-----	-----	370, 069	549, 352	1, 746, 319	790, 008
Oregon	1, 702, 969	1, 911, 671	(1)	(1)	4, 264, 404	4, 687, 747	4, 275, 251	4, 341, 166
Pennsylvania	3, 512, 042	4, 870, 243	(1)	(1)	2, 507, 562	3, 433, 275	793, 715	166, 638
Puerto Rico	58, 150	76, 400	-----	-----	(1)	(1)	152, 238	589, 792
Rhode Island	278, 242	287, 211	-----	-----	237, 686	245, 161	-----	-----
South Carolina	637, 101	864, 339	-----	-----	(1)	(1)	-----	-----
South Dakota	86, 529	97, 382	(1)	(1)	839, 139	304, 509	12, 512, 679	5, 200, 809
Tennessee	1, 067, 195	1, 550, 934	89, 700	34, 500	861, 430	1, 022, 978	503, 323	119, 338
Texas	6, 879, 188	8, 546, 819	-----	-----	5, 285, 047	5, 508, 582	2, 761, 004	875, 520
Utah	892, 326	727, 021	-----	-----	1, 101, 896	807, 186	1, 797, 519	934, 621
Vermont	129, 766	102, 445	-----	-----	256, 274	416, 576	647, 449	229, 615
Virginia	893, 014	1, 459, 936	-----	-----	2, 575, 242	3, 765, 490	224, 154	128, 446
Washington	3, 415, 190	3, 077, 110	861, 777	698, 397	3, 985, 095	3, 819, 553	3, 596, 768	2, 367, 490
West Virginia	635, 651	781, 411	-----	-----	613, 441	669, 631	-----	-----
Wisconsin	2, 786, 990	2, 376, 825	59, 774	17, 932	4, 270, 359	3, 396, 608	9, 916, 963	6, 352, 208
Wyoming	(1)	(1)	5, 530	12, 166	2, 524, 679	1, 476, 413	1, 353, 478	820, 785
Undistributed [1]	540, 019	839, 100	1, 913, 459	1, 330, 284	761, 438	1, 059, 384	-----	-----
Total	88, 793, 195	103, 304, 001	10, 965, 519	6, 417, 912	110, 343, 622	108, 668, 952	131, 978, 907	71, 225, 162

[1] Figures that may not be shown separately are combined as "Undistributed."
[6] Includes 63,936 tons building gravel valued at $14,527, produced by railroads for their own use.

TABLE 4.—Sand and gravel sold or used by producers in the United States in 1954, by States, uses, and class of operations—Continued

State	Gravel—Continued				Sand and gravel			
	Railroad ballast [7]		Other [8]		Total commercial		Total Government-and-contractor	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Alabama	(1)	(1)	(1)	(1)	3,513,177	$3,353,878	453,168	$96,980
Alaska	(1)	(1)	146,249	$173,548	693,221	1,134,581	5,946,417	5,167,358
American Samoa							1,800	675
Arizona	(1)	(1)	(1)	(1)	2,589,679	2,694,929	1,174,401	372,147
Arkansas	132,862	$115,570	23,468	31,513	4,111,477	4,691,654	2,500,383	1,875,152
California	426,344	374,604	354,746	406,704	50,790,923	55,240,561	19,733,689	12,898,017
Colorado			(1)	(1)	3,812,097	4,273,452	9,740,309	4,753,541
Connecticut	(1)	(1)	189,038	215,951	3,793,577	4,014,765	1,052,705	299,792
Delaware			(1)	(1)	885,887	734,871	85,760	17,657
Florida					3,433,242	2,647,852	35,600	13,300
Georgia					2,698,531	2,462,952	4,750	3,400
Hawaii					97,000	235,000	22,121	83,754
Idaho	(1)	(1)	(1)	(1)	2,724,273	2,383,961	3,993,427	2,184,958
Illinois	655,363	398,934	412,972	321,707	22,696,390	25,097,837	1,746,665	1,066,550
Indiana	415,030	328,692	472,052	373,850	13,813,246	11,625,646	591,852	253,670
Iowa	119,603	81,140	134,583	169,614	9,174,293	8,190,820	3,025,363	1,085,710
Kansas	(1)	(1)	128,264	120,857	8,340,949	6,365,665	2,080,605	828,506
Kentucky	(1)	(1)	(1)	(1)	4,254,107	4,263,501	475,499	138,292
Louisiana	53,145	40,706	77,566	103,051	7,641,229	9,592,566	268,923	94,069
Maine	(1)	(1)	62,615	15,794	1,041,159	694,294	6,419,461	1,843,849
Maryland	11,110	25,399	(1)	(1)	9,179,458	12,089,005	918,342	82,608
Massachusetts	(1)	(1)	919,055	492,060	8,385,305	7,799,675	1,254,969	566,734
Michigan	284,306	267,750	374,016	213,138	25,968,923	22,501,069	6,071,716	3,015,100
Minnesota	932,618	550,305	353,960	161,349	11,313,724	10,280,813	12,535,132	6,037,707
Mississippi	144,669	64,917	(1)	(1)	5,208,459	4,179,421	233,378	107,450
Missouri	80,241	54,494	50,162	33,023	8,843,331	9,591,420	1,047,974	612,061
Montana	351,246	269,533	195,941	87,997	2,451,324	2,510,647	10,889,220	4,949,613
Nebraska			6,017	11,360	7,093,702	6,069,316	1,454,174	922,998
Nevada			(1)	(1)	1,096,124	1,899,299	2,435,167	1,057,238
New Hampshire	(1)	(1)	(1)	(1)	810,439	916,083	1,430,109	178,391
New Jersey	(1)	(1)	205,775	147,127	10,005,325	14,704,474		
New Mexico	(1)	(1)	(1)	(1)	1,347,328	1,681,149	5,172,011	6,659,102
New York	(1)	(1)	650,598	386,319	27,852,021	28,933,593	2,230,312	822,708
North Carolina	(1)	(1)	(1)	(1)	4,485,189	4,286,430	2,956,011	1,221,854
North Dakota	481,868	423,352	292,059	345,025	1,440,903	1,495,862	5,664,563	723,885
Ohio	382,022	293,920	1,895,773	1,878,142	25,566,340	27,757,376	260,880	116,093
Oklahoma			4,417	6,864	3,210,890	3,379,576	2,213,241	885,455
Oregon	158,578	136,860	589,871	517,486	8,077,895	8,779,614	5,079,344	5,369,766
Pennsylvania	(1)	(1)	(1)	(1)	13,401,243	20,424,196	817,201	171,794
Puerto Rico			1,200	1,500	218,850	236,800	155,840	596,854
Rhode Island			58,983	34,919	1,013,014	979,470		
South Carolina	134,034	112,588			2,775,161	2,542,202	38,589	8,058
South Dakota	(1)	(1)			1,526,825	906,888	17,583,533	6,933,505
Tennessee	(1)	(1)	(1)	(1)	4,552,084	5,986,894	603,101	154,245
Texas	764,711	449,099	1,294,669	809,964	23,136,286	23,892,530	3,179,349	948,281
Utah	(1)	(1)	(1)	(1)	3,429,868	2,568,788	1,898,101	1,023,498
Vermont			(1)	(1)	732,167	824,406	749,382	286,590
Virginia			87,895	33,180	6,801,454	8,504,834	313,949	153,037
Washington	431,382	288,307	595,995	455,058	11,156,084	10,166,292	4,888,603	3,428,722
West Virginia	26,142	25,777			4,073,991	8,351,153		
Wisconsin	855,996	418,223	483,243	302,719	12,870,884	10,574,731	11,107,838	6,821,707
Wyoming	(1)	(1)			2,804,023	1,846,218	1,359,637	835,309
Undistributed [1]	1,549,890	892,187	2,028,979	1,494,200				
Total	8,391,160	5,612,357	12,090,161	9,344,019	396,933,071	416,359,009	163,894,564	87,767,740

[1] Figures that may not be shown separately are combined as "Undistributed."
[7] Includes 3,374,183 tons of ballast gravel valued at $1,662,641, produced by railroads for their own use.
[8] Includes 542,630 tons of gravel valued at $183,292, used by railroads for fills and similar purposes.

Government-and-Contractor Production.—In accordance with the desire of the industry, the Bureau of Mines has classified all sand and gravel production into two categories—commercial and Government-and-contractor. The Government-and-contractor classification includes direct output by Government agencies and some output of private producers. All of the production of a private producer must be on contract to a Government agency to have the production classed as Government-and-contractor. If any part of the production was sold, the entire production reverts to the commercial classification.

The quantity of sand and gravel reported by Government-and-contractor operations for 1954 was considerably higher than in 1953. The graphic relationships of Government-and-contractor and commercial production are shown in figure 2. Of the total quantity pro-

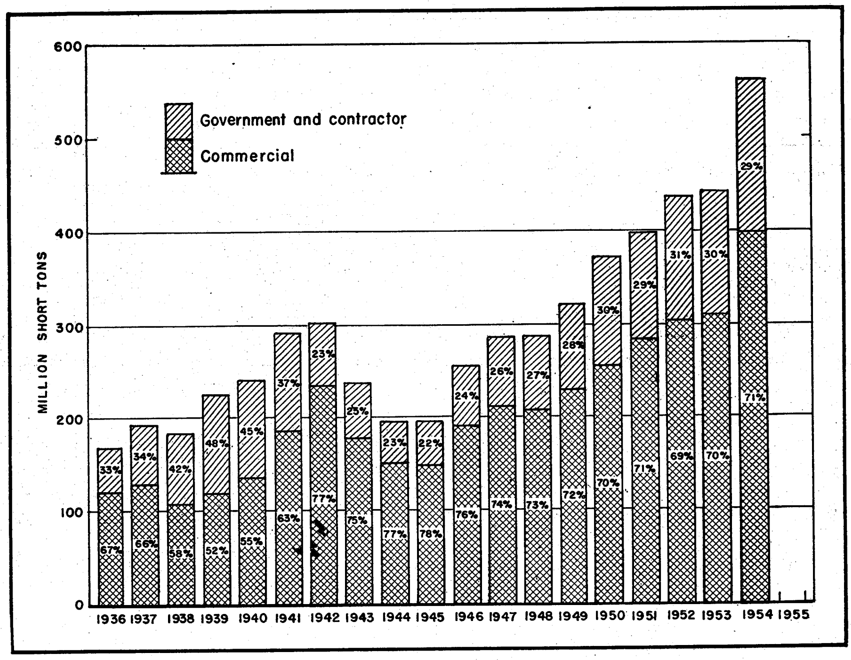

FIGURE 2.—Sand and gravel sold or used in the United States by producers, 1936–54.

TABLE 5.—Sand and gravel sold or used by Government-and-contractor producers in the United States,[1] 1945–49 (average) and 1950–54, 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)
1945–49 (average)	1,319	646	6,239	2,443	3,145	1,964	60,134	25,844	70,837	30,897
1950	2,759	1,675	11,159	4,286	5,216	4,510	93,765	43,245	112,899	53,716
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	19,748	8,826	10,966	6,418	131,979	71,225	163,895	87,768

[1] Includes Territories of the United States, possessions, and other areas administered by the United States.

duced at Government-and-contractor operations, the contractors produced 70 percent. States reported 61 percent of the total Government-and-contractor production, counties 27 percent and municipalities 2 percent, respectively. The remaining 10 percent was produced by or for Federal agencies.

TABLE 6.—Sand and gravel sold or used by Government-and-contractor producers in the United States,[1] 1945–49 (average) and 1950–54 by types of producer

Type of producer	1945–49 (average)		1950		1951	
	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	38,349	$0.33	48,742	$0.33	41,637	$0.36
Contractors	32,488	.57	64,157	.59	73,178	.53
Total	70,837	.43	112,899	.48	114,815	.47
States	34,659	.46	61,798	.50	60,387	.43
Counties	27,634	.31	37,841	.30	34,249	.37
Municipalities	1,628	.40	2,109	.54	2,159	.47
Federal agencies	6,916	.75	11,151	.89	18,020	.77
Total	70,837	.43	112,899	.48	114,815	.47

Type of producer	1952		1953		1954	
	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	46,901	$0.35	46,250	$0.38	49,232	$0.37
Contractors	86,882	.48	85,253	.53	114,663	.61
Total	133,783	.44	131,503	.48	163,895	.54
States	68,928	.44	71,199	.49	99,711	.54
Counties	39,107	.37	39,954	.38	43,378	.42
Municipalities	2,068	.52	2,720	.46	3,920	.42
Federal agencies	23,680	.53	17,630	.64	16,886	.81
Total	133,783	.44	131,503	.48	163,895	.54

[1] Includes Territories of the United States, possessions, and other areas administered by the United States.

Degree of Preparation.—Seventy-nine percent of the total tonnage of sand and gravel was washed, screened, or otherwise prepared in 1954. The remaining tonnage was a bank-run product used mainly as a base for secondary roads. The major portion of the unprepared material was produced by Government-and-contractor operations. The bulk of the output of commercial operations was in the form of specifically sized material to be recombined in the manner required to meet the purchaser's specifications.

Size of Plants.—The industry includes a wide range of plant sizes. Some are 1- or 2-man operations, whereas others are huge plants having annual capacities exceeding 1 million tons. The average plant output of commercial operators (except railroads) in 1954 was less than in 1953. As shown in table 8, there was a substantial increase in the number of small- and medium-sized plants reporting production, but the percentages of output by the various size categories changed very little.

TABLE 7.—Sand and gravel sold or used by producers in the United States,[1] 1953–54, by classes of operation and degrees of preparation

	1953			1954		
	Quantity		Average value per ton	Quantity		Average value per ton
	Short tons	Percent		Short tons	Percent	
Commercial operations:						
Prepared	[2] 277,503,735	90	$1.04	352,208,376	89	$1.11
Unprepared	31,392,616	10	.75	44,724,695	11	.58
Total	[2] 308,896,351	100	1.01	396,933,071	100	1.05
Government-and-contractor operations:						
Prepared	58,365,305	44	.74	89,906,284	55	.71
Unprepared	73,137,569	56	.27	73,988,280	45	.33
Total	131,502,874	100	.48	163,894,564	100	.54
Grand total	[2] 440,399,225	----------	.85	560,827,635	----------	.90

[1] Includes Territories of the United States, 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, 1953–54, by size groups [1]

Size group, in short tons annual production	1953				1954			
	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	920	35.3	9,048	3.0	1,692	40.7	16,618	4.2
25,000 to less than 50,000	440	16.9	15,884	5.3	737	17.7	26,445	6.7
50,000 to less than 100,000	461	17.7	32,754	10.8	709	17.1	50,829	12.9
100,000 to less than 200,000	373	14.3	53,531	17.7	511	12.3	72,062	18.4
200,000 to less than 300,000	166	6.4	40,844	13.5	210	5.1	52,097	13.3
300,000 to less than 400,000	89	3.4	30,844	10.2	111	2.7	38,104	9.7
400,000 to less than 500,000	48	1.9	21,320	7.0	62	1.5	27,991	7.1
500,000 to less than 600,000	32	1.2	17,368	5.7	34	.8	18,343	4.7
600,000 to less than 700,000	18	.7	11,693	3.9	35	.8	22,597	5.8
700,000 to less than 800,000	14	.5	10,658	3.5	15	.4	11,186	2.8
800,000 to less than 900,000	13	.5	10,905	3.6	12	.3	10,160	2.6
900,000 to less than 1,000,000	4	.2	3,814	1.3	2	(3)	1,878	.5
1,000,000 and over	27	1.0	44,032	14.5	26	.6	44,379	11.3
Total	2,605	100.0	302,695	100.0	4,156	100.0	392,689	100.0

[1] Excludes operations by or for States, counties, municipalities, and Federal Government agencies as follows—1953: 1,035 operations with an output of 131,502,874 tons of sand and gravel; 1954: 1,503 operations, 163,894,564 tons. Excludes operations by or for railroads as follows—1953: 110 operations with an output of 5,891,851 tons of sand and gravel; 1954: 93 operations, 4,243,955 tons. Includes Territories of the United States, 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.

Methods of Transportation.—The sand and gravel industry in 1954 transported 77 percent of its total output in trucks. Railroads handled most of the remainder. Although the percentage shipped by water was relatively small nationally, it was of major importance in some areas. Greater accessibility to deposits being rapidly depleted and increasing freight rates have contributed to the high rate of truck usage in the sand and gravel industry. Details of the various methods of transportation for 1952 to 1954 are shown in table 9.

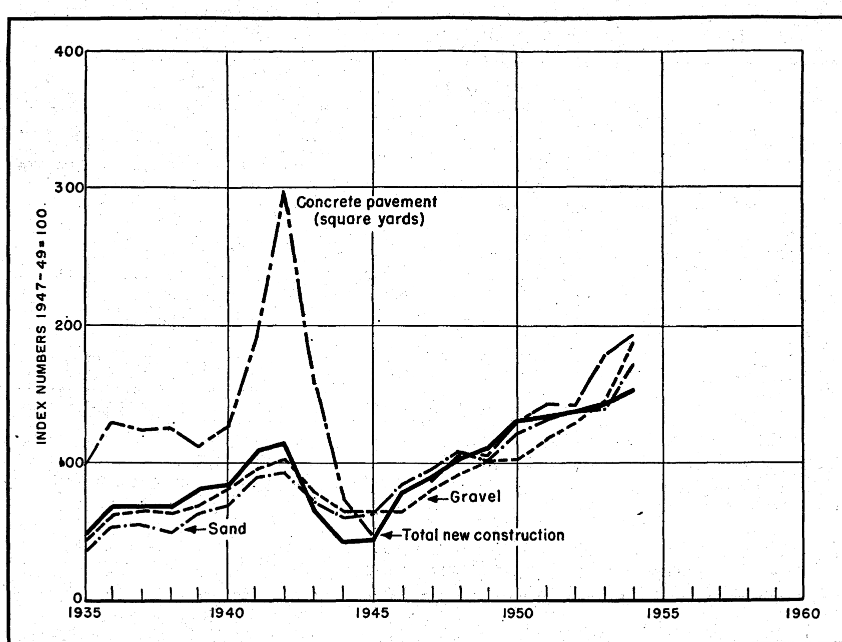

FIGURE 3.—Quantity of sand and gravel produced compared with value of total new construction, adjusted to 1947–49 prices, and total square yards of concrete pavements contracted for in the United States, 1935–54. Data on construction from Construction Volume and Costs and on pavements from Survey of Current Business.

TABLE 9.—Sand and gravel sold or used in the United States,[1] 1952–54, by method of transportation

	1952		1953		1954	
	Thousand short tons	Percent of total	Thousand short tons	Percent of total	Thousand short tons	Percent of total
Commercial:						
Truck	[2] 187,378	43	189,733	43	269,888	48
Rail	83,381	19	74,612	17	77,845	14
Waterway	25,891	6	27,416	6	25,437	5
Unspecified	5,189	1	[2] 17,135	4	23,763	4
Total commercial	[2] 301,839	69	[2] 308,896	70	396,933	71
Government-and-contractor: Truck [3]	133,783	31	131,503	30	163,895	29
Grand total	[2] 435,622	100	[2] 440,399	100	560,828	100

[1] Includes Territories of the United States, possessions, and other areas administered by the United States.
[2] Revised figure.
[3] Entire output of Government-and-contractor operations assumed to be moved by truck.

Employment and Productivity.—Employment and productivity in the commercial sand and gravel industry were affected by the increased statistical coverage in 1954. Therefore no direct comparisons can be made with the previous year. The men added through increased coverage were mainly employed in small operations. These less mechanized operations reduced the average production per man-hour compared with the previous year. Productivity data by regions for 1953 and 1954 are summarized in the accompanying table.

TABLE 10.—Employment in the commercial sand and gravel industry and average output per man in the United States, 1945–49 (average) and 1950–54, by regions [1]

	Employment					Production (short tons)	Average output per man		Percent of commercial industry represented
	Average number of men	Time employed							
		Average number of days	Total man shifts	Man-hours			Per shift	Per hour	
				Average man per day	Total				
1945–49 (average)	20,206	240	4,842,018	8.7	42,102,503	171,172,449	35.4	4.1	83.8
1950	24,276	238	5,771,740	8.7	50,250,732	236,420,288	41.0	4.7	91.8
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									
Maine, N. H., Vt., R. I., Mass., and Conn	1,050	200	210,021	8.5	1,792,373	10,141,391	48.3	5.7	93.4
N. Y	1,213	218	264,074	8.3	2,199,398	16,513,245	62.5	7.5	84.8
Pa., N. J., and Del	2,374	272	645,470	8.5	5,481,574	21,658,519	33.6	4.0	97.3
W. Va., Va., and Md	1,480	257	380,888	9.6	3,648,866	11,854,571	31.1	3.2	81.6
S. C., Ga., Ala., Fla., and Miss	1,321	267	352,941	8.7	3,058,486	14,047,120	39.8	4.6	99.2
N. C., Ky., and Tenn	1,190	254	301,862	9.0	2,709,754	10,717,818	35.5	4.0	98.9
Ark., La., and Texas	1,830	270	494,724	9.1	4,482,133	17,152,323	34.7	3.8	92.5
Ohio	1,965	244	480,222	8.7	4,170,821	21,087,588	43.9	5.1	89.1
Ill. and Ind	1,843	240	442,216	8.5	3,759,539	27,532,567	62.2	7.3	87.7
Mich. and Wis	2,401	227	543,953	8.2	4,449,120	31,819,456	58.5	7.2	87.5
N. Dak., S. Dak., and Minn	807	150	121,155	10.0	1,209,704	8,302,746	68.5	6.9	68.2
Nebr. and Iowa	843	211	178,184	9.8	1,748,760	10,299,088	57.8	5.9	86.0
Kans., Mo., and Okla	1,249	244	304,191	8.7	2,654,221	13,299,245	43.7	5.0	93.0
Wyo., Colo., N. Mex., Utah, and Ariz	793	217	172,447	8.1	1,395,896	8,896,096	51.6	6.4	95.8
Calif. and Nev	3,144	248	780,438	8.1	6,324,094	44,247,592	56.7	7.0	99.7
Mont., Wash., Oreg., and Idaho	1,071	206	220,978	8.2	1,805,977	10,498,031	47.5	5.8	79.5
Alaska, Hawaii, and Puerto Rico	89	151	13,435	8.5	113,536	677,309	50.4	6.0	58.1
Total	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	98.4
N. C., Ky., and Tenn	1,537	266	408,944	8.7	3,575,996	12,812,430	31.3	3.6	96.7
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

[1] Excludes plants operated by or directly for States, counties, municipalities, and Federal Government agencies.

CONSUMPTION

The demand for sand and gravel in the construction industry (including railroad ballast) accounted for 94 percent of the 1954 production compared with 93 percent for the previous year. Except railroad ballast, the quantities reported for construction uses were considerably higher than in 1953.

There was a 9-percent rise in concrete-pavement contract awards in 1954.

The quantity of industrial sands produced was 12 percent lower in 1954 than in 1953. The tonnage of glass sand was down 6 percent, molding sand 20, grinding and polishing 10, fire and furnace 7, and engine 18. Filter-sand consumption, on the other hand, was substantially higher.

Ground Sand.—Statistics for ground sand are shown in table 11. In previous years ground-sand figures have been incorporated with ground sandstone in the Minerals Yearbook Abrasive Materials chapter. The values reported for ground sand ranged from $6.51 to $10.26 per short ton in 1954.

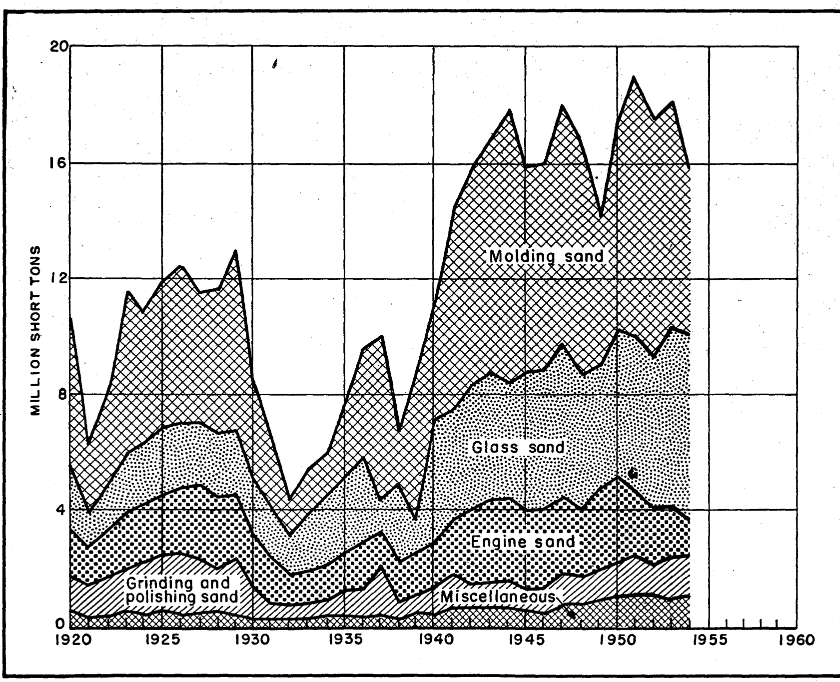

FIGURE 4.—Production of industrial sands in the United States, 1920–54.

TABLE 11.—Ground sand sold or used by producers in the United States in 1954, by uses

Use	Short tons	Value	
		Total	Average per ton
Abrasives	182,046	$1,466,762	$8.06
Enamel	24,255	234,891	9.68
Filler	118,643	832,619	7.02
Filter purposes	(1)	(1)	(1)
Foundry uses	123,645	1,083,819	8.77
Glass	(1)	(1)	(1)
Pottery, porcelain, and tile	147,256	1,209,410	8.21
Unspecified	115,890	1,189,035	10.26
Undistributed [1]	9,619	62,631	6.51
Total	721,354	6,079,167	8.43

[1] Figures that may not be shown separately are combined as "Undistributed."

STOCKS

Since stockpiles of sand and gravel are relatively small and constant from year to year, production and sales are considered in this chapter to be equivalent terms that may be used interchangeably.

PRICES

With few exceptions, commercial sand and gravel prices in 1954 were higher than in 1953. The average values for Government-and-contractor output were, as in previous years, much lower than those for commercial sand and gravel because large quantities of unprepared material were included. The average per ton value at the source, along with the percentage of change with each class of material, can be found in table 1.

FOREIGN TRADE [4]

Sand and gravel is a low priced commodity that ordinarily cannot bear transportation costs over long distances. Consequently, in 1954 foreign trade was relatively small and usually for specialized uses. An example of such specialized use is the export of sand to the desert areas of Arabia for use in secondary recovery of oil.[5]

The United States supplied 633,611 tons of silica sand at Can$1,854,174 to Canada. This composed 97 percent of the total silica sand imported by Canada in 1954. The sand and gravel exported by the United States to all countries in 1954 totaled 1,058,053 short tons valued at $3,125,457.

As shown in table 12, importation of glass sand, mainly from Belgium–Luxembourg, nearly doubled in 1954 compared with the 1953 figure, while sand for other uses decreased slightly.

[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] Ladoo, R. B., A New Look at Industrial Mineral Resources: Pit and Quarry, vol. 47, No. 6, December 1954, pp. 89–90.

TABLE 12.—Sand and gravel imported for consumption in the United States, 1945–49 (average) and 1950–54, 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
1945–49 (average)	8,243	$13,214	276,919	$236,897	113,273	$44,019	398,435	$294,130
1950	9,191	25,481	290,025	266,065	146,079	29,011	445,295	320,557
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

[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: 1945–47: "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, and 74 short tons valued at $79,095 in 1954 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 earlier years.

TECHNOLOGY

Liquid cyclones are used as classifiers and, very rarely, as thickeners. The operation, nature, and range of the results obtainable were described in an article that included diagrams, tables, and graphs. Application to the separation of clay and sand was suggested by the data.[6]

Where the loss of fines in the washing process has been of some concern, various methods have been used for increasing the recovery. The screw-type spiral classifiers seem to be preferred to the rake type. In many instances ball mills have been used for producing fines where they were lacking and liquid cyclones of several types have been put to use in recovering the fines. The liquid cyclone usually has a dewatering unit following it.

Heated screens have been found effective in preventing screen blinding. In some instances the dry material which is to be crushed is previously moistened so as to prevent dust from forming.[7]

Various types of wet classifiers and their application to the separation of sand sizes were described and tabulated, with the characteristics, specifications, and operating details of each.[8]

An example of a flexible wet method of producing a variety of sand sizes was reported. During washing, each of 5 sizes of sand was diverted 1 of 3 ways—to the coarse sand blending flume, to the fine-sand blending flume, or to waste.[9]

[6] Fitch, E. B., and Johnson, E. C., Operating Behavior of Liquid Cyclones: Min. Eng., vol. 5, No. 1953, pp. 304–308.
[7] Lenhart, Walter B., Progress in Technical Developments as Observed in Field of Travel: Rock Products, vol. 57, January 1954, p. 154.
[8] Hitzrot, H. W., A Guide to the Proper Application of Classifiers: Min. Eng., vol. 6, No. 5, May 1954, pp. 534–541.
[9] Lenhart, Walter B., Blend Five Sizes to Make Either Concrete or Masons Sand: Rock Products, vol. 57, No. 9, September 1954, pp. 76–78.

Research was continued on underwater screening with special emphasis placed on the finer sizes. High capacity was achieved. The lower noise levels achieved are advantageous, especially in densely populated areas. Many types of unconventional underwater screens were in the testing stage.[10]

At Folsom Dam rod mills, vibrating and rotary scrubber screens, and liquid cyclones were used to obtain fines needed to meet specifications.[11]

One operation had rotary scrubbers with a ½-inch wire trommel on each end to supplement the classifiers, which not only cleaned the coarse particles, but also the discharged sand was reported to screen much more efficiently.[12]

A unique application for silica sand has been developed for use in increasing oil recovery from oil-bearing strata. The special sand used is pumped under pressure into oil-bearing beds; the fractures and pore space developed facilitate oil recovery.[13]

The Highway Research Board of the National Research Council developed data on the economic and technical factors involved in establishing desirable specifications for highway-freight motor vehicles and highway design. The American Association of State Highway Officials was planning to construct a $4 million test strip to provide data needed to guide new road design, maintenance and improvements, as well as the basis for writing new laws covering weight limits and taxes.[14]

In some deposits a substantial fraction of the material occurs as larger sizes that must be crushed to meet specifications. For this purpose a portable gravel plant has been developed which combines both crushing and screening operations.[15]

Both sides of a conveyor belt were used for transporting sand and gravel at a Vancouver operation. The top side of the belt transported material to storage. The belt then moved to the tunnel underneath the storage piles, where the reverse side of the belt was used for reclaiming the aggregates.[16]

A description of the technology used in underground mining of sand was published. Silica sand bonded by 1 to 2 percent clay was mined from the St. Peter sandstone near Ottawa, Ill., in open pits by hydraulic methods. These hydraulic methods were adapted to one underground mine. The sandstone was blasted and then disintegrated and washed to a sump by hydraulic nozzles, the slurry picked up from the sump by a sand ejector or hydraulic elevator and transferred through rubber-lined pumps to a washing plant.[17]

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10 Rock Products, vol. 57, January 1954, p. 155.
11 Lenhart, Walter B., Problems of Fine-Sand Recovery at Folsom Dam: Rock Products, vol. 57, May 1954, p. 70.
12 Lenhart, Walter B., Scrubber Supplement Classifiers: Rock Products, vol. 57, August 1954, p. 84.
13 Rock Products, vol. 57, No. 2, February 1954, p. 99.
14 Highway Research Board, National Research Council, Study of Economic Aspects of the Truck Size-and-Weight Problem: June 25, 1954, with a reprint from Business Week of Mar. 7, 1953.
15 Rock Products, vol. 57, February 1954, p. 76.
16 Utley, Harry F., Double-Duty Conveyor Belt Stars in Two-Way Transit System: Pit and Quarry vol. 46, No. 12, June 1954, pp. 118, 120.
17 Bryant, A. D., Hydraulic Methods for Underground Mining of Silica Sand: Min. Eng., vol. 5, No. 3, March 1953, pp. 282–283.

Commercial glass fibers were being produced from sand dredged from the Kansas River, as the sand contains silica and feldspar in nearly the correct proportions for this product.[18]

Properties of natural and synthetic molding sands and the advantage of using mixtures of both types to obtain greater uniformity of properties were outlined in a publication.[19]

The effect of molding-sand grain size on pore space and permeability and their influence on thermal conductivity were a subject of a research report.[20]

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[18] American Ceramic Society Bulletin, vol. 33, No. 6, June 1954, p. 30.

[19] Geilenkirchen, Thedor, Molding Sands Giesserei, vol. 41 (24), 1954, pp. 650–653; abs. Am. Ceram. Soc., vol. 38, No. 3, March 1955, p. 571.

[20] Gittus, J. H., Influence of Grain Size Distribution on Some Properties of Sand, British Cast Iron Research Assoc., Jour. Research and Develop., vol. 5, No. 6, 1954, pp. 318–330; abs. Am. Ceram. Soci. Jour., vol. 38, No. 1, 1955.

Secondary Metals—Nonferrous

By Archie J. McDermid [1] [2]

EXCEPT for nickel and antimony, the recovery of all nonferrous metals from scrap and residues was less in 1954 than in 1953, largely because of a general decline in industrial activity. Secondary copper had the largest and aluminum the second largest tonnage drop. There was a rising trend in consumption of both copper and aluminum scrap in 1954, but the uptrend was insufficient to offset the high consumption following removal of price ceilings in February 1953. The decreases in recovery of secondary lead and zinc were the result of smaller quantities of these metals contained as alloying ingredients in the copper scrap consumed in 1954. Secondary recovery of lead from lead scrap and of zinc from zinc scrap was higher in 1954 than in 1953. Secondary antimony was virtually unchanged from 1953.

Another factor that tended to reduce secondary recovery of copper and aluminum was the scarcity of scrap due to high exports in late 1953 and throughout 1954. Domestic primary producers of these metals, in efforts to maintain the competitive positions of their products and to reduce price fluctuation, maintained prices of primary aluminum and copper in 1954 at or near those of 1953, whereas prices of scrap, as well as of primary metal, in some foreign countries were considerably higher in the latter part of 1954. Producers of secondary copper- and aluminum-alloy ingot often had to buy scrap at export prices, then sell ingot at prices competitive with domestic primary metals. Foundries could sometimes buy refined metal and make alloys more economically than they could buy alloy ingot from secondary smelters. However, the supply of domestic refined copper continued to be insufficient for domestic demands. Reported consumption, by foundries, of copper scrap, refined copper, and brass ingot was 25, 6, and 5 percent less, respectively, in 1954 than in 1953. Most secondary smelters are dealers as well as consumers of scrap and could take advantage of the at least temporary profit in marketing scrap abroad. Such action, however, doubtless would have resulted in loss of customers in later periods, when more plentiful supplies of metal were available.

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[1] Commodity-industry analyst.
[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 1.—Salient statistics of nonferrous secondary metals recovered from scrap processed in continental United States, 1953–54, in short tons

Metal	From new scrap		From old scrap		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1953						
Aluminum	289,626	$114,807,746	78,940	$31,291,816	368,566	$146,099,562
Antimony	3,356	2,409,608	19,004	13,644,872	22,360	16,054,480
Copper	529,076	303,689,624	429,388	246,468,712	958,464	550,158,336
Lead	57,987	15,192,594	428,750	112,332,500	486,737	127,525,094
Magnesium	5,892	3,134,544	6,038	3,212,216	11,930	6,346,760
Nickel	3,116	3,880,043	5,236	6,519,867	8,352	10,399,910
Tin	9,475	18,148,415	21,439	41,064,261	30,914	59,212,676
Zinc	230,443	53,001,890	64,235	14,774,050	294,678	67,775,940
Total		514,264,464		469,308,294		983,572,758
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

TABLE 2.—Secondary metals recovered as unalloyed metal, in alloys, and in chemical compounds in the United States, 1945–49 (average) and 1950–54, in short tons

Metal	1945–49 (average)	1950	1951	1952	1953	1954
Aluminum	277,767	243,666	292,608	304,522	368,566	292,041
Antimony	19,780	21,862	23,943	23,089	22,360	22,358
Copper	891,547	977,239	932,282	903,197	958,464	839,907
Lead	436,010	482,275	518,110	471,294	486,737	480,925
Magnesium	7,476	9,476	11,526	11,477	11,930	8,250
Nickel	7,760	8,795	8,602	7,479	8,352	8,605
Tin	29,577	35,481	34,434	32,261	30,914	29,334
Zinc	306,874	326,030	314,377	310,423	294,678	271,774

SCOPE OF REPORT

Table 3 classifies the plants canvassed in nonferrous secondary metal surveys by type of operation and kind of material consumed. Plants have been recorded in over one column if they used scrap items of more than one base; some smelters are listed as lead smelters, aluminum smelters, and copper smelters because they consumed lead-, aluminum-, and copper-base scrap. In the same way, some foundries have been counted as both aluminum and brass foundries. The tabulation of plants in some categories is subject to limitations. The large number of foundries and the small size of many of them make it impossible to obtain reports from all units. Also, a few large corporations operating two or more plants prefer to file consolidated reports, in which the number and location of plants are not given.

Data in this chapter are based on reports from smelters, brass and aluminum rolling mills, wire mills, primary producers, brass foundries, some manufacturers, and aluminum foundries.

TABLE 3.—Number and classification of plants in the United States reporting consumption of nonferrous scrap metals, refined copper, and copper-alloy ingots in 1954

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] 129	[4] 112	271	83	
Distillers				[5] 22	
Chemical plants	10	50		20	
Brass mills		62			
Wire mills		[6] 13			
Foundries and miscellaneous manufacturers	[7] 158	[8] 1,604	30	[9] 57	[10] 138

[1] Data omitted, as primary producers report on a consolidated basis, making the number of plants difficult to determine.
[2] Primary refineries that consumed copper-base scrap.
[3] Includes 124 aluminum-alloy ingot makers and 5 military aluminum smelters.
[4] Includes 77 secondary copper smelters and 35 smelters using copper materials in other than copper alloys.
[5] Includes 15 secondary plants and 7 primary producers that used scrap in addition to ore. Includes producers of zinc dust and redistilled slab.
[6] Refers to companies operating wire mills. Some companies operate more than one plant.
[7] Foundries using aluminum scrap in nonferrous castings.
[8] Brass foundries.
[9] Includes foundries, galvanizers, die casters, and zinc rolling mills.
[10] Foundries and miscellaneous manufacturers reporting use of nonferrous scrap other than copper or aluminum. Excludes small plants canvassed only at 5-year intervals.

Detailed information on primary metals may be found in the chapters devoted to those metals.

Definitions of terms used in this chapter follow:

Consumption means the quantity of material melted, rolled, drawn, or otherwise converted to castings, sheet, wire, rod, chemicals, etc. It does not mean the melting loss. Consumption of scrap is always measured at the point where it loses its identity as scrap and becomes secondary metal.

Secondary metals are metals or alloys recovered from scrap and residues. The term "secondary" applies only to the source of the metal and has no relation to the type of product recovered as to quality, degree of purity, or physical characteristics.

Scrap metal as a general term is meant to include metallic scrap and byproduct residues. The scrap of any particular metal is meant to include all scrap of that metal. For example, the term "copper scrap" includes unalloyed copper scrap, copper-alloy scrap, copper-base alloy scrap and copper, brass, and bronze skimmings or other residues not including primary residues. The scrap classified as that of a particular metal is scrap which contains a greater percentage of that metal than of any other.

Scrap metals are divided into three main categories—old scrap, new scrap, and home scrap.

Old scrap consists of metal articles that have been discarded because of wear, damage, or obsolescence, usually after serving a useful purpose. Typical examples are discarded trolley wire, battery plates, railroad-car boxes, fired-cartridge cases, and obsolete military equipment (frequently unused).

New scrap consists of process scrap (plant scrap) generated in manufacturing articles from primary or refined metal and consumed at a plant of different location from the plant of generation. New scrap also includes defective, finished, or semifinished articles returned by purchasers to be reworked. Clippings, borings, and turnings and other items of process scrap, when consumed outside the plant where generated, are new scrap, whether clean, rusty, or oily and whether generated recently or long before reclamation. Skimmings, slags, and drosses, generated in processing scrap or refined metal, are new scrap. Flue dust from smelting brass scrap is new scrap. Zinc-chemical residues resulting from the consumption of zinc dust in manufacturing sodium hydrosulfite are also new scrap. Aircraft plants melt zinc-die alloys and antimonial lead to make dies and remelt the dies to make new ones whenever necessary. The same material may be remelted several times during a year. In such instances the dies are not considered to be scrap. If, however, they are sold to a smelter for redistillation or remelting, they are considered to be old scrap. Tailings from ore concentration are primary residues, not scrap.

Home scrap (*runaround scrap*) is process scrap consumed in the plant of generation.

Toll scrap is scrap treated for a toll or conversion charge and is reported by the plant at which the scrap is consumed, not by the plant owning the material.

Purchased scrap is a term used in nonferrous-scrap-metal questionnaires to cover all scrap entering commercial transactions. It includes new scrap, old scrap, and toll scrap, all of which have passed through commercial transactions. It also includes scrap generated at one plant and transferred to another plant of the same company for processing, which usually involves transportation charges. The term also includes scrap reclaimed in shipyard repairwork and from line operations at railroad foundries, although no definite financial transaction may have resulted.

Secondary metal products are those made from scrap, with or without addition of alloying ingredients such as primary metal or scrap of metals other than the base metal of the alloy produced. Secondary production includes both the metals recovered from scrap and the added alloying ingredients. Secondary recovery includes only the metals recovered from scrap. Products made from primary or refined metals to which scrap has been added as an alloying ingredient have a secondary metal content consisting of the metals contained in the scrap minus melting loss.

The recovery tables that appear near the beginning of each of the sections on metals in this chapter contain two series of significant figures. The figures in the left column of each table represent the recoverable metal in the scrap processed. They are obtained by multiplying the reported gross weights of scrap consumed during the year by percentage recovery factors to obtain the metallic recovery (weight after melting loss), then multiplying the metallic recovery by composition percentages of the products to obtain the quantities of aluminum, copper, lead, zinc, etc., recoverable. The recoverable zinc from zinc die-cast scrap is part of the zinc from zinc-base scrap, as shown in the zinc-recovery table in the Secondary Zinc section of this chapter; the recoverable copper is credited to zinc-base scrap in the copper-recovery table and the recoverable aluminum to the zinc-base scrap in the aluminum-recovery table.

Tonnages of metal recovered are listed on the right side of the recovery table, by products, as reported by respondents. The totals so derived for each side of the table do not agree because the actual weight of metal produced from melting or other treatment of scrap is seldom precisely the same as the calculated recoverable weight. As presented in the tables, however, the items have been adjusted to give the exact balance theoretically expected. The word "recovery" may therefore be applied to both sides of the table.

SECONDARY ALUMINUM

Recovery of secondary aluminum in 1954 totaled 292,000 short tons valued [3] at $119 million, a 21-percent decrease in quantity from the 369,000 tons valued at $146 million, recovered in 1953. The data are not strictly comparable because in 1953, as in previous years, the recovery from aluminum-base scrap included alloying metals contained in the scrap, as well as aluminum, whereas in 1954 the recovery from this scrap included only the aluminum recovered. The change in procedure was inaugurated to make the secondary aluminum calculations uniform with those of the other secondary metals.

The chief reason for the decline in secondary recovery was the decrease in industrial activity, but contributing factors were shortage of scrap and the greater availability of primary aluminum. The unusually heavy exportation of scrap, which began late in 1953, continued throughout 1954. Prices paid in the foreign market were higher in many instances than the secondary aluminum smelters could pay and sell ingot in competition with primary aluminum, production of which increased sharply in 1954. Exports of aluminum scrap totaled 39,000 tons in 1954 compared with 5,000 in 1953. Imports were 27,000 tons in 1953 and 15,000 in 1954. Of the tonnage exported in 1954, West Germany received 25,000 tons and Italy 9,000. In a move to curb exports the Bureau of Foreign Commerce, effective June 11, 1954, limited aluminum-scrap export licenses to orders having firm purchase and delivery provisions.

Even if the domestic supply of aluminum scrap had been more plentiful, domestic consumption probably would have been somewhat less than in 1953 because of the decreased business activity in 1954 compared with 1953. According to data published by the Bureau of the Census,[4] shipments of aluminum mill products were 6 percent lower in 1954 than in 1953 and of aluminum castings 5 percent lower.

Both scrap and primary aluminum are used in these products. Wrought product scrap can be used in both wrought products and castings. Both kinds of scrap are used by secondary smelters in castings and for deoxidizing purposes. Cast scrap is used by the primary producers in both wrought products and castings but if used in the former it must be diluted with virgin metal. Casting alloys usually contain a greater proportion of alloying ingredients, especially silicon, than wrought-product alloys.

[3] These values were computed at 20.30 cents per pound in 1954 and 19.82 cents in 1953, the average prices received by primary producers for virgin pig aluminum in those years.

[4] U. S. Department of Commerce, Bureau of the Census, Facts for Industry, Nonferrous Castings, Summary for 1954, July 22, 1955; and Aluminum and Magnesium Mill Products, Summary for 1954, Apr. 28, 1955.

TABLE 4.—Aluminum recovered from scrap processed in the United States. 1953–54, in short tons

Recoverable aluminum content of scrap processed

Kind of scrap	1953	1954
New scrap:		
Aluminum-base	[3] 288,994	[4] 231,418
Copper-base	150	104
Zinc-base	203	285
Magnesium-base	279	245
Total	289,626	232,052
Old scrap:		
Aluminum-base	[5] 78,072	[6] 59,316
Copper-base	138	92
Zinc-base	245	340
Magnesium-base	485	241
Total	78,940	59,989
Grand total	368,566	292,041

Aluminum recovered from scrap processed

Form of recovery	1953 [1]	1954 [2]
As metal	5,203	5,752
Aluminum alloys	357,084	280,932
In brass and bronze	360	264
In zinc-base alloys	1,149	1,450
In magnesium alloys	94	48
In chemical compounds	4,676	3,595
Grand total	368,566	292,041

[1] The term "aluminum" covers aluminum alloys, and the figures include all constituents of the alloys recovered from aluminum-base scrap.
[2] The term aluminum covers aluminum only, not including other constituents of alloys recovered from aluminum-base scrap.
[3] Recoverable aluminum-alloy content of aluminum-base scrap; the recoverable aluminum content of new aluminum-base scrap was 270,393 tons in 1953.
[4] Recoverable aluminum content of aluminum-base scrap; the recoverable aluminum-alloy content of new aluminum-base scrap was 246,609 tons in 1954.
[5] Recoverable aluminum-alloy content of aluminum-base scrap; the recoverable aluminum content of old aluminum-base scrap was 69,645 tons in 1953.
[6] Recoverable aluminum content of aluminum-base scrap; the recoverable aluminum-alloy content of old aluminum-base scrap was 66,438 tons in 1954.

TABLE 5.—Production of secondary aluminum and aluminum-alloy products in the United States, 1952–54, gross weight in short tons

Product	1952	1953	1954
Secondary aluminum ingot: [1]			
Pure aluminum (98.5 percent)	4,893	5,203	5,752
Aluminum-silicon (Cu max., 0.6 percent) alloys	15,372	21,647	16,714
Aluminum-silicon (Cu, 0.6 to 2 percent) alloys	7,092	8,012	5,129
No. 12 alloy and variations	20,665	17,963	16,454
Aluminum-copper (Si max., 1.5 percent) alloys	[2] 6,240	[2] 4,448	[2] 7,598
No. 319 alloy and variations	37,055	34,369	27,427
AXS 679 alloy and variations	61,839	74,646	67,330
Aluminum-silicon-copper-nickel alloys	15,474	17,316	20,466
Deoxidizing and other dissipative uses	43,398	43,682	27,487
Aluminum-base hardeners	6,485	8,387	7,374
Aluminum-magnesium alloys	1,019	675	849
Aluminum-zinc alloys	3,181	2,678	3,377
Miscellaneous	10,307	12,719	13,402
Total	233,020	251,745	219,359
Secondary aluminum recovered by primary producers and independent fabricators	73,392	111,106	83,973
Aluminum-alloy castings	7,811	12,907	12,094
Aluminum in chemicals	3,293	4,676	3,595

[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 and 12,139 tons in 1954.
[2] Of the total, 1,031 tons was produced in 1952, 883 tons in 1953 and 5,434 tons in 1954 at Naval Air Stations and United States Air Force Bases.

TABLE 6.—Stocks and consumption of new and old aluminum scrap in the United States in 1954, 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	
Secondary smelters: [2] [3]						
2S and 3S sheet and clips	722	13,708	11,729	2,092	13,821	609
Castings and forgings	968	21,056	3,363	17,811	21,174	850
Alloy sheet	3,201	48,553	40,682	7,874	48,556	3,198
Borings and turnings	3,938	69,742	71,077	--------	71,077	2,603
Grindings and sawings	241	877	967	--------	967	151
Dross and skimmings	683	20,107	19,801	--------	19,801	989
Foil and wire	568	4,345	1,534	2,732	4,266	647
Utensils	385	6,210	--------	6,098	6,098	497
Aircraft	699	12,865	--------	13,411	13,411	153
Pistons	119	1,946	--------	2,006	2,006	59
Irony aluminum	629	8,215	--------	8,336	8,336	508
Miscellaneous	2,486	28,950	16,389	13,167	29,556	1,880
Total	14,639	236,574	165,542	73,527	239,069	12,144
Primary producers and fabricators:						
2S and 3S sheet and clips	809	17,031	17,271	17	17,288	552
Castings and forgings	123	447	337	185	522	48
Alloy sheet	2,272	43,988	44,608	--------	44,608	1,652
Borings and turnings	788	5,421	5,985	--------	5,985	224
Dross and skimmings	--------	10	10	--------	10	--------
Foil and wire	350	1,973	959	939	1,898	425
Aircraft	98	--------	--------	32	32	66
Miscellaneous	615	21,580	19,092	2,011	21,103	1,092
Total	5,055	90,450	88,262	3,184	91,446	4,059
Foundries and miscellaneous manufacturers: [3]						
2S and 3S sheet and clips	219	3,504	3,395	40	3,435	288
Castings and forgings	327	3,810	3,185	687	3,872	265
Alloy sheet	256	1,698	1,816	92	1,908	46
Borings and turnings	283	3,836	3,787	--------	3,787	332
Dross and skimmings	15	855	851	--------	851	19
Foil and wire	28	32	58	2	60	--------
Utensils	--------	523	--------	459	459	64
Aircraft	3	45	--------	48	48	--------
Pistons	20	102	--------	119	119	3
Miscellaneous	15	316	94	158	252	79
Total	1,166	14,721	13,186	1,605	14,791	1,096
Chemical plants:						
Castings and forgings	5	507	30	465	495	17
Dross and skimmings	1,328	4,183	4,403	--------	4,403	1,108
Miscellaneous	26	323	165	146	311	38
Total	1,359	5,013	4,598	611	5,209	1,163
Grand total:						
2S and 3S sheet and clips	1,750	34,243	32,395	2,149	34,544	1,449
Castings and forgings	1,423	25,820	6,915	19,148	26,063	1,180
Alloy sheet	5,729	94,239	87,106	7,966	95,072	4,896
Borings and turnings	5,009	78,999	80,849	--------	80,849	3,159
Grindings and sawings	241	877	967	--------	967	151
Dross and skimmings	2,026	25,155	25,065	--------	25,065	2,116
Foil and wire	946	6,350	2,551	3,673	6,224	1,072
Utensils	385	6,733	--------	6,557	6,557	561
Aircraft	800	12,910	--------	13,491	13,491	219
Pistons	139	2,048	--------	2,125	2,125	62
Irony aluminum	629	8,215	--------	8,336	8,336	508
Miscellaneous	3,142	51,169	35,740	15,482	51,222	3,089
Total	22,219	346,758	271,588	78,927	350,515	18,462

[1] Revised figures.
[2] Excludes secondary smelters owned by primary aluminum companies.
[3] Quantitative coverage of aluminum scrap consumption by foundries and independent secondary smelters is estimated at 80 percent in 1953 and 1954.

Production of aluminum-alloy ingot by independent secondary smelters decreased 13 percent to 219,000 tons; and the secondary aluminum content of production by primary producers, including rolling mills owned by these producers or others, declined 24 percent to 84,000 tons. The alloy made in greatest quantity by secondary smelters was AXS 679 alloy, output of which decreased 10 percent to 67,000 tons. The secondary metal content of aluminum castings produced by independent foundries decreased 6 percent to 12,000 tons in 1954. As secondary recovery of aluminum decreased much more percentagewise than shipments of wrought-aluminum products and castings, the percentage of primary aluminum in the average composition of those products increased.

An undetermined quantity of process scrap generated in rolling mills of primary producers and consumed in their smelters was unrecorded, being regarded as home scrap. Most of the scrap reported used by primary producers was consumed in wrought products. Some was used in casting-alloy ingot and some in castings but was so diluted with primary metal that distribution of the secondary metal by type of product could not be specified.

The decrease in aluminum-scrap consumption at secondary smelters in 1954 was less than at primary plants. For example, the use of alloy sheet by primary producers, which in 1953 had exceeded similar use in secondary smelters, decreased 23 percent to 45,000 tons in 1954. Secondary smelters in 1954 consumed 49,000 tons of alloy sheet. Of the 25,000 tons of aluminum skimmings used in 1954, secondary smelters consumed 79 percent, chemical plants 18 percent, and foundries 3 percent. A considerable additional quantity of skimmings was generated but not used. Total reported aluminum-scrap consumption in 1954 was 350,000 tons compared with 413,000 in 1953.

Treatment of aluminum skimmings usually begins with screening, either wet or dry, to remove metallic aluminum, which is then remelted. The fines (chiefly aluminum oxide) are discarded, except for minor uses. No methods of reclaiming aluminum from aluminum oxide have been perfected, except those used in recovering primary metal from ores. Aluminum probably could be recovered from fine skimmings in electrolytic units such as are used to produce metallic aluminum from alumina; however, inasmuch as the skimmings contain oxides of iron, silica, and the other ingredients of the alloys from which they are generated, they could not be smelted with alumina which, as made in the Bayer process, contains a minimum of impurities.

TABLE 7.—Dealers' average monthly aluminum scrap buying prices and consumers' alloy-ingot prices at New York in 1954, in cents per pound

[Metal Statistics, 1955]

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
New aluminum clippings	11.60	11.25	11.42	12.87	13.57	13.00	13.00	13.00	14.21	14.50	14.50	14.50	13.12
Cast aluminum scrap	8.92	8.75	8.92	10.37	10.92	10.00	10.00	10.00	10.81	11.00	11.00	11.00	10.14
No. 12 aluminum-alloy ingot	19.24	18.65	19.18	20.72	20.23	19.50	19.50	19.85	20.18	20.84	20.89	21.29	20.01

SECONDARY ANTIMONY

Recovery of secondary antimony in 1954 totaled 22,400 tons valued [5] at $13,600,000. The quantity recovered was virtually the same as in 1953, but the value in that year was $16,100,000.

TABLE 8.—Antimony recovered from scrap processed in the United States, 1953–54, in short tons

Recoverable antimony content of scrap processed			Antimony recovered from scrap processed		
Kind of scrap	1953	1954	Form of recovery	1953	1954
New scrap:			In antimonial lead [1]	14,941	15,726
Lead-base	3,356	3,497	In other lead alloys	7,277	6,486
Tin-base			In tin-base alloys	142	146
Total	3,356	3,497	Grand total	22,360	22,358
Old scrap:					
Lead-base	18,837	18,741			
Tin-base	167	120			
Total	19,004	18,861			
Grand total	22,360	22,358			

[1] Includes 1,747 tons of antimony recovered in antimonial lead from secondary sources at primary plants in 1953 and 1,565 tons in 1954.

All the secondary antimony recovered was a constituent of lead- or tin-alloy scrap and was recovered in lead- or tin-alloy products, but the scrap was not always converted to a product of the same composition as that of the scrap. Of the 22,400 tons of secondary antimony recovered, 15,700 tons was recovered in antimonial lead, compared with 14,900 in 1953. All the antimony recovered from battery-lead plate scrap was recovered in antimonial lead, but some of the lead in the plate scrap was reclaimed as soft lead. In the latter process the antimony was removed from the scrap, in reverberatory furnaces usually, by blowing air into the melt, oxidizing the antimony as a slag to be skimmed off and returned to the blast furnace. There the oxide was reduced to metallic antimony in the production of antimonial lead. Battery-plate scrap, the largest source of secondary antimony, yielded 57 percent of the antimony reclaimed in 1954 compared with 55 percent in 1953. Type-metal scrap and dross yielded 22 percent of the secondary antimony recovered in 1954, babbitt 7 percent, hard lead 6 percent, and cable lead, slag, pewter, and lead dross the remaining 8 percent.

Secondary lead and copper smelters recovered 87 percent of the total secondary antimony in 1954, primary lead producers 7 percent, and manufacturers and foundries 6 percent.

In addition to the 22,400 tons of secondary antimony, 5,300 tons of primary antimony was used in making lead and tin alloys in 1954. All of the 6,900 tons of antimony used in making nonmetal products was primary and was in the form of ore, primary residues, metallic antimony, antimony oxide, or antimony sulfide. Secondary antimony recovery in 1954 was more than double the domestic smelter produc-

[5] The values were computed at 30.47 cents per pound in 1954 and 35.90 cents in 1953, the average New York selling price for primary antimony in each year.

tion of antimony (8,600 tons) plus the 2,000 tons of antimony recovered in antimonial lead by primary lead refineries from foreign and domestic silver and lead ores.

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. Primary antimony information is given in the Antimony chapter.

SECONDARY COPPER AND BRASS

Recovery of copper in unalloyed and alloyed form from all classes of nonferrous scrap metal in 1954 totaled 840,000 short tons valued[6] at $496 million, a 12-percent decrease in quantity from the 958,000 tons valued at $550 million recovered in 1953.

Of the decline, the brass mills were responsible for 69,000 tons, foundries and miscellaneous manufacturers 27,000, primary copper producers 12,000, secondary smelters 7,000, and chemical plants 2,000, all in recovery of copper from copper-base scrap; the remainder of the decrease, about 2,000 tons, was in recovery of copper from other-than-copper-base scrap. Although secondary copper recovery declined in 1954, the trend was upward in the latter half of the year.

One reason for lowered production at brass mills in 1954 was labor strikes, which idled many brass mills for 1 to 2 months in late summer when business activity was increasing. Recovery of copper, in alloyed and unalloyed form, from copper scrap, by brass mills, decreased 19 percent, whereas recovery by secondary smelters declined 2 percent, and that of the primary copper producers 6 percent.

TABLE 9.—Copper recovered from scrap processed in the United States, 1953–54, in short tons

Recoverable copper content of scrap processed			Copper recovered from scrap processed		
Kind of scrap	1953	1954	Form of recovery	1953	1954
New scrap:			As unalloyed copper:		
Copper-base	522,502	427,407	At primary plants	189,585	179,943
Aluminum-base	6,303	5,202	At other plants	53,270	32,298
Nickel-base	246	197			
Lead-base			Total	242,855	212,241
Zinc-base	25	35			
			In brass and bronze	663,560	586,298
Total	529,076	432,841	In alloy iron and steel	2,769	1,487
			In aluminum alloys	27,232	21,386
Old scrap:			In other alloys	498	440
Copper-base	425,827	404,160	In chemical compounds	21,550	18,055
Aluminum-base	2,619	2,181			
Nickel-base	824	655	Total	715,609	627,666
Lead-base	21				
Tin-base	96	69	Grand total	958,464	839,907
Zinc-base	1	1			
Total	429,388	407,066			
Grand total	958,464	839,907			

Unalloyed copper, including refined copper, copper shot, copper powder, and black copper, produced by secondary smelters in 1954, totaled 29,000 tons compared with 24,000 in 1953. Copper-alloy

[6] These values are computed at 29.5 cents per pound in 1954 and 28.7 cents in 1953, the average weighted prices for all grades of refined copper sold by producers in those years.

ingot production by this group decreased 14,000 tons to 292,000 in 1954 owing chiefly to a 10,000-ton drop in output of the tin bronzes and a 5,000-ton drop in manganese and aluminum bronze. Production of red brass and yellow brass ingot increased about 3,000 tons and constituted 63 percent of the total ingot production.

TABLE 10.—Copper recovered as refined copper, in alloys and in other forms, from copper-base scrap processed in the United States, 1953–54, in short tons

	From new scrap		From old scrap		Total	
	1953	1954	1953	1954	1953	1954
By secondary smelters	60,047	64,460	215,160	204,093	275,207	268,553
By primary copper producers	112,489	103,714	85,209	82,131	197,698	185,845
By brass mills	327,607	243,756	34,146	48,837	361,753	292,593
By foundries and manufacturers	20,007	13,644	82,311	61,477	102,318	75,121
By chemical plants	2,352	1,833	9,001	7,622	11,353	9,455
Total	522,502	427,407	425,827	404,160	948,329	831,567

The lowered domestic demand for copper scrap, which followed signing of the Korean armistice in July 1953, continued during the first half of 1954, but scrap remained scarce because of the strong market abroad. Exports of copper and copper-base scrap were abnormally high in 1954 but had a declining trend somewhat as domestic demand for scrap increased. Exports totaled 170,000 tons in 1954 compared with 68,000 in 1953. Scrap became scarce in the later months of 1954 and consumers requested the Department of Commerce to curb exports of copper and brass scrap.[7] As a result, under terms of a restrictive quota for export of copper scrap, effective October 19, exporters were required to certify that the scrap was available and was destined to an actual consumer. Increasing demand for scrap caused net increases of 4 cents and 4.6 cents per pound, respectively, in quoted prices of No. 1 copper scrap and No. 1 composition solids at the end, compared with the beginning of the year. The price of No. 115 copper-alloy ingot rose 5.5 cents in the same period.

After the usual low point in July, due to employee vacations and shutdowns for repairs, the trend in secondary copper operations at scrap-consuming plants was upward. Consumption of scrap by major consuming groups was greater in December 1954 (100,000 tons) than in any other month since June 1953. Nevertheless, total copper scrap consumption in 1954 dropped 11 percent to 1,229,000 tons.

The greatest tonnage decline in consumption of individual items of copper scrap in 1954 was a 99,000-ton decrease in use of yellow brass scrap by brass mills. Consumption of unalloyed copper scrap by brass mills declined 20,000 tons whereas that of cartridge cases increased 15,000 tons. Consumption of copper scrap, including both unalloyed and alloyed metal, by primary copper producers, was 327,000 tons, virtually the same as in 1953, but the grade of scrap was lower. The copper recovered from copper scrap, by primary producers, as refined copper and in chemicals, totaled 186,000 tons in 1954, compared with 198,000 tons in 1953. Consumption of low-grade scrap and residues by these producers rose 23,000 tons, but their use of unalloyed copper and refinery brass decreased 24,000 tons.

[7] American Metal Market, vol. 61, No. 195, Oct. 9, 1955, p. 4.

TABLE 11.—Analysis and production of secondary copper and copper-alloy products in the United States, 1953–54

Item produced from scrap	Approximate analysis (percent)						Gross weight produced (short tons)	
	Cu	Sn	Pb	Zn	Ni	Al	1953	1954
Unalloyed copper products:								
Refined copper (99.9 and over Cu+Ag)	100						179,507	174,917
Refined copper (under 99.9 Cu+Ag)	99						31,433	31,508
Copper sheet, rod, tubing, etc	99						23,370	(1)
Copper powder	98						6,816	4,779
Copper castings	98						1,729	1,037
Total							242,855	212,241
Brass and bronze ingots:								
Tin bronze	88	10		2			18,183	14,734
Leaded-tin bronze	88	6	1.5	4.5			21,152	18,216
Leaded red brass	85	5	5	5			98,686	98,283
Leaded semired brass	81	3	7	9			60,322	62,584
High-leaded-tin bronze	80	10	10				16,822	14,099
Do	84	6	8	2			17,207	16,946
Do	75	5	20				5,963	5,481
Leaded yellow brass	66	1	3	30			21,917	23,071
Manganese bronze	62			27		5	18,157	14,079
Aluminum bronze	89					10	5,115	4,298
Nickel silver	58	2	17	18	14		3,728	2,996
Do	65	4	3	5	22			
Low brass	80			20			3,084	2,345
Silicon bronze	92			4			4,835	4,807
Conductor bronze	94	2	2	2			548	612
Hardeners and special alloys	81						9,708	9,248
Total [2]							305,427	291,799
Brass-mill billets made by ingot makers							6,632	(1)
Brass and bronze sheet, rod, tubing, etc.[1] [3]							465,610	393,301
Brass and bronze castings [4]							111,824	84,222
Brass powder							1,160	1,125
Copper in chemical products (content)							21,550	18,055

[1] Production from this item combined with brass and bronze sheet, rod, and tubing in 1954.
[2] Gross weight of brass and bronze ingot. Includes 241,150 tons of copper, 10,076 of tin, 13,905 of lead, 39,780 of zinc, 441 of nickel, and 75 of aluminum in 1953; and 224,664 tons of copper, 10,387 of tin, 14,448 of lead, 41,864 of zinc, 366 of nickel, and 70 of aluminum in 1954.
[3] Gross weight of secondary brass and bronze in commercial shapes. Includes 339,067 tons of copper, 116 of tin, 5,254 of lead, 119,782 of zinc, 1,311 of nickel, and 80 of aluminum in 1953; and 294,493 tons of copper, 125 of tin, 3,105 of lead, 93,947 of zinc, 1,576 of nickel, and 55 of aluminum in 1954.
[4] Gross weight of secondary metal in brass and bronze castings. Includes 83,039 tons of copper, 5,221 of tin, 17,505 of lead, 5,919 of zinc, 60 of nickel, and 80 of aluminum in 1953; and 62,879 tons of copper, 3,748 of tin, 12,371 of lead, 5,093 of zinc, 63 of nickel, and 68 of aluminum in 1954.

Consumption by secondary smelters of the two largest scrap items, composition and yellow brass, was 97,000 and 70,000 tons, respectively, in 1954, about the same as in 1953. The largest declines were 7,000 tons in low-grade scrap, 7,000 tons in auto radiators (unsweated) and 4,000 tons in unalloyed scrap. There were no noteworthy gains in scrap consumption by foundries and miscellaneous manufacturers. Their losses were 22,000 tons in railroad-car boxes, 8,000 in composition scrap, 6,000 in unalloyed copper scrap, and 5,000 in low-grade scrap and residues.

The brass mills used more copper scrap than any other group; its average grade was higher than that used by any other group. Metal recovered from copper scrap by brass mills, including copper, zinc, and other metals contained in the scrap, was 98 percent of the weight of scrap consumed. Primary producers used scrap of lower average grade than any other group. They recovered an average of 57 pounds of copper from each 100 pounds of scrap they consumed.

TABLE 12.—Stocks and consumption of new and old copper scrap in the United States in 1954, 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	
Secondary smelters:						
No. 1 wire and heavy copper	1, 837	41, 732	2, 107	38, 390	40, 497	3, 072
No. 2 wire, mixed heavy, and light copper	3, 304	41, 274	3, 595	36, 993	40, 588	3, 990
Composition or red brass	4, 436	97, 097	39, 175	57, 803	96, 978	4, 555
Railroad-car boxes	98	1, 720		1, 190	1, 190	628
Yellow brass	5, 861	70, 410	14, 238	55, 649	69, 887	6, 384
Cartridge cases	168	1, 355	44	1, 295	1, 339	184
Auto radiators (unsweated)	1, 879	38, 779		38, 285	38, 285	2, 373
Bronze	2, 340	35, 227	11, 892	23, 348	35, 240	2, 327
Nickel silver	481	2, 608	368	2, 161	2, 529	560
Low brass	276	3, 398	3, 082	258	3, 340	334
Aluminum bronze	68	451	50	280	330	189
Low-grade scrap and residues	6, 957	41, 092	25, 166	18, 102	43, 268	4, 781
Total	27, 705	375, 143	99, 717	273, 754	373, 471	29, 377
Primary producers:						
No. 1 wire and heavy copper	428	24, 581	18, 847	5, 722	24, 569	440
No. 2 wire, mixed heavy, and light copper	2, 140	83, 160	50, 160	31, 539	81, 699	3, 601
Refinery brass	11, 282	32, 686	12, 975	29, 960	42, 935	1, 033
Low-grade scrap and residues	46, 210	145, 393	90, 014	87, 358	177, 372	14, 231
Total	60, 060	285, 820	171, 996	154, 579	326, 575	19, 305
Brass mills:						
No. 1 wire and heavy copper	3, 637	59, 815	45, 040	14, 143	59, 183	4, 078
No 2 wire, mixed heavy, and light copper	2, 498	31, 521	30, 456	686	31, 142	1, 341
Yellow brass	35, 910	217, 503	218, 520	324	218, 844	18, 204
Cartridge cases	940	53, 958	4, 630	48, 556	53, 186	4, 941
Bronze	2, 029	1, 645	1, 763	43	1, 806	1, 212
Nickel silver	1, 727	8, 370	8, 789	18	8, 807	1, 682
Low brass	4, 567	18, 804	20, 660	281	20, 941	2, 829
Aluminum bronze	215	584	639		639	1, 735
Mixed alloy scrap		5, 211	5, 211		5, 211	4, 588
Total	51, 523	397, 411	335, 708	64, 051	399, 759	40, 615
Foundries, chemical plants, and other manufacturers:						
No. 1 wire and heavy copper	2, 091	14, 145	5, 604	9, 023	14, 627	1, 609
No. 2 wire, mixed heavy, and light copper	1, 645	10, 033	4, 147	6, 111	10, 258	1, 420
Composition or red brass	3, 371	11, 862	2, 381	8, 781	11, 162	4, 071
Railroad-car boxes	4, 837	50, 692		50, 496	50, 496	5, 033
Yellow brass	2, 154	12, 820	4, 320	8, 253	12, 573	2, 401
Auto radiators (unsweated)		820		804	804	16
Bronze	1, 143	6, 448	718	5, 469	6, 187	1, 404
Nickel silver	7	29	5	20	25	11
Low brass	164	1, 869	449	1, 313	1, 762	271
Aluminum bronze	112	396	199	232	431	77
Low-grade scrap and residues	1, 969	20, 979	449	20, 518	20, 967	1, 981
Total	17, 493	130, 093	[2] 18, 272	[2] 111, 020	[2] 129, 292	18, 294
Grand total:						
No. 1 wire and heavy copper	7, 993	140, 273	71, 598	67, 278	138, 876	9, 199
No. 2 wire, mixed heavy, and light copper	9, 587	165, 988	88, 358	75, 329	163, 687	10, 352
Composition or red brass	7, 807	108, 959	41, 556	66, 584	108, 140	8, 626
Railroad-car boxes	4, 935	52, 412		51, 686	51, 686	5, 661
Yellow brass	43, 925	300, 733	237, 078	64, 226	301, 304	26, 989
Cartridge cases	1, 108	55, 313	4, 674	49, 851	54, 525	5, 130
Auto radiators (unsweated)	1, 879	39, 599		39, 089	39, 089	2, 389
Bronze	5, 512	43, 320	14, 373	28, 860	43, 233	4, 943
Nickel silver	2, 215	11, 007	9, 162	2, 199	11, 361	2, 253
Low brass	5, 007	24, 071	24, 191	1, 852	26, 043	3, 434
Aluminum bronze	395	1, 431	888	512	1, 400	2, 001
Low-grade scrap and residues [3]	66, 418	240, 150	128, 604	155, 938	284, 542	22, 026
Mixed alloy scrap		5, 211	5, 211		5, 211	4, 588
Total	156, 781	1, 188, 467	625, 693	603, 404	1, 229, 097	107, 591

[1] Revised for brass mills and grand total; beginning 1954 these stocks include home scrap. The lines do not balance.
[2] Of the totals shown, chemical plants reported the following: Unalloyed copper scrap, 1,476 tons of new and 3,504 old; copper-base alloy scrap 439 tons of new and 20,411 old.
[3] Includes refinery brass.

Most of the zinc, aluminum, silver, or other metals contained in the scrap consumed by this group was recovered as oxides from the flue dust, slagged off in the furnace, or recovered from the sludge in the refining department. Primary plants use considerable quantities of copper and brass skimmings, which contain varying percentages of copper oxide. When smelted in a reverberatory furnace with copper sulfide concentrate, the sulfur reduces the copper oxide to metallic copper. At plants of secondary smelters, where no concentrate is available to provide sulfur, skimmings and other residues containing copper oxide may be smelted in a blast furnace or cupola, which is a small blast furnace, where the reducing agent is coke, or in a reverberatory furnace in which the oxides would be reduced by stirring the melt with green poles. Scrap containing much attached iron is usually smelted in the blast furnace, where the iron is oxidized and fluxed to iron silicate slag. Iron may be oxidized in the reverberatory furnace by blowing air into the melt through tubing, then converted to iron silicate slag by addition of sand. However, if the iron content of the scrap is high, it is smelted more economically in the blast furnace. More low-grade scrap, including irony brass, refinery brass, skimmings, and slag, was used by primary producers than by any other group. Of the 285,000 tons of this material consumed in 1954, the primary producers used 220,000 tons. The purpose of the primary producers is to produce refined copper; other metals recovered are byproducts. A few secondary copper smelters produce refined copper from scrap, but the principal function of most of the group is to remelt scrap to make alloy ingot, in which the metals in the scrap remain alloyed in the product. The brass mills and foundries are also remelters. A few secondary smelters and foundries operate blast furnaces for production of copper alloys, but most of these alloys are made in crucibles, melting furnaces, or reverberatories.

TABLE 13.—Consumption of copper and brass materials in the United States, 1953–54, by principal consuming groups, in short tons

Item consumed	Primary producers	Brass mills	Wire mills	Foundries and other manufacturers [1]	Secondary smelters
1953					
Copper scrap	327,640	499,655	----------	140,819	386,899
Primary material	[2] 1,293,117	----------	----------	----------	----------
Refined copper [3]	----------	689,477	753,029	32,555	15,305
Brass ingot	----------	[4] 14,162	838	[4 5] 289,083	----------
Slab zinc	----------	[4] 162,433	----------	[4] 7,340	[4] 8,409
Miscellaneous	----------	546	----------	335	18,424
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	[5] 285,712	----------
Slab zinc	----------	97,310	----------	4,060	6,898
Miscellaneous	----------	555	----------	313	18,696

[1] Excludes chemical plants.
[2] Recoverable copper content; gross weight not available.
[3] Detailed information on consumption of refined copper will be found in the Copper chapter of this volume.
[4] Revised figure.
[5] Shipments to foundries by smelters.

In table 14 the ingot consumption has been classified under 9 general types, and by States, combined in 9 groups, according to the customary practice in the Minerals Yearbook. As in 1953, the geographic division containing Ohio and Illinois consumed more than any other group—104,000 tons—and Ohio more than any other State—37,000 tons. The division using the next largest total was the Middle Atlantic, in which 59,000 tons was consumed, 32,000 in Pennsylvania. These 2 regions together consumed 68 percent of the total quantity used by foundries. Of the 292,000 tons of copper-alloy ingot produced in 1954, about 40 percent was made in the Chicago metropolitan area, 17 percent in the New York City area, and 6 percent in Ohio. Consumption of composition ingot—the largest item—was 143,000 tons or 59 percent of the total.

In table 15 consumption of the different types of ingot has been compared percentagewise for 1949 to 1954.

Consumption of brass and bronze ingot reported by foundries in 1954 totaled 242,000 short tons compared with 256,000 in 1953 and 269,000 in 1952. In addition to the 242,000 tons reported consumed by the foundries, 6,000 tons (15,000 tons in 1953) was used by brass and wire mills. Thirteen hundred and seventy-one foundries reported consumption of ingot in 1954, an average of 177 tons each. The average consumption in 1953 and 1952 was 197 and 186 tons, respectively. Secondary copper smelters' shipments of brass ingot in 1954 were 291,000 tons, virtually all of which (except the 6,000 tons used by the mills) was shipped to the foundries. On this basis, and assuming that stocks of ingot remained the same, coverage of the foundry consumption survey was 85 percent in quantity in 1954, 88 percent in 1953, and 93 percent in 1952. Consumption of copper scrap, refined copper, and other raw materials by foundries also decreased in 1954, as shown in table 13. About 3,300 foundries (including a small number of other manufacturers) were canvassed for consumption of brass ingot, refined copper, and scrap. Of the 1,900 reporting quantities large enough to tabulate, 1,400 reported appreciable use of brass ingot.

TABLE 14.—Foundry consumption of brass ingot, in the United States in 1954, by geographic divisions and States, in short tons

Geographic division and State	Tin bronze	Leaded tin bronze	Leaded red brass bronze	High-leaded tin bronze	Leaded yellow brass	Manganese bronze	Hardeners	Nickel silver	Low brass	Total
New England:										
Connecticut	264	1,723	5,552	174	2,060	214	12	14	391	10,404
Maine	25	24	87	7	6	100	7		17	273
Massachusetts	672	2,790	4,330	240	347	543	12	114	249	9,297
New Hampshire	11	24	466	64	92	60		74	30	821
Rhode Island and Vermont	70	35	1,163	30	40	37	4		439	1,818
Total	1,042	4,596	11,598	515	2,545	954	35	202	1,126	22,613
Middle Atlantic:										
New Jersey	960	807	4,896	526	368	631	26	28	27	8,269
New York	1,562	3,351	10,298	570	486	1,661	203	217	414	18,762
Pennsylvania	2,131	3,052	15,754	2,598	1,908	3,262	602	102	2,370	31,779
Total	4,653	7,210	30,948	3,694	2,762	5,554	831	347	2,811	58,810
East North Central:										
Illinois	1,266	2,048	19,662	1,484	250	852	73	348	1,074	27,057
Indiana	178	344	9,644	507	82	144	33	31	48	11,011
Michigan	383	1,489	11,651	833	1,047	1,675	81	19	216	17,394
Ohio	2,186	4,571	20,869	6,508	227	1,313	198	367	506	36,745
Wisconsin	1,084	511	5,295	1,456	1,275	349	21	1,399	128	11,518
Total	5,097	8,963	67,121	10,788	2,881	4,333	406	2,164	1,972	103,725
West North Central:										
Iowa	42	81	1,888	72	11	108	6	33		2,241
Kansas	18	1	94	8	95	7			2	225
Minnesota	240	428	1,961	346	43	63	5	10	140	3,236
Missouri	155	73	2,439	335	971	92	26	115	408	4,614
Nebraska and South Dakota	51	8	160	2	49	51			1	322
Total	506	591	6,542	763	1,169	321	37	158	551	10,638
South Atlantic:										
Delaware	1	10	527	12	8	11				569
Florida	35	13	72	2		139	2		96	359
Georgia	3	369	30	1		3			2	408
Maryland and District of Columbia	52	98	260	20		73	10	107	47	667
North and South Carolina	9	26	47	386	143	15	1	2	1	630
Virginia	400	213	146	121	135	27	11		5	1,058
West Virginia		78	5,055	58	348	33				5,572
Total	500	807	6,137	600	634	301	24	109	151	9,263

East South Central:										
Alabama	32	416	4,723	169	930	519	11	24	185	7,009
Kentucky		236	299	43	5,778	8			24	6,388
Mississippi	1		4			11				16
Tennessee	76	147	794	1,110	80	40	4			2,251
Total	109	799	5,820	1,322	6,788	578	15	24	209	15,664
West South Central:										
Arkansas and Louisiana	29	17	37	16		20			3	122
Oklahoma	327	367	130	84	4		5		13	930
Texas	81	27	2,064	147	12	222	5	2	77	2,637
Total	437	411	2,231	247	16	242	10	2	93	3,689
Mountain:										
Arizona, Colorado, and New Mexico	94	41	172	26	1	23			1	358
Idaho, Montana, and Utah		3								3
Total	94	44	172	26	1	23			1	361
Pacific:										
California	339	867	12,624	873	1,194	629	70	40	354	16,990
Oregon	4		10	446		5			13	478
Washington	50	15	65	22	1	105	6		2	266
Total	393	882	12,699	1,341	1,195	739	76	40	369	17,734
Grand total	12,831	24,303	143,268	19,296	17,991	13,045	1,434	3,046	7,283	242,497

TABLE 15.—Foundry consumption of brass ingot in the United States, percent by type of ingot, 1949–54

(Percent of total)

Type of ingot	Tin bronze	Leaded tin bronze	Leaded red brass	High-leaded tin bronze	Leaded yellow brass	Manganese bronze	Hardeners	Nickel silver	Low brass	Total consumption, tons
1949	5.6	15.2	57.9	6.1	7.2	4.3	1.0	0.7	2.0	162,188
1950	4.4	15.0	61.8	4.6	6.9	3.7	1.3	.6	1.7	273,433
1951	6.1	15.8	54.2	7.5	7.5	4.9	1.2	.6	2.2	325,786
1952	7.2	12.5	54.5	8.1	6.7	6.6	.8	1.3	2.3	268,651
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

TABLE 16.—Brass and copper scrap imported into and exported from the United States' 1945–49 (average) and 1950–54, in short tons

[U. S. Department of Commerce]

	1945–49 (average)	1950	1951	1952	1953	1954
Imports for consumption:						
Brass scrap (gross weight)	45,537	37,537	6,523	10,321	9,679	5,272
Copper scrap (copper content)	4,887	34,242	6,792	5,125	7,827	4,752
Exports:						
Brass scrap	5,062	9,054	4,857	[1] 6,261	[1] [2] 33,680	[1] 93,972
Copper scrap	2,512	9,445	7,701	8,941	34,568	75,776

[1] Copper-base alloy scrap (new and old); not strictly comparable to earlier years.
[2] Revised figure.

TABLE 17.—Dealers' average monthly buying prices for copper scrap and consumers' alloy-ingot prices at New York in 1954, in cents per pound

[Metal Statistics, 1955]

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
No. 1 heavy copper scrap	22.55	22.19	23.41	24.10	24.67	24.75	24.75	24.75	25.10	25.65	25.99	26.62	24.54
No. 1 composition scrap	16.39	15.94	17.12	17.90	19.00	19.25	19.25	19.25	19.45	20.12	20.55	21.00	18.77
No. 1 composition ingot	24.50	23.72	23.56	25.67	26.50	27.00	27.00	27.51	28.34	29.31	29.50	29.93	26.88

SECONDARY LEAD

In 1954 secondary lead recovered totaled 481,000 short tons valued[8] at $132 million, a decrease of 1 percent in quantity from the 487,000 tons valued at $128 million reclaimed in 1953. For the ninth successive year secondary lead recovery exceeded domestic mine recovery (325,000 tons) and also was greater than imports of lead (443,000 tons).

[8] Values are computed at 13.7 cents per pound for 1954 and 13.1 cents for 1953, the average weighted prices for all grades of refined lead sold by producers in those years.

TABLE 18.—Lead recovered from scrap processed in the United States, 1953–54, in short tons

Recoverable lead content of scrap processed			Lead recovered from scrap processed		
Kind of scrap	1953	1954	Form of recovery	1953	1954
New scrap:			As metal:		
Lead-base	49,902	49,657	At primary plants	4,211	5,066
Copper-base	8,085	6,281	At other plants	122,363	114,941
Total	57,987	55,938	Total	126,574	120,007
Old scrap:					
Battery-lead plates	247,332	258,438	In antimonial lead [1]	236,555	238,839
All other lead-base	152,897	143,825	In other lead alloys	92,379	98,584
Copper-base	28,498	22,708	In copper-base alloys	30,826	23,341
Tin-base	23	16	In tin-base alloys	403	154
Total	428,750	424,987	Total	360,163	360,918
Grand total	486,737	480,925	Grand total	486,737	480,925

[1] Includes 36,749 tons of lead recovered in antimonial lead from secondary sources at primary plants in 1953 and 43,555 tons in 1954.

The total consumption of lead scrap was 2 percent greater in 1954 than in 1953, but secondary lead recovery from lead scrap was about the same in each year. The largest tonnage increases in scrap consumption were 17,000 tons (4 percent) in battery plates and 4,000 tons (5 percent) in drosses and residues. The largest decreases were 6,700 tons (10 percent) in soft lead scrap and 6,000 tons (28 percent) in common babbitt. Plate scrap was the most important and available item. Lead dross and slags are low-grade scrap, because, as tapped or skimmed from the lead furnace or melting pot, they contain oxides, flux, and impurities that have risen to the top of the molten lead and been absorbed by the flux. The lead oxides are reduced to lead in the blast furnaces or cupolas commonly used by secondary lead smelters in making antimonial lead. It is more practicable for secondary smelters to reduce oxides of lead than those of other metals. Reduction of oxides of copper is accomplished in cupolas or blast furnaces by a few secondary smelters, but those of aluminum and zinc are reduced only at primary plants, as explained in the sections of this chapter devoted to those metals.

From lead-consumption reports and visits to plants of producers of antimonial lead and lead storage batteries it was learned that the performance of automobile battery grids has been improved in recent years by changes in composition; these changes include the reduction of the antimony content to about 7 percent, the addition of about 0.3 percent of arsenic, and the addition of smaller percentages of other metals, such as silver, tin, and tellurium. The addition of small quantities of silver allows reduction in the antimony content of the grids and thus decreases undesirable local action within the battery. The arsenic inhibits plate corrosion due to overcharging when automobile voltage regulators get out of adjustment. These changes have increased the life of batteries, thus tending to decrease the ratio of battery-lead plate scrap generated to automobile miles driven. Battery-plate scrap consumption in 1948 (384,000 tons) approximately equaled that in 1954 (389,000 tons), but many more automobiles were in opera-

TABLE 19.—Stocks and consumption of new and old lead scrap in the United States in 1954, 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	3,960	63,624		62,978	62,978	4,606
Hard lead	3,624	18,916		19,717	19,717	2,823
Cable lead	352	24,677		24,198	24,198	831
Battery-lead plates	23,729	395,677		388,613	388,613	30,793
Mixed common babbitt	426	5,737		5,711	5,711	452
Solder and tinny lead	796	15,920		16,267	16,267	449
Type metals	734	19,234		18,800	18,800	1,168
Dross and residues	24,999	76,022	81,502		81,502	19,519
Total	58,620	619,807	81,502	536,284	617,786	60,641
Foundries and other manufacturers:						
Soft lead	290	515	16	588	604	201
Hard lead	154	570	23	515	538	186
Cable lead	14	8				22
Battery-lead plates	60	46		17	17	89
Mixed common babbitt	429	9,841	80	9,741	9,821	449
Solder and tinny lead	574	1,548	1,414	188	1,602	520
Type metals	3	62		61	61	4
Dross and residues	120	102	147		147	75
Total	1,644	12,692	1,680	11,110	12,790	1,546
Grand total:						
Soft lead	4,250	64,139	16	63,566	63,582	4,807
Hard lead	3,778	19,486	23	20,232	20,255	3,009
Cable lead	366	24,685		24,198	24,198	853
Battery-lead plates	23,789	395,723		388,630	388,630	30,882
Mixed common babbitt	855	15,578	80	15,452	15,532	901
Solder and tinny lead	1,370	17,468	1,414	16,455	17,869	969
Type metals	737	19,296		18,861	18,861	1,172
Dross and residues	25,119	76,124	81,649		81,649	19,594
Total	60,264	632,499	83,182	547,394	630,576	62,187

[1] Revised figures.

tion in 1954 than in 1948. The significance of these changes to the secondary smelter is that generation of battery-plate scrap may decline in relation to demand and that production of refined lead from this scrap will involve removal of a greater variety of metals than previously. A factor tending to increase the quantity of lead per battery in 1954 was the trend toward use of the 12-volt battery in automobiles.

Secondary lead recovered in copper-base alloys, as shown in table 18, was 7,000 tons less in 1954 than in 1953 because less copper-base scrap, in which all this lead was contained, was used in 1954 than in 1953. Secondary lead recovered as metal declined from 127,000 tons in 1953 to 120,000 in 1954 because cable lead, which contains about 1 percent antimony, has been shown combined with antimonial lead in 1954, whereas in 1953 it was shown as recovered as metal. Lead recovered from lead-base scrap, both old and new, was 452,000 tons in 1954 compared with 450,000 in 1953. Quantities in the shipment table (table 20) are approximately equal to secondary production. As shown in table 20, secondary lead in lead-solder shipments increased 21 percent but decreased 27 percent in common babbitt and 39 percent in type metals, compared with corresponding data for 1953.

Primary refiners recovered 48,600 tons of lead from scrap in 1954, or 11 percent of the total secondary lead recovered. Of the former total, 5,100 tons was refined lead, and 43,500 tons was in antimonial lead. Corresponding quantities in 1953 were 40,900, 4,200, and 36,700 tons, respectively. Table 21 presents a breakdown of shipments of secondary lead and tin products by type of plant. About 86 percent of the shipments in 1954 was made by secondary smelters, 10 percent by primary producers, and 4 percent by manufacturers and foundries.

TABLE 20.—Secondary metal content of shipments [1] of secondary lead and tin products in the United States in 1954, gross weight in short tons

Products	Lead	Tin	Antimony	Copper	Total
Refined pig lead	103,345				103,345
Remelt lead	15,884				15,884
Lead foil	778				778
Total	120,007				120,007
Refined pig tin		3,127			3,127
Remelt tin		157			157
Tin foil					
Total		3,284			3,284
Lead and tin alloys:					
Antimonial lead	238,839	323	15,726	25	254,913
Common babbitt	16,740	1,204	2,018	34	19,996
Genuine babbitt	38	261	33	23	355
Other tin babbitts	116	549	113	51	829
Solder	45,985	7,924	1,805	9	55,723
Type metals	18,994	1,028	2,505	3	22,530
Cable lead [2]	15,969	4	96	13	16,082
Miscellaneous lead-tin alloys	711	20	38		769
Total	337,392	11,313	22,334	158	371,197
Composition foil	185	110	24		319
Tin content of chemical products		662			662
Grand total	457,584	15,369	22,358	158	495,469

[1] Most of the figures herein represent shipments rather than production of the items involved. However, it has been necessary to record actual production figures in some instances where the information is procured from reports on that basis.
[2] Formerly included in "remelt lead."

TABLE 21.—Shipments of secondary lead and tin products in the United States in 1954, by type of plant, gross weight in short tons

Plant	Lead	Tin	Antimony	Copper	Total
Secondary smelters	397,213	10,992	19,413	136	427,754
Primary producers	48,621		1,565		50,186
Manufacturers and foundries	11,750	4,377	1,380	22	17,529
Total	457,584	15,369	22,358	158	495,469

The shipments by smelters consisted chiefly of refined lead, and lead and tin alloys in pig, bar, or ingot form, but some fabricated products were made and shipped by these plants and 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. Solder

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and babbitt in bar form were included in the pig, bar, or ingot classification.

About nine-tenths of the total shipments of secondary lead and tin products by manufacturers and foundries was made by bearing manufacturers and can companies. The former remelted and made new bearings from those worn out by railroads in line operations. Some of this work was done in plants owned by the railroads and some in other plants as a toll operation. The can companies' secondary output was contained in solder used in making cans. The remaining tenth of the shipments by this group was made by nonferrous foundries and miscellaneous manufacturers of lead and tin products. The output by all plants recorded as manufacturers and foundries was chiefly fabricated products, but a little was in pig, bar, or ingot form.

Recovery of secondary metals from lead and tin scrap in 1954 was largest in March, when 39,000 tons of metal was recovered. The fourth quarter, when 112,000 tons was reclaimed, was the best quarter of the year for secondary production. Battery-plate smelting charges, an indicator of lead-scrap supply and demand, were high in January and February at $68 and $75 per ton, respectively, when scrap was plentiful, gradually decreased to $50 in the summer months of June, July, and August, when scrap was scarcer, and increased again to $65 in December.

Percentage and remelt metals reshipped within the secondary lead industry in 1954 totaled about 25,400 tons. Shipments consisted of 5,000 tons of solder, 2,300 tons of common babbitt, 8,700 tons of soft lead, 7,000 tons of antimonial lead, 1,700 tons of type metals, 300 tons of cable lead, 300 tons of tin-base babbitt, and 70 tons of remelt tin. These shipments were in addition to the 383,000 tons of secondary metals in pig form and 75,200 tons of fabricated products shipped to consumers by smelters.

The price of primary lead at New York was 13.50 cents per pound from January 1 to January 18, when it fell to 13.00 cents. On February 18 the price dropped to 12.50 cents but started upward on March 9 and, after several changes, reached 15.00 cents on October 5, where it stayed for the remainder of the year.

TABLE 22.—Dealers' monthly average buying prices for lead scrap and prices of refined lead at New York and average battery-plate smelting charges in 1954

[American Metal Market]

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
							Cents per pound						
No. 1 heavy scrap lead	10.01	9.54	9.82	11.04	11.12	11.23	11.12	11.18	11.66	11.75	11.75	11.75	11.00
Refined lead	13.25	12.82	12.93	13.91	14.00	14.11	14.00	14.06	14.60	14.97	15.00	15.00	14.05
							Dollars per ton						
Battery-plate smelting charge	68	75	60	54	57	50	50	50	52	57	62	65	58

SECONDARY MAGNESIUM

Secondary magnesium recovered from scrap in 1954, including that treated on toll, totaled 8,300 short tons valued [9] at $4,455,000, compared with 11,900 tons valued at $6,347,000 in 1953.

TABLE 23.—Magnesium recovered from scrap processed in the United States, 1953–54, in short tons

Recoverable magnesium content of scrap processed			Magnesium recovered from scrap processed		
Kind of scrap	1953	1954	Form of recovery	1953	1954
New scrap:					
Magnesium-base	3,945	3,305	In magnesium-alloy ingot [1]	6,710	3,581
Aluminum-base	1,947	1,692	In magnesium-alloy castings	436	289
			In magnesium-alloy shapes	3	3
Total	5,892	4,997	In aluminum alloys	3,113	2,602
Old scrap:			In zinc and other alloys	4	8
Magnesium-base	5,393	2,682	In chemical and other dissipative uses	86	2
Aluminum-base	645	571	In cathodic protection	1,578	1,765
Total	6,038	3,253	Grand total	11,930	8,250
Grand total	11,930	8,250			

[1] Figures include secondary magnesium incorporated in primary magnesium ingot.

The 3,700-ton decrease in recovery of secondary magnesium in 1954 was due largely to a 3,100-ton drop in recovery of that metal in magnesium alloy ingot and a 500-drop in aluminum alloys, which was partly counter balanced by a 200-ton increase in secondary magnesium used in cathodic protection. Magnesium recovered in aluminum alloys declined in 1954 because less magnesium-containing aluminum scrap was reported used in 1954.

TABLE 24.—Stocks and consumption of new and old magnesium scrap in the United States in 1954, gross weight in short tons

Scrap item	Stocks, beginning of year	Receipts	Consumption			Stocks, end of year
			New scrap	Old scrap	Total	
Cast scrap	971	3,894	1,068	3,274	4,342	523
Solid wrought scrap	[1] 135	945	1,039		1,039	41
Borings, turnings, drosses, etc	[1] 89	2,075	2,113		2,113	51
Total	[1] 1,195	6,914	4,220	3,274	[2] 7,494	615

[1] Revised figure.
[2] Includes 351 tons consumed in making magnesium castings, 3 tons in wrought products, 409 tons in aluminum alloys, 9 tons in other alloys, 4,499 tons in magnesium-alloy ingot, 2,221 tons in cathodic protection and 2 tons in miscellaneous dissipative uses.

The total consumption of magnesium-base scrap declined 31 percent from 11,600 tons in 1953 to 7,500 tons in 1954, whereas consumption of primary magnesium decreased 12 percent from 47,000 (revised) tons in 1953 to 41,000 tons in 1954. However, magnesium scrap used in magnesium products, including magnesium-alloy ingot, magnesium castings, and magnesium wrought products, decreased 45 percent, or

[9] Values were calculated at 26.6 cents per pound in 1953 and 27.0 cents in 1954, the average prices paid for primary magnesium ingot (98.5 percent) f.o.b. Freeport, Tex., during the 2 years.

to 4,900 tons, compared with a decrease of 48 percent, or to 18,000 tons, for primary magnesium used in magnesium products. These decreases were due chiefly to the general decline in business in 1954 compared with 1953. In 1954 no magnesium scrap was reported used in making primary magnesium ingot, but 3,800 tons of magnesium cast scrap was so used in 1953, which accounts for most of the 4,000-ton decrease in total consumption of scrap in 1954. Consumption of magnesium residues increased about 6 percent to 2,100 tons. Tonnage of magnesium scrap used in secondary magnesium ingot was about 4,500 tons in both years. Alloy ingot, whatever its quality and metal content, is considered to be a secondary product if its content exceeds 50 percent secondary metal and to be a primary product if its content exceeds 50 percent primary metal.

SECONDARY NICKEL

The recovery of secondary nickel from nonferrous scrap, totaled 8,600 short tons, valued[10] at $10,800,000, in 1954—an increase of 3 percent in quantity over the 8,400 tons, valued at $10,400,000, recovered in 1953. The greatest recovery of secondary nickel was in copper-base alloys, which supplied 2,800 tons in 1954 compared with 3,000 in 1953. The decline chiefly resulted from decreased consumption of nickel silver scrap—from 13,000 tons in 1953 to 11,400 tons in 1954. Most of the secondary nickel recovered in copper-base alloys was contained in nickel-silver scrap used in making copper alloys. The second largest recovery of secondary nickel in 1954 was the nickel in nickel scrap added to melts of steel alloys, which amounted to 2,000 tons, or 24 percent of the total secondary nickel recovered, compared with 18 percent in 1953.

TABLE 25.—Nickel recovered from scrap processed in the United States, 1953–54, in short tons

Recoverable nickel content of scrap processed		
Kind of scrap	1953	1954
New scrap:		
Nickel-base	1,046	2,114
Copper-base	1,702	1,592
Aluminum-base	368	289
Total	3,116	3,995
Old scrap:		
Nickel-base	4,623	4,194
Copper-base	472	313
Aluminum-base	140	103
Lead-base	1	--------
Total	5,236	4,610
Grand total	8,352	8,605

Nickel recovered from scrap processed		
Form of recovery	1953	1954
As metal	989	1,324
In nickel-base alloys	1,184	1,030
In copper-base alloys	3,032	2,785
In aluminum-base alloys	542	395
In lead-base alloys	26	12
In cast iron and steel [1]	1,518	2,030
In chemical compounds	1,061	1,029
Grand total	8,352	8,605

[1] Includes only nonferrous nickel scrap added to cast iron and steel.

[10] These values were computed at 62.88 cents a pound for 1954 and 62.26 cents a pound for 1953, the average spot-delivery price of Grade F nickel ingot and shot in 10,000-pound lots at New York.

The total consumption of nickel scrap was virtually the same in 1954 as in 1953, but the total recovery of nickel was greater in 1954 because of the increase of 79 percent, or to 3,200 tons, in consumption of unalloyed nickel scrap. This change made the nickel content of the total scrap treated in 1954 higher than the nickel content of that treated in 1953. The copper content of the nickel scrap treated in 1954 was lower than in 1953 because less Monel scrap, which is one-third copper, was consumed in 1954.

The total 1954 consumption of nickel scrap (8,100 tons), was less than one-tenth of the consumption of refined nickel, whereas the total consumption of copper scrap (1,229,000 tons) was on the same level as consumption of refined copper (1,255,000 tons). A main reason for the difference in ratios is that the nickel content of the iron and steel scrap consumed and the nickel in the plating on it are not included in the data presented here. Primary nickel used for these purposes in 1954 totaled 60,000 tons, much of which will eventually return for consumption in ferrous scrap form.

TABLE 26.—Stocks and consumption of new and old nickel scrap in the United States in 1954, 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	88	1,715	124	1,373	1,497	306
Monel metal	369	2,020	474	1,460	1,934	455
Nickel silver	[1] 481	[1] 2,608	[1] 368	[1] 2,161	[1] 2,529	[1] 560
Miscellaneous nickel alloys	25	2	7	14	21	6
Nickel residues	37	537		508	508	66
Total	519	4,274	605	3,355	3,960	833
Foundries and plants of other manufacturers:						
Unalloyed nickel	221	1,700	1,435	286	1,721	200
Monel metal	231	636	88	449	537	330
Nickel silver	[1] 1,734	[1] 8,399	[1] 8,794	[1] 38	[1] 8,832	[1] 1,693
Miscellaneous nickel alloys	22	315	40	273	313	24
Nickel residues	196	1,623	348	1,231	1,579	240
Total	670	4,274	1,911	2,239	4,150	794
Grand total:						
Unalloyed nickel	309	3,415	1,559	1,659	3,218	506
Monel metal	600	2,656	562	1,909	2,471	785
Nickel silver	[1] 2,215	[1] 11,007	[1] 9,162	[1] 2,199	[1] 11,361	[1] 2,253
Miscellaneous nickel alloys	47	317	47	287	334	30
Nickel residues	233	2,160	348	1,739	2,087	306
Total	1,189	8,548	2,516	5,594	8,110	1,627

[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 spot delivery price of Grade F nickel ingot and shot in 10,000-pound lots at New York was 62.42 cents per pound from the beginning of 1954 until November 24, when it was raised to 66.92 cents. It continued at that figure for the remainder of the year. Dealers' buying prices for nickel clippings at New York, as published in the American Metal Market, ranged from 60 to 65 cents per pound during the period from January 1 to November 19, when they declined to 55 cents and then increased to 57 cents before the end of the year. The prices of Monel clippings ranged from 22 cents to 28 cents; price fluctuations paralleled those of nickel clippings.

Imports of nickel scrap in 1952, 1953, and 1954 were 500, 900, and 400 tons, respectively.

SECONDARY TIN

Secondary tin recovered in 1954 totaled 29,300 short tons, valued [11] at $53,900,000, a 5-percent decrease in quantity from the 30,900 tons valued at $59,200,000 in 1953. The decline in total recovery was due chiefly to a 1,300-ton decrease in the recoverable tin content of old copper-base scrap consumed by foundries in 1954. As in previous years, more tin was salvaged from copper scrap than from lead scrap, and more from lead scrap than from tin scrap.

TABLE 27.—Tin recovered from scrap processed in the United States, 1953–54, in short tons

Recoverable tin content of scrap processed			Tin recovered from scrap processed		
Kind of scrap	1953	1954	Form of recovery	1953	1954
New scrap:			As metal:		
Tin plate	3,392	3,521	At detinning plants	2,993	3,030
Tin-base	1,035	1,341	At other plants	208	254
Lead-base	2,394	2,301	Total	3,201	3,284
Copper-base	2,654	3,118	In solder	8,536	7,924
Total	9,475	10,281	In tin babbitt	734	810
Old scrap:			In chemical compounds	555	662
Tin cans	80	49	In lead-base alloys	4,296	2,689
Tin-base	2,889	2,360	In brass and bronze	13,592	13,965
Lead-base	7,279	7,110	Total	27,713	26,050
Copper-base	11,191	9,534			
Total	21,439	19,053			
Grand total	30,914	29,334	Grand total	30,914	29,334

In the secondary tin content of products, as shown in table 27, the greatest decrease in 1954 was 37 percent or to 2,700 tons in secondary tin recovered in lead-base alloys. The only other loss was 7 percent or to 7,900 tons in solder, slight increases being registered in all other products shown in the table. Tinplate scrap and old tin cans provided only 12 percent (3,600 tons) of the total secondary tin recovered in 1954, although 40 percent (37,000 tons) of the total tin used was devoted to making tinplate. In comparison, solder scrap provided 27 percent of the total secondary tin recovered, and 23 percent (21,000 tons) of the total tin used was devoted to making solder. In 1954 the secondary tin industry consumed 4,908 short tons of tin-base scrap, from which 3,701 tons of tin was recovered. This represents 1,508 pounds of tin per ton of tin-base scrap treated. The corresponding recovery for 1953 was 1,525 pounds, when 5,147 tons of tin-base scrap was treated. The metal recovered from tin-base scrap averaged 98 percent tin. Metals other than tin recovered from tin-alloy scrap, either separately or still alloyed with the tin, were 120 tons of anti-

[11] Values are computed at 91.81 cents per pound in 1954 and 95.77 cents in 1953, the average New York selling price for Straits tin in each year.

mony, 16 tons of lead, and 69 tons of copper—a total of 205 tons or 5 percent of the total metal recovered from tin-base scrap.

Consumption of tin-base scrap by smelters and other consumers dropped 5 percent below that for 1953 to a total of 4,900 tons. Use of tin scruff and dross, containing on an average 60 percent metal, chiefly tin, increased from 1,100 tons in 1953 to 1,800 tons in 1954, whereas treatment of high-tin babbitt, a higher-grade item, containing about 90 percent metal, including tin, lead, and antimony, decreased from 2,400 tons to 1,700 in the same period. These two comprised about three-fourths of the total tin scrap treated in each year.

Research conducted by the Bureau of Mines at its Northwest Electrodevelopment Laboratory in Albany, Oreg., resulted in development of a method for recovering lead and tin from solder dross generated in canning operations. Recovery was difficult because such dross is contaminated with zinc chloride from the flux used in the soldering operation. The basis of the new method of treating the dross includes water leaching followed by smelting with a sodium carbonate-borax flux, with coke as a reducing agent. At the end of 1954 experimental work had been completed, and a report was in preparation.

TABLE 28.—Stocks and consumption of new and old tin scrap in the United States in 1954, 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	31	741		730	730	42
Tin scruff and dross	488	1,553	1,804		1,804	237
No. 1 pewter	22	56		57	57	21
High-tin babbitt	212	1,634		1,723	1,723	123
Residues	327	417	555		555	189
Total	1,080	4,401	2,359	2,510	4,869	612
Foundries and other manufacturers:						
Block-tin pipe, scrap, and foil	8	15	5	10	15	8
High-tin babbitt	4	23	4	19	23	4
Residues	1	1	1		1	1
Total	13	39	10	29	39	13
Grand total:						
Block-tin pipe, scrap, and foil	39	756	5	740	745	50
Tin scruff and dross	488	1,553	1,804		1,804	237
No. 1 pewter	22	56		57	57	21
High-tin babbitt	216	1,657	4	1,742	1,746	127
Residues	328	418	556		556	190
Total	1,093	4,440	2,369	2,539	4,908	625

[1] Revised figures.

Secondary tin recovered by detinning plants, as metal and in chemical compounds, increased 4 percent in 1954. The total tin recovered was 3,690 short tons in 1954 compared with 3,550 in 1953. Tinplate clippings and old cans were the source of 3,570 tons in 1954, 2,970 of which was reclaimed as metal and 600 tons in the form of tin compounds. In 1953 such materials provided 3,470 tons of tin, 2,970 tons as metal, and 500 tons in compounds. The treatment of other tin-bearing materials accounted for the remaining production of 120 tons in 1954 and 80 tons in 1953.

TABLE 29.—Tin recovered from scrap processed at detinning plants in the United States, 1953–54

	1953	1954
Scrap treated:		
Clean tinplate clippings……long tons..	526,226	566,377
Old tin-coated containers……do….	10,850	6,348
Total……do….	537,076	572,725
Tin recovered:		
From new tinplate clippings……short tons..	3,392	3,521
From old tin-coated containers……do….	80	49
Total……do….	3,472	3,570
Form of recovery:		
As metal……short tons..	2,966	2,974
In compounds……do….	506	596
Total [1]……do….	3,472	3,570
Weight of tin compounds produced……short tons..	1,125	1,014
Average quantity of tin recovered per long ton of clean tinplate scrap used..pounds..	12.88	12.43
Average quantity of tin recovered per long ton of old tin-coated containers used..do…	14.81	15.55
Average delivered cost of clean tinplate scrap……per long ton..	$28.81	$18.04
Average delivered cost of old tin-coated containers……do….	$32.53	$21.05

[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 76 tons from these sources in 1953.

The tonnage of tinplate clippings treated in 1954—566,400 long tons—was the largest on record; this was 8 percent more than the previous peak of 526,200 tons in 1953. The average cost of such clippings, delivered to plants, decreased from $28.81 a long ton in 1953 to $18.04 in 1954. One of the products of the detinning industry is steel scrap, which is sold to open-hearth mills. The average quoted composite price of steel scrap declined from $39.52 per gross ton in 1953 to $28.59 in 1954. Old cans processed decreased from 10,900 long tons in 1953 to only 6,400 tons in 1954. Tin recovered from tinplate clippings in 1954 was 3,500 short tons, 4 percent more than 1953, while that from old cans (50 tons) decreased 39 percent. Much larger quantities of tin could have been recovered from old tin cans but for the difficulty of gathering them and delivering them to detinning plants.

The average quantity of tin recovered per long ton of tinplate scrap treated was 12.43 pounds in 1954, compared with 12.88 pounds in 1953. The lower recovery continued to reflect treatment of a larger proportion of electrolytic tin plate carrying a thinner coating of tin. The average quantity of tin recovered per long ton of old tin cans increased from 14.81 pounds in 1953 to 15.55 pounds in 1954.

Imports of tinplate scrap were 29,200 long tons in 1954 as compared with 37,600 in 1953. Exports of tinplate scrap in 1954 were 940 long tons (5,200 in 1953), mostly to Mexico.

TABLE 30.—Tinplate scrap imported for consumption in the United States, by countries, 1953–54, in long tons

[U. S. Department of Commerce]

Country	1953	1954
North America:		
Canada	23, 930	25, 144
Cuba	1, 243	1, 133
Total	25, 173	26, 277
Europe:		
Finland	210	
France	98	
Iceland	11	22
United Kingdom	24	
Total	343	22
Asia: Philippines	45	
Africa:		
Algeria	705	614
British East Africa	80	40
French Morocco	3, 373	809
Madagascar		25
Tunisia	184	135
Union of South Africa	1, 935	1, 249
Total	6, 277	2, 872
Oceania:		
Australia	5, 460	
New Zealand	284	
Total	5, 744	
Grand total	37, 582	29, 171

SECONDARY ZINC

Secondary zinc recovered in 1954 from purchased scrap and residues totaled 272,000 short tons, valued[12] at $58,703,000, compared with 295,000 tons, valued at $67,800,000, recovered in 1953. The decreased recovery in 1954 was the result of lower consumption of copper-base scrap with consequent lessened recovery of zinc.

Zinc recovered from new copper scrap in brass and bronze products in 1954 decreased 29,000 tons to a total of 88,000 tons, whereas zinc recovered from old zinc scrap increased 8,000 tons. Recovery of zinc from zinc scrap in zinc metal products, including redistilled slab, zinc dust, remelt spelter, and in zinc alloys, totaled 111,000 tons, or 24,000 tons more than in 1953. Secondary zinc recovery in zinc chemicals and in aluminum alloys declined 25 and 22 percent, respectively. Total zinc recovered from zinc-base scrap in 1954 (137,000 tons) was greater than zinc recovered from copper-base scrap (132,000 tons) for the first time since 1950.

Consumption of sal skimmings declined 18 percent to 21,000 tons in 1954. Most of it was used in making zinc chloride and zinc ammonium chloride, but a little was distilled to make slab zinc. This residue, like flue dust, was generated beyond the capacity of industry to use it. Investigations at Bureau of Mines laboratories of the Eastern Experiment Station in College Park, Md., have demonstrated the feasibility of recovering high-purity zinc and chlorine from sal

[12] Values were calculated at the average weighted price for all grades of refined zinc, which was 10.8 cents per pound in 1954 and 11.5 cents in 1953.

TABLE 31.—Zinc recovered from scrap processed in the United States, 1953–54, in short tons

Recoverable zinc content of scrap processed		
Kind of scrap	1953	1954
New scrap:		
Zinc-base	110,774	109,236
Copper-base	117,611	88,291
Aluminum-base	1,985	1,526
Magnesium-base	73	64
Total	230,443	199,117
Old scrap:		
Zinc-base	19,622	27,558
Copper-base	42,888	43,760
Aluminum-base	1,604	1,279
Magnesium-base	121	60
Total	64,235	72,657
Grand total	294,678	271,774

Zinc recovered [1] from scrap processed		
Form of recovery	1953	1954
As metal:		
By distillation:		
Slab zinc	50,344	[2] 67,381
Zinc dust	22,185	23,893
By remelting	6,116	7,247
Total	78,645	98,521
In zinc-base alloys	8,535	12,506
In brass and bronze	168,951	131,602
In aluminum-base alloys	3,673	2,854
In magnesium-base alloys	194	213
In chemical products:		
Zinc oxide (lead-free)	11,430	9,489
Zinc sulfate	4,566	2,996
Zinc chloride	12,981	11,117
Lithopone	5,008	1,998
Miscellaneous	695	478
Total	216,033	173,253
Grand total	294,678	271,774

[1] Zinc content.
[2] Includes zinc content of redistilled slab made from remelt die-cast slab.

skimmings, using amalgam-metallurgy techniques. Impure zinc chloride electrolyte was prepared by leaching skimmings with water and hydrochloric acid. The electrolyte was used in an amalgam cell to produce chlorine and zinc amalgam. Zinc amalgam was subsequently refined in another electrolytic cell, producing zinc of 99.99-percent purity. By the end of 1954, laboratory work on this project had been completed, and a report was being prepared.

Coke is sometimes used as a reducing agent, with sal ammoniac as a flux, in recovering metallic zinc from die-cast skimmings. In this operation it is questionable whether any zinc oxide is reduced to zinc; but the coke may, to some extent, prevent the metallic zinc from oxidizing. Consumption of die-cast skimmings increased from 6,500 tons in 1953 to 9,500 in 1954. This residue is generated in small quantities when zinc die-cast or die alloys are melted to make die castings or dies. Usually no flux is used in this operation. When obsolete or scrap dies or die castings are melted, skimmings are generated in larger quantities, and flux is used if the plant is in an area where fumes are not prohibited. If fumes are prohibited, the melting is often done without flux. In this case the resulting skimmings contain up to 90 percent zinc, including metal and oxide. From 10 to 40 percent of the zinc content of the skimmings can be recovered by remelting and still more if melted with flux. If flux is used in melting scrap dies or die castings, the zinc content of the skimmings generated runs from 60 percent to 85 percent depending upon the proportion of flux used. Die-cast skimmings are generally sold to zinc distillers or secondary smelters whose equipment is better adapted to smoke control than the facilities of die casters, or which are located where strict limitation of smoke is unnecessary.

TABLE 32.—Production of secondary zinc and zinc-alloy products in the United States, 1945–49 (average) and 1950–54, gross weight in short tons

Products	1945–49 (average)	1950	1951	1952	1953	1954
Redistilled slab zinc	54,132	66,970	48,657	55,111	52,875	[1] 68,013
Zinc dust	25,881	27,507	29,754	25,113	25,297	26,714
Remelt spelter [2]	7,517	7,243	4,454	3,197	2,938	4,456
Remelt die-cast slab	7,992	12,647	5,596	7,098	5,695	9,418
Zinc-die and die-casting alloys	3,046	5,233	4,919	3,400	3,411	4,037
Galvanizing stock	667	354	198	203	107	186
Rolled zinc	2,735	3,589	3,474	2,948	3,132	2,701
Secondary zinc in chemical products	45,768	43,693	40,760	31,205	34,680	31,540

[1] Includes redistilled slab made from remelt die-cast slab.
[2] Contains small tonnages of bars, anodes, etc.

Production of redistilled slab in 1954 increased 29 percent to 68,000 tons, that of zinc dust (including both primary and secondary) 6 percent to 27,000 tons, and that of remelt die-cast slab 65 percent to 9,400 tons. Considerable quantities of remelt die-cast slab were redistilled to make redistilled slab zinc, and most of the production that was not redistilled was roasted to make zinc oxide or melted to make die castings. Zinc die-cast or die alloy is not, in general, suitable for use in brass ingot, because it contains 4 or 5 percent of aluminum, a metal used by secondary copper smelters only in aluminum-bronze or manganese-bronze alloys.

Consumption of zinc scrap in 1954 totaled 198,000 tons (5 percent above the 1953 total) owing to an 18,000-ton increase by the smelters and distillers; consumption by chemical plants and other manufacturers decreased 10,000 tons or 21 percent. The former group used 16,000 tons of flue dust in 1954 compared with 7,000 in 1953, most of it in distillation to slab zinc. A little was used in chemicals, but, being in oxide form, it was not suitable for smelting in blast or reverberatory furnace. Zinc oxide is commercially reduced to metal only in the distillation retort. Although flue dust generated at secondary copper smelters is chiefly zinc oxide, it is not pure and is not as readily refined to that product as chemical residues. In 1954 and in previous years flue dust was generated beyond the capacity of industry to use it.

All chemical residues that were reported consumed in 1954 were generated as a byproduct in the manufacture of sodium hydrosulfite used in paper manufacture, and the chief product from this consumption was lead-free zinc oxide, some of it pure enough for use in pharmaceuticals. A considerable quantity of chemical residues not reported as scrap was consumed in 1954, as well as in previous years. In chemical plants where the residues generated as a byproduct in making sodium hydrosulfite from zinc dust were used in the same plant to make zinc oxide, the production of the latter was reported as made from material other than scrap. The zinc content of the oxide so made in 1954 was 7,188 tons. Where the residues generated were shipped to a smelter or another chemical plant for processing to make zinc oxide, the production of the latter was reported as made from scrap. The demand for chemical residues for use as scrap was greater than the available supply.

TABLE 33.—Stocks and consumption of new and old zinc scrap in the United States in 1954, gross weight in short tons

Class of consumer and type of scrap	Stocks, beginning of year	Receipts	Consumption			Stocks, end of year
			New scrap	Old scrap	Total	
Smelters and distillers:						
Clippings	208	2,759	2,666	-----	2,666	301
Sheet and strip	564	4,373	-----	4,304	4,304	633
Engravers' plates	176	2,025	-----	1,783	1,783	418
Skimmings and ashes	3,396	34,441	32,532	-----	32,532	5,305
Sal skimmings	239	1,670	1,504	-----	1,504	405
Die-cast skimmings	1,275	9,785	9,451	-----	9,451	1,609
Galvanizers' dross	7,572	52,788	55,596	-----	55,596	4,764
Die castings	1,834	27,445	-----	26,388	26,388	2,891
Rod and die scrap	144	1,216	-----	1,077	1,077	283
Flue dust	214	19,015	16,083	-----	16,083	3,146
Chemical residues	117	12,015	9,716	-----	9,716	2,416
Total	15,739	167,532	127,548	33,552	161,100	22,171
Chemical plants, foundries, and other manufacturers:						
Clippings	80	3,612	3,556	-----	3,556	136
Sheet and strip	7	82	-----	79	79	10
Engravers' plates	1	141	-----	141	141	1
Skimmings and ashes	987	4,119	4,665	-----	4,665	441
Sal skimmings	7,375	22,029	19,122	-----	19,122	10,282
Galvanizers' dross	9	10	-----	-----	-----	19
Die castings	72	1,398	1,074	236	1,310	160
Rod and die scrap	12	39	-----	42	42	9
Flue dust	182	1,496	1,343	-----	1,343	335
Chemical residues	775	7,282	7,004	-----	7,004	1,053
Total	9,500	40,208	36,764	498	37,262	12,446
Grand total:						
Clippings	288	6,371	6,222	-----	6,222	437
Sheet and strip	571	4,455	-----	4,383	4,383	643
Engravers' plates	177	2,166	-----	1,924	1,924	419
Skimmings and ashes	4,383	38,560	37,197	-----	37,197	5,746
Sal skimmings	7,614	23,699	20,626	-----	20,626	10,687
Die-cast skimmings	1,275	9,785	9,451	-----	9,451	1,609
Galvanizers' dross	7,581	52,798	55,596	-----	55,596	4,783
Die castings	1,906	28,843	1,074	26,624	27,698	3,051
Rod and die scrap	156	1,255	-----	1,119	1,119	292
Flue dust	396	20,511	17,426	-----	17,426	3,481
Chemical residues	892	19,297	16,720	-----	16,720	3,469
Total	25,239	207,740	164,312	34,050	198,362	34,617

Consumption of galvanizers' dross, which is generated, with zinc skimmings and sal skimmings, in hot-dip galvanizing operations, increased 4 percent to 56,000 tons in 1954. Of the total, 29,000 tons (52 percent) was used in manufacturing zinc dust and, as in other years, was the principal source of that product.

The products listed in table 34 are intermediate rather than end products and may have been used later in making others on the list. To avoid revealing individual company operations, when only 1 or 2 plants reported use of 1 kind of scrap in 1 kind of product, the consumption was assigned to "Miscellaneous zinc alloys" or "Miscellaneous zinc chemicals." Of the 198,000 tons of zinc scrap consumed in 1954, over 99 percent was used in zinc-base products; some primary materials were used in addition to scrap, or could have been used in all of these products except the remelt and redistilled items. Scrap, however, was the principal raw material in all products shown in the table except lead-free zinc oxide, which was made chiefly from ore.

TABLE 34.—Distribution of 1954 zinc scrap consumption, by type of product, gross weight in short tons

Type of scrap	Product in which scrap was used									Total zinc, scrap consumption
	Redistilled slab	Remelt spelter and rolled zinc	Remelt die-cast slab	Miscellaneous zinc alloys	Zinc dust	Zinc oxide, lead-free	Zinc chloride [1]	Miscellaneous zinc chemicals	Brass and bronze	
New clippings	638	4,337	320	78				34	815	6,222
Old zinc	1,244	1,841	329			207		22	740	4,383
Engravers' plates	768	465	58	228				134	272	1,925
Skimmings and ashes	31,918	478		136			[2] 4,665			37,197
Sal skimmings	449						20,066	111		20,626
Die-cast skimmings	4,469		3,203	1,779						9,451
Galvanizers' dross	17,221	397		20	29,028	8,930				55,596
Die-cast and rod and die scrap	9,566		[3] 12,825	113		5,964		42	307	28,817
Flue dust	16,083							1,343		17,426
Chemical residues				142		[4] 16,228		350		16,720
										198,363

[1] Includes zinc ammonium chloride.
[2] Used in production of zinc chloride, zinc ammonium chloride, zinc sulfate, and lithopone.
[3] Includes 1,283 tons used in making die castings or dies.
[4] Used in producing zinc oxide and zinc sulfate.

TABLE 35.—Dealers' monthly average buying prices for zinc scrap at New York and prices of Prime Western zinc at East St. Louis in 1954, in cents per pound

[Metal Statistics, 1955]

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
New zinc clips	4.75	4.50	4.89	5.75	5.75	6.20	6.25	6.25	6.90	7.00	7.00	7.00	6.02
Old zinc	3.37	3.25	3.63	4.37	4.37	4.82	4.87	4.87	5.43	5.50	5.50	5.50	4.62
Prime Western zinc	9.75	9.37	9.66	10.25	10.29	10.96	11.00	11.00	11.44	11.50	11.50	11.50	10.69

Silver

By James E. Bell [1] and Kathleen M. McBreen [2]

WITH A MINE OUTPUT of recoverable silver totaling 36,941,400 fine ounces in 1954, the United States production of this metal declined for the fourth successive year. The 1954 output was 2 percent less than that of 1953 and 45 percent below the average for the 5 prewar years 1936–40. Among the principal silver-producing States, the output in 1954 was 1, 70, 23, 20, 47, 8, and 2 percent less in Arizona, California, Montana, Nevada, New Mexico, Utah, and Washington, respectively, than in the preceding year and 55 and 8 percent greater in Colorado and Idaho, respectively. The drop in the domestic output in 1954 reflected curtailed mining of base-metal ores containing byproduct silver, partly because of lower prices for lead and zinc and partly because of labor strikes.

Idaho maintained its position as the leading silver-producing State by a very wide margin, followed in order by Utah, Montana, and Arizona, which have held the same rank since 1943. These 4 States supplied 85 percent of the total domestic output of 1954. About two-thirds of Idaho's silver came from dry ore of which silver was the principal product. Virtually all the remaining United States silver output was recovered as a byproduct of ores mined principally for base metals or gold. Approximately 99 percent of the domestic silver production was recovered in smelting ores and concentrates.

Silver production outside the United States was 3 percent less in 1954 than in the preceding year, with gains in Canada, Australia, and Peru more than offset by drops in Mexico, Central America, and Bolivia. For more than a decade the world production rate of silver has remained far below prewar levels.

The United States Treasury buying price for domestic silver mined after July 1, 1946, remained unchanged at $0.9050505+ per fine troy ounce. The New York market held at $0.8525 per ounce of silver 0.999 fine during the entire year 1954, owing largely to the policy of the Bank of Mexico of buying or selling the Mexican silver output to stabilize the price to the greatest extent possible. The New York price continued to influence quotations for silver in other countries; and the London market was also remarkably stable in 1954, with prices ranging from 72d ($0.8453) to 74⅝d ($0.8660) per ounce 0.999 fine. The Bombay market remained under Government control, in

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

TABLE 1.—Salient statistics of silver in the United States,[1] 1945–49 (average) and 1950–54

	1945–49 (average)	1950	1951	1952	1953	1954
Mine production, fine ounces	32,106,669	42,459,014	39,764,932	39,452,330	37,570,838	36,941,384
Ore (dry and siliceous) produced (short tons):						
Gold ore	2,784,171	3,584,360	2,606,202	2,339,160	2,198,688	2,248,604
Gold-silver ore	402,961	433,461	368,184	237,211	81,658	46,345
Silver ore	349,068	627,349	492,143	502,208	555,050	680,442
Percentage derived from—						
Dry and siliceous ores	25	33	32	31	29	40
Base-metal ores	75	67	68	69	71	60
Placers	(2)	(2)	(2)	(2)	(2)	(2)
Net consumption in industry and the arts fine ounces	101,017,800	110,000,000	105,000,000	96,500,000	106,000,000	86,000,000
Imports	$59,483,387	$110,035,107	$103,468,510	$67,296,379	$95,103,962	$79,699,120
Exports	$38,744,287	$6,201,874	$8,590,185	$4,921,285	$8,426,910	$3,636,256
Monetary stocks (end of year) fine ounces [3]		1,983,000,000	1,965,000,000	1,938,000,000	1,926,000,000	1,935,000,000
Price, average, per fine ounce [4]	$0.846+	$0.905+	$0.905+	$0.905+	$0.905+	$0.905+
World production fine ounces (estimated)	164,300,000	[5] 203,300,000	[5] 199,600,000	[5] 215,100,000	[5] 216,600,000	213,400,000

[1] Includes Alaska.
[2] Less than 0.5 percent.
[3] Owned by Treasury Department; privately held coinage not included.
[4] Treasury buying price for newly mined silver.
[5] Revised figure.

isolation from all other markets. World consumption of silver for coinage dropped 7,500,000 ounces to 67,300,000, of which 54 million was for United States coinage. Silver continued to flow to the United States in 1954, but the excess of imports over exports was 12 percent smaller in 1954 than in the earlier year.

Legislation proposed in 1954 included two bills to repeal existing silver purchase laws and a bill in effect providing for a bimetallic monetary standard based on substantially higher statutory prices for gold and silver. No action was taken on these bills by the Congress.

LEND-LEASE SILVER

During World War II the United States supplied to various countries around 411 million ounces of silver for coinage and industrial uses. The silver was released under lend-lease arrangements that provide for its return within 5 years of official termination of the war, the date of which was marked by signing of the Japanese Peace Treaty on April 28, 1952. By countries, the quantities loaned under these agreements were approximately as follows: India and Pakistan, 226 million ounces; United Kingdom, 88,100,000; Netherlands, 56,700,000; Saudi Arabia, 22,300,000; Australia, 11,800,000; Ethiopia, 5,400,000; and Fiji Islands, 200,000. The Netherlands remitted about 11 million ounces to the United States in 1954, and it appeared probable that other countries would make payments on schedule. The silver returned by the Netherlands was accounted for by the United States Treasury as an addition to free stocks (that is, stocks eligible for sale to industry).

DOMESTIC PRODUCTION [3]

Production of silver in the United States is measured at mines and refineries. Both measures are tabulated by States of origin, but there is a small variation in them explained largely by timelag. Over a period of years, the deviation is found to be small. Compared with the mine reports compiled by the Bureau of Mines, the refinery reports compiled by the Bureau of the Mint in cooperation with the Bureau of Mines for the 50 years, 1905–54, show a total excess of silver of 15,020,576 ounces (a difference of 0.57 percent).

There is no record of the silver production of the United States before 1834, but it is known that the output was insignificant. Approximately 750,000 ounces of silver was recovered between 1834 and 1858, mostly from gold-silver bullion produced in the southern Appalachian and California gold districts. The advent of the United States as a major producer of silver dates, however, from discovery of the Comstock lode in 1859. Data, by 5-year periods, of the silver production from 1834 to 1954 are presented in table 3.

TABLE 2.—Silver produced in the United States,[1] 1905–54, according to mine and mint returns, in fine ounces of recoverable metal

Year	Mine (fine ounces)	Mint (fine ounces)
1905–49	2,447,471,556	2,463,304,034
1950	42,459,014	42,308,739
1951	39,764,932	39,907,257
1952	39,452,330	39,840,300
1953	37,570,838	37,735,500
1954	36,941,384	35,584,800
Total 1905–54	2,643,660,054	2,658,680,630

[1] Includes Alaska.

TABLE 3.—Mine production of silver in the United States by 5-year periods, 1834–1954 [1]

Period	Quantity, fine ounces	Average annual production, fine ounces	Period	Quantity, fine ounces	Average annual production, fine ounces
1834–35	26,297	13,149	1896–1900	279,544,300	55,908,860
1836–40	92,835	18,567	1901–5	278,798,400	55,759,680
1841–45	112,968	22,594	1906–10	277,326,600	55,465,320
1846–50	193,500	38,700	1911–15	338,337,073	67,667,415
1851–55	193,500	38,700	1916–20	325,952,991	65,190,598
1856–60	309,400	61,880	1921–25	314,007,876	62,801,575
1861–65	28,810,600	5,762,120	1926–30	288,896,791	57,779,358
1866–70	49,113,200	9,822,640	1931–35	158,006,438	31,601,288
1871–75	121,083,300	24,216,660	1936–40	334,039,072	66,807,814
1876–80	157,680,500	31,536,100	1941–45	227,789,929	45,557,986
1881–85	182,878,629	36,575,726	1946–50	173,968,164	34,793,633
1886–90	231,045,135	46,209,027	1951–54	153,729,484	38,432,371
1891–95	287,068,980	57,413,796			

[1] Merrill, Charles White, Summarized Data of Silver Production: Bureau of Mines Econ. Paper 8, 1930, 58 pp. (Table 2 of this paper brought to date.)

[3] Production data for 1954 were collected jointly with the Bureau of the Census (U. S. Department of Commerce). Production totals will be compared with Census totals when they are available and differences adjusted or explained.

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MINE PRODUCTION

Mine production of recoverable silver in the United States declined in 1954 for the fourth successive year. The yield in 1954 was 2 percent less than in 1953 and 13 percent under the postwar high reached in 1950. The downtrend in the 4-year period was related to less output of base-metal ores containing byproduct silver because of falling metal prices or labor strikes; an appreciable decrease in the average silver content of the base-metal ores mined was also a factor. The rate of domestic silver production in 1954 remained far below prewar levels.

All tonnage figures used in this section are short tons of 2,000 pounds "dry weight"; that is, they do not include moisture. The unit weight for silver is the troy ounce (480 grains). The totals are calculated upon the basis of recoverable silver shown by assays to be contained in ore, bullion, and other material produced.

Most of the predominately silver deposits in the United States have been depleted, and for many years the greater part of the domestic output has been recovered as a byproduct of ores mined principally for copper, lead, or zinc. Virtually all the current domestic silver output is obtained from lode deposits, mainly from underground oper-

TABLE 4.—Mine production of silver in the United States,[1] in 1954, by months

	Fine ounces		Fine ounces
January	2, 976, 940	August	3, 013, 652
February	3, 113, 603	September	2, 844, 887
March	3, 383, 203	October	2, 731, 629
April	3, 110, 842	November	3, 121, 526
May	3, 315, 235	December	3, 109, 864
June	3, 241, 067		
July	2, 978, 936	Total	36, 941, 384

[1] Includes Alaska.

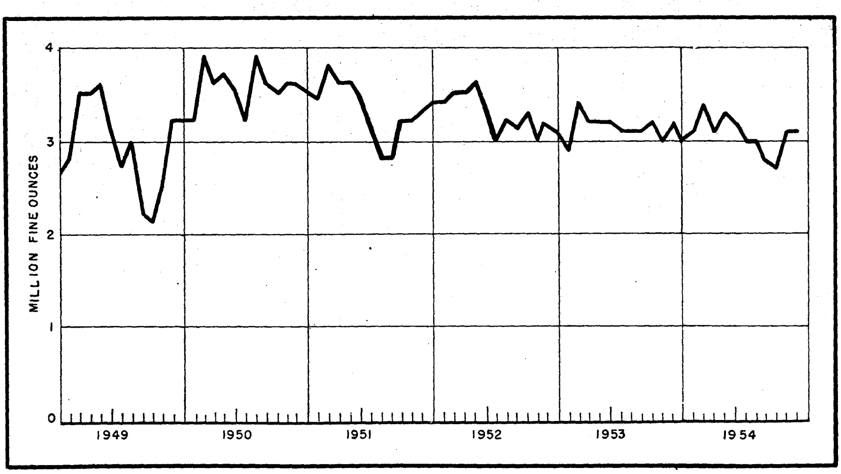

FIGURE 1.—Mine production of silver in the United States, 1949–54, by months, in terms of recoverable silver.

ations; about 0.1 percent is derived as a byproduct of gold placer mining. With respect to data on production, as far as possible, the mine unit used is not the operator but the mining claim or group of claims.

PRINCIPAL MINING DISTRICTS AND LEADING MINES

The leading silver-producing districts in the United States for many years have included many better known for base-metal output than for silver yield, and this situation prevailed again in 1954. For over a decade the leaders have been, in order, the Coeur d'Alene region in Idaho, the Summit Valley (Butte) district in Montana, and the West Mountain (Bingham) district in Utah; these 3 districts produced 64 percent of the domestic silver output in 1954.

Of the 25 leading domestic silver-producing mines in 1954, only 4 depended exclusively on silver ore; ores with values chiefly in copper, lead, zinc, and gold supplied most of the silver production. The 10 leading mines (each producing over 1 million ounces of silver in 1954) contributed 68 percent of the United States total output; the entire 25 leading mines contributed 85 percent. As several operators worked more than one of the leading silver mines, as well as some smaller mines, the output of silver by companies was substantially more concentrated than by mines.

TABLE 5.—Mine production of recoverable silver in the United States, 1945–49 (average) and 1950–54, by districts and regions that produced 200,000 fine ounces or more during any year (1950–54), in fine ounces

District or region	State	1945–49 (average)	1950	1951	1952	1953	1954
Coeur d'Alene Region	Idaho	8,350,142	15,056,131	13,639,808	13,752,081	13,636,680	14,898,699
Summit Valley (Butte)	Montana	4,868,036	6,121,264	5,950,647	5,514,330	6,289,415	4,663,429
West Mountain (Bingham).	Utah	3,897,215	4,963,586	4,923,249	5,338,291	5,027,419	4,109,083
Redcliff (Battle Mountain)	Colorado	194,497	669,461	412,788	348,090	581,100	2,111,786
Warren (Bisbee)	Arizona	1,161,051	1,079,311	1,292,719	1,242,935	1,266,153	1,379,192
Tintic	Utah	964,099	924,722	944,818	666,345	562,649	932,683
Park City Region	do	1,232,353	952,632	1,131,360	861,563	802,036	826,270
Pioneer	Arizona	303,701	529,186	581,952	606,563	627,890	634,044
Big Bug	do	410,301	701,973	636,812	581,699	591,388	579,281
Upper San Miguel	Colorado	425,789	730,860	621,257	764,478	717,939	576,525
Warm Springs	Idaho	408,145	502,973	506,363	630,886	561,554	554,213
Copper Mountain	Arizona	472,502	754,591	612,336	402,593	369,470	403,017
Ajo	do	391,291	473,020	437,675	450,303	435,940	390,104
Southeastern	Missouri	99,085	236,273	184,424	517,432	359,781	352,971
Flint Creek	Montana	87,826	22,528	82,033	233,799	[1] 225,005	331,544
Creede	Colorado	333,558	345,247	236,652	174,219	173,966	238,685
Mineral Creek	Arizona	30,468	130,669	172,765	214,030	265,857	207,785
Rush Valley	Utah	(2)	95,324	189,110	179,401	204,793	181,653
California (Leadville)	Colorado	(2)	(2)	272,352	322,000	196,239	137,557
Coso	California	657,222	600,440	570,595	(2)	(2)	(2)
Pioche	Nevada	514,477	608,710	415,622	425,475	317,628	79,313
Ash Peak	Arizona	92,742	227,342	193,419	136,072	168,163	50,074
Central	New Mexo.	(2)	(2)	236,484	306,236	78,842	30,426
Animas	Colorado	392,244	564,321	415,876	321,308	99,619	11,912
Verde (Jerome)	Arizona	436,029	456,254	408,891	233,946	30,553	6,791
Resting Springs	California	(2)	(2)	(2)	(2)	(2)	(2)
Grand Island	Colorado	15,662	58,262	109,206	274,104	(2)	----------
Sand Springs	Nevada	67,826	200,217	111,529	----------	----------	----------

[1] Combined with First Chance and Henderson districts in 1953 to avoid disclosure of individual company output.

[2] Figure withheld to avoid disclosure of individual company operations.

TABLE 6.—Twenty-five leading silver-producing mines in the United States in 1954, in order of output

Rank	Mine	District	State	Operator	Source of silver
1	Sunshine	Evolution	Idaho	Sunshine Mining Co	Silver ore.
2	Butte Hill Lead-Zinc Mines	Summit Valley	Montana	The Anaconda Co	Lead-zinc ore.
3	Utah Copper	West Mountain (Bingham)	Utah	Kennecott Copper Corp	Copper ore.
4	Bunker Hill	Yreka	Idaho	Bunker Hill & Sullivan Mining & Concentrating Co.	Lead-zinc ore.
5	Eagle	Redcliff (Battle Mountain)	Colorado	The New Jersey Zinc Co	Silver, zinc ores.
6	Butte Hill Copper Mines	Summit Valley	Montana	The Anaconda Co	Copper ore.
7	United States and Lark	West Mountain (Bingham)	Utah	U. S. Smelting, Refining & Mining Co	Lead-zinc, lead, copper ores.
8	Copper Queen-Lavender Pit	Warren (Bisbee)	Arizona	Phelps Dodge Corp	Copper ore.
9	Silver Summit	Evolution	Idaho	Polaris Mining Co	Silver ore.
10	Galena	Placer Center	do	American Smelting & Refining Co	Do.
11	Chief No. 1	Tintic	Utah	Chief Consolidated Mining Co	Lead, silver, lead-zinc ores.
12	Magma	Pioneer (Superior)	Arizona	Magma Copper Co	Copper ore.
13	Iron King	Big Bug	do	Shattuck Denn Mining Corp	Lead-zinc ore.
14	Treasury Tunnel, etc	Upper San Miguel	Colorado	Idarado Mining Co	Copper-lead-zinc ore.
15	Triumph	Warm Springs	Idaho	Triumph Mining Co	Lead-zinc ore.
16	Lucky Friday	Hunter	do	Lucky Friday Silver-Lead Mines	Do.
17	Mayflower-Galena	Blue Ledge	Utah	New Park Mining Co	Do.
18	Morenci	Copper Mountain	Arizona	Phelps Dodge Corp	Copper ore.
19	New Cornelia	do	do	do	Copper ore, copper tailings.
20	Page	Yreka	Idaho	American Smelting & Refining Co	Lead-zinc ore.
21	Algonquin	Flint Creek	Montana	Trout Mining Division	Do.
22	Star	Hunter	Idaho	Sullivan Mining Co	Do.
23	Amethyst, etc	Creede	Colorado	Emperius Mining Co	Silver, lead-zinc ores.
24	Ray Mines	Mineral Creek	Arizona	Kennecott Copper Corp	Copper ore.
25	Ontario Dump	Uintah	Utah	McFarland & Hullinger	Silver ore.

TABLE 7.—Mine production of recoverable silver in the United States, 1944–54, with production of maximum year, and cumulative production from earliest record to end of 1954, by States, in fine ounces

	Maximum production [1]		Production by years											Total production from earliest record to end of 1954
	Year	Quantity	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	
Western States and Alaska:														
Alaska	1916	1,379,171	13,362	9,983	41,793	66,150	67,341	36,056	52,638	31,023	32,986	35,387	33,697	20,147,423
Arizona	1937	9,422,552	4,394,039	3,558,216	3,268,765	4,569,084	4,837,740	4,970,736	5,325,441	5,120,985	4,701,330	4,351,429	4,298,811	330,862,970
California	1921	3,629,223	778,936	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	115,968,922
Colorado	1893	25,838,600	2,248,830	2,226,780	2,240,151	2,557,653	3,011,011	2,894,886	3,492,278	2,787,882	2,813,643	2,200,317	3,417,072	753,601,420
Idaho	1937	19,587,766	9,931,614	8,142,667	6,491,104	10,345,779	11,448,875	10,049,257	16,095,019	14,753,023	14,923,165	14,639,740	15,867,414	628,607,684
Montana	1892	19,038,800	7,093,215	5,942,070	3,273,140	6,326,190	6,930,716	6,327,025	6,590,747	6,393,768	6,138,185	6,689,556	5,177,942	799,723,952
Nevada	1913	16,090,083	1,259,636	1,043,380	1,250,651	1,377,579	1,790,020	1,800,209	1,537,217	981,669	941,195	697,086	560,182	599,288,869
New Mexico	1885	2,343,800	535,275	465,127	338,000	515,833	537,674	380,855	338,581	443,267	479,318	205,309	109,132	70,764,700
Oregon	1941	276,158	20,243	10,461	6,927	30,379	13,596	12,195	13,565	6,218	4,037	12,259	14,335	5,331,896
South Dakota	1900	536,200	5,445	26,564	86,901	111,684	94,693	109,383	142,065	139,590	132,102	138,642	151,407	10,707,575
Texas	1938	1,433,008	5,355	23,265	42,922	20,547	3,065	2,691	2,454	1,381	4,672		100	33,303,273
Utah	1925	21,276,689	7,593,075	6,106,545	4,118,453	7,780,032	8,045,329	6,724,880	7,083,808	7,310,665	7,194,109	6,725,807	6,179,243	776,216,392
Washington	1902	721,450	321,608	281,444	264,453	293,736	375,831	357,853	363,656	334,948	315,645	321,202	313,735	15,506,479
Wyoming	1901	21,400	3	31	26	95	11	21		2		11	74	74,906
Total			34,200,636	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	4,160,106,461
West Central States: Missouri	1952	517,432	92,243	94,822	69,401	93,600	114,187	123,413	236,273	184,424	517,432	359,781	352,971	6,144,078
States east of the Mississippi:														
Alabama	1936	869		1										5,239
Georgia	1904	1,500				13	3							10,963
Illinois	1924	8,891	2,437	2,198	2,302	1,790	4,047	3,128	2,001	3,465	3,781	2,338	1,160	159,052
Maryland	1917	1,092												2,595
Michigan	1916	716,640	54,218	21,863		3,089								10,256,112
New York	1951	47,568	25,238	14,271	15,786	22,409	18,788	18,378	32,628	47,568	38,895	35,398	34,576	637,762
North Carolina	1906	30,769	1,461										439	357,662
Pennsylvania	1942	15,501	13,545	10,434	7,887	9,863	13,731	10,827	10,563	13,575	9,247	6,972	8,415	264,747
South Carolina	1940	8,047												35,325
Tennessee	1920	110,719	45,907	35,391	18,016	79,147	39,692	41,833	39,958	24,960	57,569	68,935	60,759	3,451,203
Vermont	1954	48,572	18,862	20,586	35,275	21,469	24,910	27,446	28,205	41,300	45,361	43,128	48,572	[2] 384,443
Virginia	1944	18,993	18,993	1,300								1,169	1,773	82,331
Total			180,661	106,044	79,266	137,780	101,171	101,612	113,355	130,868	154,853	157,940	155,694	15,647,434
Grand total			34,473,540	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	36,941,384	4,181,897,973

[1] States east of the Mississippi figures are peaks since 1896, except New York and Pennsylvania which are peaks since 1905. The Illinois figure is the peak since 1907. Alaska, California, Nevada, and Oregon are peaks since 1880.

[2] Includes a small quantity for New Hampshire.

ORE PRODUCTION, CLASSIFICATION, METAL YIELD, AND METHODS OF RECOVERY

Tables 8 to 13 give details on classes of ore, metal yield in fine ounces of silver to the ton, and silver output by classes of ore and by methods of recovery, embracing all ores that yielded silver in the United States in 1953. These tables were compiled from the individual State chapters in Volume III, Minerals Yearbook, in which more detailed data are presented. Details of ore classification are given in the Gold chapter of this volume.

The lead, zinc, and lead-zinc ores in most districts in the States east of the Rocky Mountains carry no appreciable quantity of silver; such ores are excluded from this report unless otherwise indicated.

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 1954 [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	19,721	0.010	-	-	-	-
Arizona	1,330	.453	2,376	4.691	9,093	7.454
California	194,904	.297	-	-	1,753	5.680
Colorado	141,759	.083	2,216	5.681	95,455	19.750
Idaho	3,557	.235	2,208	11.579	379,706	28.770
Montana	4,040	1.415	17,875	6.566	2,778	6.818
Nevada	170,529	.078	2,555	7.334	21,306	6.204
New Mexico	120	.983	995	1.506	101	16.554
Oregon	868	.199	2,004	6.395	-	-
South Dakota	1,600,784	.095	-	-	-	-
Texas	-	-	-	-	-	-
Utah	308	2.526	16,116	3.990	170,220	4.757
Washington	109,089	1.931	-	-	30	9.467
Wyoming	1,420	.022	-	-	-	-
Total	2,248,429	.202	46,345	5.697	680,442	20.355
States east of the Mississippi	175	2.509	-	-	-	-
Total	2,248,604	.202	46,345	5.697	680,442	20.355

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	26	1.385	-	-	-	-
Arizona	43,126,983	.078	4,309	4.076	-	-
California	8,558	3.026	4,799	13.222	-	-
Colorado	213	2.061	34,937	4.238	-	-
Idaho	162,145	.069	119,681	3.269	63	68.825
Montana	3,789,454	.451	8,641	8.117	894	10.158
Nevada	9,615,197	.012	11,403	13.289	-	-
New Mexico	6,734,682	.015	45,200	.045	-	-
Oregon	44	1.386	-	-	-	-
South Dakota	-	-	-	-	-	-
Texas	-	-	10	10.000	-	-
Utah	24,100,099	.110	11,798	5.692	-	-
Washington	449,664	.145	600	2.298	-	-
Wyoming	25	1.720	-	-	-	-
Total	87,987,090	.092	241,378	3.781	957	14.020
States east of the Mississippi	4,600,625	.011	74	-	-	-
Total	92,587,715	.088	241,452	3.780	957	14.020

See footnotes at end of table.

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 1954[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					19,747	0.012
Arizona	2,727	0.547	337,974	2.412	43,484,792	.099
California	122	26.975	21,381	6.600	231,517	1.303
Colorado	200,130	1.247	498,467	2.225	973,177	3.511
Idaho	[2] 127,786	.611	1,165,816	3.801	[2] 1,960,962	8.091
Montana	54,945	1.113	1,225,661	2.599	5,104,288	1.014
Nevada	505	2.677	21,707	5.954	9,843,202	.057
New Mexico					6,781,098	.016
Oregon					2,916	4.475
South Dakota					1,600,784	.095
Texas					10	10.000
Utah	[3] 16,940	.396	541,683	4.745	24,857,164	.249
Washington	150	.207	992,608	.037	1,552,141	.202
Wyoming					1,445	.051
Total	403,305	.996	4,805,297	2.584	96,413,243	.377
States east of the Mississippi	2,049,697		2,826,298	.035	[4] 9,476,869	[4] .016
Total	2,453,002	.164	7,631,595	1.640	105,890,112	.345

[1] Missouri excluded.
[2] Includes 111,689 tons of old zinc slag.
[3] Zinc slag.
[4] Excludes magnetite-pyrite ore and gold and silver therefrom. Includes material classified as fluorspar ore mined in Illinois and Kentucky.

TABLE 9.—Mine production of silver in the United States,[1] 1945–49 (average) and 1950–54, 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	
1945–49 (average)	0.2	25.0	23.6	6.7	1.8	42.7	32,106,669
1950	.2	32.8	19.6	5.1	1.0	41.3	42,459,014
1951	.2	31.9	20.8	4.2	1.8	41.1	39,764,932
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	36,941,384

[1] Includes Alaska.

TABLE 10.—Mine production of silver in the United States in 1954, by States and sources, in fine ounces of recoverable metal

State	Placers	Dry ore	Copper ore	Lead ore	Lead-copper ore	Zinc ore	Zinc-lead, zinc-copper, and zinc-lead-copper ores	Total
Alaska	33,468	193	36					33,697
Arizona	6	79,523	3,385,120	17,562		1,492	815,108	4,298,811
California	7,909	67,902	25,900	63,450		3,291	141,123	309,575
Colorado	226	1,909,636	439	148,075		249,656	1,109,040	3,417,072
Idaho	1,077	10,950,636	11,254	391,212	4,336	78,124	4,430,775	15,867,414
Illinois							1,160	1,160
Missouri				352,971				352,971
Montana	55	142,023	1,709,985	70,138	9,081	61,137	3,185,523	5,177,942
Nevada	2,475	164,314	111,253	151,535		1,352	129,253	560,182
New Mexico		3,288	103,792	2,052				109,132
New York							34,576	34,576
North Carolina		439						439
Oregon	1,286	12,988	61					14,335
Pennsylvania			[1] 8,415					8,415
South Dakota		151,407						151,407
Tennessee							60,759	60,759
Texas				100				100
Utah		874,854	2,660,484	67,152		6,703	2,570,050	6,179,243
Vermont			48,572					48,572
Virginia							1,773	1,773
Washington	20	210,942	65,031	1,379		31	36,332	313,735
Wyoming		31	43					74
Total	46,522	14,568,176	8,130,385	1,265,626	13,417	401,786	12,515,472	36,941,384

[1] From magnetite-pyrite ore.

TABLE 11.—Silver produced in the United States from ore and old tailings, in 1954, by States and methods of recovery, in terms of recoverable metal [1]

State	Total ore, old tailings, etc., treated (short tons)	Ore and old tailings to mills				Crude ore to smelters	
		Short tons	Recoverable in bullion	Concentrates smelted and recoverable metal			
			Fine ounces	Concentrates (short tons)	Fine ounces	Short tons	Fine ounces
Western States and Alaska:							
Alaska	19,747	19,719	191	6	1	28	37
Arizona	[2] 40,357,494	[2] 39,605,855	29,301	1,337,628	2,834,323	751,639	1,435,181
California	231,517	221,030	49,045	9,615	140,583	10,487	112,038
Colorado	973,177	868,655	11,336	114,845	1,439,448	104,522	1,966,062
Idaho	[3] 1,960,962	1,836,190	1,482	210,667	15,670,489	124,772	194,366
Montana	5,104,288	4,974,479	20	429,171	4,946,401	129,809	231,466
Nevada	9,843,202	9,744,828	9,990	262,426	220,954	98,374	326,763
New Mexico	6,781,098	6,672,467	44	201,926	81,870	108,631	27,218
Oregon	2,916	2,872	50	169	12,935	44	64
South Dakota	1,600,784	1,600,784	151,407				
Texas	10					10	100
Utah	24,857,164	24,620,983		835,157	5,167,817	236,181	1,011,426
Washington	1,552,141	1,499,349	51,632	69,845	236,157	52,792	25,926
Wyoming	1,445	1,420	24	1	7	25	43
Total	93,285,945	91,668,631	304,522	3,471,456	30,750,985	1,617,314	5,330,690
States east of the Mississippi	[4] 9,476,869	9,476,748		562,412	155,694	121	
Total	102,762,814	101,145,379	304,522	4,033,868	30,906,679	1,617,435	5,330,690

[1] Missouri excluded.
[2] Excludes 3,127,298 tons of ore leached from which no gold or silver was recovered.
[3] Includes 111,683 tons of old zinc slag.
[4] Excludes magnetite-pyrite ore from Pennsylvania. Includes material classified as fluorspar ore mined in Illinois and Kentucky.

TABLE 12.—Silver produced at amalgamation and cyanidation mills in the United States and percentage of silver recoverable from all sources, 1945–49 (average) and 1950–54 [1]

Year	Bullion and precipitates recoverable (fine ounces)		Silver from all sources (percent)			
	Amalgamation	Cyanidation	Amalgamation	Cyanidation	Smelting [2]	Placers
1945–49 (average)	75, 215	322, 385	0. 2	1. 0	98. 6	0. 2
1950	153, 806	449, 699	. 4	1. 0	98. 4	. 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

[1] Includes Alaska. Illinois, Michigan, and Missouri excluded, 1945–46; Missouri excluded, 1947–54.
[2] Both crude ores and concentrates.

TABLE 13.—Silver produced at amalgamation and cyanidation mills in the United States in 1954, 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	191		0. 57	
Arizona	3	29, 298	(1)	0. 68
California	9, 617	39, 428	3. 11	12. 74
Colorado	4, 003	7, 333	. 12	. 21
Idaho	1, 482		. 01	
Montana	20		(1)	
Nevada	363	9, 627	. 06	1. 72
New Mexico	44		. 04	
Oregon	50		. 35	
South Dakota	80, 168	71, 239	52. 95	47. 05
Washington		51, 632		16. 46
Wyoming		24		32. 43
Total	95, 941	208, 581	. 26	. 57
States east of the Mississippi				
Grand total	95, 941	208, 581	. 26	. 56

[1] Less than 0.01 percent.

REFINERY PRODUCTION

Table 14 contains official estimates of production of silver in the United States, made by the Bureau of the Mint, based upon arrivals at United States mints and assay offices and at privately owned refineries. The mints and assay offices determine the State source of all newly mined, unrefined material when deposits are received. The State source of material received by privately owned refineries is determined from information submitted by them and by intervening smelters, mills, etc., involved in the reduction processes.

TABLE 14.—Silver refined in the United States, 1945–49 (average) and 1950–54, and approximate distribution by source (State), in 1954, in fine ounces

[U. S. Bureau of the Mint]

State or Territory	Fine ounces	State or Territory	Fine ounces
1945–49 (average)	32, 585, 323	1954—Continued	
1950	42, 308, 739	New Mexico	110, 000
1951	39, 907, 257	New York	125, 800
1952	39, 840, 300	North Carolina	50
1953	37, 735, 500	Oregon	14, 000
		Pennsylvania	8, 400
1954:		South Dakota	151, 200
Alaska	35, 500	Tennessee	64, 300
Arizona	4, 300, 000	Texas	100
California	325, 000	Utah	6, 100, 000
Colorado	2, 600, 000	Vermont	48, 600
Idaho	15, 000, 000	Virginia	1, 800
Illinois	1, 200	Washington	330, 000
Missouri	282, 800	Wyoming	50
Montana	5, 500, 000		
Nevada	586, 000	Total	35, 584, 800

CONSUMPTION AND USES IN INDUSTRY AND THE ARTS

Monetary use has claimed by far the largest part of the silver output through the years, but this use to a large extent takes the form of stockpiling in Government and private hoards that can be made available to industry and the arts without smelter or refinery preparation. In contrast, the silver that enters industry and the arts is consumed much as are other metals, and any return as secondary metal requires the usual channels of collection, smelting, and refining. The consumption of silver in the arts antedates written history, but its industrial use is a comparatively recent development. Silver has many properties that make it valuable in the arts and industries. It is beautiful in color and has the ability of taking a fine finish. It is highly malleable and ductile and ranks first among metals in conductivity of electricity and heat. It is resistant to corrosion, especially by weak acids and organic compounds.

Consumption of silver in the United States in the arts and industries was 19 percent smaller in 1954 than in the preceding year and was the least since 1941. For many years consumption of silver in the United States has exceeded any annual output ever achieved by domestic mines.

Traditionally the principal nonmonetary consumer of silver has been the silverware industry, mostly in the manufacture of tableware from "sterling silver" (an alloy composed of 92.5 percent silver and

TABLE 15.—Silver produced in the United States, 1792–1954 [1]

Period	Fine ounces	Value [2]
1792–1847	309, 500	$404, 500
1848–1873	146, 218, 600	193, 631, 500
1874–1954	4, 073, 726, 530	3, 092, 411, 455
Total	4, 220, 254, 630	3, 286, 447, 455

[1] Includes Alaska. From Report of the Director of the Mint. The estimates for 1792–1873 are by R. W. Raymond, Commissioner of Mining Statistics, Treasury Department, and since then, by the Director of the Mint.

[2] Silver valued in 1934 and thereafter at Government's average buying price for domestic product.

TABLE 16.—Net industrial[1] consumption of silver in the United States, 1945–49 (average) and 1950–54, in fine ounces

[U. S. Bureau of the Mint]

Year	Issued for industrial use	Returned from industrial use	Net industrial consumption
1945–49 (average)	134,904,124	33,886,324	101,017,800
1950	155,257,340	45,257,340	110,000,000
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

[1] Including the arts.

7.5 percent copper). In recent years, however, the consumption of silver in the arts has been exceeded by that for industry, and the number of industrial applications for silver and its alloys continues to expand.

The leading industrial consumer of silver in 1954 was photography, followed by electroplating, and the manufacture of silver-clad equipment for chemical plants.

Of growing importance were silver solders and brazing alloys, which are made in a wide variety of types containing 10 to 80 percent silver, with the balance copper, zinc, or other metals. Silver-bearing alloys were widely used in joining pipes, making electrical connections, and forming mechanical assemblies. Silver alloyed with about 10 percent of copper continued to find much use in electrical contacts; small additions of silver to copper impart hardness to commutator bars. Soft lead-silver solder containing about 2.5 percent silver has advantages over soft lead-tin solders or babbitt metal for some uses.

Compounds of silver were used for caustic, astringent, and antiseptic purposes in medicine. Silver has had considerable use in dentistry as dental fillings and in surgery as suture wires and plates.

MONETARY STOCKS

Silver holdings in the United States Treasury in bullion and coin increased 9 million ounces in 1954 to 1,935 million ounces. These holdings do not include some 411 million ounces released by the United States to various countries during World War II under lend-lease agreements that provide for the return of the silver.

Coinage requirements of silver for governments were approximately 67,300,000 ounces in 1954, compared with 74,800,000 ounces in 1953. Of the total used, the United States used 54,000,000 ounces, Canada 1,800,000 ounces, Belgium 1,500,000 ounces, and other countries about 10,000,000 ounces.

PRICES

The Treasury buying price for silver domestically mined after July 1, 1939, was fixed at $0.711+ per fine troy ounce on July 6, 1939. On July 31, 1946, the President approved an act (Public Law 579, 79th Congress), which provided that seigniorage to be deducted for silver mined after July 1, 1946, and delivered to the Treasury be reduced from 45 to 30 percent. The effect was to raise the price of domestically mined silver to $0.9050505+ per ounce; there has been no price change since.

The New York price of silver per troy ounce 0.999 fine remained at $0.8525 during the entire year 1954. This remarkable stability was due in large part to the policy of the Bank of Mexico of buying the Mexican silver production and holding or selling it according to market demand. The London price of silver per troy ounce 0.999 fine ranged in 1954 from 72d. to 74⅜d., equivalent in United States currency to $0.8453 and $0.8660, respectively.

FOREIGN TRADE [4]

As has been normal for many years, imports of silver again exceeded exports in 1954 by a wide margin. The excess of imports in 1954, however, was 12 percent less than in the preceding year.

TABLE 17.—Value of silver imported into and exported from the United States, 1945–49 (average) and 1950–54

[U. S. Department of Commerce]

	Imports	Exports	Excess of imports over exports
1945–49 (average)	$59,483,367	$38,744,287	$20,739,080
1950	110,035,107	6,201,874	103,833,233
1951	103,468,510	8,590,185	94,878,325
1952	67,296,379	4,921,285	62,375,094
1953	95,103,962	8,426,910	86,677,052
1954	79,699,120	3,636,256	76,062,864

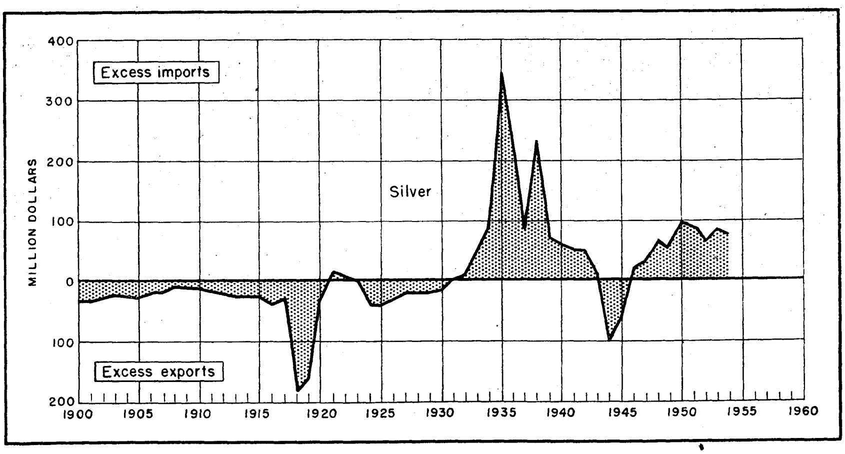

FIGURE 2.—Net imports or exports of silver, 1900–54.

[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 United States Department of Commerce.

TABLE 18.—Silver imported into the United States, in 1954 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					$9,750	
British Honduras					2,800	
Canada	10,430,717	$8,908,689	11,093,581	$9,393,268	1,419,236	$8,163
Cuba	179,479	155,210			546,400	
El Salvador	239,557	202,788			346,000	
Guatemala	15,351	13,051				
Honduras	3,512,151	2,993,841			779,852	
Mexico	6,888,254	5,768,452	23,130,815	19,619,638	11,876	19,880
Nicaragua	138,071	118,631				
Panama					129,000	
Total	21,403,580	18,160,662	34,224,396	29,012,906	3,244,914	28,043
South America:						
Bolivia	4,340,878	3,700,179				
Brazil	4,116	3,486				
Chile	1,052,883	896,340				
Colombia	33,418	28,443				
Ecuador	50,190	42,658				
Peru	7,750,640	6,629,976	6,555,778	5,587,654		193,195
Venezuela	231	198				
Total	13,232,356	11,301,280	6,555,778	5,587,654		193,195
Europe:						
Belgium-Luxembourg	171,377	148,855				
France	280	239				
Greece	59,680	50,877				
Netherlands	11,228,682	8,253,699	55,443	47,404	12,800	
Norway	1,700	1,448				
Portugal	51,672	43,288				
Turkey	50,781	43,191				
United Kingdom	62,808	54,002	164,490	140,223	7,150	260
Total	11,626,980	8,595,599	219,933	187,627	19,950	260
Asia:						
Iran	46,783	39,463				29,236
Israel	6,754	5,740				
Japan	101,606	86,162	888,524	752,617		
Lebanon	308,632	260,905				27,925
Philippines	412,376	359,421				
Saudi Arabia						206,196
Total	876,151	751,691	888,524	752,617		263,357
Africa:						
Angola	33,069	28,109				
British East Africa [1]	5,489	4,665				
Egypt					4,097	
Federation of Rhodesia and Nyasaland [1]	138,813	119,710				
Nigeria	232	197				
Union of South Africa	539,530	460,174				
Total	717,133	612,855			4,097	
Oceania: Australia	1,152,243	982,273			140	
Grand total	49,008,443	40,404,360	41,888,631	35,540,804	3,269,101	484,855

[1] Effective July 1954 Nyasaland excluded from British East Africa and combined with Northern and Southern Rhodesia as Federation of Rhodesia and Nyasaland.

TABLE 19.—Silver exported from the United States in 1954, 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					$10,000	
Bermuda					1,000	
Canada			63,518	$54,324		$2,040,469
Canal Zone					729	
Cuba			22,167	19,156		871
Honduras						22
Netherlands Antilles					1,000	
Panama						558
Total			85,685	73,480	12,729	2,041,920
South America:						
Brazil			37,969	32,877		
Colombia			213,411	186,053		
Venezuela			25,055	21,736		
Total			276,435	240,666		
Europe:						
Germany, West	1,175	$1,000	400,307	350,000		
Iceland			4,525	3,847		
Switzerland			3,444	2,941		
United Kingdom	28,742	24,421	902,222	780,306		
Total	29,917	25,421	1,310,498	1,137,094		
Asia: Saudi Arabia					4,500	
Africa: Liberia					100,000	
Oceania: New Zealand						446
Grand total	29,917	25,421	1,672,618	1,451,240	117,229	2,042,366

WORLD REVIEW

The world output of silver of 213,400,000 ounces in 1954 was 4 percent less than in 1953. Production gains in Canada, Australia, and Peru were more than offset by drops in Mexico, Central America, and Bolivia. The world production rate of silver in 1954 was about 20 percent under the average for the 5 prewar years, 1936–40.

According to the Bureau of the Mint, the world output of silver from 1493 through 1954 was 20,039,463,100 troy ounces, valued at $17,278,499,800. Of this total yield, North America produced 62 percent and South America 20 percent. Mexico contributed 35 percent of the total, the United States 21, Bolivia 9, Peru 9, and Canada 4. It has been estimated that about one-third of the total world production of silver is in circulation as coinage or held by governments for monetary purposes; one-third, including that hoarded, is privately owned; and one-third has been misplaced or dissipated.

Australia.—With a gain of 11 percent in 1954 compared with 1953, silver production in Australia rose for the fifth successive year. Most of Australia's silver was recovered as a byproduct of copper, lead, and zinc mining, and the increasing production of silver has paced the expanding output of these metals.

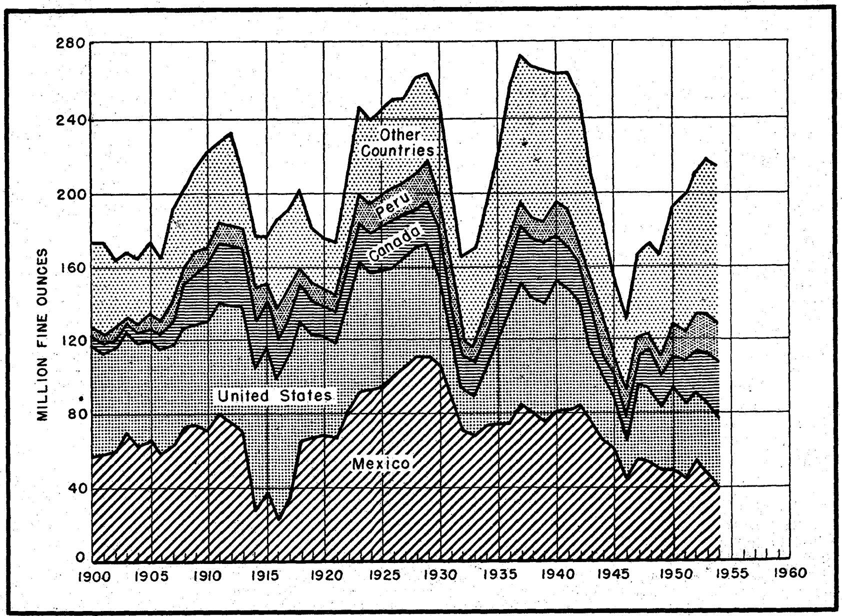

FIGURE 3.—World production of silver, 1900–54.

TABLE 20.—World production of silver, 1945–49 (average) and 1950–54, by countries,[1] in fine ounces [2]

(Compiled by Pauline Roberts and Berenice B. Mitchell)

Country	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
United States	32, 581, 881	42, 308, 739	39, 907, 257	39, 840. 300	37, 735, 500	35, 584, 800
Canada	14, 976, 501	23, 221, 431	23, 125, 825	25, 222, 227	28, 299, 335	30, 680, 491
Central America and West Indies:						
Costa Rica [3]	1, 441	215	582	----	----	----
Cuba	144, 795	[3] 221, 779	[3] 172, 318	[3] 163, 211	[3] 167, 895	[3] 179. 479
Guatemala	16, 300	339, 360	309, 857	371, 679	328, 636	[4] 284, 000
Honduras	2, 940, 458	3, 514, 556	3, 182. 254	3, 703, 975	5, 640. 251	3, 432, 023
Nicaragua	[5] 224, 427	[3] 133, 282	[3] 141, 764	[3] 137, 309	[3] 443, 684	[3] 138, 071
Panama	80	1, 940	5, 788	----	----	----
Salvador	[5] 259, 728	462, 973	352, 102	368, 448	353, 169	256, 778
Mexico	54, 035, 861	49, 141, 445	43, 797, 734	50, 353, 560	47, 873, 677	39, 896, 467
Total	105, 181, 500	119, 346, 000	110, 995, 000	120, 161, 000	120, 842, 000	110, 452, 000
South America:						
Argentina	[4] 2, 147. 350	1, 150, 000	1, 253, 879	962, 948	895, 474	1, 639, 698
Bolivia (exports)	6, 646, 742	6, 558, 751	7, 137, 465	7, 073, 163	6, 113, 013	5, 047, 666
Brazil	22, 952	21, 155	20, 315	17, 301	[4] 18, 000	[4] 18, 000
Chile	750, 237	946, 196	1, 191, 089	1, 246, 356	1, 497, 839	1, 488, 995
Colombia	129. 360	115, 711	129, 773	123, 165	117, 385	112, 534
Ecuador	221, 280	273, 200	33, 600	82, 297	86, 600	35, 126
Peru	11, 202, 688	13, 367, 700	14, 959, 129	18, 386, 141	19, 650, 694	20, 400, 932
Total	21, 121, 000	22, 433, 000	24, 725. 000	27, 891, 000	28, 379, 000	28, 743, 000
Europe:						
Austria	[4] 2, 585	8, 681	5, 466	3, 215	5, 144	5, 787
Czechoslovakia [4]	1, 145, 600	1, 608. 000	1, 608, 000	1, 608, 000	1, 608. 000	1. 608, 000
Finland	143, 950	115, 939	157, 275	150, 083	235, 794	239, 459
France	486, 916	719, 855	705, 902	713, 746	482, 261	376, 164
Germany:						
East [4]	1, 864, 200	3, 215, 000	3, 536, 600	3, 536, 600	4, 501, 100	4, 500, 000
West	823, 356	1, 637, 116	1, 819, 957	1, 877, 700	2, 314, 435	2, 401, 660

See footnotes at end of table.

TABLE 20.—World production of silver, 1945–49 (average) and 1950–54, by countries,[1] in fine ounces[2]—Continued

Country	1945–49 (average)	1950	1951	1952	1953	1954
Europe—Continued						
Greece	[4] 18,780	----------	64,300	72,403	61,665	85,360
Hungary [4]	19,450	48,200	48,200	64,300	64,300	64,300
Italy	408,424	850,998	809,234	838,041	832,383	872,025
Norway	189,689	167,184	163,969	147,893	112,528	96,452
Poland [4]	57,880	96,500	96,500	96,500	96,500	96,500
Portugal [4]	14,944	68,288	65,459	77,740	59,447	64,300
Rumania [4]	390,650	578,700	643,000	643,000	643,000	643,000
Spain	531,708	823,831	735,908	553,128	1,144,939	1,312,522
Sweden	1,159,484	1,275,709	1,145,917	2,196,281	1,571,464	2,215,604
U. S. S. R.[4]	11,230,200	24,000,000	24,000,000	24,000,000	25,000,000	25,000,000
United Kingdom	20,852	18,153	26,777	30,734	28,914	32,000
Yugoslavia	1,003,583	2,386,839	3,032,008	2,577,043	3,048,019	2,829,394
Total [4]	19,500,000	38,000,000	39,000,000	39,000,000	42,000,000	42,500,000
Asia:						
Burma	98,060	1,800	280,270	154,783	672,403	1,278,289
China	32,750	320,000	320,000	[4] 400,000	[4] 320,000	[4] 320,000
India	12,094	15,676	14,612	17,675	16,864	----------
Japan	2,007,190	3,964,733	4,609,998	5,177,909	6,028,489	6,051,413
Korea:						
North [4]	85,440	(6)	(6)	(6)	(6)	(6)
Republic of	25,036	10,160	5,401	11,381	52,213	50,252
Philippines	86,423	216,034	274,602	693,751	572,046	527,160
Saudi Arabia	50,874	124,287	109,912	111,945	150,626	63,681
Taiwan (Formosa)	7,280	20,603	32,762	2,000	20,930	20,060
Total [4]	2,400,000	4,700,000	5,700,000	6,600,000	7,900,000	8,400,000
Africa:						
Algeria	28,261	31,765	8,681	8,648	[4] 6,000	[4] 3,000
Bechuanaland	857	39	70	281	463	292
Belgian Congo	4,321,490	4,459,951	3,795,266	4,727,252	4,961,631	4,550,166
French Morocco	312,196	1,007,900	1,865,000	2,283,000	2,251,000	1,993,300
Gold Coast (exports)	43,609	43,317	52,853	44,116	44,949	48,214
Kenya	6,295	2,586	2,150	17,315	21,758	1,245
Mozambique	675	71	83	102	209	44
Nigeria	1,731	325	200	270	172	----------
Rhodesia and Nyasaland, Federation of:						
Northern Rhodesia [7]	198,145	173,304	100,702	348,954	514,699	406,225
Southern Rhodesia	89,788	85,549	79,731	81,356	84,566	81,657
South-West Africa	271,229	843,737	1,030,066	1,064,335	795,702	779,879
Swaziland	124	60	18	----------	----------	----------
Tanganyika (exports)	23,182	31,014	35,697	35,900	41,580	42,672
Tunisia	46,535	73,432	61,119	70,732	39,095	106,097
Uganda (exports)	133	35	14	14	55	----------
Union of South Africa	1,185,764	1,119,135	1,162,588	1,176,433	1,193,152	1,317,674
Total	6,530,000	7,872,000	8,194,000	9,859,000	9,955,000	9,330,000
Oceania:						
Australia:						
Commonwealth	9,311,178	10,677,456	10,792,032	11,425,872	12,402,963	13,827,038
New Guinea	[8] 19,789	35,366	45,011	62,965	58,693	48,977
Fiji	29,586	37,736	24,869	25,838	19,328	[4] 20,000
New Zealand	231,206	199,701	133,291	51,016	75,888	33,049
Total	9,591,800	10,950,000	10,995,000	11,566,000	12,557,000	13,929,000
World total (estimate)	164,300,000	203,300,000	199,600,000	215,100,000	221,600,000	213,400,000

[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.
[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] Year ended May 31 of year following that stated.

Canada.—Silver production in Canada rose 8 percent in 1954, reaching 30,680,500 ounces. Of this output, 84 percent was recovered as a byproduct of base-metal ores, 14 percent from cobalt-silver ores and silver ores, and 2 percent as a byproduct of gold mining. Most of the output was exported to the United States.

Honduras.—The New York and Honduras Rosario Mining Co. closed its Rosario silver-gold mine at San Juancito in 1954 because of depletion of ore reserves; this famous property was a steady producer for around 75 years. The company planned to spend $600,000 exploring its El Mochito silver-lead property in the Department of Santa Barbara to see whether the life of this mine could be extended.

India.—A silver refinery near Calcutta for the Government of India was under construction in 1954, and was expected to go into operation in 1956. The refinery will be used to extract the silver contained in demonetized coins introduced during World War II, which were being replaced by nickel coins. The coinage withdrawn contains around 300 million ounces of silver; recovery of this metal presumably will enable repayment of lend-lease silver acquired during the war.

Mexico.—Silver production in Mexico dropped sharply 17 percent in 1954 to 39,896,500 ounces; however, Mexico maintained its position as the leading silver-producing country of the world by a large margin. The Comision de Fomento Minero (Commission for the Promotion of Mining) had projects underway for rehabilitating the famous Guanajuato and Catorce silver mining districts, with the first stage consisting of exploration of some of the old mines at depth.

Peru.—Peru has held the rank of leading silver producer of South America for many years. Silver production increased 4 percent in 1954, showing a gain for the sixth successive year. Most of Peru's silver output was obtained as a byproduct or coproduct of complex ores mined principally for base metals.

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Slag—Iron Blast-Furnace

By Oliver S. North [1]

PRODUCTION of processed iron blast-furnace slag remained at a high level in 1954, although 1¼ million tons less than the record established in 1953. The decrease corresponded with the reduced output of pig iron during this same period. Production of screened and unscreened air-cooled slag declined, whereas the output of granulated and expanded slags was higher than in 1953 or any previous year.

Marked increases were noted in the use of screened air-cooled slag as aggregate in highway and airport construction and in expanded slag for lightweight concrete and lightweight concrete block. Declines were noted in the use of screened air-cooled slag for railroad ballast, sewage trickling filter medium, roofing, and bituminous construction; unscreened air-cooled slag in highway and airport construction; and granulated slag for agricultural purposes.

Except for an 18-cent-per-ton increase for slag used in roofing, the average values of the screened and unscreened air-cooled and granulated slag products changed little in 1954. The average value of expanded slag used in lightweight concrete and concrete block was lower than in 1953.

Since stocks of processed slag are relatively small and constant from year to year, production virtually equals consumption, and therefore those terms are used interchangeably in this chapter.

TABLE 1.—Iron blast-furnace slag processed in the United States, 1942–54, 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					
1942	13, 591, 896	$11,832,670	$0. 87	2, 073, 611	$884, 178	$0. 43	3, 457, 211	$467, 202	----------	----------	------
1943	13, 736, 642	11, 714, 225	. 85	1, 364. 779	540, 465	. 40	1, 329, 215	242, 121	76, 971	$112, 817	$1. 47
1944	10, 730, 613	9, 260, 257	. 86	776, 302	303, 460	. 39	733, 255	95, 702	165, 822	232, 508	1. 40
1945	11, 427, 689	9, 841, 813	. 86	406, 775	140, 527	. 35	567, 297	80, 949	234, 107	335, 931	1. 43
1946	14, 332, 896	13, 250, 693	. 92	596, 957	211, 078	. 35	1, 003, 789	86, 383	773, 150	1, 321, 685	1. 71
1947	16, 712, 177	17, 045, 020	1. 02	447, 908	257, 683	. 58	1, 290, 958	95, 087	1, 130, 636	2, 127, 692	1. 88
1948	17, 656, 200	19, 254, 900	1. 09	604, 100	370, 000	. 61	1, 517, 500	184, 700	1, 353, 200	2, 550, 400	1. 88
1949	17, 769, 330	21, 090, 445	1. 19	727, 595	372, 727	. 51	1, 885, 428	416, 632	1, 199, 026	2, 698, 908	2. 25
1950	20, 047, 844	24, 444, 231	1. 22	1, 005, 436	639, 499	. 64	2, 168, 365	647, 665	1, 704, 388	3, 749, 463	2. 20
1951	23, 276, 692	29, 531, 983	1. 27	1, 732, 969	969, 975	. 56	2, 249, 281	888, 644	2, 068, 492	4, 917, 091	2. 38
1952	21, 056, 846	27, 501, 892	1. 31	1, 364, 463	749, 375	. 55	2, 507, 604	1, 041, 835	1, 970, 463	4, 581, 107	2. 32
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

[1] Excludes value of slag used for hydraulic cement manufacture.

[1] Commodity-industry analyst.

DOMESTIC PRODUCTION

The output of slag from iron blast furnaces in 1954, as reported to the Bureau of Mines by producers of pig iron, was 33,791,125 short tons compared with an estimated 41,250,000 tons in 1953. The iron-blast-furnace-slag industry utilized about 86 percent of the total blast-furnace slag produced in 1954.

According to reports of processors to the National Slag Association, the quantity of slag processed in the United States in 1954 for commercial use, was 29,235,142 short tons valued at $39,476,408. These totals were 4 and 1 percent, respectively, lower than the preceding year's figures of 30,511,603 short tons valued at $40,067,294. Decreased production was mainly due to the reduced output of pig iron and consequent lower tonnage of slag available for processing. The output in 1954 came from 45 companies operating 68 plants processing air-cooled slag, 15 plants processing granulated slag, and 20 plants producing expanded slag.

Iron blast-furnace slag was processed in Alabama, California, Colorado, Illinois, Indiana, Kentucky, Maryland, Michigan, Minnesota, New York, Ohio, Pennsylvania, Tennessee, Texas, and West Virginia. The majority of the plants are east of the Mississippi River.

As in 1953 and other recent years, the output of processed slag was greater in Ohio than in any other State, constituting in 1954 about 25 percent of the Nation's total compared with 22 percent in 1953. Pennsylvania also produced a larger portion of the national total in 1954 than in 1953. Alabama, Ohio, and Pennsylvania combined supplied 66 percent of the total tonnage reported for 1954 compared with 61 percent in 1953.

TABLE 2.—Iron blast-furnace slag processed in the United States, 1953–54, by States

[National Slag Association]

	Screened air-cooled			All types		
	Quantity		Value	Quantity		Value
	Short tons	Percent of total		Short tons	Percent of total	
1953						
Alabama	4,968,949	21	$5,716,263	5,732,096	19	$6,930,713
Ohio	5,558,426	23	8,582,638	6,636,693	22	10,428,466
Pennsylvania	4,170,038	17	6,479,202	6,055,988	20	7,981,724
Other States [1]	9,324,211	39	11,899,845	12,086,826	39	14,726,391
Total	24,021,624	100	32,677,948	30,511,603	100	40,067,294
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

[1] California, Colorado, Illinois, Indiana, Kentucky, Maryland, Michigan, Minnesota, New York, Tennessee, Texas, and West Virginia.

TRANSPORTATION

As in past years, virtually the entire tonnage of processed slag in 1954 was moved by truck and rail, with waterway transportation again accounting for but 2 percent of the total. Truck shipments increased from 53 percent of the national total in 1953 to 60 percent in 1954 continuing a long-term trend. The quantity shipped by each method of transportation is shown in table 3.

TABLE 3.—Shipments of iron blast-furnace slag in the United States, 1953–54, by method of transportation

[National Slag Association]

Method of transportation	1953		1954	
	Short tons	Percent of total	Short tons	Percent of total
Rail	13,742,136	45	11,011,987	38
Truck	16,229,800	53	17,574,770	60
Waterway	539,667	2	648,385	2
Total	30,511,603	100	29,235,142	100

CONSUMPTION AND USES

Screened air-cooled slag—the major type produced by the industry—constituted 76 percent of the total output of processed slag in 1954. The remaining 24 percent was divided among the other types as follows: Unscreened air-cooled, 3 percent; granulated, 12 percent; and expanded, 9 percent.

Screened Air-Cooled Slag.—The consumption of screened air-cooled slag decreased nearly 7 percent in 1954. The use of screened, air-cooled slag as aggregate in portland-cement concrete construction, bituminous construction, highway and airport construction other than portland cement and bituminous, and railroad ballast consumed 20,041,709 short tons or 90 percent of the total tonnage. Major increases in 1954 occurred in agricultural slag, aggregate in highway and airport construction, and aggregate in concrete block. The principal decreases were in its use as railroad ballast, sewage trickling filter medium, roofing (cover material and granules), and aggregate in bituminous construction. Other important uses for this material were in the manufacture of concrete block and pipe, mineral wool, and glass, and as road fill (parking lots and driveways).

Unscreened Air-Cooled Slag.—In 1954 the quantity of unscreened air-cooled slag processed totaled 808,548 short tons valued at $537,207—decreases of 4 and 8 percent, respectively, from the 1953 figures. About 55 percent of this material was used as aggregate in highway and airport construction.

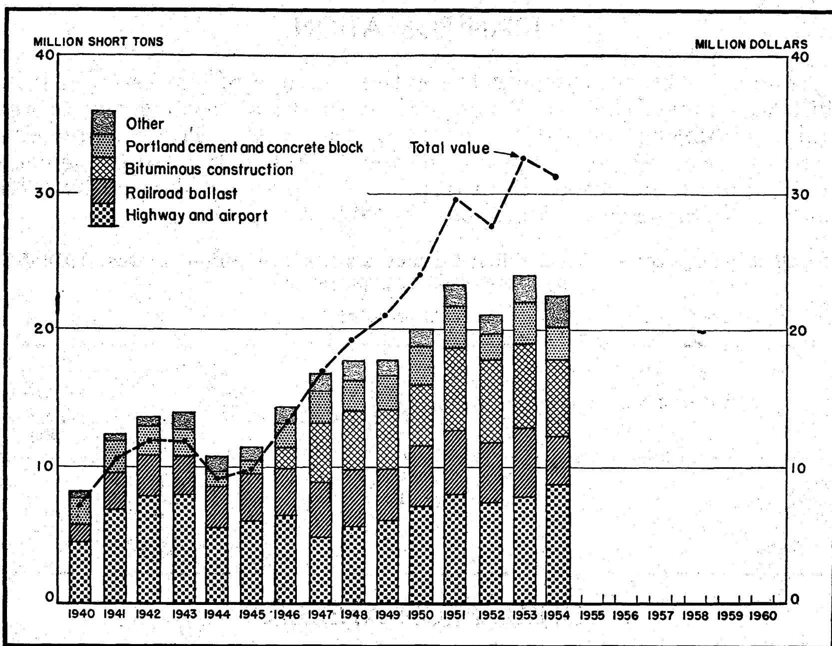

FIGURE 1.—Quantity of screened, air-cooled iron blast-furnace slag sold or used in the United States, 1940–54, by uses, and total value.

TABLE 4.—Air-cooled iron blast-furnace slag sold or used by processors in the United States, 1953–54, by uses

[National Slag Association]

Use	Screened		Unscreened	
	Short tons	Value	Short tons	Value
1953				
Aggregate in:				
Portland-cement concrete construction	2,351,990	$3,413,602		
Bituminous construction (all types)	6,040,107	9,007,418		
Highway and airport construction [1]	7,753,146	10,894,480	533,998	$363,644
Manufacture of concrete block	616,958	853,246		
Railroad ballast	5,204,602	5,349,918	4,400	3,300
Mineral wool	469,112	642,552		
Roofing (cover material and granules)	449,677	908,825		
Sewage trickling filter medium	82,679	142,308		
Agricultural slag, liming	6,643	10,790		
Other uses	1,046,710	1,454,809	306,913	214,139
Total	24,021,624	32,677,948	845,311	581,083
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

[1] Other than in portland-cement concrete and bituminous construction.

Granulated Slag.—The consumption of granulated slag in 1954 reached a record 3,455,005 short tons—an increase of 3 percent over the 1953 figure. Of that quantity, 41 percent was used as a raw material in manufacturing hydraulic cement, 40 percent as road fill, and the remainder for concrete-block manufacture, agricultural slag and liming, and other purposes. Utilization of granulated slag increased for all purposes except as an agricultural and liming material.

Expanded Slag.—Consumption of expanded slag reached another record high of 2,599,112 short tons valued at $6,198,822—increases of 14 and 12 percent, respectively, compared with the 1953 figures. The bulk of this material was used in manufacturing lightweight concrete block and as aggregate in lightweight concrete.

TABLE 5.—Granulated and expanded iron blast-furnace slag sold or used by processors in the United States, 1953–54, by uses

[National Slag Association]

Use	Granulated		Expanded	
	Short tons	Value	Short tons	Value
1953				
Road fill, etc.	1,311,311	$804,158		
Agricultural slag, liming	89,355	123,805		
Manufacture of hydraulic cement	1,413,291	(1)		
Aggregate for concrete-block manufacture	302,953	209,987	2,220,117	$5,381,934
Aggregate in lightweight concrete			63,180	168,233
Other uses	242,000	112,500	2,461	7,646
Total	3,358,910	(2) 1,250,450	2,285,758	5,557,813
1954				
Road fill, etc.	1,384,125	957,545		
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

[1] Data not available.
[2] Excludes value of slag used for hydraulic cement manufacture.

PRICES

Average values per ton for the various types of processed slag in 1954 are shown in table 6. Values for screened air-cooled slag ranged from $1.05 per short ton for railroad ballast to $2.20 for slag used in the roofing industry. For most screened air-cooled slag products the average values were irregularly a few cents per ton higher or lower than in 1953. The average value of unscreened air-cooled slag used in highway and airport construction remained unchanged at 68 cents per short ton. Among the use classifications of granulated slag, the average value of slag used in concrete block increased from 69 cents to $1.11 per short ton, while average values of slag for other uses increased moderately. The average values reported for expanded slag products were lower than in the previous year.

TABLE 6.—Average value per short ton of iron blast-furnace slag sold or used by processors in the United States, 1953–54, by uses

[National Slag Association]

Use	Air-cooled		Granulated	Expanded
	Screened	Unscreened		
1953				
Aggregate in—				
Portland-cement concrete construction	$1.45			[1] $2.66
Bituminous construction (all types)	1.49			
Highway and airport construction [2]	1.41	$0.68		
Manufacture of concrete block	1.38		$0.69	2.42
Railroad ballast	1.03	.75		
Mineral wool	1.37			
Roofing (cover material and granules)	2.02			
Sewage trickling filter medium	1.72			
Agricultural slag, liming	1.62		1.39	
Road fill, etc			.61	
Other uses	1.39	.70	.46	3.11
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	.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

[1] Lightweight concrete.
[2] Other than in portland-cement and bituminous construction.

RECOVERY OF IRON

The recovery of iron by slag processors during 1954 totaled 302,000 short tons, a decrease of 15 percent compared with the preceding year's figure. Iron was recovered from the slag by magnetic methods or hand picking.

EMPLOYMENT

An average of 1,915 plant and yard personnel per active day worked 4,716,547 man-hours in producing processed slag during 1954. This compares with 4,957,704 man-hours and an average active day employment of 1,920 plant and yard employees in 1953.

TECHNOLOGY

The principal developments during the year in the technology of processing and utilizing iron blast-furnace slag were described in the patents and articles abstracted in the following paragraphs.

A patent was issued covering the manufacture from finely ground granulated blast-furnace slag of a cementitious material having high latent hydraulic binding properties. The slag is wet-ground to a paste, usually containing 25 to 30 percent water. This paste is dried to a moldable state (approximately 20 percent water) either by conventional drying methods or by adding previously air-dried slag paste or dry sand or other aggregate which might be suitable to the intended use. Blocks or bricks are formed from the moldable composition, air dried, crushed and a catalyst added to promote setting. Certain economic and practical advantages were claimed for this method of cement manufacture.[2]

A patent described the methods of application and advantages of using a foundry core-forming mix comprising mainly granular blast-furnace or open-hearth slag and silica sand in varying proportions, depending on the characteristics required in the product. The granular slag used is the byproduct globules from rock wool manufacture. It was claimed that the following properties of the mix are improved by the addition of the slag: Permeability, resistance to thermal shock, coefficient of expansion, and flowability.[3]

Two patents were granted on apparatus and methods for producing foamed blast-furnace slag.[4]

The chemical composition of sweet-clover crops produced on soils limed with slag was compared with that of such crops produced on soils limed with a pure limestone that supplied only insignificant quantities of the elements (except calcium) supplied by the slag. On a heavy loam soil, slag liming produced crops containing 2 to 4 times as much manganese, less calcium, and frequently more copper. On this soil and on a sandy loam it produced crops containing up to 2.5 times as much magnesium and significantly more boron. As judged by yield and soil pH, the slag was as effective a liming material on the sandy loam as the limestone, but limestone was more effective on the heavy loam. It was noted that the relative effectiveness of this slag and limestone for liming the soil, as well as their effects on crop composition, may be strongly modified by the kind of soil.[5]

Further information was published on the use of granulated blast-furnace slag cement, made by the Trief process, in large Scottish dams. Cement produced in this way compared favorably in quality with low-heat portland cement.[6]

A study was made of the methods of grinding blast-furnace-slag cements. It was found that, under the test conditions, a closed-circuit mill ground the clinker finer than an open-circuit mill. Also grinding temperatures in the closed-circuit mills were markedly lower than in open-circuit mills.[7]

Granulated blast-furnace slag was used at the Universal Atlas Cement Co. Universal, Pa. plant as a component of the kiln feed from which portland cement clinker is manufactured.[8] Portland-

[2] Trief, V., Method for Producing Metallurgical Cement: U. S. Patent 2,687,969, Aug. 31, 1954.
[3] Miner, H. W., and Rock, E. J. (assigned to Fairbanks, Morse & Co., Chicago, Ill.), Foundry Molding Material: U. S. Patent 2,687,966, Aug. 31, 1954.
[4] Huttemann, P. F., Klotzbach, G. A., Vorwerk, O. K., and Gallai-Hatchard, M. (assigned to Hüttenwerk Rheinhausen Aktiengesellschaft, Rheinhausen, Germany), [Foaming Bed for the Foaming of Fiery Molten Masses]: U. S. Patent 2,693,666, Nov. 9, 1954.
Vorwerk, O. K. (assigned to Hüttenwerk Rheinhausen Aktiengesellschaft, Rheinhausen, Germany). [Method of Pouring Liquid Slag]: U. S. Patent 2,691,249, Oct. 12, 1954.
[5] Chichilo, P. P., Armiger, W. H., Specht, A. W., and Whittaker, C. W., Furnace Slag as a Source of Plant Nutrients and Its Liming Effectiveness Relative to Limestone: Agricultural and Food Chemistry, vol. 2, No. 9, Apr. 28, 1954, pp. 458-462.
[6] Indian Concrete Journal (Bombay), Blast-Furnace Cement for Scottish Hydro-Electric Scheme: Vol. 28, No. 6, June 15, 1954, pp. 219-220 (in English).
[7] Borner, H., Closed-Circuit or Open-Circuit Grinding?: Pit and Quarry, vol. 47, No. 1, July 1954, pp. 104-107, 110; No. 2, August 1954, pp. 117-220, 123-125.
[8] Nordberg, B., Universal Starts Up New Raw Mill: Rock Products, vol. 57, No. 2, February 1954, pp. 78-80.
Trauffer, W. E., Universal-Atlas Completes First of Three Stages of Plant Reconstruction: Pit and Quarry, vol. 47, No. 1, July 1954, pp. 80-85, 90.

pozzolan cement (sometimes referred to simply as "slag" cement) was produced at the Hamburg, N. Y., plant of Federal Portland Cement Co. by intergrinding granulated blast-furnace slag with portland-cement clinker.[9]

Slag produced at the world's largest blast furnace—Middletown, Ohio—was processed and marketed for a variety of purposes. The facilities and methods used for producing expanded slag from this material were described.[10]

The properties of concretes made with blends of portland cement and air-entraining granulated blast-furnace slag were investigated. Results of the tests indicated that finely ground blast-furnace slag containing an air-entraining admixture can be used satisfactorily in concrete when blended with non-air-entraining portland cement in the proportion, by volume, of approximately 1 to 6. This is the same ratio in which natural cement usually is blended with portland cement in the Northeastern States. The durability of concrete specimens made from the blend of slag and portland cement was reported equal or superior to that of corresponding concretes made from either air-entraining or non-air-entraining portland cements used alone or blended with natural cement.[11]

Some concrete-block producers in Midwestern States used granulated slag to replace part of the more costly lightweight aggregates. A satisfactory block was made with a mixture of one-third to one-half granulated slag and the remainder a lightweight aggregate, such as expanded slag, expanded shale, cinders, or expanded clay.[12]

A comprehensive article described the production, physical properties, chemical composition and properties, and uses of the three types of commercial blast-furnace slag. Particular emphasis was placed on the production of and demand for slag produced by the blast furnaces at Sydney, Nova Scotia, Canada. Utilization of the Sydney slag has been restricted by limited local markets and the high cost of transportation to other markets.[13]

The usefulness and variety of applications of iron-blast-furnace-slag aggregates were discussed in a professional paper. Points stressed were its durability, adaptability, nonskid properties, and greater volume yield of mix per ton of aggregate when used as a macadam base material. The rough, vesicular nature of crushed slag particles is credited with helping to make bituminous road mixes more stable than is the case when a relatively smooth, solid aggregate is used.[14]

Largely because the demand for processed slags exceeds the supply available from blast furnaces, the industry is considering the possibility of using open-hearth slag for certain purposes. The chemical composition of raw open-hearth slag is such that its use for concrete or as a

[9] Nordberg, B., Operates Cement Kilns for Best Efficiency Rather Than for Overcapacity: Rock Products, vol. 57, No. 9, September 1954, pp. 70–75, 90–92.
[10] Trauffer, W. E., Lightweight Slag Aggregate; New Plant Processes Slag From World's Largest Blast Furnace: Pit and Quarry, vol. 47, No. 6, December 1954, pp. 73–75, 86.
[11] Grieb, W. E., and Werner, G., Properties of Concrete Containing a Blend of Portland Cement and Air-Entraining Ground Blast-Furnace Slag: Public Roads, vol. 28, No. 3, August 1954, pp. 46–49.
[12] Concrete, Water-Granulated Blast-Furnace Slag: Vol. 62, No. 8, August 1954, pp. 32–33.
[13] Wallace, J. R., Fedora, P., and Weiner, N. D., Properties and Applications of Iron Blast-Furnace Slag: Canadian Min. and Met. Bull. (Montreal), vol. 47, No. 503, March 1954, pp. 160–169.
[14] Bauman, E. W., The Role of Slag As a Mineral Aggregate: Public Works Eng. Newsletter, vol. 20, No. 8, February 1954, pp. 4, 6, 10.

base course for bituminous road surfaces has not been deemed advisable. It was suggested that an economical means of treating open-hearth slag to improve its properties might be found. Also, experiments were reported underway for reclaiming manganese from open-hearth slag, which, if successful, will yield residual slag similar to the blast-furnace type. About 12 million tons of open-hearth slag is available annually at the current rate of steel production.[15]

[15] Rock Products, Slag Industry Developing New Markets: Vol. 57. No. 12, December 1954, pp. 104, 106, 123–124.

Slate

By D. O. Kennedy[1] and Nan C. Jensen[2]

PRODUCTION of slate in the United States was slightly greater in 1954 than in 1953, principally because of increased output of granules and flour which offset decreased production of dimension slate. The drop in production of dimension slates was due to the continued decline in demand for roofing slates. Output of other classes of dimension slates remained nearly the same in 1954 as in 1953. A small production of expanded slate for use as a lightweight aggregate was reported.

DOMESTIC PRODUCTION

Domestic production (sales by producers) of slate increased 9 percent in 1954 despite a decline in the number of operators from 68 in 1953 to 57 in 1954.

The principal product from the underground slate mine in Maine continued to be electrical slate. Small quantities of roofing slate and flagging also were produced. The total output from Maine was lower in 1954 than in 1953; only one mine was operated.

The number of producers in New York dropped from 20 in 1953 to 13 in 1954, but the value of slate sales increased slightly. Flagging, granules, and flour were the principal products, but small quantities of roofing and flooring slates were sold.

Pennsylvania produced all types of slate, including 66 percent of the roofing slate sold in the United States in 1954. The number of operators decreased from 18 in 1953 to 17 in 1954, but the total value of products sold was nearly the same as in 1953. There were so few producers in some counties that production could not be shown by counties. The downward trend in sales of roofing slates continued, with a 10-percent drop in quantity and a 12-percent drop in value. Sales of electrical slates increased in quantity but remained nearly the same in value. There were so few producers of electrical slates that sales were included with structural slates in table 3.

Sales of structural and sanitary slates, which had increased steadily since 1945, decreased 9 percent in quantity in 1954 but increased 5 percent in value compared with 1953. Vault-cover sales decreased to almost nothing in 1954 and were included with sales of structural slate in table 3. Sales of blackboards and bulletin boards increased

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

TABLE 1.—Salient statistics of the slate industry in the United States, 1953–54

Domestic production (sales by producers)	1953			1954				
	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* 142,292	53,470	$3,005,649	*Squares* 117,729	43,549	$2,401,087	−17	−20
Mill stock:	*Sq. ft.*			*Sq. ft.*				
Electrical slate	274,205	1,990	504,698	250,292	1,801	392,588	−9	−22
Structural and sanitary slate	1,501,049	11,781	962,295	} 1,533,196	12,088	1,103,926	+1	+13
Grave vaults and covers	13,388	120	11,097					
Blackboards and bulletin boards [1]	1,080,034	2,578	699,098	1,295,911	2,989	808,872	+20	+16
Billiard-table tops	71,851	526	43,316	116,338	918	72,937	+62	+68
Total mill stock	2,940,527	16,995	2,220,504	3,195,737	17,796	2,378,323	+9	+7
Flagstones, etc.[2]	13,493,948	82,438	1,458,651	14,824,636	90,281	1,569,409	+10	+8
Total slate as dimension stone		152,903	6,684,804		151,626	6,348,819	−1	−5
Granules, flour, and other		545,686	5,953,661		[3] 609,295	[3] 6,611,795	+12	+11
Grand total		698,589	12,638,465		760,921	12,960,614	+9	+3

[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.

TABLE 2.—Slate sold by producers in the United States, 1945–49 (average) and 1950–54, by States and uses

	Operators	Roofing		Mill stock		Other uses (value)[1]	Total value
		Squares (100 square feet)	Value	Square feet	Value		
1945–49 (average)	69	163,764	$2,875,890	2,462,194	$1,309,486	$6,061,380	$10,246,756
1950	94	197,570	4,098,842	3,180,600	2,130,430	8,818,209	15,047,481
1951	77	205,120	4,357,412	3,168,540	2,127,387	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							
Arkansas	1					379,076	379,076
California	2					(2)	(2)
Georgia	2					(2)	(2)
Maine	1	(2)	(2)	(2)	(2)	(2)	(2)
Maryland	1					(2)	(2)
New York	13	242	10,879	2,950	272	1,730,897	1,742,048
Pennsylvania	17	77,819	1,487,870	2,505,839	1,616,981	1,314,588	4,419,439
Vermont	16	(2)	(2)	(2)	(2)	3,613,865	4,537,283
Virginia	4	(2)	(2)			(2)	468,911
Undistributed		39,668	902,338	686,948	761,070	1,142,778	1,413,857
Total	57	117,729	2,401,087	3,195,737	2,378,323	8,181,204	12,960,614

[1] Flagging and similar products, granules, and flour.
[2] Included with "Undistributed" to avoid disclosure of individual company operations.

20 percent in quantity and 16 percent in value compared with 1953. Billiard-table-top sales returned nearly to the 1952 level, with increases of 62 percent in quantity and 68 percent in value compared with 1953. Since the decrease in import duty on school slates in 1951, the domestic production of school slates has almost ceased. The small production in Pennsylvania in 1954 was included with blackboards in table 3. Sales of other products, including flagging, granules, and flour, increased 3 percent in value in 1954 compared with 1953.

TABLE 3.—Slate sold by producers in Pennsylvania, 1945–49 (average) and 1950–54, by uses

Year	Operators	Roofing slate		Mill stock					
		Squares (100 square feet)	Value	Electrical		Structural and sanitary		Vaults and covers	
				Square feet	Value	Square feet	Value	Square feet	Value
1945–49 (average)	22	114,134	$1,812,937	62,534	$34,563	471,448	$285,327	105,894	$38,441
1950	27	124,280	2,341,127	11,050	12,044	849,970	611,004	2,340	2,097
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)

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		
1945–49 (average)	863,546	$393,801	244,102	$128,878	327,462	$10,664	$1,170,485	$3,875,096
1950	1,420,960	829,510	161,030	95,996	279,100	8,936	1,645,300	5,546,014
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

[1] To avoid disclosure of individual company operations, electrical (1954) and vaults and covers (1953–54) included with structural and sanitary.
[2] A small quantity of school slates included with blackboards and bulletin boards.

Due to the limited number of producers of some slate products in Vermont and Virginia in 1954, separate figures for these products cannot be given. The production in Vermont was greater than in 1953, but that in Virginia decreased. Sales of roofing slate in Vermont decreased, but sales of structural and sanitary slate, flagging, and granules increased. Sales of roofing slate and granules decreased in Virginia. The number of operators in Vermont decreased from 19 in 1953 to 16 in 1954 and in Virginia from 5 to 4. Purple, green, mottled, and other types of "colored" slates were produced in the Vermont area. The principal product of the Virginia quarries in Buckingham County was roofing slate. Sales in 1954 decreased both in quantity and value compared with 1953.

The production of granules and flour in Montgomery County, Ark., increased 21 percent in quantity and 20 percent in value in 1954 compared with 1953.

Granules and flour were produced in Bartow County, Ga., and El Dorado County, Calif. The production of slate for use as an expanded lightweight aggregate was reported from Polk County, Ga. Slate flagging was produced in El Dorado County, Calif., and granules in Harford County, Md. Separate figures could not be given for these products due to the small number of producers.

CONSUMPTION AND USES

Dimension Slate.—The term "dimension slate" is applied to roofing slates, mill stock, and flagging slates that are cut to specified sizes and shapes.

TABLE 4.—Dimension slate sold by producers in the United States, 1945–49 (average) and 1950–54

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
1945–49 (average)	163,764	61,836	$2,875,890	12,380	$1,309,486	35,972	$561,590	110,188	$4,746,966
1950	197,570	74,060	4,098,842	15,140	2,130,430	79,440	1,342,053	168,640	7,571,325
1951	205,120	77,500	4,357,412	16,890	2,127,387	76,760	1,522,911	171,150	8,007,710
1952	145,640	54,050	3,067,513	16,720	2,049,895	75,480	1,469,396	146,250	6,586,804
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

[1] Includes flagstones, walkways, stepping stones, and miscellaneous slate.

Residential building has been the chief market for roofing slate. Asbestos-cement shingles, asphalt composition, and metal roofing have replaced slate to such a degree that roofing-slate sales have fallen far below the level of new dwelling-unit construction since 1948, as shown graphically in figure 1. Figure 2, indicates that sales of roofing slates, which represented about 50 percent of all slate sales in the 1920's, dropped to 19 percent of total sales in 1954.

Mill stock has been used in office buildings, schools, and other nonresidential structures for blackboards, steps, baseboards, and other units. Since 1950 sales of mill stock have not paced the growth in nonresidential building, and other materials are being substituted for slate, as indicated in figure 1. Sales of blackboards and bulletin slates, one item of mill-stock slate, are shown in figure 2.

Sales of miscellaneous slate for flagstones, walkways, stepping stones, and other uses, which represented only 12 percent of the total sales of dimension slate in the 1945–49 period, increased to 25 percent of the total sales in 1954. These sales, combined with mill-stock sales other than sales of blackboards and bulletin boards, are shown in figure 2.

Crushed Slate.—Sales of granules, flour, and other crushed slates are shown in table 5. Since 1949, sales of these products have represented about 50 percent of all slate sales and have remained between 6 and 7 million dollars per year.

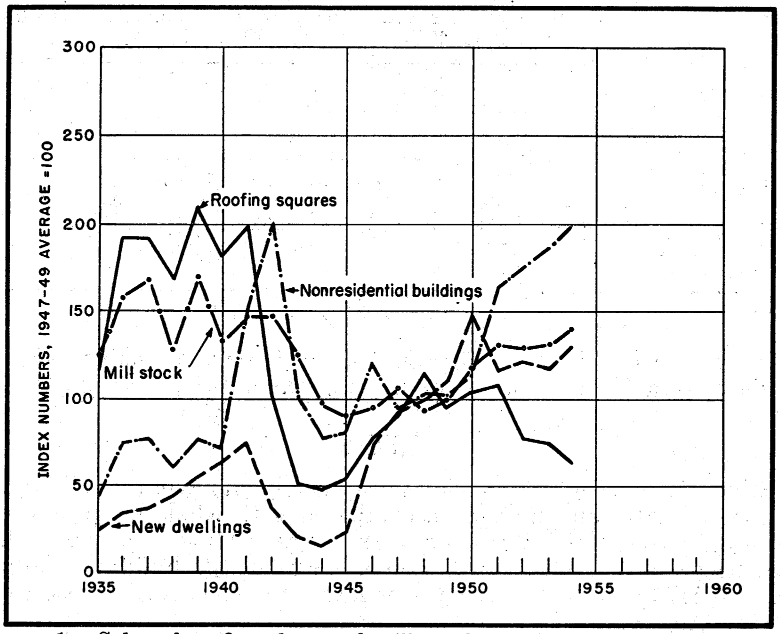

FIGURE 1.—Sales of roofing slate and mill stock compared with number of new dwelling units and value of certain new nonresidential construction, adjusted to 1947–49 prices, 1935–54. Data on number of new dwelling units in nonfarm areas from U. S. Department of Labor; data on nonresidential construction from U. S. Department of Commerce and U. S. Department of Labor.

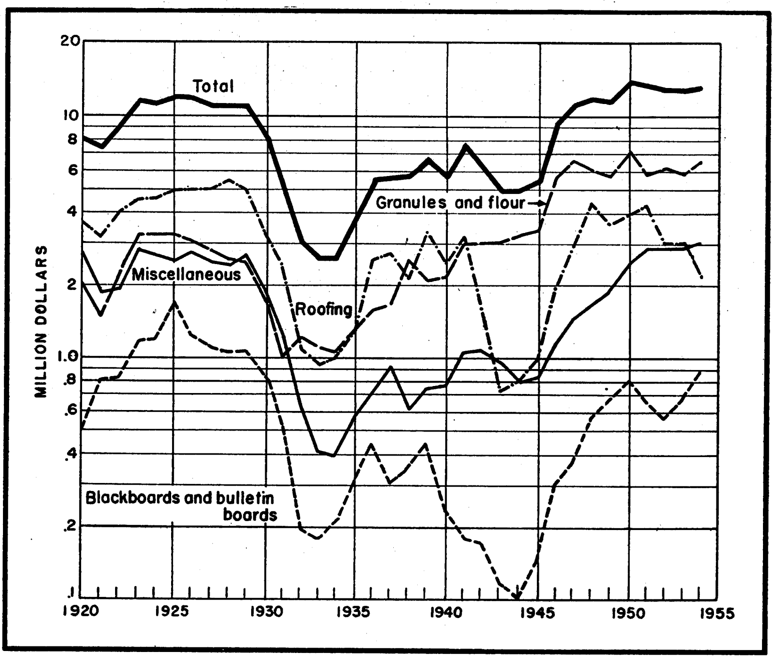

FIGURE 2.—Value of slate sold in the United States, 1920–54, by principal uses.

TABLE 5.—Crushed slate (granules and flour) sold by producers in the United States, 1945–49 (average) and 1950–54

Year	Granules		Flour		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1945–49 (average)	488,974	$4,901,124	146,304	$598,666	635,278	$5,499,790
1950	595,200	6,747,325	166,530	728,831	761,730	7,476,156
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

[1] Includes a small quantity of crushed slate used for lightweight aggregate.

Included with the sales of granules and flour is a small production of slate from Georgia, used for making expanded lightweight aggregate.

PRICES

Price History.—Figure 3 shows graphically the average selling price of roofing slates and mill stock compared with wholesale prices of all building materials for the past 19 years. Mill-stock prices have advanced more rapidly than the average of all building materials since 1951, but roofing-slate prices have remained fairly close to the 1947–49 average.

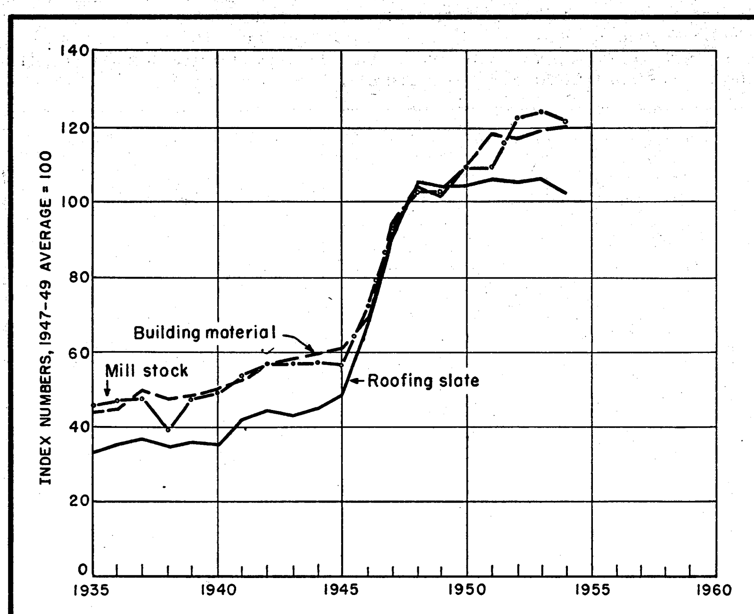

FIGURE 3.—Average selling price of slate compared with wholesale prices of building materials in general, 1935–54. Wholesale prices from U. S. Department of Labor.

Roofing Slates.—The value of roofing slates at the quarries decreased from $21.12 per square in 1953 to $20.26 in 1954. In New York it was $44.95 in 1954 compared with $35.40 in 1953; in Pennsylvania the 1954 price was $19.12 per square compared with $19.60 in 1953. There were so few producers in Maine and Virginia that sales in these States were grouped with those in Vermont and gave an average price of $22.75 per square in 1954.

Mill Stock.—The average price of mill stock was 74 cents per square foot in 1954, 2 cents less than in 1953. The average price of electrical slates dropped from $1.84 per square foot in 1953 to $1.57 in 1954; structural and sanitary slates increased from 64 cents per square foot in 1953 to 72 cents; blackboards and bulletin boards declined from 65 cents to 62 cents; and billiard-table tops increased from 60 cents to 63 cents.

Granules and Flour.—The average price of granules decreased from $12.90 per ton in 1953 to $12.42 in 1954, and the price of flour decreased from $5.66 to $5.36 per ton.

FOREIGN TRADE [3]

Imports.—Slate was imported from four European countries during 1954—West Germany, Italy, Portugal, and Norway. The value of imports in 1954 was 35 percent less than in 1953, and as in 1953 imports consisted mainly of framed and unframed school slates.

TABLE 6.—Slate imported for consumption in the United States, 1945–49 (average) and 1950–54, by countries

[U. S. Department of Commerce]

Country	1945–49 (average)	1950	1951	1952	1953	1954 [1]
North America:						
Canada	$412		$10,257	$4,117	$2,790	
Mexico	49					
Total	461		10,257	4,117	2,790	
South America: Brazil				1,201		
Europe:						
Germany		$1	8,241	[2] 26,623	[2] 35,299	[2] $23,013
Italy	6,989	66,548	187,702	121,366	127,076	74,480
Netherlands				219		
Norway	2	967				1,996
Portugal	462	27,320	45,561	79,743	57,481	45,262
Spain	85			846		
Switzerland	87	328	64	63		
United Kingdom	16	2,172	12	1,993	1,403	
Total	7,641	97,336	241,580	230,853	221,259	144,751
Asia:						
China	23	123				
Japan	28	288	295	98	96	
Total	51	411	295	98	96	
Oceania: Australia			70			
Grand total	8,153	97,747	252,202	236,269	224,145	144,751

[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] 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.

TABLE 7.—Slate exported from the United States, 1945–49 (average) and 1950–54, by uses [1]

Use	1945–49 (average)	1950	1951	1952	1953	1954
Roofing	$7,659	$19,824	$4,138	$15,110	$9,132	$17,129
School slates [2]	19,867	8,138	3,891	2,355	1,796	(3)
Electrical	5,033	14,635	13,819	10,041	23,225	9,085
Blackboards	47,754	107,466	51,056	62,992	89,346	[3] 91,257
Billiard tables	78,117	47,000	88,669	85,657	65,129	71,961
Structural (including floors and walkways) } Slate granules and flour }	383,682	417,148	294,007	201,748	175,770	231,312
Total	542,112	614,211	455,580	377,903	364,398	420,744

[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.

Exports.—The downward trend of exports since 1950 was reversed in 1954, when exports increased 15 percent compared with 1953. Exports of all products except electrical slates gained.

TECHNOLOGY

The utilization of waste from slate quarries continued to be of interest in England. Waste slate was reported to be a constituent of bricks in two plants.[4]

The use of expanded slate for making lightweight concrete gained interest in the United States. The first report of slate being produced for this purpose was submitted to the Bureau of Mines by a company in Georgia in 1954.

A patent was filed during 1954 on the use of slate flour as part of a fusible resinous composition for joining pipes of clay, cement, concrete, or iron.[5]

[4] Quarry Managers' Journal (London), Hopeful News for Slate Quarries: Vol. 37, No. 11, May 1954, pp. 564–565; Bricks From Slate Waste: Vol. 38, No. 6, December 1954, p. 392.
[5] Seymor, R. B., Pipe-Joining Composition: U. S. Patent 2,675,365, Apr. 13, 1954.

Sodium and Sodium Compounds

By Robert T. MacMillan[1] and Annie L. Marks[2]

NATURAL SODA ASH supplied a greater proportion of the national market in 1954 than in the previous year. An important factor was expansion of the output from the large Wyoming trona deposit.

DOMESTIC PRODUCTION

Although the bulk of the sodium carbonate (soda ash) used in this country was manufactured from salt by the ammonia soda process, a substantial part of the total (10 percent in 1954) has been produced from natural deposits in California and Wyoming.

Production of natural sodium carbonate increased 26 percent over the record tonnage of the previous year. On the other hand, the increase in natural sodium carbonate was somewhat more than offset by decreased production of the manufactured variety.

TABLE 1.—Manufactured sodium carbonate produced [1] and natural sodium carbonates sold or used by producers in the United States, 1945–49 (average) and 1950–54

Year	Manufactured soda ash (ammonia-soda process) [2]	Natural sodium carbonates [3]	
	Short tons	Short tons	Value
1945–49 (average)	4,335,077	[4] 238,397	[4] $4,622,075
1950	3,991,199	351,075	7,543,769
1951	5,093,927	350,688	8,368,037
1952	4,442,450	323,479	7,828,033
1953	[5] 4,879,396	419,206	10,627,460
1954	[6] 4,701,364	527,282	13,536,345

[1] U. S. Bureau of the Census.
[2] In 1954 reported as total crude bicarbonate (58% Na_2O). Before January 1953 reported as total wet and dry (98–100 percent Na_2CO_3). Includes quantities consumed in manufacturing finished light and finished dense soda ash, caustic soda as well as quantities consumed in manufacturing refined sodium bicarbonate.
[3] Soda ash and trona (sesquicarbonate).
[4] Exclusive of Wyoming in 1948–49.
[5] Revised figure.
[6] Preliminary figure.

In California natural soda ash was produced by the following companies: American Potash & Chemical Corp., with a plant at Trona on Searles Lake; Columbia-Southern Chemical Corp., a subsidiary of Pittsburgh Plate Glass Co.; and West End Chemical Co., with a plant at Westend on Searles Lake.

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

In Wyoming sodium carbonate was produced from bedded deposits of trona ($NaHCO_3.Na_2CO_3.2H_2O$) at Westvaco by Intermountain Chemical Corp., a subsidiary of Food Machinery & Chemical Corp., and Wyoming Chemical Corp.

Since beginning operations at Westvaco in 1953 Intermountain Chemical Corp. has been steadily increasing production of sodium carbonate and according to reports approached full capacity in 1954.[3]

A 10-foot bed of trona was mined by advanced techniques at a depth of 1,500 feet. In a refining plant at the surface the raw ore was crushed, screened, and fed to a battery of dissolvers. Impurities such as iron, aluminum, and silicon were largely removed; and, by crystallization and calcination, a pure sodium carbonate was produced. The operation was described in an article.[4] It was reported that this trona deposit contains 250 million tons.[5]

Production of sodium sulfate (crude salt cake), including both the manufactured and the natural variety, was somewhat less than in the previous year. Salt-cake tonnage produced from natural deposits increased slightly. The following firms and individuals reported production of natural sodium sulfates: American Potash & Chemical Corp., with a plant at Trona on Searles Lake; Ozark-Mahoning Co., with a plant at Monahans, Tex., which produced from subterranean brines; William E. Pratt, from deposits in Wyoming; and Iowa Soda Products Co., with a plant at Rawlins, Wyo.

TABLE 2.—Sodium sulfate produced and sold or used, by producers in the United States, 1945–49 (average) and 1950–54

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
1945–49 (average)	594,145	182,320	130,835	217,271	$2,706,426
1950	561,395	185,626	184,254	186,537	2,199,336
1951	707,388	219,942	233,666	(3)	(3)
1952	662,373	177,929	202,813	236,825	3,217,000
1953	[4] 685,184	204,159	[4] 219,751	248,230	3,340,760
1954	[5] 663,476	[5] 145,093	[5] 237,744	249,701	3,890,303

[1] U. S. Bureau of the Census.
[2] Includes Glauber's salt converted to 100-percent Na_2SO_4 basis.
[3] Figures withheld to avoid disclosure of individual company operations.
[4] Revised figure.
[5] Preliminary figure.

Most of the sodium sulfate used by industry was a coproduct or byproduct of other chemical manufacturing operations.[6] Of these the largest producers of sodium sulfate in 1954 were the Mannheim plants, in which salt (NaCl) and sulfuric acid were reacted to produce hydrochloric acid and sodium sulfate. Other chemical products of which sodium sulfate was a byproduct were rayon, sodium dichromate, phenol, boric acid, lithium salts, cellophane, and formic acid.

[3] Mining World, vol. 17, No. 4, April 1955, p. 80.
[4] Chemical Engineering, Natural Soda Ash: Vol. 61, No. 3, March 1954, pp. 342–345.
[5] Mining Record (Denver), Wyoming Trona Is New Bonanza Find: Vol. 65, No. 30, July 29, 1954, p. 9.
[6] Chemical and Engineering News, Sodium Sulfate: Vol. 32, No. 44, Nov. 1, 1954, p. 4432.

The West End Chemical Co. was reported to be planning to add sodium sulfate to the list of chemicals which it produced from Searles Lake brines.[7] The new 150-ton-per-day unit was expected to begin producing in mid-1955.

According to the Bureau of the Census, United States Department of Commerce, 126,887 short tons of metallic sodium (100 percent basis) was produced in the United States in 1954. This represents a 5-percent increase over the 1953 production of 120,981 short tons. The metal was produced at 4 plants by the following 3 companies: National Distillers Chemical Co., with a plant at Ashtabula, Ohio; E. I. du Pont de Nemours & Co., Inc., with a plant at Niagara Falls, N. Y.; and Ethyl Corp., with plants at Baton Rouge, La., and Houston, Tex. Substantially all the sodium was produced in Down's cells by electrolysis of a molten mixture of salt (NaCl) and calcium chloride. The function of the calcium chloride is to lower the melting temperature of the salt from 1,472° to 1,112° F. It is not affected by the current. Energy consumption was approximately 5 kw.-hr. per pound of sodium.

CONSUMPTION AND USES

Soda ash, one of the largest chemical commodities, had a multitude of uses in the chemical and metallurgical industries. It entered into the production of glass, soap, detergents, cleansers, aluminum, vanadium, pulp and paper, textiles, water softeners, petroleum products, and a number of chemicals.

Except for nonferrous metals, the estimated consumption of soda ash in all the major use categories decreased slightly in 1954. Continued expansion in the aluminum industry was largely responsible for the estimated increase in soda-ash consumption by nonferrous metals.

The glass industry continued to be the largest single consumer of soda ash, with caustic and bicarbonate production second. The trend toward increased use of detergents was reflected in more soda ash going into sodium phosphates and less into soaps.

Salt cake (sodium sulfate) was used primarily by the kraft pulp industry in digesting wood pulp to produce fiber for the manufacture of paper. It was reported that 80 percent of salt-cake production finds its way into sulfate-pulp production.[8]

Production of sulfate pulp increased 66 percent from 6 million tons in 1949 to 10 million tons in 1954 to meet increasing demand for paper products. During this period the consumption of salt cake and chemicals substituted for salt cake increased from 618,000 to 877,000 tons or 42 percent. However, more efficient utilization was attained so that the salt cake required per ton of pulp produced dropped from 206 pounds in 1949 to an estimated 174 pounds per ton in 1954. This was largely achieved through the use of electrical precipitating equipment for recovering chemicals from the stack gases.[9]

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[7] Chemical Week, Swing Into Salt Cake: Vol. 76, No. 25, June 18, 1955, pp. 22–23.
[8] Chemical Week, Stint in Salt Cake: Vol. 75, No. 26, Dec. 25, 1954, pp. 55–57.
[9] American Paper & Pulp Association, Critical Materials Committee, Survey of Salt-Cake Consumption (unpub. rept.).

Despite the more efficient use of salt cake by the kraft industry some shortages of salt cake were evident.[10] These were aggravated by the fact that salt cake was produced largely as a byproduct, and the production of salt cake was thus geared to such commodities as hydrochloric acid, rayon, sodium dichromate, and others. Increases in imports, largely from Canada, and larger production from natural sources helped to ease the situation.

TABLE 3.—Estimated consumption of sodium carbonate in the United States, 1945–49 (average) and 1950–54, by industries, in thousand short tons

[Chemical Engineering]

Industry	1945–49 (average)	1950	1951	1952	1953	1954
Glass	1,344	1,225	1,640	1,410	[1] 1,520	1,490
Caustic and bicarbonate	1,077	700	994	766	[1] 736	704
Nonferrous metals	190	245	333	320	[1] 417	487
Pulp and paper	211	200	320	305	330	312
Soap	132	105	120	115	[1] 100	88
Cleansers [2]	126	110	142	135	[1] 158	154
Water softeners	102	100	105	95	120	117
Textiles	68	65	56	39	40	31
Exports	105	50	152	106	[1] 165	164
Petroleum refining	23	24	29	31	33	33
Other chemicals	976	1,050	1,253	1,180	[1] 1,270	1,281
Miscellaneous	219	151	296	262	[1] 414	352
Total	4,573	4,025	5,440	4,764	[1] 5,303	5,213

[1] Revised figure.
[2] Includes modified sodas.

TABLE 4.—Consumption of soda ash in "Other Chemicals", 1953–54, in thousand short tons

[Chemical Engineering]

	1953	1954		1953	1954
Calcium carbonate	[1] 188	184	Sodium silicate	230	228
Sodium chromates	[1] 109	99	Sodium sulfite	[1] 44	43
Sodium hydrosulfite	[1] 12	13	Sodium thiosulfate	15	15
Sodium nitrate	[1] 168	164	Unaccounted for	[1] 25	15
Sodium phosphate, tripoli	350	388			
Dibasic	[1] 8	9	Total	[1] 1,270	1,281
Tetra	[1] 64	72			
Other [2]	[1] 57	51			

[1] Revised figure.
[2] Tribasic sodium phosphate consumes approximately 28 percent; monobasic, 6 percent; meta 54 percent; acid pyro, 12 percent.

Sodium sulfate was also consumed in manufacturing glass, synthetic detergents, ceramics, mineral stock feeds, pharmaceuticals, and chemicals.

The production of sodium metal in 1954 was higher than in 1953. A high percentage of the sodium production goes into the manufacture of tetraethyl lead (TEL), a gasoline antiknock compound. Other important uses of sodium were in: Ester reduction, sodium cyanide, sodium peroxide, sodium amide, sodium hydride, and pharmaceuticals. A new industrial use for sodium was in the production of titanium.

[10] Chemical and Engineering News, Newest Shortage: Sodium Sulfate: Vol. 32, No. 35, p. 3468.

Two plants for manufacturing titanium by a sodium-reduction process were reported to be under construction.[11] Another potential use for sodium was as a heat-transfer medium in nuclear power plants.[12]

PRICES

Prices of certain grades of soda ash were reduced slightly during the year, while salt cake in bulk showed a steady increase.

In the first half year (according to Oil, Paint and Drug Reporter) dense soda ash, 58 percent, carlots, works, was quoted at $1.75 per 100 pounds in paper bags and $1.45 in bulk. From July to the end of the year these prices were reduced to $1.70 and $1.40, respectively. Light soda ash, 58 percent, carlots, works, was quoted at $1.65 in paper bags and $1.35 in bulk throughout the year.

Bulk salt cake, works, 100 percent Na_2SO_4 basis, was quoted in Oil, Paint and Drug Reporter at $19 per ton from January to June. From June to August the price quoted was $22 per ton, and from August to the year end the quotation was $24 per ton.

Sodium metal in tank cars at Ashtabula, Ohio, and Niagara Falls, N. Y., was quoted at $0.16 per pound and $0.17 per pound in 12-pound bricks.

FOREIGN TRADE [13]

Imports of sodium sulfate in 1954 were nearly twice those in 1953. Canada supplied the bulk; Belgium, United Kingdom, West Germany, and Holland supplied smaller tonnages. There were small shipments of soda ash from United Kingdom and Canada.

Substantial tonnages of soda ash and salt cake were exported from the United States, but exports totaled only 3 and 2 percent, respectively, of the domestic production.

TABLE 5.—Sodium sulfate imported for consumption in the United States, 1945–49 (average) and 1950–54

[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
1945–49 (average)	28,520	$397,730	29	$582	49	$991	28,598	$399,303
1950	61,612	737,118			5,565	107,330	67,177	844,448
1951	77,559	940,202			3,904	101,139	81,463	1,041,341
1952	50,822	803,054			5,105	141,254	55,927	944,308
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

[11] Chemical Engineering, British to Use Sodium Reduction for Titanium: Vol. 62, No. 2, February 1955, p. 136.

[12] Iron Age, Work on Sodium-Graphite Reactor: Vol. 174, No. 4, July 22, 1954, p. 74.
Chemical and Engineering News, Hot Corrosion—New Problems: Vol. 32, No. 14, Apr. 5, 1954, p. 1348.

[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.

TABLE 6.—Sodium carbonate and sodium sulfate exported from the United States, 1945–49 (average) and 1950–54

[U. S. Department of Commerce]

Year	Sodium carbonate		Sodium sulfate	
	Short tons	Value	Short tons	Value
1945–49 (average)	105,432	$5,059,183	[1] 14,440	[1] $500,000
1950	63,497	2,173,428	16,834	422,263
1951	155,146	6,903,150	25,634	797,360
1952	105,933	4,031,110	27,909	781,582
1953	165,405	5,819,304	28,192	804,887
1954	163,548	5,527,442	24,965	822,684

[1] Not separately classified before 1949.

TECHNOLOGY

Soda Ash.—A patent was granted on a method for producing dense soda-ash monohydrate. Densities of 66.1 pounds per cubic foot were claimed.[14] Glass plants ordinarily use dense ash because of materials-handling and furnace-life problems involved in using light ash.

Sodium Sulfate.—The use of cans of Glauber's salt (sodium sulfate hydrate) for stabilizing the temperature inside a thermally insulated package has been developed [15] for shipping temperature-sensitive materials such as vaccines. The temperature stabilizing function of Glauber's salt is dependent on a phase change occurring at 90° F. Above this temperature, the salt loses water of crystallization absorbing 104 B. T. U. per pound of salt. Below 90° F. the anhydrous salt absorbs water of crystallization liberating equivalent heat. Other materials may be developed which operate on the same principle but in different temperature ranges, however, the physical and chemical characteristics of sodium sulfate decahydrate, together with its cheapness and availability, make it particularly well suited for temperature stabilization in the range 37° to 90° F.

The process employed by the American Potash & Chemical Corp. in producing soda ash, salt cake, and other salts, including those of potassium, boron, and lithium from Searles Lake brines, was described.[16] The salt deposit was formed as a dry lake bed in southern California. The exposed salt bed covers an area of approximately 12 square miles and is 60 to 70 feet thick. The surface deposit is porous, consisting of 55 percent solid-phase salts and 45 percent voids filled with mother liquor or brine. This brine is pumped from the lake bottom to a series of evaporators, where, under carefully controlled conditions of temperature and concentration, a large number of salts are separately crystallized. A separate large salt bed exists below the surface deposit.

Sodium.—The high reactivity of metallic sodium has made it an increasingly important chemical but also one hard to handle and control in reaction. With the advent of sodium dispersions, which are described as stable suspensions of microscopic sodium particles in

[14] Rohn, H. W. (assigned to Columbia Southern Chemical Corp.), Sodium Carbonate: U. S. Patent 2,670,269, February 1954.
[15] Chemical and Engineering News, vol. 32, No. 34, Aug. 23, 1954.
[16] Leonardi, M. L., American Potash & Chemical Corp., Main Plant Cycle: Min. Eng., vol. 6, No. 2, February 1954, pp. 203–208.

inert mediums [17] many of the problems involved in handling sodium and controlling sodium reactions were being solved. Stable, fluid dispersions of sodium in high-boiling hydrocarbons have been made, which are 50 percent metallic sodium. Compared with sodium in bulk form the surface area of the dispersed sodium particles, ranging from submicron to 20 microns in size, is relatively enormous. The dispersions therefore were expected to increase reaction rates in many instances and to provide many new uses for sodium.[18]

A patent was issued for a process for separating sodium metal from a gaseous mixture of sodium vapor and carbon monoxide.[19] Such a mixture results from the reaction between sodium carbonate and carbon at 1,100° C. The sodium vapor is selectively absorbed in molten tin in the temperature range 900°–1,200° C. The tin-sodium alloy is stripped of its sodium with nitrogen gas at 900°–1,200° C. When the gas is cooled, metallic sodium is condensed and cast into bricks.

WORLD REVIEW

NORTH AMERICA

Canada.—Production (shipments) of natural sodium sulfate in Canada increased from 115,600 short tons in 1953 to 165,500 short tons 1954.[20]

Four companies produced natural sodium sulfate from bedded deposits and brine lakes in Saskatchewan. These were: Ormiston Mining & Smelting Co., Ltd., Ormiston; Midwest Chemicals, Ltd., Palo; Sybouts Sodium Sulfate Co., Ltd., Gladmar; and Saskatchewan Minerals, Sodium Sulfate Division, Chaplin. Natural Sodium Products, Ltd., which had been a producer, ceased operations in 1952 and its plants at Bishopric and Alsask have been bought by the Saskatchewan Provincial Government.[21] Production at these plants will be expanded.[22]

SOUTH AMERICA

Brazil.—A major project for developing Brazilian soda-ash sources was the plant being built at Cabo Frio by the National Alkali Co.[23] According to data of the National Bank for Economic Development, this project will begin operations in late 1956 or early 1957 with an annual production of 72,000 tons of soda ash and 20,000 tons of caustic soda. A saving of $7.7 million in foreign exchange will be effected by the anticipated reduction of imports.

EUROPE

Netherlands.—Domestic soda-ash requirements (80,000 tons per year) will be more than met when the projected new soda factory is completed at Delfzijl, in the Province of Groningen.[24] Using brine

[17] Chemical and Engineering News, Sodium in New Role: vol. 32, No. 2, Jan. 11, 1954.
[18] Frank, Charles E., and Foster, Walter E., Sodium-Promoted Condensation of Organic Halids and Carbonyl Compounds: Ind. Eng. Chem., vol. 46, No. 5, May 1954, pp. 1019–1021.
[19] Deyrup, Alden J., Manufacture of Sodium: U. S. Patent 2,685,505, Aug. 3, 1954.
[20] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 4, April 1955, pp. 59–60.
[21] Northern Miner, Toronto, vol. 41, No. 40, Dec. 23, 1954, pp. 17–18.
[22] Chemical and Engineering News, vol. 33, No. 5, Jan. 31, 1955, p. 422.
[23] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 3, September 1954, pp. 71–73.
[24] Chemical and Engineering News, vol. 32, No. 47, Nov. 22, 1954, p. 4672.

from nearby salt deposits,[25] the plant will produce 550 tons of soda ash per day by the ammonia-soda process. Capital requirements of $13.5 million were to be met largely by State-owned salt and coal-mining companies and State-guaranteed loans.

ASIA

India.—It was reported that Dhrangadhra Chemical Works, Ltd., will spend $2.1 million to build a soda-ash and caustic-soda plant at Tuticorin, Madras State.[26] The proposed plant, with an estimated daily capacity of 100 tons of soda ash and 60 tons of caustic, will become India's second largest producer. Tata Chemicals was the largest producer, with an estimated 56,000 tons of soda ash yearly. It was reported that a new caustic soda plant having a capacity of 11.25 tons of caustic soda per day will be opened at Indore.[27]

[25] Oil, Paint and Drug Reporter, vol. 167, No. 13, Mar. 28, 1955, p. 4.
[26] Chemical Week, vol. 76, No. 25, June 18, 1955, p. 33.
[27] Chemical and Engineering News, vol. 32, No. 44, Nov. 1, 1954, p. 4398.

Stone

Wallace W. Key [1] and Nan C. Jensen [2]

STONE ranked second in tonnage in the mineral industry in 1954, and exceeded 400 million short tons for the first time.[3] Only the sand and gravel industry produced more.

Stone output was increasing, and new production capacity was being projected to meet anticipated future requirements of road building, other construction, and industrial markets.

TABLE 1.—Stone sold or used by producers in the United States,[1] 1945–49 (average) and 1950–54, by kinds

Year	Granite		Basalt and related rocks (traprock)		Marble		Limestone	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1945–49 (average)	12, 386, 554	$32, 408, 380	18, 593, 504	$24, 874, 903	223, 962	$9, 234, 281	145, 637, 860	$180, 320, 604
1950	[2] 22, 546, 099	[2] 51, 457, 233	22, 894, 830	34, 372, 735	267, 220	10, 932, 234	180, 918, 910	252, 755, 827
1951	[2] 20, 288, 467	[2] 49, 405, 475	29, 404, 512	42, 914, 706	256, 339	10. 641, 219	205, 479, 815	287, 675, 332
1952	[2] 22, 279, 002	[2] 51, 531, 884	29, 760, 760	46, 437, 787	238, 048	10, 888, 353	[2] 217, 105, 542	[2] 308, 244, 992
1953	[2] 23, 485, 156	[2] 55, 110, 162	30, 097, 694	46, 479, 615	453, 800	12, 190, 552	[2] 225, 126, 119	[2] 317, 971, 834
1954	23, 450, 347	56, 704, 986	30, 807, 781	49, 593, 585	538, 384	13, 794, 048	[3] 324, 974, 112	[3] 433, 984, 962

Year	Sandstone		Other stone [4]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1945–49 (average)	5, 938, 908	$14, 932, 225	15, 094, 076	$12, 913, 224	197, 874, 864	$274, 683, 617
1950	9, 100, 890	23, 787, 019	16, 378, 020	16, 513, 622	[2] 252, 105, 969	[2] 389, 818, 670
1951	8, 792, 232	24, 979, 317	21, 320, 568	20, 332, 981	[2] 285, 541, 933	[2] 435, 949, 030
1952	8, 649, 584	25, 004, 372	23, 553, 491	22, 730, 718	[2] 301, 586, 427	[2] 464, 838, 106
1953	[2] 8, 655, 161	28, 270, 960	[2] 19, 023, 713	[2] 23, 305, 593	[2] 306, 841, 643	[2] 483, 328, 716
1954	[5] 12, 118, 698	[5] 35, 321, 029	16, 287, 499	20, 628, 596	408, 176, 821	610, 027, 206

[1] Includes Territories of the United States, possessions, and other areas administered by the United States. 1945–53 excludes stone used for abrasives and in making cement and lime. 1954 includes 95,029,324 tons, valued at $104,718,047, of stone used for abrasives and in making cement and lime, and oystershells for various uses.

[2] Revised figure.

[3] Includes 94,379,730 tons, valued at $101,952,758, of limestone, dolomite, cement rock, and oystershells used in making cement, lime, and dead-burned dolomite, and oystershells for various uses.

[4] Includes mica schist, conglomerate, argillite, various light-color volcanic rocks, serpentine not used as marble, soapstone sold as dimension stone, etc.

[5] Includes 649,594 tons, valued at $2,765,289, ground sandstone, quartz, and quartzite used for abrasives and other uses.

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[1] Commodity specialist.

[2] Statistical assistant.

[3] Some of the production data for 1954 were collected jointly with the Bureau of the Census (United States Department of Commerce). Production totals will be compared with the Census totals when they are available and differences adjusted or explained.

TABLE 2.—Stone sold or used by producers in the United States,[1] 1953–54, by uses

Use	1953		1954	
	Quantity	Value	Quantity	Value
Dimension stone:				
Building stone:				
Rough construction.....short tons..	[2] 208,004	[2] $1,195,606	462,024	$2,553,325
Cut stone, slabs, and mill blocks [3]..cubic feet..	[2] 12,431,184	[2] 34,184,146	14,267,398	40,626,140
Approximate equivalent in short tons.....	[2] 939,841		1,071,648	
Rubble.....short tons..	[2] 402,701	[2] 1,126,498	389,701	904,014
Monumental stone.....cubic feet..	[2] 3,040,997	[2] 18,994,881	2,842,456	18,105,085
Approximate equivalent in short tons.....	[2] 251,183		235,203	
Paving blocks.....number..	347,982	40,458	208,204	18,247
Approximate equivalent in short tons.....	2,346		977	
Curbing.....cubic feet..	1,016,140	2,499,976	1,554,943	3,408,017
Approximate equivalent in short tons.....	[2] 82,342		128,117	
Flagging.....cubic feet..	776,493	1,269,619	1,203,088	1,932,473
Approximate equivalent in short tons.....	[2] 62,026		94,613	
Total dimension stone (quantities approximate, in short tons).....	[2] 1,948,443	[2] 59,311,184	2,382,283	67,547,301
Crushed and broken stone:				
Riprap.....short tons..	[2] 7,735,037	[2] 10,052,602	7,642,332	10,979,042
Concrete and roadstone.....do....	[2] 189,158,785	[2] 251,514,832	[4] 216,614,445	[4] 289,441,803
Railroad ballast.....do....	20,778,410	20,533,252	15,172,606	14,871,002
Furnace flux (limestone).....do....	40,881,304	53,040,512	33,161,736	40,933,952
Refractory stone [5].....do....	1,937,292	8,079,005	1,529,570	5,923,312
Agriculture (limestone).....do....	[2] 18,427,513	[2] 30,103,864	18,247,121	30,199,337
Other uses.....do....	[2] 25,974,859	[2] 50,693,465	23,074,604	51,343,760
Total [6].....	[2] 304,893,200	[2] 424,017,532	315,442,414	443,692,208
Portland and natural cement (limestone, cement rock, and oystershells).....do....	(7)	(7)	71,267,567	72,660,897
Lime and dead-burned dolomite.....do....	(7)	(7)	14,594,489	19,092,152
Abrasives and other uses (ground sandstone, quartz, and quartzite).....do....	(7)	(7)	649,594	2,765,289
Unspecified uses (oystershells).....do....			3,840,474	4,269,359
Total crushed and broken stone.....do....	[2 8] 304,893,200	[2 8] 424,017,532	405,794,538	542,479,905
Grand total (quantities approximate, in short tons).....	[2 8] 306,841,643	[2 8] 483,328,716	408,176,821	610,027,206

[1] Includes Territories of the United States, possessions, and other areas administered by the United States, 1953 excludes stone used for abrasives and in making cement and lime. 1954 includes 95,029,324 tons, valued at $104,718,047, of stone used for abrasives and in making cement and lime, and oystershells for various uses.
[2] Revised figure.
[3] To avoid disclosure of individual outputs, dimension stone for refractory use is included with building stone. Sawed building stone includes: 1953—480,968 cubic feet (34,874 tons) of stone for refractory use valued at $1,254,988; 1954—302,233 cubic feet (21,919 tons), $841,028.
[4] Includes 4,677,200 tons oystershells, $5,930,350.
[5] Ganister (sandstone and quartzite) and dolomite. 1953 includes a small quantity of mica schist and soapstone.
[6] Excludes stone and oystershells for certain uses.
[7] Not included in the 1953 stone totals.
[8] Excludes stone used for abrasives and in making cement and lime and oystershells for various uses, estimated at 93,968,391 tons valued at $102,051,060.

TABLE 3.—Stone sold or used by noncommercial producers in the United States,[1] 1953–54, by uses

(Included in total production)

Use	1953		1954	
	Short tons	Value	Short tons	Value
Building stone.....	13,652	$33,597	20,264	$72,560
Rubble.....	[2] 27,069	[2] 47,703	13,680	21,582
Riprap.....	[2] 2,585,874	[2] 2,738,339	2,088,485	2,079,071
Concrete and roadstone.....	[2] 19,806,421	[2] 25,608,519	17,457,130	21,327,653
Agricultural (limestone).....	309,593	447,374	501,496	675,252
Other uses.....	3,316,744	3,286,898	2,295,479	1,911,338
Total.....	[2] 26,059,353	[2] 32,162,430	22,376,534	26,087,456

[1] Includes Territories of the United States, possessions, and other areas administered by the United States.
[2] Revised figure.

TABLE 4.—Stone sold or used by producers in the United States, 1953–54, by States

State	1953		1954	
	Short tons	Value	Short tons	Value
Alabama	[1] 3,957,452	[1] $8,154,467	7,393,530	$11,608,937
Arizona	442,358	618,748	1,205,452	1,914,315
Arkansas	[1] 3,545,350	[1] 5,069,750	4,604,067	5,929,638
California	[1,2] 14,497,348	[1,2] 18,472,652	23,303,756	37,541,114
Colorado	[1] 884,104	[1] 1,750,726	1,804,004	2,112,093
Connecticut	[2] 2,826,568	[2] 4,235,327	[2] 2,829,198	[2] 4,269,430
Delaware	80,364	215,382	(3)	(3)
Florida	[2] 9,428,959	[2] 11,309,421	[2] 14,225,356	[2] 16,832,066
Georgia	[1] 7,112,024	[1] 17,756,302	8,057,600	21,384,227
Idaho	1,141,626	2,260,875	2,329,005	3,012,613
Illinois	22,938,732	29,736,966	26,407,088	31,134,135
Indiana	[1] 9,212,887	[1] 22,297,183	11,181,838	27,460,119
Iowa	10,715,078	13,215,352	13,240,087	16,388,141
Kansas	8,769,152	11,303,950	10,377,008	12,941,822
Kentucky	[2] 7,429,505	[2] 9,268,237	10,129,725	13,285,786
Louisiana	-----------	-----------	(3)	(3)
Maine	[2] 248,501	[2] 1,215,439	1,023,709	2,355,385
Maryland	[1,2] 3,578,250	[2] 6,275,124	5,064,526	8,265,521
Massachusetts	3,457,708	8,821,108	2,942,435	9,039,590
Michigan	21,616,686	17,639,525	27,758,443	21,904,517
Minnesota	2,270,528	6,587,096	[2] 2,629,456	[2] 7,485,291
Mississippi	38,000	43,700	91,218	91,218
Missouri	[1] 13,947,834	[1] 20,552,840	18,615,739	24,695,110
Montana	[2] 802,735	[2] 1,124,731	1,319,829	1,385,239
Nebraska	1,407,158	2,069,984	2,660,170	3,511,494
Nevada	1,035,568	1,399,529	1,832,781	2,010,592
New Hampshire	76,701	538,897	72,486	473,298
New Jersey	6,036,259	13,307,856	5,772,200	12,109,950
New Mexico	624,528	510,713	771,630	714,037
New York	[2] 15,961,657	[2] 25,250,576	19,410,121	31,425,701
North Carolina	[2] 9,316,823	[2] 14,424,323	10,133,728	15,625,331
North Dakota	35,031	2,595	1,419	3,784
Ohio	[1,2] 25,285,782	[1,2] 39,041,308	32,626,737	47,802,169
Oklahoma	[1] 8,489,994	[1] 7,930,737	[2] 9,238,811	[2] 9,146,995
Oregon	[2] 4,939,080	[2] 6,301,639	5,872,353	8,617,795
Pennsylvania	[2] 26,192,607	[2] 48,094,029	40,521,756	61,193,419
Rhode Island	161,632	617,096	(3)	(3)
South Carolina	[2] 2,913,860	[2] 3,976,370	[2] 2,861,953	[2] 4,233,270
South Dakota	[1] 1,189,444	[1] 4,997,497	1,614,818	4,928,855
Tennessee	[2] 10,485,351	[2] 16,948,053	14,040,187	22,046,016
Texas	[2] 9,095,109	[2] 8,550,320	[2] 24,981,897	[2] 28,485,243
Utah	997,330	1,446,594	1,127,461	1,545,841
Vermont	527,150	8,859,703	436,870	8,178,389
Virginia	9,091,907	16,258,620	10,893,972	18,587,501
Washington	4,438,259	5,890,849	5,366,890	9,526,534
West Virginia	[2] 5,501,148	[2] 8,924,411	7,314,934	11,743,440
Wisconsin	7,450,396	[1] 15,979,756	8,289,373	16,187,738
Wyoming	1,431,372	1,839,922	1,616,015	1,665,302
Undistributed	623,379	1,993,325	469,018	1,598,089
Total	[4] 302,248,274	[4] 473,079,603	[5] 404,460,649	[5] 602,397,090
Alaska	47,086	169,711	283,734	465,423
American Samoa	74,750	16,500	57,600	15,000
Canton Island	4,200	8,750	2,600	5,000
Guam	2,080,650	5,573,169	842,660	2,275,182
Hawaii	[6] 1,299,501	[6] 2,654,358	[6] 1,483,027	[6] 2,990,632
Johnston	-----------	-----------	98	300
Midway	204	638	490	1,500
Panama Canal Zone	171,908	231,752	187,446	245,170
Puerto Rico	[6] 648,400	[6] 1,237,236	[6] 834,662	[6] 1,575,493
Virgin Islands	10,789	45,853	3,939	17,134
Wake Island	11,980	20,615	780	1,300
Undistributed	243,901	290,531	19,136	37,982
Total	[4] 4,593,369	[4] 10,249,113	[7] 3,716,172	[7] 7,630,116
Grand total	[1,4] 306,841,643	[1,4] 483,328,716	[8] 408,176,821	[8] 610,027,206

[1] Revised figure.
[2] 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.
[3] Included with "Undistributed."
[4] Does not include stone used for abrasives and in making cement and lime.
[5] Includes stone used for abrasives and in making cement and lime, and oystershells for various uses.
[6] Certain territory or area totals are incomplete, the portion not included being combined with "Undistributed."
[7] Includes stone used in making cement and lime.
[8] Includes 95,029,324 tons, valued at $104,718,047, of stone used for abrasives and in making cement and lime, and oystershells for various uses.

DIMENSION STONE

Dimension-stone producers may be divided into three main categories, based upon plant operations. The first group quarries stone and sells it as rough blocks or slabs; the second quarries stone and also uses it in manufacturing finished products; and the third group buys sawed slabs or rough blocks of stone and manufactures a finished product but does not operate quarries. Bureau of Mines production data are compiled on the basis of quantities and values of sales of both rough blocks and finished products by primary producers.

Total sales of dimension stone (including slate) in 1954 increased 21 percent over 1953 in tonnage and 12 percent in value. The total figures in table 5 include slate, but detailed statistics of that branch of the industry appear in the Slate chapter.

Quarries producing dimension stone other than slate were operated in 38 States and Hawaii and Puerto Rico in 1954. The leading States, in order of value, were Indiana, Georgia, Vermont, Ohio, Tennessee, Minnesota, Massachusetts, and Virginia. Dimension slate was quarried in six States with Pennsylvania, Vermont, and New York leading in value of production.

TABLE 5.—Dimension stone sold or used by producers in the United States,[1] 1953–54, by kinds and uses

Kind and use	1953	1954	Percent change in 1954 from 1953
Granite:			
Building stone:			
Rough construction ... short tons	[2] 57,345	49,215	−14
Value	[2] $523,740	$519,112	−1
Average per ton	[2] $9.13	$10.55	+16
Cut stone, slabs, and mill blocks ... cubic feet	[2] 662,598	703,365	+6
Value	[2] $4,042,405	$4,902,183	+21
Average per cubic foot	[2] $6.10	$6.97	+14
Rubble ... short tons	178,526	185,647	+4
Value	$425,144	$365,487	−14
Monumental stone ... cubic feet	[2] 2,777,894	2,601,136	−6
Value	[2] $16,539,832	$15,442,632	−7
Average per cubic foot	[2] $5.95	$5.94	
Paving blocks ... number	347,982	208,204	−40
Value	$40,458	$18,247	−55
Curbing ... cubic feet	919,179	1,520,198	+65
Value	$2,220,068	$3,257,440	+47
Total:			
Quantity ... approximate short tons	[2] 597,094	634,354	+6
Value	[2] $23,791,647	$24,505,101	+3
Basalt and related rocks (traprock):			
Building stone:			
Rough construction ... short tons	58,005	52,205	−10
Value	$215,840	$357,769	+66
Average per ton	$3.72	$6.85	+84
Rubble ... short tons	(3)		
Value	(3)		
Total:			
Quantity ... short tons	[2] 58,005	52,205	−10
Value	[2] $215,840	$357,769	+66

See footnotes at end of table.

TABLE 5.—Dimension stone sold or used by producers in the United States,[1] 1953–54, by kinds and uses—Continued

Kind and use	1953	1954	Percent change in 1954 from 1953
Marble:			
Building stone (cut stone, slabs, and mill blocks)...cubic feet..	634,333	754,282	+19
Value	$5,975,453	$7,192,409	+20
Average per cubic foot	$9.42	$9.54	+1
Monumental stone...cubic feet..	263,103	241,320	−8
Value	$2,455,049	$2,662,453	+8
Average per cubic foot	$9.33	$11.03	+18
Total:			
Quantity...approximate short tons..	76,255	84,626	+11
Value	$8,430,502	$9,854,862	+17
Limestone:			
Building stone:			
Rough construction...short tons..	61,264	303,241	+395
Value	$231,514	$868,725	+275
Average per ton	$3.78	$2.86	−24
Cut stone, slabs, and mill blocks...cubic feet..	7,340,467	9,172,174	+25
Value	$14,612,815	$18,392,364	+26
Average per cubic foot	$1.99	$2.01	+1
Rubble...short tons..	181,673	183,136	+1
Value	$517,653	$445,605	−14
Flagging...cubic feet..	169,550	151,824	−10
Value	$134,176	$147,176	+10
Total:			
Quantity...approximate short tons..	798,911	1,174,389	+47
Value	$15,496,158	$19,853,870	+28
Sandstone:			
Building stone:			
Rough construction...short tons..	31,390	57,363	+83
Value	$224,512	$807,719	+260
Average per ton	$7.15	$14.08	+97
Cut stone, slabs, and mill blocks...cubic feet..	3,157,491	3,288,762	+4
Value	$6,892,817	$7,167,848	+4
Average per cubic foot	$2.18	$2.18	....
Rubble...short tons..	35,690	17,185	−52
Value	$153,274	$82,648	−46
Curbing...cubic feet..	96,961	51,649	−47
Value	$279,908	$149,279	−47
Flagging...cubic feet..	556,024	1,005,823	+81
Value	$1,084,044	$1,738,953	+60
Total:			
Quantity...approximate short tons..	[2] 353,513	401,488	+14
Value	$8,634,555	$9,946,447	+15
Miscellaneous stone:[4]			
Building stone...cubic feet..	[2] 636,295	348,815	−45
Value	[2] $2,660,656	$2,971,336	+12
Average per cubic foot	[2] $4.18	$8.52	+104
Rubble...short tons..	6,812	3,733	−45
Value	$30,427	$10,274	−66
Flagging...cubic feet..	50,919	28,537	−44
Value	$51,399	$47,642	−7
Total:			
Quantity...approximate short tons..	[2] 64,665	35,221	−46
Value	[2] $2,742,482	$3,029,252	+10
Total dimension stone, excluding slate:			
Quantity...approximate short tons..	[2] 1,948,443	2,382,283	+22
Value	[2] $59,311,184	$67,547,301	+14
Slate as dimension stone[5]...approximate short tons..	152,903	151,626	−1
Value	$6,684,804	$6,348,819	−5
Total dimension stone, including slate:			
Quantity...approximate short tons..	[2] 2,101,346	2,533,909	+21
Value	[2] $65,995,988	$73,896,120	+12

[1] Includes Hawaii and Puerto Rico.
[2] Revised figure.
[3] Revised to none.
[4] Includes soapstone, mica schist, volcanic rocks, argillite, and other varieties that cannot be classified in the principal groups.
[5] Details of production, by uses, are given in the Slate chapter of this volume.

BUILDING STONE

As in previous years, dimension stone was used predominantly in the building industry in 1954. Combined sales of building stone (excluding rubble) increased 34 percent in quantity and 22 percent in value compared with 1953. Rubble, also classed as a building stone but not included in the above percentages, decreased 3 percent in quantity and 20 percent in value compared with the previous year. Table 6 gives the quantity and value of each kind of stone used for building purposes in 1954.

TABLE 6.—Building stone sold or used by producers in the United States [1] in 1954, by kinds

Kind	Rough			
	Construction		Architectural	
	Cubic feet	Value	Cubic feet	Value
Granite	596,469	$519,112	135,758	$305,468
Basalt	621,126	357,769	---	---
Marble	---	---	195,262	736,358
Limestone	3,825,795	868,725	2,845,013	3,483,692
Sandstone	738,480	807,719	1,285,586	2,166,428
Miscellaneous	---	---	---	---
Total	5,781,870	2,553,325	4,461,619	6,691,946

Kind	Finished				Total	
	Sawed		Cut		Cubic feet	Value
	Cubic feet	Value	Cubic feet	Value		
Granite [2]	347,617	$1,505,593	219,990	$3,091,122	1,299,834	$5,421,295
Basalt	---	---	---	---	621,126	357,769
Marble	198,227	1,427,403	360,793	5,028,648	754,282	7,192,409
Limestone	4,964,888	8,156,449	1,362,273	6,752,223	12,997,969	19,261,089
Sandstone	1,709,022	3,900,131	294,154	1,101,289	4,027,242	7,975,567
Miscellaneous	[3] 348,815	[3] 2,971,336	---	---	348,815	2,971,336
Total	[3] 7,568,569	[3] 17,960,912	2,237,210	15,973,282	20,049,268	43,179,465

[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 dimension granite increased slightly in total tonnage and value in 1954, but the average unit value declined $1.22 per ton compared with the previous year. Dressed granite for building and curbing counterbalanced the decline in tonnage and value of all other uses except rubble, which increased slightly in tonnage but decreased in value. Granite was quarried in 23 States, with Vermont, Massachusetts, Georgia, Minnesota, and South Dakota 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 1954, 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	13	(1)	(1)	13,337	$28,900	(1)	(1)	4,845	$19,040	22,804	$75,028	1,793	$18,318			188	$2,342	8,860	$218,628
Colorado	6									6,193	24,738	3,625	15,750					824	40,488
Connecticut	6	1,938	$23,460	(1)	(1)	21,725	$61,332	(1)	(1)	2,314	15,516	6,000	42,000			3,831	11,417	5,935	168,651
Georgia	24	300	1,200	1,100	6,600	(1)	(1)	71,393	157,182	713,125	1,949,340	148,154	710,442	(1)	(1)	(1)	(1)	193,270	3,678,193
Maine	5	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)			(1)	(1)	14,532	883,398
Maryland	3	(1)	(1)					(1)	(1)							(1)	(1)	(1)	(1)
Massachusetts	8	16,907	223,061	(1)	(1)	(1)	(1)	(1)	(1)	10,845	67,748	(1)	(1)	(1)	(1)	(1)	(1)	116,473	3,991,696
Minnesota	17			4,000	10,000	73,742	985,345	(1)	(1)	(1)	(1)	162,608	2,373,917					82,922	3,451,343
Missouri	1			12,299	35,984					14,565	50,953	8,152	80,899					2,924	167,836
New Hampshire	2	(1)	(1)			(1)	(1)											(1)	(1)
New York	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	6									14,454	77,960	59,159	582,843					6,072	660,803
Oregon	1									(1)	(1)							(1)	(1)
Pennsylvania	3	(1)	(1)			(1)	(1)					(1)	(1)					(1)	(1)
Rhode Island	2	(1)	(1)							(1)	(1)							(1)	(1)
South Carolina	1							(1)	(1)	(1)	(1)							(1)	(1)
South Dakota	6			12,216	30,124	3,000	60,000			94,169	306,950	127,796	1,906,770					19,212	2,303,844
Texas	1					33,333	500,000					3,333	100,000					3,025	600,000
Utah	1									1,827	4,800							148	4,800
Vermont	4							(1)	(1)	(1)	(1)	(1)	(1)					(1)	(1)
Washington	3							(1)	(1)			(1)	(1)			(1)	(1)	380	14,284
Wisconsin	9			(1)	(1)	(1)	(1)			(1)	(1)	(1)	(1)					10,048	1,416,126
Undistributed		30,070	271,391	92,806	193,860	435,807	2,990,038	109,409	189,265	1,058,196	4,972,931	142,024	2,065,729	208,204	$18,247	1,516,179	3,243,681	169,729	6,905,011
Total	131	49,215	519,112	135,758	305,468	567,607	4,596,715	185,647	365,487	1,938,492	7,545,964	662,644	7,896,668	208,204	18,247	1,520,198	3,257,440	634,354	24,505,101
Average unit value			$10.55		$2.25		$8.10		$1.97		$3.89		$11.92		$0.09		$2.14		$38.63
Short tons (approximate)		(2)		11,199		46,913				160,105		54,586		977		125,712			

1 Included with "Undistributed" to avoid disclosure of individual company operations.
2 596,469 cubic feet (approximate).

TABLE 8.—Monumental granite sold by quarrymen in the Barre district, Vermont, 1945–49 (average) and 1950–54

Year	Cubic feet	Value	Year	Cubic feet	Value
1945–49 (average)	914,054	$3,357,297	1952	599,544	$3,010,130
1950	917,310	3,868,351	1953	975,735	5,043,890
1951	853,963	4,100,912	1954	800,970	4,604,795

TABLE 9.—Estimated output of monumental granite in the Barre district, Vermont, 1952–54

[Barre Granite Association, Inc.]

	1952	1953	1954
Total quarry output, rough stock cubic feet	462,280	976,176	800,970
Shipped out of Barre district in rough do	92,457	195,235	160,194
Manufactured in Barre district do	369,823	780,941	640,776
Light stock consumed in district do	246,549	520,627	427,184
Dark stock consumed in district do	123,274	260,314	213,592
Number of cutters in district	1,748	2,422	2,422
Average daily wage	$15.38	$15.00	$15.12
Average number of days worked	155	240	240
Total payroll for year	$4,166,805	$8,719,200	$8,788,627
Estimated overhead	2,083,403	4,359,600	4,394,313
Estimated value of light stock	1,525,535	2,577,105	2,653,881
Estimated value of dark stock	801,289	1,728,482	1,804,852
Estimated polishing cost	930,344	1,964,554	1,611,952
Estimated sawing cost	728,096	1,537,477	1,261,527
Total value of granite	10,235,472	20,886,418	20,515,152

BASALT AND RELATED ROCKS (TRAPROCK)

Because of their dark color, basalt and related rocks are not used extensively as building stone. Sales for rough construction for the two States reporting were down slightly in quantity, but the value was higher than in 1953. The memorial stone of this group, known as "black granite," is included in the memorial granite figures.

TABLE 10.—Basalt and related rocks (traprock) (dimension stone) sold or used by producers in the United States in 1953–54, by States and use

State	1953			1954		
	Active plants	Rough construction		Active plants	Rough construction	
		Short tons	Value		Short tons	Value
Connecticut	1	(1)	(1)			
Oregon	1	2,620	$13,680	1	(1)	(1)
Pennsylvania [2]	2	(1)	(1)	2	(1)	(1)
Undistributed		55,385	202,160		52,205	$357,769
Total	4	[3] 58,005	215,840	3	[3] 52,205	357,769
Average unit value			$3.72			$6.85

[1] Included with "Undistributed" to avoid disclosure of individual company operations.
[2] 1954 includes a small quantity of dressed architectural and monumental stone.
[3] Cubic feet (approximate): 1953—690,167; 1954—621,126.

MARBLE

Dimension marble used for construction and for monumental and memorial work increased 11 percent in quantity and 17 percent in value over 1953. Marble was quarried in 10 States, with Tennessee and Georgia leading.

The average value of marble sold for memorial purposes was $11.03 per cubic foot, and that of marble for building purposes was $9.54 per cubic foot in 1954.

TABLE 11.—Marble (dimension stone) sold by producers in the United States, 1953–54, by uses

Use	1953		1954	
	Cubic feet	Value	Cubic feet	Value
Building stone:				
Rough:				
Exterior	48,872	$201,845	130,091	$547,293
Interior	125,919	416,837	65,171	189,065
Finished:				
Exterior	130,722	1,037,301	103,033	884,075
Interior	328,820	4,319,470	455,987	5,571,976
Total exterior	179,594	1,239,146	233,124	1,431,368
Total interior	454,739	4,736,307	521,158	5,761,041
Total building stone	634,333	5,975,453	754,282	7,192,409
Monumental stone (rough and finished)	263,103	2,455,049	241,320	2,662,453
Total building and monumental	897,436	8,430,502	995,602	9,854,862
Approximate short tons	76,255		84,626	

TABLE 12.—Marble (dimension stone) sold by producers in the United States in 1954, by States and uses

State	Active plants	Building		Monumental		Total		
						Quantity		
		Cubic feet	Value	Cubic feet	Value	Cubic feet	Short tons (approximate)	Value
Alabama	2	49,141	$495,791	10,000	$128,000	59,141	5,027	$623,791
Arizona	1	588	1,750			588	50	1,750
Arkansas	1	5,640	24,035			5,640	479	24,035
Colorado	2	3,772	12,093			3,772	321	12,093
Georgia	1	146,154	1,541,707	139,153	1,456,324	285,307	24,251	2,998,031
Maryland	1	(1)	(1)			(1)	(1)	(1)
Missouri	3	73,822	975,264	1,396	11,478	75,218	6,393	986,742
North Carolina	1	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Tennessee	13	(1)	(1)	(1)	(1)	324,840	27,611	3,047,135
Vermont	6	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Undistributed		475,165	4,141,769	90,771	1,066,651	241,096	20,494	2,161,285
Total	31	754,282	7,192,409	241,320	2,662,453	995,602	84,626	9,854,862
Average unit value			$9.54		$11.03			[2] $9.90
Short tons (approximate)		64,114		20,512				

[1] Included with "Undistributed" to avoid disclosure of individual company operations.
[2] Average value per cubic foot.

LIMESTONE

Limestone cut in blocks or slabs was used almost exclusively for building purposes. A small quantity was employed for flagging, but only a negligible quantity for memorials. Limestone was the predominant type of stone used in buildings; Indiana produced 75 percent of the total value, followed by Wisconsin and Alabama.

TABLE 13.—Limestone (dimension stone) sold or used by producers in the United States in 1954, 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			72,652	$97,549	154,370	$703,869	1,322	$1,322			18,349	$802,740
California	4	(1)	(1)			(1)	(1)	(1)	(1)			(1)	(1)
Connecticut	1	143	$726									143	726
Florida	4	(1)	(1)			(1)	(1)	826	1,644			(1)	(1)
Georgia	3							3,065	8,545			3,065	8,545
Hawaii	1							(1)	(1)			(1)	(1)
Illinois	9	750	3,375	776	325	2,646	6,750	1,352	5,039	21,144	$15,577	4,190	31,066
Indiana	21	16,222	96,918	2,498,519	3,154,864	5,054,282	11,427,362	49,556	128,984			613,356	14,808,128
Kansas	12	6,500	5,800	30,563	17,076	285,139	717,583	6,663	16,748	9,993	7,220	40,847	764,427
Maryland	1	(1)	(1)									(1)	(1)
Michigan	3	(1)	(1)			17,052	36,250	(1)	(1)	11,172	7,930	8,938	68,984
Minnesota	6			89,300	62,050	153,275	689,200	3,060	3,535	12,775	8,680	23,488	763,465
Missouri	14	12,167	32,436	345	1,598	2,404	3,646	33,879	67,564	27,583	25,271	48,624	130,515
Nebraska	3	1,074	2,148	30,670	10,408			500	2,500			4,181	15,056
Ohio	3	34,186	109,968					3,349	7,535			37,535	117,503
Oklahoma	3	(1)	(1)			(1)	(1)					(1)	(1)
Pennsylvania	5	22,852	83,773					48,888	144,913			71,740	228,686
Puerto Rico	7	85,500	184,000					14,389	27,476			99,889	211,476
Tennessee	3	1,507	1,230					2,785	2,785			4,292	4,015
Texas	6			98,187	113,715	219,474	410,705			4,000	1,185	23,321	525,605
Virginia	1	500	1,250					1,200	2,400			1,700	3,650
Wisconsin	20	11,829	53,751	24,001	26,107	364,812	807,007	7,538	14,175	65,157	81,313	55,685	982,353
Undistributed	[1] 2	110,011	293,350			73,707	106,300	4,764	10,440			115,046	386,930
Total	133	303,241	868,725	2,845,013	3,483,692	6,327,161	14,908,672	183,136	445,605	151,824	147,176	1,174,389	19,853,870
Average unit value			$2.86		$1.22		$2.36		$2.43		$0.97		$16.91
Short tons (approximate)		(2)		208,075		467,471				12,466			

[1] Included with "Undistributed" to avoid disclosure of individual company operations. Also includes 2 plants in Iowa.
[2] 3,825,795 cubic feet (approximate).

The total production and value of dimension limestone in 1954 increased 47 and 28 percent, respectively, over 1953. The average unit value decreased $2.49 per ton compared with the previous year, the most noticeable drop being in rough building construction.

The leading productive area for rough architectural and finished limestone blocks was the Bedford-Bloomington (Ind.) area, which supplied 81 percent of the total output and 79 percent of the value. Sales by firms operating quarries in the district are shown in table 14. Sales, by mill operators, of finished limestone processed from purchased stone are shown in table 15.

TABLE 14.—Limestone sold by producers in the Indiana oolitic limestone district, 1945–49 (average) and 1950–54, by classes

Year	Construction					
	Rough block		Sawed and semifinished		Cut	
	Cubic feet	Value	Cubic feet	Value	Cubic feet	Value
1945–49 (average)	1,838,664	$1,345,506	1,533,824	$1,733,067	562,116	$2,180,436
1950	2,192,140	2,309,303	3,213,160	4,669,493	1,191,200	5,682,062
1951	2,517,714	2,591,339	3,159,924	4,990,385	976,600	5,901,568
1952	2,220,698	2,417,319	2,736,654	4,322,803	660,382	3,915,947
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

Year	Construction—Continued			Other uses		Total	
	Total						
	Cubic feet	Short tons (approximate)	Value	Short tons	Value	Short tons (approximate)	Value
1945–49 (average)	3,934,604	285,272	$5,259,009	81,318	$170,837	366,590	$5,429,846
1950	6,596,500	478,250	12,660,858	276,620	441,797	754,870	13,102,655
1951	6,654,238	482,432	13,483,292	156,084	281,102	638,516	13,764,394
1952	5,617,734	407,286	10,656,069	176,688	327,255	583,974	10,983,324
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

TABLE 15.—Purchased Indiana limestone sold by mills in the Indiana oolitic limestone district, 1945–49 (average) and 1950–54, by classes

Year	Sawed and semifinished		Cut		Total	
	Cubic feet	Value	Cubic feet	Value	Cubic feet	Value
1945–49 (average)	119,114	$156,391	745,110	$3,055,679	864,224	$3,212,070
1950	141,510	198,859	921,900	4,674,820	1,063,410	4,873,679
1951	127,159	179,946	742,745	4,579,979	869,904	4,759,925
1952	156,935	229,940	661,844	3,687,401	818,779	3,917,341
1953	173,991	308,338	605,824	3,168,816	779,815	3,477,154
1954	[1] 881,588	[1] 1,567,847	1,028,713	5,244,156	1,910,301	6,812,003

[1] Includes 681,586 cubic feet stone, valued at $1,201,935, processed by certain companies not formerly reporting.

TABLE 16.—Limestone and marble sold by producers in the Carthage district, Jasper County, Mo., 1945–49 (average) and 1950–54, 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
1945–49 (average)	57,392	$491,181	7,530	$37,477	64,922	5,494	$528,658	251,578	$465,125	257,072	$993,783
1950	75,630	805,532	2,430	17,185	78,060	6,640	822,717	252,960	467,926	259,600	1,290,643
1951	135,715	872,264	1,850	12,509	137,565	11,693	884,773	257,609	440,496	269,302	1,325,269
1952	107,430	772,513	2,658	17,681	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

SANDSTONE

The output of sandstone for use as dimension stone increased considerably except for sawed building stone, rubble, and curbing stone. The average value remained virtually the same as in 1953, but there were some fluctuations in unit prices for different uses.

Dimension sandstone was quarried in 23 States, with Ohio furnishing 39 percent of the total production and 52 percent of the value. Salient statistics for dimension sandstone in 1954 are shown in table 17.

Bluestone, which is shown in table 18, is a type of sandstone that splits readily into thin, uniform sheets. This type of stone was utilized for flagging, building, and curbing.

TABLE 17.—Sandstone (dimension stone) sold or used by producers in the United States in 1954, 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	4	(1)	(1)	(1)	(1)			23,333	$52,818	(1)	(1)			3,205	$5,000	5,329	$92,899
Arizona	11	(1)	(1)					1,213	2,248	(1)	(1)			368,625	416,400	30,440	432,428
Arkansas	2	(1)	(1)					(1)	(1)							(1)	(1)
California	2	(1)	(1)							2,500	$5,000					(1)	(1)
Colorado	12	(1)	(1)	3,846	$9,000			32,013	43,949	(1)	(1)			58,334	48,477	24,625	387,555
Georgia	2									985	2,155			83,333	21,172	7,485	23,327
Indiana	3	(1)	(1)			(1)	(1)									12,076	314,747
Kansas	2	3,504	$24,698			1,820	$2,982							1,603	2,076	3,771	29,756
Kentucky	2			(1)	(1)			(1)	(1)					(1)	(1)	(1)	(1)
Massachusetts	1							(1)	(1)							(1)	(1)
Michigan	2	2,099	16,816					1,913	5,202	824	2,001			5,600	7,216	3,524	31,235
Missouri	1									443	9,155			2,375	1,802	633	10,957
Nevada	2			(1)	(1)	(1)	(1)									(1)	(1)
New Mexico	1	50	750			65	250	258	600			(1)	(1)	(1)	(1)	165	3,090
New York (bluestone)	9	(1)	(1)	36,090	56,121			51,127	297,021	902	5,380	(1)	(1)	206,873	443,494	26,524	809,189
Ohio	9			299,029	568,041	1,636,567	3,761,638	44,272	367,089	29	629	47,097	$145,351	125,382	291,727	156,074	5,134,475
Oklahoma	4	(1)	(1)					(1)	(1)					2,385	1,266	6,228	88,997
Pennsylvania [2]	12	14,252	90,896	22,769	16,005					7,050	45,002			64,067	119,191	28,428	271,094
Tennessee	12			755,180	1,195,363			(1)	(1)					78,993	374,440	(1)	(1)
Texas	1	708	5,984													708	5,984
Utah	3	1,890	39,690					8,449	14,885					2,346	3,572	2,732	58,147
Washington	2			(1)	(1)			(1)	(1)							6,134	328,097
Wisconsin	5	980	2,562	35,000	15,400			(1)	(1)					(1)	(1)	4,185	29,942
Undistributed		33,880	626,323	133,672	306,498	70,570	135,261	131,576	317,477	4,452	13,326	4,552	3,928	2,702	3,120	82,427	1,894,528
Total	104	57,363	807,719	1,285,586	2,166,428	1,709,022	3,900,131	294,154	1,101,289	17,185	82,648	51,649	149,279	1,005,823	1,738,953	401,488	9,946,447
Average unit value			$14.08		$1.69		$2.28		$3.74		$4.81		$2.89		$1.73		$24.77
Short tons (approximate)		(3)		97,993		123,673		23,092				3,798		78,384			

[1] Included with "Undistributed" to avoid disclosure of individual company operations.
[2] Includes 90,785 cubic feet of bluestone (approximately 7,671 tons) valued at $126,779 sold for rough construction, rubble, and flagging.
[3] 738,480 cubic feet (approximate).

TABLE 18.—Bluestone (dimension stone) sold or used in the United States, 1945–49 (average) and 1950–54 [1]

Year	Cubic feet	Value	Year	Cubic feet	Value
1945–49 (average)	275,834	$337,315	1952	318,198	$583,970
1950	390,460	604,137	1953	322,156	602,248
1951	253,935	464,200	1954	313,898	935,968

[1] New York and Pennsylvania were the only producing States.

MISCELLANEOUS STONE

The types of stone not included in the major types discussed under previous headings are incorporated in table 19. The principal varieties are mica schist, argillite, soapstone, greenstone, and light-color volcanic rocks. The total tonnage decreased in 1954, but the average unit value increased.

TABLE 19.—Miscellaneous varieties of stone (dimension stone) sold or used by producers in the United States in 1954, 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	8	1,463	$29,556	(1)	(1)	(1)	(1)	2,541	$37,565
Colorado	1			2,200	$880			2,200	880
Maryland	5	8,499	46,828	(1)	(1)	(1)	(1)	9,983	60,459
New York	4	656	8,718			413	$10,510	1,069	19,228
Oregon	3	1,277	43,213					1,277	43,213
Pennsylvania	4	(1)	(1)			146	3,711	(1)	(1)
Puerto Rico	1	1,131	1,231					1,131	1,231
Virginia	2	(1)	(1)			(1)	(1)	(1)	(1)
Washington	1	(1)	(1)					(1)	(1)
Undistributed		16,092	2,841,790	1,533	9,394	1,811	33,421	17,020	2,866,676
Total	29	[2] 29,118	2,971,336	3,733	10,274	[3] 2,370	47,642	35,221	3,029,252
Average unit value			$102.04		$2.75		$20.10		$86.01

[1] Included with "Undistributed" to avoid disclosure of individual company operations.
[2] Approximately 348,815 cubic feet.
[3] Approximately 28,537 cubic feet.

CONSUMPTION AND USES

The 39-year history of dimension-stone sales by kinds is depicted graphically in figure 1. Figure 2 compares sales indices of building limestone with all types of building stone and the contract value of nonresidential construction, where the most extensive usage of dimension-stone occurs. The diverging trend from stone noted in nonresidential construction is indicative of the rapidly growing role of alternate construction materials.

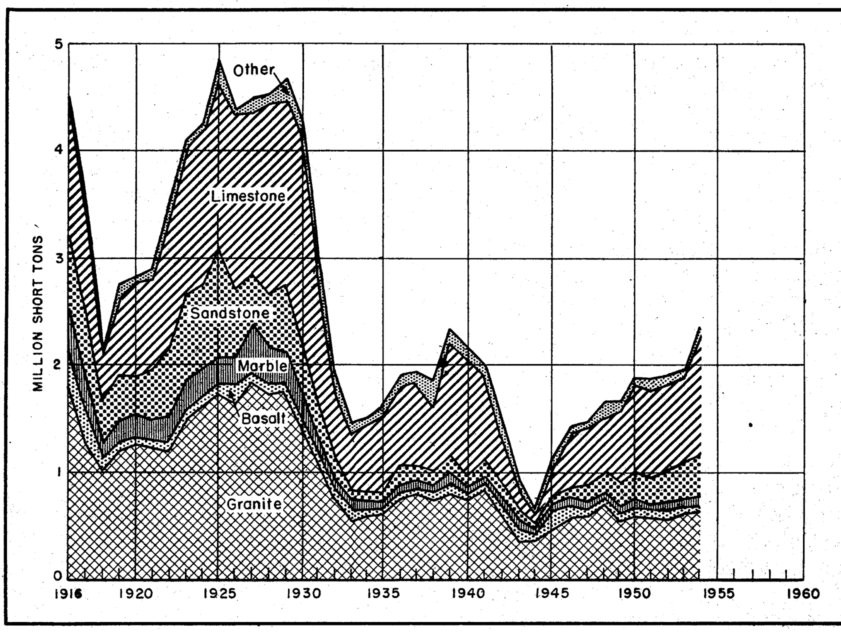

FIGURE 1.—Sales of dimension stone in the United States, by kinds, 1916–54.

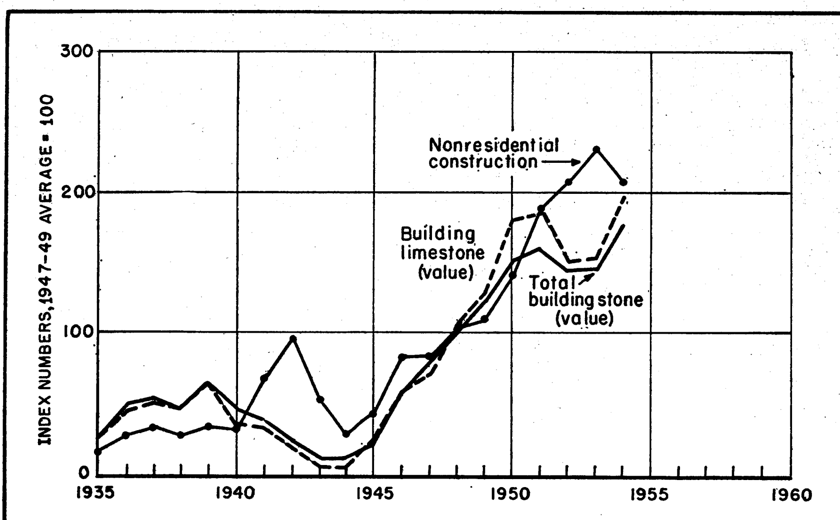

FIGURE 2.—Sales of all building stone compared with sales of building limestone and value of all nonresidential construction, 1935–54.

[Data on nonresidential-building construction from Survey of Current Business, U. S. Department of Commerce]

TECHNOLOGY

There is reported to be a trend toward use of stone veneer and some thought of attempting to cast, commercially, concrete panels with stone surfaces. Veneer panels are advantageous in space saving and are comparable to other materials in price.[4]

Many substitute materials have been developed. Some have the properties of stone, while others only have the appearance of stone. A method has been developed for giving a flagstone texture to concrete block. Flagstones are cut into various shapes, arranged into a pattern, and covered with synthetic rubber. When the rubber hardens, the surface texture of the original stone is retained. This mold then can be used to form concrete surfaces.[5]

A masonry saw has been developed for either wet or dry sawing.[6] Portable electric sanders were used to clean 17 years' accumulation of grime from a porous Texas limestone, rather than sandblasting.[7] Assembly-line cutting of Colorado sandstone was accomplished with a concrete saw mounted on a two-rail jig to produce ornamental patio squares.[8]

The technical phases of production, as well as the physical characteristics of marble for building purposes, was discussed in an article.[9]

An article dealing with the various types of building and decorative stones, giving the morphology, specifications, production, and proposals for solving some of the difficult technical problems of the building and ornamental stone industries was published.[10]

Costs and results were reported for 4 jobs on which a total of 6,265 feet was drilled with random set diamond bits and 7,341 feet was drilled with bits having oriented diamonds. Costs were lower when bits with oriented diamonds were used. Major cost factors are discussed, such as grade and size of diamonds, bit design, and matrix material.[11]

Detailed drawings of various architectural features utilizing dimension stone were included as a part of a portfolio.[12] Many dimension stone producers have gradually converted from a byproduct crushed stone operation to become a major crushed stone producer.[13]

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4 Architechural Forum, Stone in Today's Building: July 1954, pp. 156–157.
5 Rock Products, vol. 57, No. 4, April 1954, p. 201.
6 Rock Products, vol. 57, No. 4, April 1954, p. 226.
7 Construction Equipment, vol. 36, No. 9, September 1954, p. 50.
8 Construction Equipment, vol. 36, No. 12, December 1954, p. 39.
9 Romer, Shawhan, Marble: Stone, January 1954, pp.17–19.
10 Bowles, Oliver, Natural Building and Decorative Stones: Stone, January 1954, pp. 16, 22.
11 Engineering and Mining Journal, vol. 155, No. 10, Oct. 1954, pp. 94–95.
12 Indiana Limestone Institute, Bedford, Ind., A Portfolio of Detailed Plates and General Information 1955, 61 pp.
13 Rock Products, vol. 57, No. 7, July 1954, p. 48.

WORLD REVIEW

North America

Canada.—In Quebec a small output of ornamental stone for building construction was reported. Three quarries produced mill blocks; one of them started operation during the year. Canada produced very little dimension stone but relied upon imports from Italy and the United States to supply its requirements; most of this was imported in the rough and finished in Canadian marble-dressing plants.

Dimension-limestone production in 1954 increased slightly over the previous year; 83,174 tons at $2,451,584 was reported. Most of the production came from Ontario, Manitoba, and Quebec. In addition to the domestic production, a considerable quantity of Indiana limestone was imported in the form of rough blocks. Imports also were received from the United Kingdom.

Granite was quarried chiefly for the building and monumental trades. Most other uses were secondary, as they utilized the by-product material of the monumental and building-stone operations. Production of building granite in Canada was fairly well established. The monumental industry increased, in spite of competition from better known, lower-priced imports.[14]

South America

Brazil.—Annual output of marble in Brazil has been estimated at about 15,000 tons. The estimated annual requirements are 30,000 tons; the deficit traditionally has been made up of imports, chiefly from Italy. Freight from Italy to São Paulo was reported to be less than from central Minas Gerais to the same city.[15]

Europe

Italy.—Production of marble blocks totaled 468,440 metric tons in 1954. This was slightly more than in 1953.[16]

Yugoslavia.—Marble and other stone are exported to the United States, the countries of Latin America, Germany, Finland, Holland, Austria, etc. Exports in 1953 totaled 10,407 tons.[17]

CRUSHED AND BROKEN STONE

The output of crushed and broken stone in 1954 totaled 406 million tons valued at $542 million. The average value was $1.34 a ton. Production increased about 2 percent in tonnage and 3 percent in value compared with 1953.

Details on asphaltic stone and slate granules and flour are given in the Asphalt and Slate chapters of this volume.

Tables 21 and 22 give the tonnage and value of crushed stone used for concrete and roadstone and for railroad ballast for a series of years, and by States for 1954.

[14] Canadian Department of Mines and Tech. Survey, Granite in Canada, 1954 (Prelim.): Ottawa, 6 pp.
[15] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 3, September 1954, p. 66.
[16] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 4, October 1955, p. 42.
[17] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 6, December 1954, p. 64.

TABLE 20.—Crushed and broken stone sold or used by producers in the United States,[1] 1953–54, by principal uses

Use	1953			1954		
	Short tons	Value		Short tons	Value	
		Total	Average		Total	Average
Concrete and roadstone	[2] 189, 158, 785	[2] $251, 514, 832	[2] $1. 33	[3] 216, 614, 445	[3] $289, 441, 803	$1. 34
Railroad ballast	20, 778, 410	20, 533, 252	. 99	15, 172, 606	14, 871, 002	. 98
Metallurgical	40, 881, 304	53, 040, 512	1. 30	33, 161, 736	40, 933, 952	1. 23
Alkali works	6, 786, 390	6, 507, 117	. 96	5, 329, 939	4, 659, 840	. 87
Riprap	[2] 7, 735, 037	[2] 10, 052, 602	[2] 1. 30	7, 642, 332	10, 979, 042	1. 44
Agricultural	[2] 18, 427, 513	[2] 30, 103, 864	[2] 1. 63	18, 247, 121	30, 199, 337	1. 66
Refractory (ganister and dolomite)[4]	1, 937, 292	8, 079, 005	4. 17	1, 529, 570	5, 923, 312	3. 87
Asphalt filler	708, 616	2, 440, 127	3. 44	1, 007, 358	2, 907, 688	2. 89
Calcium carbide works	764, 752	564, 165	. 74	709, 453	611, 565	. 86
Sugar factories	677, 296	1, 740, 270	2. 57	788, 210	2, 141, 351	2. 72
Glass factories	910, 989	2, 248, 590	2. 47	802, 808	2, 105, 351	2. 62
Paper mills	324, 673	785, 806	2. 42	484, 372	1, 150, 428	2. 38
Other uses	[2] 15, 802, 143	[2] 36, 407, 390	[2] 2. 30	13, 952, 464	37, 767, 537	2. 71
Total	[2] 304, 893, 200	[2] 424, 017, 532	[2] 1. 39	315, 442, 414	443, 692, 208	1. 41
Portland and natural cement (limestone, cement rock, and oystershells)[5]	70, 544, 323	70, 550, 000	1. 00	71, 267, 567	72, 660, 897	1. 02
Lime, including deadburned dolomite[6]	19, 348, 000	24, 885, 000	1. 29	14, 594, 489	19, 092, 152	1. 31
Abrasives and other uses[7]	[2] 576, 068	[2] 2, 816, 060	[2] 4. 89	649, 594	2, 765, 289	4. 26
Unspecified uses (oystershells)	[8] 3, 500, 000	[8] 3, 800, 000	1. 09	3, 840, 474	4, 269, 359	1. 11
Grand total	[2] 398, 861, 591	[2] 526, 068, 592	[2] 1. 32	405, 794, 538	542, 479, 905	1. 34
Asphaltic stone	1, 440, 544	4, 349, 000	3. 02	1, 337, 822	3, 686, 227	2. 76
Slate granules and flour	545, 686	5, 953, 661	10. 91	[9] 609, 295	[9] 6, 611, 795	10. 85

[1] Includes Territories of the United States, possessions, and other areas administered by the United States.
[2] Revised figure.
[3] Includes 4,677,200 tons oystershells valued at $5,930,350.
[4] 1953 includes a small quantity of mica schist and soapstone.
[5] 1953: Consumption reported by cement companies; value estimated. 1954: Reported sold or used by producers; cement companies reported using 72,963,309 tons.
[6] 1953: Estimate based on the approximate requirement of 2 tons of stone to make 1 ton of lime; value estimated. 1954: Reported sold or used by producers; consumption by lime companies estimated as 17,258,000 tons.
[7] Ground sandstone, quartzite, and quartz from pegmatite veins or dikes, formerly reported in the Abrasive Materials chapter. Excludes friable sandstone reported in the Sand and Gravel chapter.
[8] Estimated figure.
[9] Includes a small quantity of crushed slate used for lightweight aggregate.

TABLE 21.—Crushed stone for concrete and roadstone and railroad ballast sold or used by producers in the United States,[1] 1945–49 (average) and 1950–54

Year	Concrete and roadstone		Railroad ballast		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1945–49 (average)	101, 490, 812	$119, 458, 382	17, 951, 770	$14, 656, 171	119, 442, 582	$134, 114, 553
1950	147, 107, 670	192, 293, 884	18, 614, 040	17, 519, 533	165, 721, 710	209, 813, 417
1951	168, 766, 088	216, 418, 613	21, 368, 552	20, 336, 868	190, 134, 640	236, 755, 481
1952	[2] 187, 114, 163	[2] 245, 976, 919	21, 383, 068	20, 019, 095	[2] 208, 497, 231	[2] 265, 996, 014
1953	[2] 189, 158, 785	[2] 251, 514, 832	20, 778, 410	20, 533, 252	[2] 209, 937, 195	[2] 272, 048, 084
1954	216, 614, 445	289, 441, 803	15, 172, 606	14, 871, 002	231, 787, 051	304, 312, 805

[1] Includes Territories of the United States, possessions, and other areas administered by the United States.
[2] Revised figure.

TABLE 22.—Crushed stone for concrete and roadstone and railroad ballast sold or used by producers in the United States in 1954, by States

State	Concrete and roadstone		Railroad ballast		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
Alabama	[1] 704,510	[1] $901,800	([2])	([2])	836,385	$1,079,235
Alaska	123,375	254,808	([2])	([2])	[1] 123,375	[1] 254,808
American Samoa	57,600	15,000			57,600	15,000
Arizona	216,035	333,557			216,035	333,557
Arkansas	[1] 1,042,467	[1] 1,340,292	449,636	$502,809	[1] 1,492,103	[1] 1,843,101
California	10,272,626	11,577,095	[1] 212,063	[1] 250,627	[1] 10,484,689	[1] 11,827,722
Canton	2,600	5,000			2,600	5,000
Colorado	[1] 21,047	[1] 13,561			[1] 21,047	[1] 13,561
Connecticut	[1] 627	[1] 1,584	([2])	([2])	2,669,717	3,589,999
Delaware	([2])	([2])			([2])	([2])
Florida	11,038,724	13,328,758	([2])	([2])	[1] 11,038,724	[1] 13,328,758
Georgia	5,516,401	7,635,833	[1] 451,803	[1] 513,901	[1] 5,968,204	[1] 8,149,734
Guam	842,660	2,275,182			842,660	2,275,182
Hawaii	1,335,768	2,797,194			1,335,768	2,797,194
Idaho	1,817,972	2,254,445	([2])	([2])	[1] 1,817,972	[1] 2,254,445
Illinois	18,001,469	22,484,898	652,212	716,369	18,653,681	23,201,267
Indiana	6,405,501	7,791,893	320,720	391,296	6,726,221	8,183,189
Iowa	8,696,159	11,040,385	([2])	([2])	[1] 8,696,159	[1] 11,040,385
Johnston	98	300			98	300
Kansas	5,810,310	7,706,735	1,017,909	540,271	6,828,219	8,247,006
Kentucky	7,771,869	10,419,965	421,471	419,840	8,193,340	10,839,805
Louisiana	([2])	([2])			([2])	([2])
Maine	387,836	671,632			387,836	671,632
Maryland	[1] 2,988,724	[1] 4,673,447	[1] 47,225	[1] 69,510	3,873,142	6,099,757
Massachusetts	[1] 2,069,034	[1] 3,266,767	73,363	87,683	[1] 2,142,397	[1] 3,354,450
Michigan	4,360,152	4,675,621	114,916	143,618	4,475,068	4,819,239
Midway	490	1,500			490	1,500
Minnesota	1,784,984	2,144,153	[1] 1,000	[1] 1,950	[1] 1,785,984	[1] 2,146,103
Missouri	9,358,642	12,559,091	846,584	590,293	10,205,226	13,149,384
Montana	([2])	([2])	429,892	462,768	[1] 429,892	[1] 462,768
Nebraska	787,444	1,099,300	116,117	200,981	903,561	1,300,281
Nevada	([2])	([2])	([2])	([2])	1,099,862	585,344
New Hampshire	([2])	([2])			([2])	([2])
New Jersey	5,048,749	9,692,864	[1] 124,838	[1] 223,705	[1] 5,173,587	[1] 9,916,569
New Mexico	[1] 25	[1] 100	([2])	([2])	630,168	528,804
New York	[1] 12,928,383	[1] 22,543,067	[1] 561,478	[1] 708,215	[1] 13,489,861	[1] 23,251,282
North Carolina	[1] 9,010,083	[1] 12,780,502	250,286	304,700	[1] 9,260,369	[1] 13,085,202
Ohio	11,993,911	14,850,606	995,643	1,141,636	12,989,554	15,992,242
Oklahoma	[1] 5,216,658	[1] 6,055,914	2,116,717	803,461	[1] 7,333,375	[1] 6,859,375
Oregon	[1] 4,523,391	[1] 6,364,725	60,280	66,070	[1] 4,583,671	[1] 6,430,795
Panama Canal Zone	179,273	240,270			179,273	240,270
Pennsylvania	[1] 15,099,373	[1] 22,093,015	[1] 373,911	[1] 551,322	16,544,373	23,924,243
Puerto Rico	[1] 691,080	[1] 1,273,976	1,220	2,523	[1] 692,300	[1] 1,276,499
Rhode Island	([2])	([2])			([2])	([2])
South Carolina	2,279,942	3,251,562	377,300	514,970	2,657,242	3,766,532
South Dakota	886,918	1,638,091	([2])	([2])	[1] 886,918	[1] 1,638,091
Tennessee	9,916,929	12,526,926	543,602	508,364	10,460,531	13,035,290
Texas	[1] 10,284,624	[1] 11,131,450	[1] 460,332	[1] 448,953	[1] 10,744,956	[1] 11,580,403
Utah	79,880	23,964			79,880	23,964
Vermont	70,963	102,501	([2])	([2])	[1] 70,963	[1] 102,501
Virginia	5,715,464	7,787,572	[1] 356,748	[1] 365,412	[1] 6,072,212	[1] 8,152,984
Virgin Islands	3,939	17,134			3,939	17,134
Wake	780	1,300			780	1,300
Washington	[1] 3,404,642	[1] 3,982,926	70,842	87,861	[1] 3,475,484	[1] 4,070,787
West Virginia	2,940,453	4,850,253	485,979	575,647	3,426,432	5,425,900
Wisconsin	[1] 6,136,254	[1] 6,298,256	[1] 105,419	[1] 126,989	[1] 6,241,673	[1] 6,425,245
Wyoming	[1] 573,413	[1] 391,800	[1] 356,658	[1] 341,716	1,231,911	1,013,154
Undistributed	8,214,194	10,273,233	2,776,442	3,207,542	4,249,544	5,684,533
Grand total	216,614,445	289,441,803	15,172,606	14,871,002	231,787,051	304,312,805

[1] To avoid disclosing confidential information, total is incomplete, the portion not included being combined as "Undistributed."
[2] Included with "Undistributed."

COMMERCIAL AND NONCOMMERCIAL OPERATIONS

Commercial stone is that sold in the open market, while noncommercial tonnage is that produced by or for States, counties, municipalities, and other Government units.

Table 23 shows the production of crushed stone for concrete and roadstone during recent years by both types of operations. Ninety-two percent of the crushed stone produced in 1954 was from commercial operations.

GRANULES

The output and value of roofing granules since 1945 are shown in table 24. The Slate chapter of this volume gives additional data on slate granules.

TABLE 23.—Crushed stone for concrete and roadstone sold or used by commercial and noncommercial operators in the United States,[1] 1945–49 (average) and 1950–54

(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
1945–49 (average)	91, 505, 818	$1. 17	--------	90	9, 984, 994	$1. 20	--------	10	101, 490, 812	--------
1950	130, 977, 250	1. 32	+18	89	16, 130, 420	1. 20	+22	11	147, 107, 670	+18
1951	149, 995, 593	1. 30	+15	89	18, 770, 495	1. 15	+16	11	168, 766, 088	+15
1952	[2] 168, 385, 083	1. 32	+12	90	18, 729, 080	1. 26	--------	10	[2] 187, 114, 163	+11
1953	[2] 169,352,364	[2] 1. 33	+1	90	[2] 19, 806, 421	[2] 1. 29	[2] +6	10	[2] 189,158, 785	+1
1954	199, 157, 315	1. 35	+18	92	17, 457, 130	1. 22	−12	8	216, 614, 445	+15

[1] Includes Territories of the United States, possessions, and other areas administered by the United States.
[2] Revised figure.

TABLE 24.—Roofing granules [1] sold or used in the United States, 1945–49 (average) and 1950–54, by kinds

Year	Natural		Artificially colored		Brick		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1945–49 (average)	421, 945	$3, 436, 397	924, 089	$14, 535, 247	46, 197	$759, 867	1, 392, 231	$18, 731, 511
1950	489, 794	4, 312, 531	1, 294, 275	22, 276, 565	13, 660	263, 752	1, 797, 729	26, 852, 848
1951	422, 973	3, 714, 634	[2] 1, 184, 544	[2] 20, 809, 752	(2)	(2)	1, 607, 517	24, 524, 386
1952	368, 454	3, 350, 290	[2] 1, 250, 741	[2] 22, 772, 567	(2)	(2)	1, 619, 195	26, 122, 857
1953	336, 506	3, 186, 653	[2] 1, 282, 325	[2] 24, 632, 971	(2)	(2)	1, 618, 831	27, 819, 624
1954	343, 824	3, 208, 170	1, 362, 504	26, 876, 999	--------	----------	1, 706, 328	30, 085, 169

[1] Manufactured from stone, slate, slag, and brick.
[2] A small quantity of brick granules is included with artificially colored granules.

SIZE OF PLANTS

In 1954 the average crushed-stone plant produced approximately 184 thousand short tons. The number of plants reporting production totaled 2,084. About one-fourth of the total, or 572 plants, reported production of less than 25,000 tons. These 572 plants supplied only about 1 percent of the total output. The 258 plants that produced 400,000 tons or more contributed 56 percent of the total. Table 25 shows additional details regarding commercial plants in 1954.

TABLE 25.—Number and production of commercial crushed-stone plants in the United States, 1953–54,[1] by size of output

Size of output	1953				1954			
	Number of plants	Total production of plants (short tons)	Percent of total	Cumulative total (short tons)[2]	Number of plants	Total production of plants (short tons)	Percent of total	Cumulative total (short tons)
Less than 1,000 tons	59	25,125	0.01	25,125	84	32,833	0.01	32,833
1,000 to 25,000	432	[2] 4,903,199	1.76	4,928,324	488	5,096,405	1.33	5,129,238
25,000 to 50,000	209	7,682,157	2.76	12,610,481	272	10,059,196	2.62	15,188,434
50,000 to 75,000	186	11,649,006	4.18	24,259,487	188	12,157,918	3.17	27,346,352
75,000 to 100,000	[2] 149	[2] 12,813,294	[2] 4.60	37,072,781	179	15,432,355	4.02	42,778,707
100,000 to 200,000	[2] 276	[2] 39,255,406	[2] 14.09	76,328,187	337	48,338,059	12.61	91,116,766
200,000 to 300,000	132	32,430,760	11.64	108,758,947	171	41,905,773	10.93	133,022,539
300,000 to 400,000	70	23,873,462	8.57	132,632,409	107	36,868,126	9.61	169,890,665
400,000 to 500,000	48	21,410,101	[2] 7.69	154,042,510	90	40,601,012	10.59	210,491,677
500,000 to 600,000	23	13,025,734	4.68	167,068,244	48	25,840,806	6.74	236,332,483
600,000 to 700,000	21	13,579,270	[2] 4.88	180,647,514	32	20,889,459	5.45	257,221,942
700,000 to 800,000	10	7,541,860	2.71	188,189,374	20	14,029,773	3.66	271,251,715
800,000 to 900,000	11	9,575,463	3.44	197,764,837	9	7,638,400	1.99	278,890,115
900,000 tons and over	45	80,732,186	[2] 28.99	278,497,023	59	104,561,833	27.27	383,451,948
Total	1,671	[2] 278,497,023	100.00	278,497,023	[3] 2,084	383,451,948	100.00	383,451,948

[1] Includes Alaska, Guam, Hawaii, and Puerto Rico. 1953 excludes stone used for abrasives and in making cement and lime and excludes marble, primarily a dimension stone industry. 1954 includes 95,483,082 tons, valued at $108,657,233, of stone used for abrasives and in making cement and lime; oystershells for various uses; and crushed marble.

[2] Revised figure.

[3] Includes 181 plants producing limestone exclusively for use in making cement and lime; oystershells for various uses; ground sandstone, quartz, and quartzite exclusively for uses formerly reported in the Abrasive Materials chapter; and crushed marble.

METHODS OF TRANSPORTATION

As shown in the accompanying table, about half of the total tonnage continued to be hauled by truck. Rail haulage continued to decline in 1954, reaching a new low of 20 percent. Waterways provided relatively minor but locally important transportation. Statistical details are shown in table 26 for the means of transportation of the crushed-stone industry during 1954.

TABLE 26.—Crushed stone sold or used in the United States [1] in 1954, 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	175,943,595	46	198,286,185	49
Rail	81,191,883	21	81,191,883	20
Waterway	36,493,613	10	36,493,613	9
Unspecified	89,822,857	23	89,822,857	22
Total	383,451,948	100	405,794,538	100

[1] Includes Territories of the United States, possessions, and other areas administered by the United States. Includes transportation of 95,029,324 tons of stone used for abrasives and in making cement and lime and oystershells for various uses (not formerly included in stone statistics) as follows: By truck 11,426,499 tons; rail 5,027,138; waterway 7,763,849; and unspecified methods 70,811,838.
[2] Entire output of noncommercial operations assumed to be moved by truck.

GRANITE

The output of crushed and broken granite in 1954 decreased slightly in quantity and increased in value compared with 1953. The average value increased 4 cents per ton to $1.41. Riprap increased substantially in tonnage but dropped slightly in average value. Railroad ballast decreased in tonnage and value. Concrete and roadstone material increased slightly in quantity and decreased slightly in average value. The average value of miscellaneous uses increased considerably in 1954. North Carolina continued to be the largest producing State, followed by Georgia and California.

BASALT AND RELATED ROCKS (TRAPROCK)

The rocks commercially classified as traprock include basalt, gabbro, diorite, and dark rocks. These materials are widely used for concrete aggregates, roadstone, railroad ballast, and a variety of minor uses. Sales of crushed and broken traprock in 1954 were greater in quantity and value than in 1953. The average value increased 6 cents to $1.60 compared with the previous year. New Jersey maintained the lead in value of production, followed by Oregon, Pennsylvania, New York, and Washington.

TABLE 27.—Granite (crushed and broken stone) sold or used by producers in the United States in 1954, 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	78, 221	$30, 378	123, 375	$254, 808					201, 596	$285, 186
Arizona			77, 933	116, 900					77, 933	116, 900
Arkansas	101, 745	101, 745					([2])	([2])	([2])	([2])
California	180, 061	219, 044	2, 666, 092	2, 848, 236	([2])	([2])	([2])	([2])	3, 003, 181	3, 261, 958
Colorado			1, 800	666					1, 800	666
Connecticut	2, 404	5, 951							2, 404	5, 951
Delaware			([2])	([2])			([2])	([2])	([2])	([2])
Georgia	([2])	([2])	4, 271, 062	5, 805, 181	326, 803	$383, 901	([2])	([2])	5, 078, 952	8, 080, 493
Idaho			16, 481	5, 480					16, 481	5, 480
Maine	([2])	([2])	([2])	([2])					195, 565	247, 446
Maryland	10, 500	36, 750	60, 344	138, 838					70, 844	175, 588
Massachusetts	([2])	([2])	746, 649	1, 310, 557	26, 325	31, 590	([2])	([2])	([2])	([2])
Minnesota			122, 773	186, 103	([2])	([2])	([2])	([2])	520, 256	693, 447
Missouri	903	2, 099							903	2, 099
Montana	([2])	([2])							([2])	([2])
Nevada			([2])	([2])					([2])	([2])
New Hampshire	([2])	([2])	([2])	([2])					([2])	([2])
New Jersey	([2])	([2])	415, 207	625, 333	4, 408	6, 612	([2])	([2])	([2])	([2])
North Carolina	([2])	([2])	6, 485, 359	9, 170, 131	106, 286	144, 700	([2])	([2])	6, 990, 173	9, 897, 038
Oklahoma							4, 950	$4, 950	4, 950	4, 950
Oregon							([2])	([2])	([2])	([2])
Rhode Island	2, 349	2, 349	([2])	([2])			6, 001	6, 001	([2])	([2])
South Carolina	([2])	([2])	2, 279, 942	3, 251, 562	377, 300	514, 970	([2])	([2])	([2])	([2])
Tennessee			42, 000	52, 500					42, 000	52, 500
Texas	10, 000	30, 000							10, 000	30, 000
Vermont			([2])	([2])					([2])	([2])
Virginia			([2])	([2])	([2])	([2])			1, 519, 989	2, 083, 528
Washington			([2])	([2])			([2])	([2])	18, 005	97, 435
Wisconsin	([2])	([2])	([2])	([2])					([2])	([2])
Wyoming	([2])	([2])	([2])	([2])	356, 658	341, 716	57, 898	12, 764	510, 085	420, 981
Undistributed	261, 938	366, 479	1, 661, 559	2, 361, 719	758, 166	901, 143	1, 172, 501	2, 928, 729	4, 550, 876	6, 738, 239
Total	648, 121	794, 795	18, 970, 576	26, 128, 014	1, 955, 946	2, 324, 632	1, 241, 350	2, 952, 444	22, 815, 993	32, 199, 885
Average unit value		$1. 23		$1. 38		$1. 19		$2. 38		$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 operations.

TABLE 28.—Basalt and related rocks (traprock) (crushed and broken stone) sold or used by producers in the United States in 1954, 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
American Samoa			5,600	$5,000					5,600	$5,000
Alaska	14,000	$15,000							14,000	15,000
California	74,200	95,760	1,902,332	2,547,341	99,501	$127,416	53,512	$15,518	2,129,545	2,786,035
Connecticut	(2)	(2)	(2)	(2)	(2)	(2)			2,679,177	3,600,908
Hawaii	(2)	(2)	(2)	(2)			(2)	(2)	1,220,009	2,654,353
Idaho	37,814	68,967	1,419,086	2,027,622	(2)	(2)	(2)	(2)	1,587,920	2,239,746
Maryland	(2)	(2)	(2)	(2)	(2)	(2)			838,138	1,358,344
Massachusetts	35,145	40,431	1,322,385	1,956,210	47,038	56,093	11,022	44,031	1,415,590	2,096,765
Montana	(2)	(2)			(2)	(2)	(2)	(2)	(2)	(2)
Nevada			(2)	(2)					(2)	(2)
New Jersey	81,663	161,090	4,605,717	8,996,924	120,430	217,093	132,049	225,956	4,939,859	9,601,063
New Mexico	(2)	(2)							(2)	(2)
New York			2,286,266	4,455,795	82,532	117,030			2,368,798	4,572,825
North Carolina			710,000	1,089,000	144,000	160,000			854,000	1,249,000
Oregon	177,717	159,664	4,050,036	5,905,418	60,280	66,070	71,615	61,861	4,359,648	6,193,013
Panama Canal Zone	8,173	4,900	179,273	240,270					187,446	245,170
Pennsylvania	671	1,477	2,040,963	3,307,463	(2)	(2)	(2)	(2)	2,456,956	5,479,184
Texas			(2)	(2)	(2)	(2)			(2)	(2)
Virginia			599,464	842,091					599,464	842,091
Virgin Islands			3,939	17,134					3,939	17,134
Washington	309,993	350,952	3,346,104	3,918,752	70,842	87,861	28,938	11,427	3,755,877	4,368,992
Wisconsin	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Undistributed	133,443	179,289	5,318,142	7,925,273	827,493	1,180,328	344,198	2,553,309	1,339,610	1,911,193
Total	872,819	1,077,530	27,789,307	43,234,293	1,452,116	2,011,891	641,334	2,912,102	30,755,576	49,235,816
Average unit value		$1.23		$1.56		$1.39		$4.54		$1.60

[1] Includes stone sold for fill material, roofing granules, and unspecified uses.
[2] Included with "Undistributed," to avoid disclosure of individual company operations.

MARBLE

Substantial quantities of crushed, broken, and pulverized marble are byproducts of quarries and milling operations that produce dimension marble. The value received per ton varies greatly from State to State, depending upon the market and uses to which the product is put. It is substituted for limestone in some instances, while in others it commands a high price as terrazzo or for other specialized uses. The footnote to table 29 lists the major uses for this type of material.

TABLE 29.—Marble (crushed and broken stone) sold by producers in the United States in 1954, by States [1]

State	Active plants	Short tons	Value	State	Active plants	Short tons	Value
Alabama	3	125,038	$603,466	North Carolina	1	[2]	[2]
Arizona	2	1,122	23,672	Tennessee	11	17,620	$178,789
California	1	[2]	[2]	Texas	1	28,698	493,488
Georgia	1	218,678	1,843,530	Vermont	1	4,000	4,729
Maryland	1	[2]	[2]	Virginia	1	[2]	[2]
Missouri	1	16,500	81,000	Washington	4	[2]	[2]
Nevada	1	[2]	[2]	Undistributed		27,931	549,258
New Jersey	1	[2]	[2]				
New Mexico	1	100	700	Total	32	453,758	3,939,186
New York	1	14,071	160,554	Average unit value			$8.68

[1] Includes stone used for acid neutralizer, agriculture, asphalt filler, cast stone, 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 operations.

LIMESTONE

Limestone comprised 80 percent of all crushed and broken stone produced in 1954. It was employed extensively, because it is widely distributed, is available to a multitude of markets, and can be quarried and crushed comparatively cheaply. It is essential in many applications because of its chemical composition. Fortunately, it occurs in commercial quantity in almost every State in the Union. The rise of about 10 percent in limestone output for 1954 is comparable to the rise in concrete-pavement construction (fig. 3), where much of the limestone is used. Consumption of riprap, fluxing stone, and railroad ballast decreased, while concrete and roadstone uses increased. Agricultural limestone remained substantially the same as 1953.

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.

Dolomite (high-magnesium limestone) has a variety of uses, to some of which high-calcium limestone is not applicable. Dead-burned dolomite is used as refractory lining. Since it has good refractory qualities, it is also used raw in patching furnace floors. Statistical data on dead-burned dolomite (refractory lime) are given in the Lime chapter of this volume.

Sales of dolomite and dolomitic lime are listed according to consuming market in table 32.

Table 33 shows the tonnages and values of fluxing stone used in the field of metallurgical operations.

TABLE 30.—Limestone (crushed and broken stone) sold or used by producers in the United States in 1954, 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, 839, 660	$2, 647, 803	704, 510	$901, 800	(1)	(1)	404, 896	$553, 784	(1)	(1)	7, 195, 748	$9, 237, 726
Arizona	-----	-----	(1)	(1)	(1)	(1)	-----	-----	-----	-----	(1)	(1)	714, 817	803, 366
Arkansas	-----	-----	(1)	(1)	624, 017	921, 842	42, 039	$63, 059	(1)	(1)	(1)	(1)	(1)	(1)
California	17, 861	$20, 260	100, 097	320, 223	781, 920	855, 993	(1)	(1)	(1)	(1)	10, 138, 268	$20, 128, 087	11, 038, 726	21, 328, 463
Colorado	-----	-----	361, 207	622, 397	(1)	(1)	-----	-----	-----	-----	(1)	(1)	1, 734, 191	1, 599, 196
Connecticut	-----	-----	(1)	(1)	627	1, 584	-----	-----	58, 980	228, 939	(1)	(1)	141, 539	493, 194
Florida	(1)	(1)	-----	-----	11, 038, 724	13, 328, 758	(1)	(1)	438, 205	1, 383, 828	2, 530, 138	1, 791, 113	14, 225, 356	16, 832, 066
Georgia	-----	-----	(1)	(1)	645, 339	930, 652	(1)	(1)	370, 328	674, 381	(1)	(1)	1, 806, 899	3, 722, 108
Hawaii	-----	-----	-----	-----	(1)	(1)	-----	-----	(1)	(1)	18, 293	25, 717	256, 455	323, 154
Idaho	-----	-----	20, 000	30, 000	3, 000	4, 500	-----	-----	-----	-----	(1)	(1)	(1)	(1)
Illinois	100, 418	104, 467	150, 487	250, 912	18, 001, 469	22, 484, 898	652, 212	716, 369	2, 785, 898	3, 612, 377	4, 712, 119	3, 927, 556	26, 402, 603	31, 096, 579
Indiana	87, 105	82, 687	98, 576	122, 936	6, 405, 501	7, 791, 893	320, 720	391, 296	1, 945, 673	2, 646, 616	1, 698, 831	1, 301, 816	10, 556, 406	12, 337, 244
Iowa	199, 752	243, 674	(1)	(1)	8, 696, 159	11, 040, 385	(1)	(1)	1, 446, 868	2, 041, 398	2, 828, 036	2, 969, 346	13, 240, 087	16, 388, 141
Kansas	276, 440	311, 297	-----	-----	5, 689, 557	7, 460, 157	186, 129	249, 657	526, 103	773, 935	2, 442, 009	2, 397, 305	9, 120, 238	11, 192, 351
Kentucky	(1)	(1)	21, 078	29, 763	7, 771, 869	10, 419, 965	421, 471	419, 840	1, 113, 663	1, 391, 024	(1)	(1)	10, 120, 653	13, 237, 726
Louisiana (oystershells)	-----	-----	-----	-----	(1)	(1)	-----	-----	-----	-----	-----	-----	(1)	(1)
Maine	(1)	(1)	-----	-----	-----	-----	-----	-----	(1)	(1)	(1)	(1)	616, 075	787, 231
Maryland	61, 020	113, 668	-----	-----	2, 928, 380	4, 534, 609	47, 225	69, 510	58, 011	244, 135	1, 016, 197	1, 332, 601	4, 110, 833	6, 294, 523
Massachusetts	6, 235	18, 705	(1)	(1)	(1)	(1)	-----	-----	100, 701	370, 327	(1)	(1)	375, 333	1, 097, 300
Michigan	38, 134	22, 549	10, 815, 128	9, 032, 464	4, 278, 495	4, 567, 603	114, 916	143, 618	534, 306	485, 252	11, 883, 295	7, 444, 694	27, 664, 274	21, 696, 180
Minnesota	26, 937	37, 621	350	1, 050	1, 662, 211	1, 958, 050	1, 000	1, 950	273, 002	402, 297	39, 290	176, 068	2, 002, 790	2, 577, 036
Mississippi	-----	-----	-----	-----	-----	-----	-----	-----	91, 218	91, 218	-----	-----	91, 218	91, 218
Missouri	995, 808	992, 425	24, 036	39, 870	9, 023, 880	12, 238, 833	334, 665	347, 019	1, 948, 273	2, 817, 011	5, 338, 963	6, 291, 484	17, 665, 625	22, 726, 642
Montana	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	-----	-----	528, 369	526, 255	624, 409	660, 829
Nebraska	448, 026	504, 447	-----	-----	787, 444	1, 099, 300	116, 117	200, 981	181, 767	284, 597	1, 102, 090	1, 376, 146	2, 635, 444	3, 465, 471
Nevada	-----	-----	(1)	(1)	-----	-----	-----	-----	-----	-----	(1)	(1)	(1)	(1)
New Jersey	(1)	(1)	(1)	(1)	27, 825	70, 607	(1)	(1)	120, 030	412, 131	(1)	(1)	397, 265	1, 743, 983
New Mexico	-----	-----	(1)	(1)	-----	-----	-----	-----	-----	-----	-----	-----	(1)	(1)
New York	309, 499	769, 300	94, 487	123, 625	10, 642, 117	18, 087, 272	478, 946	591, 185	307, 859	949, 662	4, 862, 667	4, 946, 437	16, 695, 575	25, 467, 481
North Carolina	-----	-----	-----	-----	1, 814, 724	2, 521, 371	-----	-----	9, 334	12, 389	1, 035	517	1, 825, 093	2, 534, 277
Ohio	96, 403	131, 842	7, 856, 164	9, 374, 281	11, 993, 911	14, 850, 606	995, 643	1, 141, 636	1, 960, 299	3, 328, 189	9, 119, 895	11, 312, 601	32, 022, 315	40, 139, 155
Oklahoma	140, 100	143, 097	-----	-----	5, 216, 658	6, 055, 914	(1)	(1)	84, 296	98, 747	(1)	(1)	6, 974, 697	7, 527, 413
Oregon	-----	-----	(1)	(1)	57, 302	67, 068	-----	-----	(1)	(1)	744, 291	1, 421, 685	810, 381	1, 513, 728
Pennsylvania	(1)	(1)	6, 483, 488	10, 857, 065	12, 074, 819	17, 159, 368	218, 483	311, 414	887, 684	2, 787, 111	(1)	(1)	35, 517, 797	49, 920, 892
Puerto Rico	-----	-----	-----	-----	679, 788	1, 246, 668	1, 220	2, 523	554	2, 546	40, 788	83, 741	722, 350	1, 335, 478
Rhode Island	-----	-----	-----	-----	-----	-----	-----	-----	(1)	(1)	-----	-----	(1)	(1)
South Carolina	-----	-----	-----	-----	-----	-----	-----	-----	38, 000	76, 000	-----	-----	38, 000	76, 000
South Dakota	(1)	(1)	-----	-----	322, 470	517, 366	-----	-----	-----	-----	(1)	(1)	812, 768	1, 128, 729

Tennessee	31,965	25,259	34,150	48,124	9,874,148	12,468,238	543,602	508,364	698,057	918,947	2,696,250	3,121,220	13,878,172	17,090,152
Texas [3]	220,013	261,857	529,170	580,993	9,510,718	10,621,824	460,332	448,953	58,667	57,239	12,136,021	13,223,692	22,914,921	25,194,558
Utah			(1)	(1)	79,880	23,964					(1)	(1)	1,100,795	1,395,122
Vermont	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	50,893	253,267	147,745	1,042,298	322,838	1,472,330
Virginia	698	698	483,806	773,150	3,768,762	5,000,257	356,748	365,412	773,776	1,468,803	3,195,260	4,696,813	8,579,050	12,305,133
Washington			(1)	(1)	(1)	(1)			33,615	134,645	1,409,191	4,282,684	1,471,642	4,459,739
West Virginia			2,419,318	3,934,239	1,471,110	2,508,420	485,979	575,647	94,028	241,603	(1)	(1)	(1)	(1)
Wisconsin	107,732	74,777	26,538	32,169	6,030,942	6,201,650	105,419	126,989	760,321	1,095,189	270,903	315,122	7,301,855	7,845,896
Wyoming	12,103	15,770	(1)	(1)	549,373	377,650	(1)	(1)	254	2,540	(1)	(1)	1,081,890	1,230,171
Undistributed	582,632	769,640	1,803,996	2,112,888	523,127	744,026	755,766	925,779	91,562	359,210	29,412,633	37,554,473	8,992,600	13,763,111
Total	3,758,881	4,644,040	33,161,736	40,933,952	[3]153,680,776	[3]199,063,091	6,638,632	7,601,201	18,247,121	30,199,337	[4]108,312,577	[4]131,689,471	323,799,723	414,131,092
Average unit value		$1.24		$1.24		$1.30		$1.14		$1.66		$1.22		$1.28

[1] Included with "Undistributed" to avoid disclosure of individual company operations.
[2] Includes 10,314,050 tons of oystershells valued at $12,193,316, sold or used for concrete and roadstone, in the making of cement and lime, and for unspecified uses.
[3] Includes 4,677,200 tons oystershells, valued at $5,930,350.
[4] Includes 89,702,530 tons, valued at $96,022,408, of limestone, dolomite, cement rock, and oystershells used in making cement, lime, and dead-burned dolomite, and oystershells for unspecified uses, not formerly included in the limestone statistics.

TABLE 31.—Limestone (crushed and broken stone) sold or used by producers in the United States [1] for miscellaneous uses, 1953–54

Use	1953		1954	
	Short tons	Value	Short tons	Value
Alkali works	6,786,390	$6,507,117	5,329,939	$4,659,840
Calcium carbide works	764,752	564,165	709,453	611,565
Coal-mine dusting	401,391	1,495,114	353,483	1,466,601
Filler (not whiting substitute):				
Asphalt	708,616	2,440,127	1,007,358	2,907,688
Fertilizer	437,986	809,916	433,590	865,122
Other	296,136	1,087,061	557,250	2,032,445
Filter beds	75,951	135,260	108,089	177,815
Glass factories	910,989	2,248,590	802,808	2,105,351
Limestone sand	1,754,023	2,265,817	1,466,842	1,832,621
Limestone whiting [2]	635,490	4,387,944	536,847	3,774,614
Magnesia works (dolomite) [3]	353,573	950,786	150,181	376,812
Mineral food	503,779	2,756,447	457,199	2,785,076
Mineral (rock) wool	12,210	18,150	48,859	167,734
Paper mills	324,673	785,806	484,372	1,150,428
Poultry grit	103,075	648,965	92,512	754,832
Refractory (dolomite)	766,404	1,098,153	645,175	1,008,492
Road base	2,283,041	1,967,440	1,908,854	1,634,578
Stucco, terrazzo, and artificial stone	104,195	997,266	282,850	1,653,374
Sugar factories	677,296	1,740,270	788,210	2,141,351
Other uses [4]	696,198	2,121,596	817,185	1,824,881
Use unspecified	1,299,607	1,821,924	1,628,991	1,735,843
Total	19,895,775	36,847,914	18,610,047	35,667,063
Portland and natural cement (limestone, cement rock, and oystershells) [5]	70,544,323	70,550,000	71,267,567	72,660,897
Lime, including dead-burned dolomite [6]	19,348,000	24,885,000	14,594,489	19,092,152
Unspecified uses (oystershells)	[7] 3,500,000	[7] 3,800,000	3,840,474	4,269,359
Grand total	113,288,098	136,082,914	108,312,577	131,689,471

[1] Includes Hawaii and Pureto Rico.
[2] Includes stone for filler for calcimine, caulking compounds, ceramics, chewing gum, explosives, floor coverings, foundry compounds, glue, grease, insecticides, leather goods, paint, paper, phonograph records, picture-frame moldings, plastics, pottery, putty, roofing, rubber, toothpaste, wire coating, and unspecified uses. Excludes limestone whiting made by companies from purchased stone.
[3] Includes stone for refractory magnesia.
[4] Includes stone for acid neutralization, carbon dioxide, chemicals (unspecified), concrete blocks and pipes, dyes, electric products, fill material, litter and barn snow, oil-well drilling, patching plaster, rayons, roofing granules, spalls, and water treatment.
[5] 1953: Consumption reported by cement companies; value estimated. 1954: Reported sold or used by producers; cement companies reported using 72,963,309 tons.
[6] 1953: Estimate based on the approximate requirement of 2 tons of stone to make 1 ton of lime; value estimated. 1954: Reported sold or used by producers; consumption by lime companies estimated as 17,258,000 tons.
[7] Estimate.

TABLE 32.—Dolomite and dolomitic lime sold or used by producers in the United States for specified purposes, 1953–54

	1953		1954	
	Short tons	Value	Short tons	Value
Dolomite for—				
Basic magnesium carbonate [1]	353,573	$950,786	150,181	$376,812
Refractory uses	766,404	1,098,153	645,175	1,008,492
Dolomitic lime for—				
Refractory (dead-burned dolomite)	2,294,815	31,455,384	1,520,854	21,960,684
Paper mills	41,000	495,000	29,000	353,000
Total (calculated as raw stone) [2]	5,792,000		3,895,000	

[1] Includes dolomite for refractory magnesia.
[2] 1 ton of dolomitic lime is equivalent to 2 tons of raw stone.

TABLE 33.—Sales of fluxing limestone, 1945–49 (average) and 1950–54, 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
1945–49 (average)	23,500,396	$20,753,044	5,952,462	$6,023,184	539,322	$604,174	212,182	$234,363	30,204,362	$27,614,765
1950	28,397,710	29,222,700	6,936,900	7,948,041	457,630	587,643	177,580	174,004	35,969,820	37,932,388
1951	32,007,284	35,941,217	6,784,102	8,279,021	842,877	992,651	295,694	409,236	39,929,957	45,622,125
1952	28,158,299	32,857,562	5,629,204	6,879,035	926,063	1,142,894	195,249	239,860	34,908,815	41,119,351
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

[1] Includes flux for copper, gold, lead, zinc, and unspecified smelters.
[2] Includes flux for foundries and for cupola and electric furnaces.

SANDSTONE

All types of crushed sandstone, except refractory stone, increased in output in 1954. The average unit value decreased 20 cents to $2.17. Six percent of the total quantity and 11 percent of the value were ground sandstone, quartz, and quartzite, formerly reported in the chapter on Abrasive Materials. This quantity was added to the miscellaneous column and broken down into uses in table 35. California remained in the lead in output, followed by Pennsylvania. Sandstone sales for 1954, by States and uses, is found in table 34.

Various types of stone, which do not conform to the other varieties discussed, are sold in significant quantities. These are light-colored volcanic rocks, schists, boulders, serpentine, flint, and chats (ore-dressing byproduct). The end uses of all these types are shown in table 36. Sales during 1954 decreased 14 percent in quantity and value. The value per ton remained the same as in 1953. Riprap was the only use that increased in 1954. There was some fluctuation in price among the various uses, but the average unit value remained the same as 1953. California led in output.

CONSUMPTION AND USES

The continued increase in population, with resulting demands for homes, industrial buildings, highways, defense, public works and industrial uses have given impetus to the stone industry. The proposed national road-building program offered opportunities for even greater utilization of the products of the stone industry.

Concrete is a major market for crushed stone, and consequently a relationship exists between crushed-stone output, cement shipments, and construction-contract awards. These comparisons are shown graphically over a period of 20 years in figure 3.

Figure 4 indicates the relationship between metallurgical uses of crushed stone and the production of pig iron and steel ingots.

Modern trends in road-building and air field construction require thicker base courses and wider pavements, calling for more and more crushed stone.

TABLE 34.—Sandstone, quartz, and quartzite (crushed and broken stone) [1] sold or used by producers in the United States in 1954, 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	(2)	(2)			(2)	(2)			(2)	(2)	44,039	$248,315
Arizona					(2)	(2)			(2)	(2)	(2)	(2)
Arkansas	(2)	(2)	(2)	(2)	418,450	$418,450	(2)	(2)			644,344	866,998
California	(2)	(2)	373,746	$734,657	1,758,401	2,352,449	3,911	$5,799	(2)	(2)	2,698,835	3,699,542
Colorado	17,644	$45,396	2,402	9,174					750	$3,750	20,796	58,320
Connecticut									(2)	(2)	(2)	(2)
Georgia					600,000	900,000	125,000	130,000			725,000	1,030,000
Idaho					33,737	17,645			(2)	(2)	(2)	(2)
Illinois	295	6,490									295	6,490
Kansas			181,625	306,700	120,753	246,578	7,767	11,650	41,514	92,496	351,659	657,424
Kentucky									(2)	(2)	(2)	(2)
Maine			4,217	8,434	(2)	(2)			(2)	(2)	197,537	437,310
Massachusetts					(2)	(2)					(2)	(2)
Michigan									50	100	50	100
Minnesota			(2)	(2)							(2)	(2)
Montana			(2)	(2)			(2)	(2)	(2)	(2)	294,843	316,709
Nebraska			20,545	30,967							20,545	30,967
Nevada	(2)	(2)							(2)	(2)	(2)	(2)
New Mexico			700	1,000	25	100					725	1,100
North Carolina									(2)	(2)	(2)	(2)
North Dakota			1,419	3,784							1,419	3,784
Ohio	78,242	947,551	(2)	(2)					(2)	(2)	410,813	2,411,036
Oklahoma									154,655	144,472	154,655	144,472
Oregon	(2)	(2)	(2)	(2)	(2)	(2)			(2)	(2)	(2)	(2)
Pennsylvania	496,848	2,247,516	(2)	(2)	983,591	1,626,184	155,428	239,908	(2)	(2)	1,644,489	4,136,317
Puerto Rico					(2)	(2)			(2)	(2)	(2)	(2)
South Dakota	(2)	(2)	(2)	(2)	552,342	1,109,933	(2)	(2)	(2)	(2)	770,732	1,485,490
Tennessee	(2)	(2)	(2)	(2)	781	6.188					(2)	(2)
Texas			14,222	10,940	204,182	151,618			485,257	361,404	703,661	523,962
Utah	21,924	65,772							1,862	22,000	23,786	87,772
Virginia					53,004	92,293			(2)	(2)	(2)	(2)
Washington			277	2,834					38,948	162,637	39,225	165,471
West Virginia	(2)	(2)			1,469,343	2,341,833					(2)	(2)
Wisconsin	(2)	(2)							(2)	(2)	(2)	(2)
Wyoming					21,000	12,600					21,000	12,600
Undistributed	269,442	1,602,095	280,497	478,665	473,241	740,635	303,872	324,632	1,945,301	7,357,253	2,948,762	9,050,403
Total	884,395	4,914,820	879,650	1,587,155	6,688,850	10,016.506	595,978	711,989	2,668,337	8,144,112	11,717,210	25,374,582
Average unit value		$5.56		$1.80		$1.50		$1.19		$3.05		$2.17

[1] Includes 649,594 tons ground sandstone, quartz, and quartzite, valued at $2,765,289, formerly reported in the chapter on Abrasive Materials. Friable sandstone is reported in the chapter on Sand and Gravel.

[2] Included with "Undistributed" to avoid disclosure of individual company operations.

TABLE 35.—Sandstone, quartz, and quartzite (crushed and broken stone) [1] sold or used by producers in the United States [2] for miscellaneous uses

Use	Short tons	Value	Use	Short tons	Value
Abrasives	32,106	$184,573	Glass	243,974	$1,010,845
Ferrosilicon	139,221	515,989	Pottery, porcelain, and tile	37,801	429,625
Fill	573,498	564,928	Road base	640,402	508,196
Filter	34,722	111,399	Other uses [3]	518,740	4,069,488
Flux	308,900	338,700			
Foundry	138,973	410,369	Total	2,668,337	8,144,112

[1] Includes 649,594 tons ground sandstone, quartz, and quartzite, valued at $2,765,289, formerly reported in the chapter on Abrasive Materials. Friable sandstone is reported in the chapter on Sand and Gravel.
[2] Includes Puerto Rico.
[3] Includes roofing granules, spalls, stone sand, and unspecified uses.

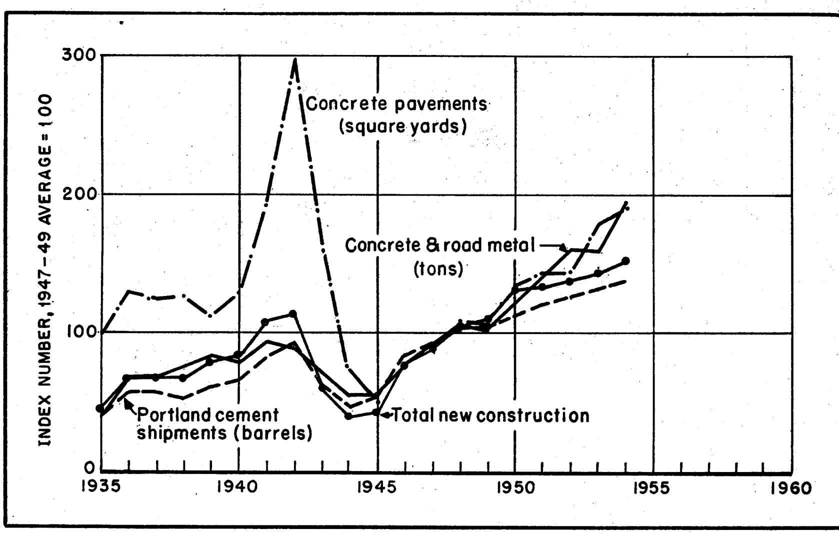

FIGURE 3.—Crushed-stone aggregates, concrete and road metal (roadstone) sold or used in the United States compared with shipments of portland cement, total new construction (value), and concrete, pavements (contract awards, square yards), 1935–54.

[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.]

TABLE 36.—Miscellaneous varieties of stone (crushed and broken stone) sold or used by producers in the United States in 1954, 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	(2)	(2)			(2)	(2)	(2)	(2)	68,138	$165,237
American Samoa			52,000	$10,000					52,000	10,000
Arizona			(2)	(2)					(2)	(2)
Arkansas	(2)	(2)	(2)	(2)	(2)	(2)			(2)	(2)
California	957,133	$2,231,996	3,163,881	2,973,076	108,651	$117,412	176,159	$620,853	4,405,824	5,943,337
Canton			2,600	5,000					2,600	5,000
Colorado			19,247	12,895					19,247	12,895
Guam			842,660	2,275,182					842,660	2,275,182
Hawaii			6,563	13,125					6,563	13,125
Idaho	17,657	14,288	345,668	199,198					363,325	213,486
Johnston			98	300					98	300
Kansas					824,013	278,964	36,480	18,900	860,493	297,864
Massachusetts			(2)	(2)					(2)	(2)
Michigan			81,657	108,018					81,657	108,018
Midway			490	1,500					490	1,500
Missouri			334,762	320,258	511,919	243,274	27,456	25,787	874,137	589,319
Montana	(2)	(2)							(2)	(2)
Nevada			(2)	(2)	(2)	(2)	(2)	(2)	348,868	142,638
New Hampshire			(2)	(2)					(2)	(2)
New Mexico			(2)	(2)	(2)	(2)	(2)	(2)	630,243	530,704
New York			(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
North Carolina			(2)	(2)					(2)	(2)
Oklahoma			(2)	(2)	(2)	(2)			2,092,209	720,360
Oregon	15,024	24,865	416,053	392,239					431,077	417,104
Pennsylvania			(2)	(2)			(2)	(2)	743,093	715,992
Puerto Rico			11,292	27,308					11,292	27,308
Rhode Island			(2)	(2)					(2)	(2)
South Carolina							(2)	(2)	(2)	(2)
South Dakota			12,106	10,792					12,106	10,792
Texas	(2)	(2)	569,724	358,008	(2)	(2)	(2)	(2)	1,297,563	1,111,646
Virginia	(2)	(2)	(2)	(2)					44,346	92,885
Wake			780	1,300					780	1,300
Washington	14,000	11,200	58,538	64,174					72,538	75,374
Wisconsin			105,312	96,606					105,312	96,606
Wyoming			3,040	1,550					3,040	1,550
Undistributed	479,047	593,173	3,458,465	4,129,370	3,085,351	1,581,639	514,452	837,094	2,882,579	4,019,822
Total	1,482,861	2,875,522	9,484,936	10,999,899	4,529,934	2,221,289	754,547	1,502,634	16,252,278	17,599,344
Average unit value		$1.94		$1.16		$0.49		$1.99		$1.08

[1] Includes stone used for fill materials, flux, refractory, road base, roofing granules, turkey grit, and unspecified uses.
[2] Included with "Undistributed" to avoid disclosure of individual company operations.

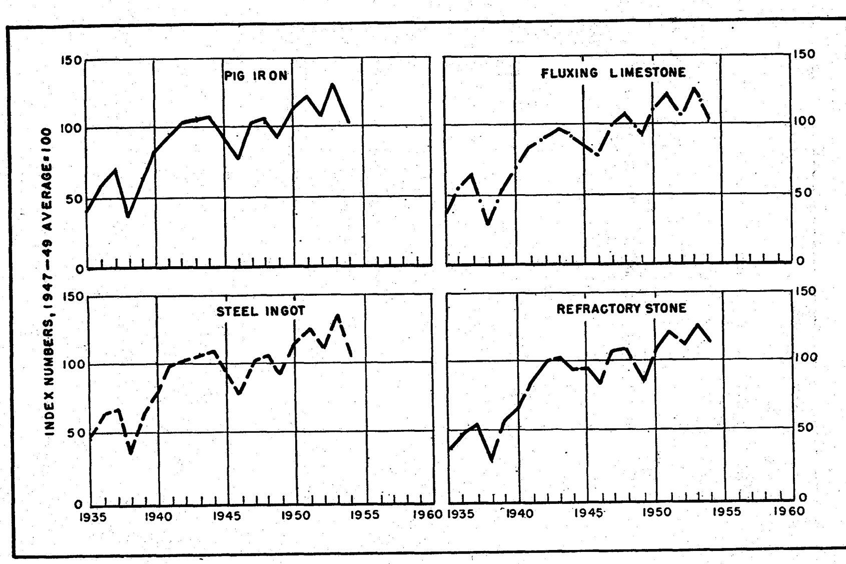

FIGURE 4.—Sales (tons) of fluxing limestone and refractory stone (including that used in making dead-burned dolomite) compared with production of steel ingot and pig iron, 1935–54.

[Statistics of steel-ingot production compiled by American Iron and Steel Institute.]

TECHNOLOGY

On the theory that the best way to sell agricultural limestone is to furnish on-the-spot soil testing, combined with advice on the need for soil conditioning and conservation measures, an Indiana stone company, through an affiliated organization, offered a conservation service to local farmers. Besides soil testing and agronomic advice, this affiliate provided assistance in utilizing limestone and in other aspects of land improvement and conservation.[18]

The shortage of properly sized masonry and cement sands has aroused concern in Florida. One plant met the situation with a sized stone sand produced from oolitic limestone. This operation had a plant arrangement in which a 25-foot-high, earth-filled ramp permitted dumping into the primary feed hopper without backing or turning.[19]

Self-unloading barges were used to discharge coral rock into 40 feet of water to feed an underwater conveyor, which carries the material to the on-shore installations. By opening a large dimension valve on one side of the barge, the center of gravity shifts, and the barge is turned completely over. The former bottom then acts as the deck for the next load.[20]

Advantages of a modern, 250-ton-per-hour portable crushing-screening plant was emphasized in an article describing the shutdown of an efficient permanent plant by a company operating two quarries.

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[18] Gutschick, Kenneth A., Midwestern Agstone Producer Offers Complete Conservation Service to Farmers: Pit and Quarry, vol. 46, No. 1, May 1954, pp. 98–100, 102–104.
[19] Lenhart, Walter B., Processing Sand From Coral Rock: Rock Products, vol. 57, No. 6, June 1954, pp. 101–103.
[20] Rock Products, Reversible, Self-Unloading Barges Haul Stone to Plant: Vol. 57, No. 6, June 1954, pp. 104–105, 108, 117.

Direct loading at the quarry face with elimination of truck haulage was a factor.[21]

Utilization of pipeline for air transportation of agricultural limestone is described where the distance is 3,500 feet and the drop 220 feet.[22] A million-ton-per-year limestone operation from 2,200 feet underground was described. Underground crushing and extensive mechanization are featured.[23]

Contractors who stockpile aggregates from overhead conveyors will be interested in recent tests showing the effectiveness of stone ladders in reducing breakage.[24]

The details of equipment and products of a limestone grinding plant using ten 50-inch roller mills was described. The feed to these mills was a ¾-inch maximum-size dolomite. Seven to 8 tons per hour per mill was obtained in the average product size range.[25] Details of screen-cloth heating in a British limestone-crushing plant was described.[26] Here a clean ⅛-inch material was separated from run-of-quarry fines carrying 5 percent moisture without preliminary drying.

The problem of increasing the proportion of fine stone sand for a large dam project was solved by using a rod mill to increase the amount of fines and liquid cyclones to recover them.[27]

Drilling in a quarry under 3 to 4 feet of water was accomplished by mounting a rotary drill with a 30-foot mast on a steel sled, which was dragged to position by a tractor.[28] The development and operation of rotary blasthole drilling at the major limestone operation in Michigan was outlined. In this operation a 6¼-inch-diameter bit was reported to have a penetration rate of up to 75 feet per hour. An air velocity of 3,000 feet per minute within the blasthole raised the cuttings to the surface, where they were caught in a collector.[29]

A new 1,000-ton-per-hour crushed-stone plant treated a tough syenite rock using many innovations, includingj et piercing, 10-inch blastholes, seismic measurement of blasts, a 7-foot-diameter cone crusher, and a 140-foot thickener. A 20-foot-per-hour blasthole drilling rate was obtained. Every size product from riprap to stone sand was produced.[30]

A quarry operator developed a mobile secondary drilling machine mounted on a three-wheel vehicle that permitted quick and short radial turning. On the front of the main assembly was a 40-foot boom, which carried an enclosed operator's chair from which all operations were handled. It was said to replace 6 to 8 hand drills.[31]

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[21] Gutschick, Kenneth A., Dillon Stone Company Operates Two Quarries With New 250-Tons-Per-Hour Portable Plant: Pit and Quarry, vol. 46, No. 12, June 1954, pp. 77–79.

[22] Pit and Quarry, Agstone for Newfoundland Farming Supplied by North Star Cement, Ltd.: Vol. 47, No. 2, August 1954, pp. 109, 112.

[23] Haller, H. F., Mining Methods—Barberton Limestone Mine: Min. Eng., vol. 6, No. 12, December 1954, pp. 1165–1168.

[24] Construction Methods and Equipment, Stone Ladders Cut Breakage: Vol. 36, No. 9, September 1954, p. 155.

[25] Nordberg, Bror, Producing Pulverized Dolomite Products: Rock Products, vol. 57, No. 5, May 1954, pp. 88–93.

[26] Mine and Quarry Engineering (London), A Somerset Limestone Operation: Vol. 20, No. 11, November 1954, pp. 478–483.

[27] Lenhart, Walter B., Problems of Fine-Sand Recovery at Folsom Dam: Rock Products, vol. 57, No. 5, May 1954, pp. 70–73.

[28] Rock Products, Drilling Under Water: Vol. 57, No. 5, May 1954, p. 60.

[29] Van Zandt, D. T., Change to Rotary Blasthole Drilling in Limestone Increases Footage, Cuts Time, Saves Manpower: Min. Eng., vol. 6, No. 8, August 1954, pp. 809–811.

[30] Gutschick, Kenneth A., Big Rock's New Quarry at Little Rock: Pit and Quarry, vol. 47, No. 4, October 1954, pp. 52–62.

[31] Lenhart, W. B., Operating Results With Secondary Drill: Rock Products, vol. 57, No. 5, May 1954, pp. 96–101, 120–121.

A self-propelled drill with remote positioning and drill controls has been developed.[32] A very large drill operated in California featured an unusual mechanism that automatically adds new sections and extends the drill stem.[33]

An article outlined a general cost analysis of the various phases of a drilling program and showed how the cost of each part can be reduced.[34]

Impure limestone was reported to be beneficiated by crushing, centrifuging, and flotation. A concentrate containing 85 percent calcite was produced.[35]

An instrument called a seismolog was developed for use as a tool in blasting operations. It records vertical, horizontal, and transverse earth tremors on a tape. This tape tells a graphic story to a skilled analyst.[36]

A Bureau of Mines report has shown that displacement, velocity, and acceleration can be differentiated and/or integrated on seismic records of low frequency and long duration. This report also shows that these same operations can be performed, with the accuracy of the original measurements, on seismic records of relatively high frequency and short duration.[37]

A gun firing an 8-gage shell was developed for use in dislodging overhanging ledges in quarries.[38]

A blasting technique using a "V"-shaped quarry face was an unusual feature of one southern operation.[39]

A comprehensive report on modern trends in prospecting and production of commercial crushed stone was issued. Descriptions of quarrying methods, transportation of quarried stone, crushing, screening, washing, production of stone sand, and related operations were included.[40]

A patent was issued on a method of making artificially colored roofing granules.[41]

Details of a new color test method for distinguishing limestone and dolomite was described.[42] It was reportedly being used by several oil companies.

In southeastern Ohio intensive testing of flexible pavements was completed by the Western Association of State Highway Officials. The results, when published, may influence future road design and specifications.[43]

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32 Rock Products, vol. 57, No. 3, March 1954, p. 68.
33 Rock Products, vol. 57, No. 3, March 1954, p. 99.
34 Mining Magazine (London), vol. 86, No. 6, December 1953, pp. 340–342.
35 Boucher, L. J., Cement-Rock Beneficiation at the Universal Atlas Cement Co., Northampton, Pa.: Min. Eng., vol. 5, No. 3, March 1953, pp. 289–293.
36 Rock Products, vol. 57, No. 3, March 1954, p. 99.
37 Blair, B. E., and Duvall, W. I., Evaluation of Gages for Measuring Displacement, Velocity, and Acceleration of Seismic Pulses: Bureau of Mines Rept. of Investigations 5073, 1954, 21 pp.
38 Engineering and Mining Journal, vol. 155, No. 11, November 1954, p. 93.
39 Rock Products, vol. 57, No. 10, October 1954, pp. 66–67, 105.
40 Goldbeck, A. T., Crushed-Stone Production: Jour. Am. Concrete Inst., vol. 25, No. 9, May 1954, pp. 761–772.
41 Lodge, James R., Artificially Colored Roofing Granules and Method for Making Same (Minnesota Mining & Manufacturing Co.), U. S. Patent 2,695,851, Nov. 30, 1954.
42 Ramsden, R. M., A Color Test for Distinguishing Limestone and Dolomite, Jour. Sedimentary Petrology, vol. 24, No. 4, December 1954, p. 282.
43 Roads and Streets, vol. 98, No. 1, January 1955, pp. 44–45.

FOREIGN TRADE [44]

The import value fluctuated for the various classes of stone in comparison with 1953. There was a general decrease in value for crushed and ground stone and an increase in dimension stone.

Exported building and monumental stone increased 13 percent in quantity and 5 percent in value compared with 1953. Crushed, ground, or broken stone combined decreased 16 percent in quantity but increased 7 percent in value compared with 1953. Other manufacturers of stone declined 13 percent in value compared with the previous year.

TABLE 37.—Stone and whiting imported for consumption in the United States, 1953–54, by classes

[U. S. Department of Commerce]

Class	1953		1954	
	Quantity	Value	Quantity	Value
Marble, breccia, and onyx:				
Sawed or dressed, over 2 inches thick...cubic feet..	538	$3,905	317	$4,005
In blocks, rough, etc...do....	175,550	912,643	200,468	968,809
Slabs or paving tiles...superficial feet..	957,592	713,093	1,032,174	[1] 665,886
All other manufactures		1,042,985		[1] 1,189,515
Total		2,672,626		[1] 2,828,215
Granite:				
Dressed...cubic feet..	[2] 104,010	628,047	87,004	[1] 735,446
Rough...do....	53,226	218,395	62,579	296,948
Paving blocks, wholly or partly manufactured number..	1,207	37,123	487	17,818
Total		883,565		[1] 1,050,212
Quartzite...short tons..	213,487	703,623	163,484	575,684
Travertine stone (unmanufactured)...cubic feet..	61,021	114,174	90,981	[1] 189,319
Stone (other):				
Dressed:				
Sandstone, limestone, etc		19,658	8,203	[1] 29,060
Travertine...cubic feet..	8,697	16,370		
Rough (monumental or building stone)..cubic feet..	4,542	11,991	5,158	10,688
Rough (other)...short tons..	98,404	212,436	65,156	[1] 205,277
Marble chip or granito...do....	13,313	117,611	15,172	[1] 129,098
Crushed or ground, n. s. p. f.		102,928		[1] 5,793
Total		480,994		[1] 379,916
Whiting:				
Chalk or whiting, precipitated...short tons..	900	42,475	955	38,605
Whiting, dry, ground, or bolted...do....	10,727	173,720	10,089	[1] 154,071
Whiting, ground in oil (putty)...do....	7	2,071	(3)	[1] 48
Total		218,266		[1] 192,724
Grand total		5,073,248		[1] 5,216,070

[1] Due to changes in tabulating procedures by the U. S. Department of Commerce data known not to be comparable to earlier years.
[2] Revised figure.
[3] Less than 1 ton.

[44] 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.

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TABLE 38.—Stone exported from the United States, 1945–49 (average) and 1950–54

[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	
1945–49 (average)	244,149	$498,457	(1)	(1)	(1)	(1)	$374,482
1950	142,955	378,645	(1)	(1)	(1)	(1)	338,207
1951	230,239	585,499	(1)	(1)	(1)	(1)	271,461
1952	277,551	648,833	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

[1] Not separately classified before January 1, 1952.

WORLD REVIEW

North America

Canada.—Successful flotation tests were reported on the cherty limestone deposits in the vicinity of Port Colborne, Ontario. A concentrate suitable for cement manufacture was produced. Silica was reduced from 34 percent to less than 9 percent at a cost, for reagents, of about 30 cents per ton of concentrate.[45]

Europe

Poland.—A discussion of the availability of dolomite in Poland and its potential applications was published.[46]

United Kingdom.—A survey of the geology of silicate rocks, with particular reference to their occurrence in Great Britain, and reviews of their industrial application was made under the following headings: Abrasives, brick, building sand, building stone, concrete aggregate, fillers, filters, fluxes, gem stones, glassmaking, insulating material, pottery, porcelain and enamel, refractories, and scientific equipment.[47]

Derbyshire Stone, Ltd., said to be one of the largest stone-quarrying companies in Great Britain, announced a special policy for the Middle East. The experience of its staff of geologists, quarrying specialists, chemists, and engineers was to be made available to Government and private industry on a consulting basis. It will investigate quarry mining sites and make recommendations for operation, including design and construction of plants, purchases and erection of machinery, and operating supervision.[48]

[45] Canadian Mining and Metallurgical Bulletin (Montreal), Beneficiation of Some Canadian Nonmetallic Ores: Vol. 47, No. 509, September 1954, p. 582.
[46] American Ceramic Society Abstracts, vol. 37, No. 10, p. 1881.
[47] Bor, Leslie, Silica Rocks in Industry: Mine and Quarry Eng., vol. 20, No. 4, April 1954, pp. 164–170.
[48] Mining Journal (London), British Quarrying "Know How" to Benefit Middle East: Vol. 243, No. 6211, Sept. 3, 1954, p. 256.

Strontium

By Joseph C. Arundale[1] and Annie L. Marks[2]

OUTPUT of strontium minerals was small in 1954 and imports dropped because of inventory adjustments by consumers.

DOMESTIC PRODUCTION

Celestite (strontium sulfate) and strontianite (strontium carbonate) are the only minerals now considered ores of strontium. Celestite, because of its relative abundance and more widespread occurrence, is commercially more important. Strontianite is significant for its higher strontium content and its occasional association with celestite. Domestic production of these minerals has been sporadic, and output has been small.

In 1954 a small tonnage of celestite was reported shipped by Pan Chemical Co. from a deposit in Imperial County, Calif. Occasionally in recent years a small output has been reported from Fidalgo Island in Puget Sound, Wash.

The following firms manufactured various primary strontium chemicals: E. I. du Pont de Nemours & Co., Wilmington, Del.; Foote Mineral Co., Philadelphia, Pa.; Barium Products, Ltd., Modesto, Calif.; and Pan Chemical Co., Los Angeles, Calif. Strontium hydride is produced by Metal Hydrides, Inc., Beverly, Mass., and a small quantity of strontium metal is made by King Laboratories, Inc., Syracuse, N. Y., and Cooper Metallurgical Associates, Cleveland, Ohio.

CONSUMPTION AND USES

Strontium imparts a characteristic crimson color to a flame and is therefore used widely in pyrotechnical applications utilizing this property. Such products have been used extensively by industry and the military. Many signal-warning flares and fusees contain strontium compounds. These are used by railroads as emergency signals and by operators of trucks, passenger automobiles, and other vehicles to warn of danger when stopped on the highway. The Armed Forces use these fusees and flares for tactical signaling and illumination. Distress-signal equipment consists of red flares and some ejection or propelling device. Tracer bullets contain a charge of strontium nitrate, peroxide, or oxalate in the base of the bullet which

[1] Assistant chief, Branch of Construction and Chemical Materials.
[2] Statistical clerk.

is ignited by the propellant and burns brightly during flight, thus permitting the gunner to judge the accuracy of his aim.

The familiar crimson color of many fireworks and pyrotechnical exhibitions is produced by any of several strontium compounds. The major uses of strontium carbonate were in ceramics, principally frits and glazes. Various other strontium compounds were used as corrosion inhibitors, fused salt baths in metal treating, in greases, and plastics stabilizer. A small tonnage of ground celestite was used to purify some of the caustic soda consumed in manufacturing rayon and paper.

Strontium metal and alloys have been used as getters in electronic tubes. The beta ray omitting isotope, strontium 90, is reported to have found application in thickness gages and as the metal "activator" in self-luminous compounds as a substitute for radium. This use was discussed in an article.[3]

PRICES

According to Oil, Paint and Drug Reporter, strontium, sulfate (celestite), air-floated, 90 percent, 325-mesh, bags, works, was quoted at $56.70 to $66.15 per short ton during 1954. These prices were unchanged from the previous year. Strontium carbonate in pure 1-ton lots was quoted at 37 cents per pound and in 5-ton lots at 35 cents per pound. Strontium nitrate, barrels or cases, works, was quoted at 11 to 12 cents per pound.

The average unit foreign value of imported strontium minerals in 1954 was $16.19 per short ton.

FOREIGN TRADE[4]

For economic reasons, nearly all United States supplies of strontium minerals have come from United Kingdom and Mexico. Imports in 1954 were substantially below the average of recent years owing to completion of shipments of crude celestite purchased by the Government during World War II under a preclusive buying agreement with Spain and because domestic consumers were liquidating some stocks accumulated during the Korean emergency and now considered too large.

TABLE 1.—Strontium minerals[1] imported for consumption in the United States, 1952–54, by countries, in short tons

[U. S. Department of Commerce]

Country	1952		1953		1954	
	Short tons	Value	Short tons	Value	Short tons	Value
North America:						
Canada	59	$607	43	$521		
Mexico	1,297	16,870	2,441	30,248	1,906	$24,887
Total	1,356	17,477	2,484	30,769	1,906	24,887
Europe: United Kingdom	8,161	168,849	4,413	93,077	1,385	28,397
Grand total	9,517	186,326	6,897	123,846	3,291	53,284

[1] Strontianite or mineral strontium carbonate and celestite or mineral strontium sulfate.

[3] Chemical Week, vol. 75, No. 7, Aug. 14, 1954, pp. 60, 62.

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

TECHNOLOGY

The Bureau of Mines issued a report on the experimental measurement of heats of formation of several titanates, including strontium metatitanate, barium-strontium metatitanate, strontium orthotitanate, and barium-strontium orthotitanate.[5] A solution calorimetry method was used to make these measurements. The data were combined with previously published entropy and heat-content values to obtain heats and free energies of formation. The thermodynamic stabilities and potential reactivities of these materials can now be evaluated at processing temperatures. Such information is useful in extractive metallurgical processes and in developing new commercial metals. It was concluded that these titanates are stable with respect to decomposition into oxides at temperatures of 298.16° to 1,800° K.; that barium-strontium metatitanate crystalline solution (containing 54.3 mole percent barium metatitanate) is stable with respect to decomposition into the constituent metatitanates at temperatures above about 400° K.; that barium-strontium orthotitanate crystalline solution (containing 50.0 mole percent barium orthotitanate) is stable with respect to decomposition into the constituent orthotitanates at temperatures above 800° K.; that strontium orthotitanate is stable with respect to decomposition into the corresponding metatitanate and excess oxide throughout the temperature range 298.16° to 1,800° K.

WORLD REVIEW

Deposits of strontium minerals occur widely throughout the world, and new occurrences are frequently found. One such discovery reported during 1954 was strontianite on the property of Yale Lead & Zinc Mines, Ltd., at Ainsworth, British Columbia, Canada.[6]

United Kingdom and Mexico probably are the largest producers of strontium minerals, but in recent years production has been reported in Germany, Spain, Canada, U. S. S. R., Tunisia, India, Pakistan, and Italy.

[5] Kelly, K. K., Todd, S. S., and King, E. G., Heat and Free Energy Dataf or Titanates of Iron and th Alkaline Earth Metals: Bureau of Mines Rept. of Investigations 5059, 1954, 37 pp.

[6] Western Miner and Oil Review ,Vancouver, vol. 28, No. 7, July 1955, p. 42

Sulfur and Pyrites

By Leonard P. Larson [1] and Annie L. Marks [2]

THE EFFECT of sulfur exploration and development programs that had been started in the previous few years became more evident in 1954. Production records were set in the United States and substantial additions to capacity were in prospect in Mexico.

DOMESTIC PRODUCTION [3]

NATIVE SULFUR

Production of sulfur in the United States was 7 percent greater in 1954 than in 1953 and 6 percent above the previous record, set in 1952. Of the total production of primary sulfur in 1954, approximately 84 percent was native sulfur, 5 percent was recovered sulfur, 6 percent was in pyrites, 4 percent was in sulfuric acid from smelters, and 1 percent was in other forms.

TABLE 1.—Salient statistics of the sulfur industry in the United States, 1945–49 (average) and 1950–54 (in long tons of sulfur content)

	1945–49 (average)	1950	1951	1952	1953	1954
Production (all forms)	4,963,136	5,986,482	6,196,859	6,284,191	6,247,971	6,675,200
Imports (pyrites and sulfur)	69,554	100,225	108,676	146,863	92,229	135,128
Producers' stocks (Frasch and recovered sulfur)	[1] 3,493,728	[1] 2,654,530	[1] 2,837,432	[2] 3,163,517	[2] 3,129,830	[2] 3,337,086
Exports (sulfur)	1,258,923	1,478,522	1,311,817	1,338,367	1,271,011	1,677,855
Apparent domestic consumption (all forms)	3,968,200	4,988,100	4,819,200	4,832,300	5,049,400	4,909,900

[1] Frasch sulfur only.
[2] Frasch and recovered sulfur.

Native sulfur production reached an alltime high during 1954, exceeding the previous record year of 1952 by 5 percent. Of the total output of native sulfur, approximately 63 percent was produced in Texas and 36 percent in Louisiana, the balance being mined in California. Texas and Louisiana produced all of the Frasch sulfur mined in the United States. Production of Frasch sulfur in Texas was slightly lower than in the previous year, whereas the output from Louisiana increased 22 percent, owing primarily to development of the Garden Island Bay mine.

The Humble Oil & Refining Co. discovered, by drilling, a major sulfur deposit 6 miles off the south coast of Louisiana and 20 miles southwest of the Freeport Sulfur Co. Grande Ecaille sulfur project.

[1] Commodity-industry analyst.
[2] Statistical assistant.
[3] Production data for 1954 were collected jointly with the Bureau of the Census (U. S. Department of Commerce). Production totals will be compared with the Census totals when they are available and differences adjusted or explained.

At least three drill holes intersecting the sulfur deposit were completed by the end of the year.

TABLE 2.—Production of sulfur and sulfur-containing raw materials by producers in the United States, 1945–49 (average) and 1950–54, in long tons

	1945–49 (average)		1950		1951	
	Gross weight	Sulfur content	Gross weight	Sulfur content	Gross weight	Sulfur content
Native sulfur or sulfur ore:						
From Frasch-process mines	4,333,654	4,333,654	5,192,184	5,192,184	5,278,249	5,278,249
From other mines [1]	4,023	1,284	3,327	1,072	3,945	1,365
Total native sulfur		4,334,938		5,193,256		5,279,614
Recovered elemental sulfur:						
Brimstone	37,827	37,798	139,731	139,352	182,495	181,935
Paste	7,167	3,152	6,452	3,123	4,614	2,078
Total recovered elemental sulfur		40,950		142,475		184,013
Pyrites (including coal brasses)	858,708	358,665	931,163	392,788	1,017,769	432,819
Byproduct sulfuric acid (basis 100 percent) produced at Cu, Zn, and Pb plants	624,780	204,176	661,529	216,000	736,672	240,800
Other byproduct sulfur compounds [2]	26,956	24,406	46,977	41,963	70,257	59,613
Total equivalent sulfur		4,963,135		5,986,482		6,196,859

	1952		1953		1954	
	Gross weight	Sulfur content	Gross weight	Sulfur content	Gross weight	Sulfur content
Native sulfur or sulfur ore:						
From Frasch-process mines	5,293,145	5,293,145	5,155,342	5,155,342	5,514,640	5,514,640
From other mines [1]	8,536	2,197	151,819	38,257	214,157	64,333
Total native sulfur		5,295,342		5,193,599		5,578,973
Recovered elemental sulfur:						
Brimstone	250,428	249,388	342,297	340,827	361,107	359,135
Paste	3,859	1,810	1,723	833	284	136
Total recovered elemental sulfur		251,198		341,660		359,271
Pyrites (including coal brasses)	994,342	418,139	922,647	379,545	908,715	405,310
Byproduct sulfuric acid (basis 100 percent) produced at Cu, Zn, and Pb plants	774,177	253,000	775,069	253,000	791,049	258,600
Other byproduct sulfur compounds [2]	77,307	66,512	92,787	80,167	85,255	73,046
Total equivalent sulfur		6,284,191		6,247,971		6,675,200

[1] Sulfur content estimated for 1945–52.
[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.

Frasch sulfur production by 5 companies operating a total of 13 mines set a new record in 1954 of 5½ million long tons—4 percent over the previous record year of 1952. Texas produced 64 and Louisiana 36 percent of the total Frasch-sulfur output. The mines of Texas Gulf Sulphur Co., the largest producer, were in Texas at Boling dome, Wharton County; Moss Bluff dome, Liberty County; and Spindletop dome, Jefferson County. Freeport Sulphur Co., the second largest producer, operated five mines in 1954. A sixth plant was under construction at Chacahoula dome in Louisiana. Freeport Sulphur Co.

operated mines in Louisiana at Grande Ecaille, Plaquemines Parish; Bay Ste. Elaine, Terrebonne Parish; and Garden Island Bay, Plaquemines Parish; and in Texas at Hoskins Mound dome, Brazoria County; and Nash dome, Fort Bend County. The Garden Island Bay mine, built at a cost of $14 million, was brought into production in 1953 and reached capacity production in February 1954. Nash dome, 35 miles southwest of Houston, Tex., on land held by the Kentucky Female Orphan School of Midway, Ky.,[4] was brought into production in

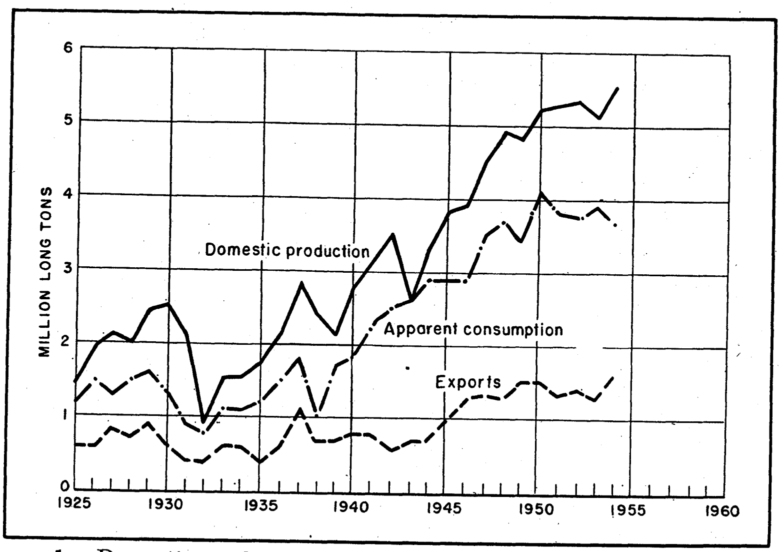

FIGURE 1.—Domestic production, apparent consumption, and exports of native sulfur, 1925–54.

February 1954. The Chacahoula dome, in a swampy area in Lafourche Parish, La., was under construction.

TABLE 3.—Sulfur produced and shipped from Frasch mines in the United States, 1945–49 (average) and 1950–54

Year	Produced (long tons)			Shipped	
	Texas	Louisiana	Total	Long tons	Approximate value
1945–49 (average)	3,396,968	936,686	4,333,654	4,511,566	$77,680,000
1950	3,949,164	1,243,020	5,192,184	5,504,714	104,000,000
1951	3,966,956	1,311,293	5,278,249	4,988,101	107,300,000
1952	3,784,595	1,508,550	5,293,145	5,141,392	110,925,000
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

Jefferson Lake Sulphur Co. operated mines at Starks dome, Calcasieu Parish, La.; Clemens dome, Brazoria County, Tex.; and Long Point dome, Fort Bend County, Tex.

Duval Sulphur & Potash Co. produced sulfur at Orchard dome, Fort Bend County, Tex.

[4] Mining Congress Journal, vol. 40, No. 5, May 1954, p. 71.

Standard Sulphur Co. operated its plant at Damon Mound, Tex., and it was reported that the company planned expansion at Damon Mound and had acquired holdings at Bryan Mound.[5] It was reported that the Sulphur Exploration Co. was investigating the sulfur potential of the Hockley Dome.[6]

Production from Leviathan Sulphur mine of Anaconda Copper Co., in Alpine County, Calif., increased during 1954.

The American Sulphur & Refining Co. was constructing a plant to concentrate native sulfur at the Sulphurdale deposits in Utah and was reported to be interested in future development of a sulfur deposit near Winnemucca, Nev.[7]

TABLE 4.—Sulfur ore (10–70 percent S) produced and shipped in the United States, 1945–49 (average) and 1950–54, in long tons [1]

Year	Produced (long tons)	Shipped	
		Long tons	Value
1945-49 (average)	4,023	3,871	$61,007
1950	3,327	3,247	60,115
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

[1] California, Colorado (1948–49 only), Nevada (except 1954), Texas (1948 only), Utah (1952 only), and Wyoming (except 1948 and 1953–54).

RECOVERED ELEMENTAL SULFUR

The production of elemental sulfur from coal and natural and refinery gases has increased rapidly since 1949 and reached a new high in 1954. A total of 33 plants reported production in 1954 from the following States, which are listed in decreasing order of tonnage: Wyoming, Texas, Arkansas, California, Indiana, Pennsylvania, New Mexico, Louisiana, New Jersey, West Virginia, Illinois, Oklahoma, and Ohio.

The Jefferson Lake Sulphur Co. was preparing to build a large sulfur-recovery plant near Manderson, Wyo. The gas for this plant was to be supplied from a natural-gas processing plant to be built by a group of oil companies.[8]

The Third Court of Civil Appeals ruled that all sulfur produced in Texas is subject to the State production tax. This was the second round in litigation brought by the Phillips Chemical Co., contending that payment of this tax does not apply to sulfur produced from sour gas.[9]

PYRITES

Continuing the trend started in 1952, the production of pyrites declined 2 percent from 1953 in 1954. Virtually all the production was classified as fines.

[5] Chemical and Engineering News, vol. 32, No. 31, Aug. 2, 1954, p. 3025.
[6] Chemical Engineering News, vol. 32, No. 31, Aug. 2, 1954, p. 3025.
[7] Western Industry, vol. 19, No. 12, December 1954, p. 94. Mining and Industrial News, vol. 22, No. 6, June 1954, p. 3. The Mining Record—Denver, vol. 65, No. 21, May 27, 1954, p. 2.
[8] Chemical Engineering, Sulfur from Sour Gas in Wyoming: Vol. 61, No. 2, February 1954, pp. 106, 110. Mining Congress Journal, vol. 40, No. 5, May 1954, p. 77.
[9] Chemical and Engineering News, vol. 32, No. 20, May 17, 1954, p. 1965.

TABLE 5.—Pyrites (ores and concentrates) produced in the United States, 1945–49 (average) and 1950–54, in long tons

Year	Quantity		Value	Year	Quantity		Value
	Gross weight	Sulfur content			Gross weight	Sulfur content	
1945–49 (average)	858,708	358,529	$3,570,400	1952	994,342	418,139	$4,947,000
1950	931,163	392,788	4,059,000	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

The Tennessee Copper Co. produced pyrites at Copperhill, Tenn., and converted it to sulfuric acid and other products. The General Chemical Division of Allied Chemical & Dye Corp., in Carroll County, Va., produced pyrites from the Gossan mine for use at its Pulaski (Va.) sulfuric acid plant. The Vermont Copper Co. operated the Elizabeth mine, Orange County, Vt., up to June, when the company was sold to Appalachian Sulphides, Inc. Appalachian Sulphides, Inc., operated the mine for the remainder of the year. The Bethlehem Cornwall Corp. produced pyrites at the Lebanon concentrator in Pennsylvania. Pyrites was sold from stock by the St. Joseph Lead Co., St. Lawrence County, N. Y. The Anaconda Copper Mining Co. recovered a substantial tonnage of pyrites in 1954 at Anaconda, Mont., as a byproduct of its base metal mining operations at Butte. The production of pyrites increased at Climax Molybdenum Co. plant, Leadville, Lake County, Colo. Rico Argentine Mining Co. produced pyrites from the Mountain Springs mine, Dolores County, Colo. The Rico Argentine Mining Co. was planning further development of its pyrites operations to serve the growing needs of the uranium mills of the Colorado Plateau.[10] The Mountain Copper Co., Ltd. was the second largest producer in the United States. It operated the Hornet mine in California.

The principal producing State in 1953 was Tennessee, followed by California, Virginia, Montana, Vermont, Pennsylvania, and Colorado.

BYPRODUCT SULFURIC ACID

As indicated in table 6, production of byproduct sulfuric acid continued to grow in 1954. The increase resulted from the stimulus given such recovery during the sulfur shortage. New capacity was installed to supply the growing markets in areas in which it had competitive advantages.

Byproduct acid produced at copper plants increased 18 percent from 1953 to 1954, and this growth more than offset a 4-percent drop at zinc plants. The Tennessee Copper Co. expanded the capacity of its Copperhill contact acid plant by addition of a new unit in 1954. The Sullivan Mining Co. added a 250-ton-per-day contact acid plant to its zinc smelter at Kellogg, Idaho, at a cost of $3 million.[11]

Eagle-Picher Co. completed a new 300-ton-per-day sulfuric acid plant at Galena, Kans. The sulfuric acid was to be used in the manufacture of phosphate fertilizer.

[10] Mining and Industrial News, vol. 22, No. 8, August 1954, p. 9.
[11] Engineering and Mining Journal, vol. 155, No. 6, June 1954, p. 130.

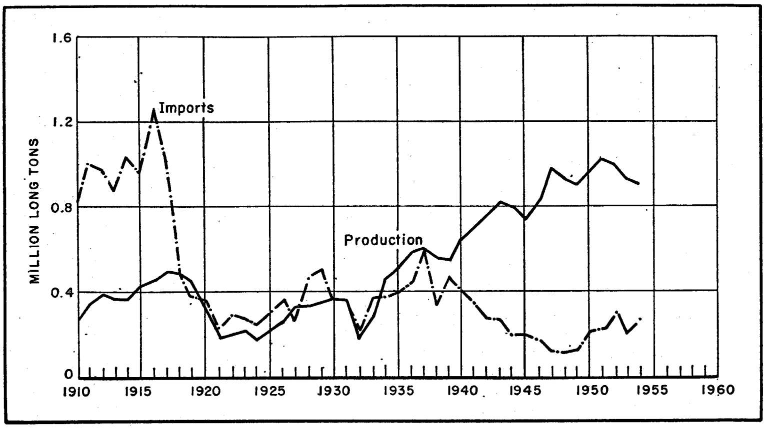

FIGURE 2.—Domestic production and imports of pyrites, 1910–54.

TABLE 6.—Byproduct sulfuric acid [1] (basis, 100 percent) produced at copper, zinc, and lead plants in the United States, 1945–49 (average) and 1950–54, in short tons

	1945–49 (average)	1950	1951	1952	1953	1954
Copper plants [2]	147,638	131,342	189,125	202,364	231,213	273,725
Zinc plants	552,116	609,571	635,948	664,714	636,864	612,250
Total	699,754	740,913	825,073	867,078	868,077	885,975

[1] Includes acid from foreign materials.
[2] Includes acid produced at a lead smelter. Excludes acid made from pyrites concentrate in Montana and Tennessee.

In 1954 acid was produced at 14 smelters in the following States: California, Illinois, Indiana, Kansas, Ohio, Oklahoma, Pennsylvania, Tennessee, Texas, Utah, and Washington.

OTHER BYPRODUCT SULFUR COMPOUNDS

Elemental sulfur and sulfuric acid constituted the bulk of the primary sulfur recovered from industrial gases, but a considerable quantity (see table 2) was recovered in the form of hydrogen sulfide and sulfur dioxide. Hydrogen sulfide or sulfur dioxide were produced in 5 States: California, Pennsylvania, Louisiana, New Jersey, and Tennessee.

CONSUMPTION AND USES

Due to the broad distribution of sulfur in industry and the complexity of its utilization, consumption data are difficult to obtain. No comprehensive canvass of sulfur consumption in the United States was conducted by the Bureau of Mines or any other agency for 1954. However, the data in tables 7 and 8 indicate the magnitude of the apparent consumption. In 1954 apparent consumption was 3 percent lower than in 1953.

Other phases of sulfur consumption in 1954 are presented in table 9, compiled from reports of the United States Department of Commerce and tables 10 and 11, prepared by Chemical Engineering magazine.

TABLE 7.—Apparent consumption of native sulfur in the United States, 1945–49 (average) and 1950–54, in long tons

	1945–49 (average)	1950	1951	1952	1953	1954
Apparent sales to consumers [1]	4,533,857	5,636,959	5,095,347	5,061,722	5,201,711	[2] 5,373,439
Imports	30	25	2,376	4,863	1,229	1,214
Total	4,533,887	5,636,984	5,097,723	5,066,585	5,202,940	5,374,653
Exports:						
Crude	1,220,130	1,440,996	1,287,773	1,304,154	1,241,536	1,647,725
Refined	38,792	37,526	24,044	34,213	29,475	30,130
Total	1,258,922	1,478,522	1,311,817	1,338,367	1,271,011	1,677,855
Apparent consumption	3,274,965	4,158,462	3,785,906	3,728,218	3,931,929	3,696,798

[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 prior to 1954, however, this tonnage was not included in the above figures.

TABLE 8.—Apparent consumption of sulfur in all forms in the United States, 1945–49 (average) and 1950–54, in long tons [1]

	1945–49 (average)	1950	1951	1952	1953	1954
Native sulfur [2]	3,275,000	4,158,500	3,785,900	3,728,200	3,931,900	3,696,800
Recovered sulfur shipments	36,500	78,600	193,800	224,500	313,800	342,300
Pyrites:						
Domestic production	358,700	392,800	432,800	418,100	379,500	405,300
Imports	69,500	100,200	106,300	142,000	91,000	133,900
Total pyrites	428,200	493,000	539,100	560,100	470,500	539,200
Smelter acid production	204,100	216,000	240,800	253,000	253,000	258,600
Other production [3]	24,400	42,000	59,600	66,500	80,200	73,000
Total	3,968,200	4,988,100	4,819,200	4,832,300	5,049,400	4,909,900

[1] Crude sulfur or sulfur content.
[2] In addition a small quantity of native sulfur from mines that do not use the Frasch process was consumed, however, this tonnage was not included in the above figures before 1954.
[3] 1948–49, hydrogen sulfide; 1950–54, hydrogen sulfide and liquid sulfur dioxide. In addition, a quantity of acid sludge is converted to H_2SO_4 but is excluded from the above figures.

TABLE 9.—Production of new sulfuric acid (100 percent H_2SO_4), by geographic divisions and States, 1950–54, in short tons

[U. S. Department of Commerce]

Division and State	1950	1951	1952	1953	1954 (preliminary)
New England [1]	201,281	210,324	172,157	190,456	169,880
Middle Atlantic:					
Pennsylvania	772,103	808,334	747,226	798,484	713,074
New York and New Jersey	1,357,087	1,348,451	1,343,165	1,504,408	1,441,943
Total Middle Atlantic	2,129,190	2,156,785	2,090,391	2,302,892	2,155,017
North Central:					
Illinois	993,759	1,073,223	1,059,602	1,131,632	1,257,759
Indiana	464,680	464,896	433,150	487,892	440,166
Michigan	(2)	(2)	196,120	226,254	217,888
Ohio	672,190	654,321	624,184	661,492	656,223
Other [3]	741,998	798,472	522,963	548,985	536,228
Total North Central	2,872,627	2,990,912	2,836,019	3,056,255	3,108,264
South:					
Alabama	290,494	298,404	290,139	306,565	269,575
Florida	526,273	535,719	[4] 741,630	900,099	1,180,626
Georgia	223,949	247,307	239,833	229,104	212,727
North Carolina	159,466	160,087	159,469	163,762	142,048
South Carolina	188,993	206,779	197,323	188,514	163,372
Virginia	560,644	549,918	550,742	532,003	463,892
Kentucky and Tennessee	853,475	835,310	841,555	857,874	944,404
Texas	972,260	947,916	1,086,957	996,601	1,212,530
Delaware and Maryland	1,354,643	1,340,009	1,221,445	1,210,674	1,203,396
Louisiana	(2)	435,335	505,768	602,858	730,021
Other [5]	980,179	489,988	459,972	437,816	467,900
Total South	6,110,376	6,046,772	[4] 6,294,833	6,425,870	6,990,491
West [6]	829,317	984,075	951,928	1,051,435	1,127,560
Total United States	12,142,791	12,388,868	[4] 12,345,328	13,026,908	13,551,212

[1] Includes data for plants in Connecticut, Maine, Massachusetts, and Rhode Island.
[2] Included with "Other."
[3] Includes data for plants in Iowa, Kansas, Michigan (1950–51 only), Missouri, and Wisconsin.
[4] Revised figure.
[5] Includes data for plants in Arkansas, Louisiana (1950 only), Mississippi, Oklahoma, and West Virginia.
[6] Includes data for plants in Arizona, California, Colorado, Idaho (1954 only), Montana, Utah, Washington, and Wyoming.

TABLE 10.—Estimates of principal nonacid uses of sulfur and pyrites (sulfur equivalent) in the United States, 1952–54, in thousand long tons

[Chemical Engineering]

Use	1952	1953	1954 (preliminary)
Wood pulp	380	[1] 390	[1] 400
Carbon bisulfide	200	220	200
Other chemicals, dyes	90	95	90
Insecticides, fungicides	105	100	100
Rubber	75	80	75
Other	130	135	135
Total	980	1,020	1,000

[1] Includes an estimated 10,000 tons of S equivalent in pyrites used in making sulfite liquor.

TABLE 11.—Estimates of United States use of sulfuric acid [1] (basis, 100 percent), 1952–54, in thousand short tons

[Chemical Engineering]

Industry	1952 (revised)	1953 (revised)	1954 (preliminary)	Industry	1952 (revised)	1953 (revised)	1954 (preliminary)
Fertilizers:				Iron and steel	840	1,010	850
Superphosphate	4,050	4,050	4,060	Other metallurgical	220	220	220
Ammonium sulfate	1,235	1,150	1,320	Industrial explosives	375	420	400
Chemicals	3,720	4,000	3,880	Textile finishing	30	30	30
Petroleum refining	1,660	1,780	1,770	Miscellaneous [2]	630	670	650
Inorganic pigments	1,250	1,300	1,300	Total	14,645	15,300	15,100
Rayon and film	635	670	620				

[1] Recycled acid, including reused, concentrated, fortified, and reconstituted acid is estimated at about 2,300,000 short tons in 1952; 2,273,000 tons in 1953, and 1,900,000 tons in 1954.
[2] Includes estimated gross acid going into military explosives.

Increases were noted in the domestic consumption of recovered sulfur, pyrites, and smelter acid, but the quantities of native sulfur, and "other" forms used were lower. Of the pyrites produced in the United States, 760,000 long tons was consumed by the producer, and 170,000 tons was sold. Virtually the entire pyrite supply was used in manufacturing sulfuric acid.

STOCKS

On December 31, 1954, producers of Frasch sulfur had a total of 3.2 million long tons of sulfur in stock. Of this total, 2.9 million tons was stockpiled at the mine, and 299,000 tons was in transit or elsewhere. Producers' stocks of Frasch sulfur increased by 7 percent in 1954. Stocks of recovered sulfur at the end of 1954 totaled 109,000 tons compared with 107,000 tons in 1953, an increase of approximately 2 percent.

PRICES

Throughout 1954 sulfur was quoted in E&MJ Metal and Mineral Markets at $25.50 to $27.50 f. o. b. Texas mines. Oil, Paint and Drug Reporter, quoted crude, bulk, carlots, mines, contract, long tons, $26.50; export, f. o. b. vessels, Gulf ports, $31 to $33; domestic and Canadian, f. o. b. vessel, Gulf ports, $28 to $33 in January and $28 to $29.50 from February–December.

The average value of sulfur shipped from Frasch mines in 1954 was $26.65 per long ton.

E&MJ Metal and Mineral Markets quoted domestic and Canadian pyrites, per long ton, nominal at $9 to $11 delivered to consumers' plants. Oil, Paint and Drug Reporter quoted pyrites, Canadian works, long ton, $3 to $5 throughout 1954. The f. o. b. mine valuations reported by domestic producers to the Bureau of Mines ranged from $3.32 to $8.49 per long ton, and the average figure was $7.88.

FOREIGN TRADE[12]

As restrictions had been eased and demand was active, exports of sulfur from the United States increased 32 percent in total quantity in 1954 and equaled 25 percent of the total production, compared with 20 percent in 1953. Imports of elemental sulfur, as shown in table 12, increased slightly over 1953. Available import statistics on pyrites are shown in tables 14 and 15. The totals for 1953 and 1954 are not directly comparable, as they were compiled by different methods. Statistics showing the export of pyrites are not available, as they are not classified separately by the United States Department of Commerce.

TABLE 12.—Sulfur imported into and exported from the United States, 1945–49 (average) and 1950–54

[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
1945–49 (average)	1	$22	30	$9,101	1,220,130	$24,178,100	38,792	$2,007,219
1950			25	6,172	1,440,996	30,950,531	37,526	2,249,311
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	[1] 2,019,670
1954	110	2,289	1,104	[2] 55,958	1,647,725	50,446,136	30,130	2,161,979

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

[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 13.—Sulfur exported from the United States, 1953–54, by countries of destination

[U. S. Department of Commerce]

Country	Crude				Crushed, ground, refined, sublimed, and flowers			
	1953		1954		1953		1954	
	Long tons	Value	Long tons	Value	Pounds	Value	Pounds	Value
North America:								
Canada	317,630	$8,560,690	292,435	$8,356,756	7,644,696	$263,970	8,863,915	$285,770
Central America	70	2,021	---	---	903,068	34,328	534,807	19,427
Mexico	40	1,520	754	22,883	7,477,672	193,608	4,276,950	140,836
West Indies	29,997	836,646	27,589	834,700	233,068	11,038	280,868	11,857
Total	347,737	9,400,877	320,778	9,214,339	16,258,504	502,944	13,956,540	457,890
South America:								
Argentina	14,881	427,071	9,842	329,707	169,400	21,856	119,800	25,746
Brazil	69,159	1,966,562	82,126	2,760,638	2,154,010	127,494	4,182,375	229,969
Colombia	---	---	---	---	1,415,155	51,555	927,827	34,414
Ecuador	36	1,391	---	---	58,698	2,800	147,333	4,496
Paraguay	65	4,851	191	6,466	667,685	[1] 23,618	---	---
Peru	---	---	49	2,688	846,621	25,744	1,013,151	24,716
Uruguay	2,500	64,200	4,921	152,540	77,500	2,373	35,000	3,995
Venezuela	655	21,307	1,069	39,015	542,184	27,202	349,778	26,101
Other South America	---	---	---	---	26,000	2,365	---	---
Total	87,296	2,485,382	98,198	3,291,054	5,957,253	[1] 285,007	6,775,264	349,437
Europe:								
Austria	18,505	545,152	29,495	969,335	---	---	---	---
Belgium-Luxembourg	34,000	957,975	48,500	1,497,950	622,415	15,505	133,200	3,673
France	93,333	2,631,186	176,430	5,455,098	---	---	---	---
Germany, West	12,500	349,315	35,500	1,105,000	349,060	67,784	303,600	58,676
Greece	778	22,711	---	---	17,467,963	362,941	19,067,598	397,533
Netherlands	---	---	---	---	5,250	1,137	7,700	1,667
Norway	---	---	---	---	150,000	5,639	254,500	9,168
Portugal	---	---	---	---	25,240	4,677	71,200	10,475
Sweden	2,000	54,800	---	---	55,600	11,999	106,750	22,685
Switzerland	23,750	674,250	53,870	1,710,260	367,396	30,409	208,120	21,297
United Kingdom	182,032	5,024,056	409,208	12,502,434	---	---	---	---
Yugoslavia	197	7,880	909	37,996	6,400,264	130,058	8,984,562	230,029
Other Europe	---	---	1,000	41,250	25,300	5,187	17,600	3,858
Total	367,095	10,267,325	754,912	23,319,323	25,468,488	635,336	29,154,830	759,061
Asia:								
India	50,949	1,415,237	69,825	2,195,763	8,087,251	247,919	7,371,702	215,377
Indonesia	3,100	84,480	6,310	195,610	862,846	31,112	405,890	17,488
Israel and Palestine	3,300	93,650	[2] 1,000	[2] 31,000	2,331,774	53,701	[2] 43,220	[2] 4,887
Korea, Republic of	---	---	---	---	1,530,990	40,583	2,611,553	59,091
Lebanon	20	773	---	---	656,770	14,897	650,000	16,417
Pakistan	248	6,913	822	27,088	55,740	2,138	---	---
Philippines	14,900	591,400	3,600	167,550	253,606	11,769	272,355	11,221
Syria	---	---	---	---	1,102,466	27,063	500,808	11,330
Other Asia	1,719	51,777	1,673	54,123	418,524	24,926	235,110	7,145
Total	74,236	2,244,230	83,230	2,671,134	15,299,967	454,108	12,090,638	342,956
Africa:								
Algeria	21,816	580,374	11,419	344,989	---	---	---	---
Belgian Congo	---	---	---	---	244,562	8,461	---	---
Egypt	1,444	48,151	246	8,781	1,555,778	36,229	3,749,955	96,190
French Morocco	10,000	288,500	7,000	217,000	---	---	---	---
Tunisia	15,500	416,475	13,000	382,500	---	---	---	---
Union of South Africa	76,000	2,133,800	67,000	2,028,400	987,340	71,698	902,174	95,100
Other Africa	---	---	1,969	69,300	240	108	---	---
Total	124,760	3,467,300	100,634	3,050,970	2,787,920	116,496	4,652,129	191,290
Oceania:								
Australia	139,875	3,885,788	167,838	5,131,831	57,300	7,099	182,850	19,800
New Zealand	100,537	2,802,807	122,135	3,767,485	194,600	18,680	679,339	41,545
Total	240,412	6,688,595	289,973	8,899,316	251,900	25,779	862,189	61,345
Grand total	1,241,536	34,553,709	1,647,725	50,446,136	66,024,032	[1] 2,019,670	67,491,590	2,161,979

[1] Revised figure. [2] Israel.

TABLE 14.—Pyrites, containing over 25 percent sulfur, imported for consumption in the United States, 1945–49 (average) and 1950–54, by countries

[U. S. Department of Commerce]

Country	1945–49 (average)		1950		1951	
	Long tons	Value	Long tons	Value	Long tons	Value
North America:						
Canada	105,468	$239,510	208,725	$411,823	221,487	$457,365
Mexico	11	32				
Total	105,479	239,542	208,725	411,823	221,487	457,365
Europe:						
Germany, West						
Malta, Gozo, Cyprus			19	57		
Norway	230	345				
Portugal	60	533				
Spain	39,091	107,283				
Total	39,381	108,161	19	57		
Oceania: Australia			22	242		
Grand total	144,860	347,703	208,766	412,122	221,487	457,365

Country	1952		1953		1954	
	Long tons	Value	Long tons	Value	Long tons	Value [1]
North America:						
Canada	295,820	$865,547	190,227	$662,566	[2] 46,649	[2] $292,025
Mexico			247	753		
Total	295,820	865,547	190,474	663,319	46,649	292,025
Europe:						
Germany, West			(3)	182		
Malta, Gozo, Cyprus						
Norway						
Portugal	227	16,267				
Spain						
Total	227	16,267	(3)	182		
Oceania: Australia						
Grand total	296,047	881,814	190,474	663,501	[2] 46,649	[2] 292,025

[1] Due to changes in tabulating procedures by the U. S. Department of Commerce data kown not to be comparable with previous years.
[2] In addition to data shown an estimated 232,920 long tons ($627,620) were imported from Canada.
[3] Less than 1 ton.

TABLE 15.—Pyrites, containing over 25 percent sulfur, imported for consumption in the United States, 1945–49 (average) and 1950–54, by customs district, in long tons

[U. S. Department of Commerce]

Customs district	1945–49 (average)	1950	1951	1952	1953	1954
Buffalo	91,886	208,569	221,391	295,626	172,375	[1] 30,594
Chicago		36				
Connecticut	14					
Duluth and Superior			46			
Galveston	4					
Michigan	1,883	5				260
New York	60	41		227	(2)	
Ohio	1					
Philadelphia	50,994					
Rochester			50			
St. Lawrence				194	2,656	7,115
San Diego	7					
Vermont		115			15,443	8,680
Washington	11					
Total	144,860	208,766	221,487	296,047	190,474	[1] 46,649

[1] In addition to data shown, an estimated 232,920 long tons was imported through the Buffalo customs district.
[2] Less than 1 ton.

TECHNOLOGY

Three methods for analyzing sulfur were reported during 1954. An automatic method developed by Esso Standard Oil Co., based on converting sulfur to sulfur dioxide, was reported to be more precise than manual analysis as there is no loss of sulfur dioxide from insufficient iodine nor loss of excess iodine by volatilization.[13] The second method is used for determining traces of sulfur in organic liquids in the range of from 1 to 100 p. p. m. by use of a catalyst-packed furnace capable of burning 15 to 30 grams of sample per hour. The sulfur is absorbed from combustion gases in a hydrogen peroxide solution after which the excess hydrogen peroxide is decomposed with the aid of a platinum catalyst. The resulting sulfate is measured by a sensitive conductometric procedure.[14] The Research and Control Instrument Division of North American Philips Co., Inc., announced development of a new X-ray technique that has been successfully used for quantitative measurement of sulfur in a specimen. A new type of goniometer housing which permits the Gieger counter to travel 146° and permits the use of helium instead of air in the X-ray path is used in conjunction with a standard spectrograph. The method has a probable sensitivity limit of 0.5 percent sulfur in oil.[15]

Activated carbon that has been treated with various metal oxides, such as vanadium, copper, iron, or chromium, is the base for a catalyst. To remove H_2S from the gas or air stream, the catalyst oxidizes hydrogen sulfide to sulfur and water with very high efficiency from air or gas in a range up to 2 percent by volume until the catalyst has increased 25 percent in weight. The catalyst may be reactivated by dissolving the sulfur and then drying the catalyst with an air current heated to about 125° C.[16]

[13] Chemical and Engineering News, Automatic Sulfur Analysis: Vol. 32, No. 51, Dec. 20, 1954, pp. 5040, 5042.
[14] Chemical and Engineering News, Traces of Sulfur: Vol. 32, No. 11, Mar. 15, 1954, p. 1017.
[15] Industrial and Mining Standard (Melbourne), Sulfur Analysis: Vol. 109, No. 2760, Mar. 4, 1954, p. 12.
[16] Chemical and Engineering News, New Catalyst Removes H_2S From Gas or Air Stream: Vol. 32, No. 20, May 17, 1954.

Hydrogen sulfide occurs in natural gas in amounts that range from minute quantities to nearly 50 percent by volume. It is essential that these gases be desulfurized to less than 5 grams of sulfur per 100 cubic feet to reduce the objectionable odor, health hazard, and corrosive effects on pipelines, compressors, and combustion equipment. The gas, once removed, must be disposed of by venting to the atmosphere or burning in a flare or under a boiler. Recent legislation on atmospheric pollution in some areas dictates that the hydrogen sulfide and sulfur dioxide should not be released to the air. For nuisance prevention and market reasons the recovery of sulfur from natural gases has become more attractive economically in recent years.[17]

Using a process developed jointly by Noranda and the Research Council of Canada, Noranda Mines, Ltd., was preparing to distill elemental sulfur directly from pyrites. A deficiency of oxygen in the first stage of the process causes the sulfur to be distilled without oxidation. In the second stage the remaining sulfur is recovered as sulfur dioxide for conversion to sulfuric acid by North American Cyanamid, Ltd.[18]

The Chemico sulfur process for the recovery of sulfur from low grade surface deposits was described.[19]

For 4 years Harvard University had been conducting an investigation into the physiological effects of sulfur compounds on guinea pigs and humans. The results of the experiment showed the effects of a concentration of 5 p. p. m. of sulfur dioxide on normal people and on workmen who were routinely exposed to concentrations above 10. Measurements were taken of the respiratory rate, pulse rate, and tital volume (volume of the average respiration) after breathing sulfur dioxide through a face mask for 10 minutes. The charts show that the reaction of individuals accustomed to an irritant gas is not the proper standard by which to judge the reactions of others. Sulfur dioxide at a given concentration is much more damaging when a small quantity of sulfuric acid is present. The exposure of guinea pigs to such an atmosphere results in lack of growth, lung injury, and marked respiratory response.[20]

A solvent process, investigated by the Pacific Mining Co. at Jamestown, Calif., for the extraction of sulfur at atmospheric temperatures in standard equipment was described in an article. The process is based on the solubility of sulfur in certain hydrocarbons.

The solvents were selected among other factors for their vaporization temperatures. The temperature range of the solvent should not be so high as to prevent ready vaporization when the temperature is raised at the end of the last digester tube and should not be so low as to permit excessive vapor loss as it circulates at the process working temperatures. The residual solvent contained in the rock is removed as a gas and recovered by condensation. Laboratory and pilot-plant work indicated that the quantity of solvent remaining in the discarded rock was very low. Ore crushed to one-fourth inch is fed into a sequence of heated digester tubes, where the sulfur is dissolved in the heated solvent flowing counter current to the ore. The pregnant

[17] Canadian Chemical Processing, Purifying Natural Gas: Vol. 38, No. 3, March 1954, p. 72.
[18] Chemical Engineering, Sulfur by Distillation: Vol. 61, No. 9, September 1954, p. 105.
[19] Forbath, T. P., Sulphur Recovery From Low-Grade Surface Deposits: Trans. AIME, vol. 196, Tech. Pub. 3628-H, September 1953.
[20] Chemical and Engineering News, Sulfur Compounds: Vol. 32, No. 13, Mar. 29, 1954, p. 1269.

solution is passed through a filter to remove the finely divided rock. The sulfur is precipitated as the temperature is lowered and recovered as a mixture of sulfur crystals and solvent by filtration. Residual solvent can be recovered directly by melting the sulfur or by washing with a wash solvent of low boiling point.[21]

WORLD REVIEW

NORTH AMERICA

Canada.—In 1954 the production of Canadian [22] sulfur in all forms reached a record high of 521,902 short tons, an increase of approximately 22 percent over the previous high established in 1952. Recovery of sulfur was 39 percent higher in 1954 than the 1953 production of 374,922 tons. The percentage increase of the various segments of supply was as follows: Byproduct pyrites—49 percent, smelter gases—31 percent, and elemental sulfur from natural gases—16 percent. The increased production of sulfur from smelter gases resulted principally from the first full year of operations of the sulfuric acid plant of the Consolidated Mining & Smelting Co. of Canada, Ltd., Kimberley, British Columbia. Canadian shipments (sales) of pyrites in 1954 had a sulfur content of 278,237 tons, compared with 186,650 tons in 1953, and sold for approximately Can$4 a long ton f. o. b. mine. Exports of Canadian pyrites in 1954 had a sulfur content of 188,608 tons, of which 140,122 tons or 74 percent was shipped to firms in the United States.

Pyrite flotation concentrate obtained as a byproduct from the treatment of base-metal ores was shipped by the Weedon Pyrite & Copper Corp., Ltd., Waite Amulet Mines, Ltd., Normetal Mining Corp., Ltd., East Sullivan Mines, Ltd., and Britannia Mining & Smelting Co., Ltd.

Sulfuric acid was manufactured by the Aluminum Co. of Canada, Arvida, Quebec, from sulfur dioxide recovered from the flash roasting of zinc concentrate obtained from the Barvue Mines, Ltd., at Barraute in western Quebec. Acid was recovered from stack gases at Trail and Kimberley, British Columbia, by Consolidated Mining & Smelting Co. of Canada, Ltd., and at Copper Cliff, Ontario, by Canadian Industries, Ltd.

A plant was built by Anglo-Newfoundland Development Co. at Grand Falls, Newfoundland, to produce sulfur dioxide gas, to be used in papermaking, from pyritic flotation concentrate supplied by the Buchans Mining Co. Ltd.[22]

[21] Mining Congress Journal, Pacific Extraction Process: Vol. 40, No. 6, June 1954, pp. 77–781.
[22] Department of Mines and Technical Surveys (Ottawa), Sulfur and Pyrites in Canada in 1954 (Prelim.), 4 pp.

TABLE 16.—World production of native sulfur, by countries,[1] 1945–49 (average) and 1950–54, in long tons [2]

(Compiled by Helen L. Hunt)

Country [1]	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Mexico	4,480	11,000	11,375	11,784	5,900	[3] 6,000
United States	4,333,654	5,192,184	5,278,249	5,293,145	5,155,342	5,515,543
South America:						
Argentina	10,146	7,662	7,560	18,300	21,000	[3] 17,000
Bolivia (exports)	2,093	4,307	9,100	5,497	2,458	2,565
Chile	12,913	15,228	29,672	47,821	32,275	39,075
Colombia	[4] 693	1,461	2,479	2,974	2,657	5,118
Ecuador	42	27	1	2,353	100	64
Peru	1,337	2,111	2,251	5,066	4,916	[3] 5,000
Europe:						
France (content of ore)	5,006	5,571	11,000	17,871	10,818	[3] 10,000
Italy (crude) [5]	148,266	209,767	197,382	232,706	224,161	200,215
Spain	3,988	6,800	6,700	4,800	5,100	5,400
Asia:						
Japan	38,400	91,160	140,181	176,652	186,556	184,745
Philippines	----------	----------	----------	----------	1,089	761
Taiwan (Formosa)	552	2,657	2,732	5,001	3,423	5,873
Turkey	3,056	5,911	7,273	8,232	9,626	9,862
Total (estimate) [1]	4,700,000	5,700,000	5,900,000	6,000,000	5,800,000	6,200,000

[1] Native sulfur believed to be also produced in China (continental) and U. S. S. R., but complete data are not available; estimates by senior author of chapter included in total.
[2] This table incorporates a number of revisions of data published in previous Sulfur and Pyrites chapters.
[3] Estimate.
[4] Average for 1948–49.
[5] In addition the following tonnages of ground sulfur rock (30 percent "S") were produced and used as an insecticide: 1945–49 (average), 18,696 tons; 1949, 19,213 tons; 1950, 15,778 tons; 1951, 22,120 tons; 1952, 21,482 tons; 1953, 16,940 tons; 1954, 22,803.

TABLE 17.—World production of pyrites (including cupreous pyrites), by countries,[1] 1945–49 (average) and 1950–54, in long tons [2]

(Compiled by Helen L. Hunt)

Country [1]	1945–49 (average) gross weight	1950		1951		1952		1953		1954	
		Gross weight	Sulfur content	Gross weight	Sulfur content	Gross weight	Sulfur content	Gross weight	Sulfur content	Gross weight	Sulfur content
North America:											
Canada (sales)	186,154	279,118	134,363	397,274	192,288	494,630	235,036	364,515	166,651	517,856	248,425
Cuba	----	----	----	----	----	10,000	4,540	[3] 50,000	[3] 24,200	118,105	56,690
United States	858,708	931,163	392,788	1,017,769	432,819	994,342	418,139	922,647	379,545	908,715	405,310
South America: Brazil	[3] 3,700	(4)	(4)	(4)	(4)	----	----	----	----	----	----
Europe:											
Austria	6,227	13,315	3,157	10,075	2,703	7,907	2,261	69	29	(4)	(4)
Czechoslovakia	[3] 3,900	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Finland	146,933	159,491	69,000	228,874	97,230	241,059	103,230	255,488	108,263	248,528	105,401
France	190,919	243,705	104,858	276,128	121,497	289,765	127,497	293,295	129,050	294,966	123,885
Germany, West	284,981	516,903	188,501	487,106	181,497	485,431	182,163	506,375	180,073	577,021	212,546
Greece	34,812	86,294	[3] 41,300	177,276	[3] 86,800	198,060	[3] 97,000	221,579	[3] 110,800	192,479	[3] 96,500
Italy	561,477	886,687	[3] 407,900	884,004	395,946	1,122,777	505,528	1,206,019	542,709	1,212,007	545,403
Norway	587,990	736,970	812,847	685,053	290,953	701,364	302,329	733,095	332,105	[3] 777,500	344,474
Poland	[3] 45,700	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Portugal	405,264	603,834	271,726	718,090	323,141	743,961	334,783	640,855	288,384	574,174	258,379
Rumania	[3] 4,900	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Spain	1,243,281	1,627,587	[3] 781,500	1,972,481	[3] 946,800	2,341,049	[3] 1,124,000	2,039,923	[3] 979,300	1,883,459	[3] 904,100
Sweden	328,491	400,385	199,107	400,509	199,604	407,055	201,770	382,848	189,178	392,896	193,563
United Kingdom	17,649	13,288	[3] 5,300	15,586	[3] 6,200	9,692	[3] 3,800	10,244	[3] 3,900	[3] 4,900	[3] 1,950
Yugoslavia	138,140	115,317	[3] 52,200	151,351	[3] 68,500	185,158	83,526	170,271	[3] 77,000	159,718	[3] 71,800
Asia:											
China	[3] 49,200	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Cyprus	487,030	816,785	392,057	944,682	453,447	1,056,026	506,893	994,345	477,342	1,103,367	[3] 529,500
India	----	----	----	530	230	2,168	930	277	[3] 120	----	----
Japan	873,168	1,896,327	774,504	2,215,244	890,528	2,586,855	1,037,329	2,306,260	922,504	1,812,461	812,498
Korea, Republic of	12,217	----	----	----	----	743	[3] 340	765	[3] 350	----	----
Taiwan (Formosa)	453	338	108	6,622	2,119	32,707	10,466	24,892	8,961	23,857	9,543
Turkey	----	----	----	----	----	19,045	[3] 9,500	22,727	[3] 11,300	33,935	16,928
Africa:											
Algeria	34,160	24,679	10,366	30,953	13,619	23,631	10,397	29,290	12,893	32,971	14,527
French Morocco	[5] 49	1,450	681	1,918	863	1,993	857	2,005	799	1,537	575
Rhodesia and Nyasaland, Federation of: Southern Rhodesia	17,567	13,592	5,437	27,823	11,964	18,752	8,064	36,086	15,517	36,387	15,283
Tunisia	3,023	1,132	[3] 492	----	----	----	----	----	----	----	----
Union of South Africa	36,010	35,457	15,376	32,851	14,245	30,649	13,198	92,362	36,259	225,534	[3] 96,900
Oceania: Australia	107,068	112,173	53,036	151,389	71,443	198,714	93,569	167,008	77,812	195,459	44,102
World total (estimate) [1]	8,300,000	11,600,000	4,900,000	13,000,000	5,400,000	14,300,000	6,000,000	13,600,000	5,800,000	13,500,000	5,700,000

[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. [3] Estimate.

[4] Data not available; estimate by senior author of chapter included in total. [5] Average for 1948–49.

Noranda Mines, Ltd., Port Robinson, Ontario, began production at its new $4.7 million sulfur-iron plant in October.[23] The plant was designed to produce 62 tons of elemental sulfur, 240 tons of SO_2 (sulfur equivalent), and 250 tons of iron sinter daily from 370 tons of pyrites obtained from the Horne mine.[24] The anticipated annual rate of production approximated 18,000 tons of elemental sulfur, 36,000 tons of sulfur dioxide, and 72,000 tons of iron sinter from 100,000 tons of pyrites. A $5 million, 1,500-ton mill was planned by Noranda to treat ore from the West MacDonald mine and subsequently to treat ore from the Horne mine. Large reserves of 1 percent copper ore carrying pyrites have been developed by Noranda's subsidiary, The Gaspé Copper Mines, Ltd. It has been calculated that the reserves will last 35 years at a production rate of 6,500 tons per day.[25]

Mexico.—The existence of sulfur domes on the Isthmus of Tehuantepec has been known for many years. Years of exploration and development bore fruit early in 1954, when the first shipment of Frasch sulfur was delivered to the port of Coatzocoalcos. The domestic sulfur demand in Mexico, according to National Financiera, was approximately 51,000 long tons annually, of which 35,000 tons was used for the production of industrial acids and 16,000 for nonacid uses. It was hoped that the fertilizer production will expand substantially.[26]

The Mexican Gulf Sulphur Co., the first firm to produce sulfur by the Frasch process in Mexico, started operations in March and produced about 55,000 long tons in 1954. Sales were made only to domestic markets in Mexico, and at the end of the year the company had almost 50,000 tons in stock. The Pan American Sulphur Co. started operations in November and produced about 30,000 tons.[27]

Texas International Sulphur Co., Houston, Tex., signed an agreement in December 1953 with Central Minera S. A. of Mexico to develop the sulfur deposits on the Isthmus of Tehuantepec.[28]

Seven separate parcels of land, containing 106,732 acres, some of which adjoin the producing areas of other companies, had been staked by Central Minera.[29] Texas International Sulphur Co. engaged in core drilling for sulfur on three salt domes.[30]

Pan American Sulphur Co., which began producing sulfur from its $6 million Jaltipan plant, anticipated that its plant would be able to produce approximately 500,000 tons annually in 1955. The power plant was designed for a water-heating capacity of 3.3 million gallons per 24 hours and can be expanded to 5 million gallons. Foundations for this expansion were incorporated in the original structure. Shipping facilities at the plant and at the port of Coatzocoalcos were completed and had a loading capacity of 500 tons per hour.[31]

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[23] Skillings Mining Review, Noranda Mines, Ltd., Building Plant Near Welland, Ont., to Treat Pyrite: Vol. 43, No. 17, July 31, 1954, p. 8.

[24] Foreign Commerce Weekly, Canada Develops New Source of Sulfur: Vol. 52, No. 24, U. S. Dept. of Commerce, Dec. 13, 1954, p. 27.

[25] Engineering and Mining Journal, Noranda's Elemental Sulfur Plant Slated to Begin Operation October 1: Vol. 155, No. 9, September 1954, p. 142.

[26] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 4, October 1954, p. 74.

[27] Kearney, John H., A New Empire of Frasch-Process Sulphur Is Rising From the Jungles of Mexico: Eng. and Min. Jour., vol. 156, No. 1, January 1955, 6 pp.

[28] Skillings Mining Review, Texas International Sulphur Co. Begins Core Drilling on Vast Sulphur Concession in Tehuantepec: Vol. 43, No. 7, May 22, 1954, p. 6

[29] Chemical Engineering, Texas Enterprise Will Tap Vast Mexican Sulfur Find: Vol. 61, No. 2, February 1954, pp. 388–389.

[30] Mining Congress Journal, vol. 40, No. 6, June 1954, p. 99.

[31] Wall Street Journal, Pan American to Boost Output in 1955 Near Jaltipan, Mexico: Vol. 144, No. 119, Dec. 17, 1954, p. 4.

The Gulf Sulphur Corp. was developing a dome near the San Cristobal plant of Mexican Gulf Sulphur Co.[32]

SOUTH AMERICA

Argentina.—Argentina's administration of military factories (Direccion General de Fabricaciones Militares) awarded contracts to United States and Ecuadoran exporters.[33]

A 10-million-peso plant designed to turn out 50 tons of sulfur dioxide daily from zinc concentrate may enable Argentina to reduce its sulfur imports. The plant was being built by Zarata Sulphurico S. A. at Zarata (near Buenos Aires).[34] A 300-ton sulfur-flotation plant was installed by Fábricas Militares at La Casualidad for treatment of autoclave "ripios," of which a large stock had accumulated.[35]

Bolivia.—Bolivia exported 2,607 metric tons of sulfur valued at $157,549 in 1954. The Bolivian Government is making a study of the sulfur industry to determine means of increasing sulfur production.[36]

Brazil.—The total capacity of the 17 plants producing sulfuric acid in Brazil was adequate to meet industrial needs. Nearly all sulfur requirements were imported. Approximately 2,500 metric tons of sulfur is produced annually from iron pyrites in the State of Santa Catarina. Sulfuric acid equivalent to about 1,650 tons of sulfur is produced directly from pyrites in Minas Gerais and recovered from the manufacture of zinc blende in São Paulo. Imports of crude sulfur during 1951 totaled 56,951 tons and in 1952 67,645 tons, requirements being estimated at 120,000 tons annually. Approximately 60 to 65 percent of the sulfur imports was used in producing sulfuric acid for fertilizer, textile, metallurgical, dye, and other industries. The remainder was used for the manufacture of carbon sulfide, insecticides, and in the sugar industry.[37]

Chile.—A sulfuric acid plant was being built at Antofagasta by Corfo to provide acid for the leaching of copper oxide ores in the Province. Brimstone was to be obtained from the volcanic sulfur deposits in the area. It was scheduled for production during the first half of 1955.

The Chilean sulfur industry was at a low ebb in 1954. In 1953 the only major producers still in operation were the Sociedad Azufrera Aucanquilcha and the Cia. Azufrera Nacional. Aucanquilcha was producing sulfur at the rate of 12,000 metric tons per year compared with a capacity of 24,000 tons. During 1953 this company completed two flotation plants at Olláque and Amincha. The Aucanquilcha plant at Amincha was to utilize some of the equipment of an old plant installed by Cacrefomi at that location. A refining plant installed by Soc. Azufrera Polan, utilizing a new system for recovering sulfur, was forced to close in 1953.

Government spokesmen were quoted in 1953 as stating that arrangements had been made whereby the National Commercial Institute would export sulfur and with the derived exchange import

[32] Engineering and Mining Journal, In Latin America (Mexico): Vol. 155, No. 2, February 1954, p. 194.
[33] Chemical Week, Sulfur Argentina: Vol. 75, No. 11, Sept. 11, 1954, p. 26.
[34] Chemical Week, vol. 74, No. 19, May 8, 1954, p. 24.
[35] Engineering and Mining Journal, vol. 155, No. 12, December 1954, p. 160.
[36] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 4, April 1955, p. 60.
[37] Bureau of Mines, Mineral Trade Notes: Vol. 39 ,No. 3, September 1954, pp. 76–77

motor vehicles. The motor vehicles, which are in short supply in Chile, would be sold at prices high enough to permit the sulfur producers to recover the cost that had gone into stockpiling of sulfur. The stockpiles have been estimated to contain 30,000 tons of sulfur. The arrangements call for sales of 60,000 tons of sulfur, with 20,000 tons each going to France, Germany, and the United Kingdom. The companies were to be paid 8,000 pesos per ton for 99.5-percent refined material. In 1953 the domestic price of refined sulfur was 9,500 pesos, based on an estimated production cost of 8,000 pesos f. o. b. mine.

The status of the industry in late 1953 was as follows: 22 plants were in existence having an annual capacity of 126,000 metric tons, out of which 7 plants producing 23,400 tons were in operation, 13 plants were closed, and 2 were closed and bankrupt.[38]

Ecuador.—The Tixan mine operated by the Ecuadoran Mining Co. was in financial difficulties, because very little of its production was consumed locally and the company had not been able to compete in world markets.[39]

Peru.—Negotiations were being carried on between a large American firm, the Peruvian Government, and concession owners of a sulfur deposit in the highlands of southern Peru in the vicinity of Moquegua and Tacna for the construction of a 100-ton-a-day sulfur refinery. The known deposits, which lie at an elevation of 15,000 feet, are covered by 5 separate major concessions and 4 marginal concessions already in the hands of private owners. The sulfur content of the impregnated rock varies greatly, some contains as high as 49 percent sulfur. The sulfur content of the deposits was expected to average 35 percent. The overburden is shallow, and an open-pit mining method could be employed.[40]

Venezuela.—A number of reports indicated that efforts were being made to develop sulfur produced in capacity in Venezuela. Exploration projects were conducted but no commercial output was reported.[41]

EUROPE

Finland.—The production of pyrites in Finland during 1953 was reported from four companies, namely, Outokumpu, Aijala, Metsämonttu and Otanmäki. Outokumpu and Aijala mines reported the analysis of the pyrites from their concentration plants as follows: Outokumpu mine—42.67 percent S, 44.17 percent Fe, 1.32 percent Cu, and 2.04 percent Zn; Aijala mine—45.0 percent S, 42.0 percent Fe, and 1.18 percent Cu. The pyrites were shipped to cellulose mills and sulfuric-acid plants, which extracted the sulfur and returned the sinter to Outokumpu. Since domestic production of pyrites covers only half of cellulose-industry needs, the balance is imported in the form of raw sulfur. A total of 70,284 tons of pyrites was exported, chiefly to East Germany, West Germany, and Poland.[42]

France.—The Berre-l' Etang refinery of the French oil company, Compagnie de Raffinage Shell-Berre, was expected to produce 4,000 to 5,000 tons of sulfur during 1954. The 1953 production of sulfur in France totaled about 15,000 tons per year or about 30 percent of

[38] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 2, August 1954, pp. 78–79.
[39] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 2, August 1954, p. 79.
[40] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 3, September 1954, pp. 75–76.
[41] Mining World, Venezuela Looks to More Production of Sulfur: Vol. 16, No. 8, July 1954, p. 77.
[42] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 2, August 1954, pp. 70–71.

domestic requirements. The balance of the requirement for elemental sulfur was imported, mainly from Italy and the United States.[43]

Production of sulfur was stopped at the native sulfur mines of Malvezy near Narbonne, Aude Province, by Société Lanquedocienne de Recherches et d'Explorations Minières because of suspension of a Government subsidy.[44]

Germany, East.—Sulfuric acid in the Soviet Zone of Germany apparently was in short supply. The acid production under the 5-year plan was to have been virtually doubled between 1950 and 1955. Substantial increases in acid supplies were needed because of the large requirements of the fertilizer and rayon industries. Under trade agreements negotiated with Norway, Yugoslavia, and Greece, substantial tonnages of pyrites were to be imported. Production of indigenous pyrites was to be increased one-third during the 5-year plan.[45]

Greece.—The Greek-Polish compensation trade agreement, signed at Vaduz on October 22, 1952, for 1 year, was extended to December 31, 1953. According to the Bank of Greece, the value of pyrites exported between March 11, 1953, to September 30, 1953, amounted to $585,000.[46]

Italy.—The Italian sulfur industry continued to encounter serious difficulties in marketing. Production was slightly lower than in the previous year. The Central Government authorized the Bank of Sicily to lend the Ente Zolfi Italiano (Italian Sulfur Board) 1,000 million lire to meet modernization and labor costs. The loan was recognized by the industry to be an emergency measure to provide the time necessary for the industry and the Government to negotiate more fundamental measures. The general impression appeared to be that the situation was unlikely to improve unless there was a steep rise in the price of sulfur.[47] At the height of the Korean War in 1950, exports of sulfur from Sicily totaled 209,971 tons; in 1953 exports had declined to 6,853 tons. Free World markets were being supplied from other sources, and sales behind the Iron Curtain were being restricted.[48]

Norway.—The Orkla Grube-Aktiebolag metallurgical plant, Lokken, Norway, produced elemental sulfur as a byproduct from copper-bearing pyrites containing 41 percent sulfur. At this plant a furnace charge, consisting of lump pyrite, coke, silica, and limestone, is smelted in a water-jacketed furnace. The furnace is designed to permit part of the contained sulfur to be distilled off in the upper portion of the furnace, while the H_2S is oxidized to form FeO and SO_2 in the smelting zone. Sulfur dioxide is reduced in the furnace shaft with the aid of coke, used as a reducing agent, to sulfur and CO_2. The reaction between FeO, silica and limestone, forms a slag containing approximately 80 percent $2(FeO).SiO_2$ and about 15 percent $CaO.FeO.2(SiO_2)$.

The gases distilled off in the upper portion of the furnace contain about 300 grams of sulfur per cubic meter and other sulfur compounds such as SO_2, H_2S, CS_2, and COS. After the gases are cleaned, they are

[43] Chemical Week, vol. 74, No. 2, Jan. 9, 1954, p. 21.
[44] Mining World, vol. 16, No. 2, February 1954, pp. 69 and 71.
[45] Chemical Engineering News, Germany Short on H_2SO_4: Vol. 32, No. 49, Dec. 6, 1954, pp. 48–53.
[46] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 2, February 1954, p. 63.
[47] Engineering and Mining Journal, vol. 155, No. 9, September 1954, pp. 226, 228.
[48] Chemical and Engineering News, Sicily Protests U. S. Action: Vol. 32, No. 35, Aug. 30, 1954, p. 3426.

passed through a catalyzer, and sulfur compounds are converted to sulfur. After leaving the catalyzer the gases are cooled from 450° to 130° C. in waste-heat boilers, where most of the sulfur is condensed. The gases are passed through a second catalyzer after they have been washed with liquid sulfur in scrubbers and reheated in heat exchangers to 300° C. Sulfur formed in the second catalyzer is scrubbed with liquid sulfur. Damage to surrounding vegetation is prevented by passing the tail gases through limestone and spraying with sea water. The arsenic is removed from the sulfur by washing with milk of lime in the final step, and the sulfur then is granulated or molded.

Sulfur-production capacity at Orkla in 1954 totaled 115,000 metric tons per year; matte, 15,000 tons; and copper, 6,000 tons.[49]

Poland.—It was reported that Polish geologists, led by Doctor Pavlovski, discovered a large sulfur deposit in Poland. As deposits previously discovered have been small and the domestic needs exceed the supply, early development of the new deposit was anticipated.[50]

Sweden.—A new sulfuric acid plant was installed at the Boliden Mining Co. copper smelter at Ronnskar in North Sweden. The plant will utilize approximately one-third of the sulfur dioxide contained in the 14 million cubic feet of gas produced from the smelting of copper and lead ores in the manufacture of 90 tons of H_2SO_4 per day. The present capacity of the plant covers one-tenth of Sweden's annual consumption of sulfuric acid estimated to be 350,000 metric tons. The plant may eventually be increased to 50,000 tons if conditions warrant it.[51]

Spain.—Owing to a decline in the export market in 1953, the production of pyrites in Spain totaled about 2 million metric tons—a reduction of approximately 19 percent compared with 1952, when almost 2.6 million tons was produced. Domestic consumption increased 762,000 tons, of which 565,000 tons was used in manufacturing sulfuric acid. The balance was used in the production of elemental sulfur laid down for heap leaching of copper and in other uses. Exports declined 29 percent—from 1,682,000 metric tons in 1952 to 1,192,000 tons in 1953. The United Kingdom, Netherlands, Belgium, and France greatly reduced their imports, and only West Germany increased its purchases. The companies primarily affected by the decline in exports were the Rio Tinto Co., Ltd., and Tharsis Sulphur & Copper Co., Ltd., the two largest producers in Spain.

The Rio Tinto Co., Ltd., completed the installation and began operating a heavy-medium concentrating plant for beneficiative old stocks of low-grade washed ore. The plant was designed to produce a 48- to 50-percent sulfur concentrate from a feed running about 30 percent sulfur. The annual capacity of the plant was reported to be 200,000 tons.

In December 1953 the only exporter of pyrites from the Murcia region, Minerales de Cartagena, S. A., terminated its activities as a producer, merchant, and exporter of pyrites. It was reported that inferior quality had placed Murcia pyrites in a disadvantageous competitive position.

[49] Kiaer, Thorry, Smelter Gases Yield Elemental Sulfur at Orkla-Grube Plant in Norway: Eng. and Min. Jour., vol. 155, No. 7, July 1954, pp. 88–90.
[50] Engineering and Mining Journal, vol. 155, No. 7, July 1954, p. 162.
[51] Chemical Age (London), Sulfur-Recovery Plant: Vol. 70, No. 1813, Apr. 10, 1954, p. 840.

Progress was made in constructing the new Hinojedo sulfur plant being built by Cia Real Asturiana. The projected annual capacity was 10,000 tons of sulfur, using pyrites as the raw material.[52]

ASIA

Cyprus.—The Annual Report for 1954 of the Inspector of Mines of Cyprus pointed out that the firm demand and reasonably stable prices over the past few years for the majority of mineral products were reflected in increased production in 1954. A slight increase in exports of copper- and sulfur-bearing products was expected if favorable conditions persisted. The Limni treatment plant of the Cyprus Sulphur & Copper Co., Ltd., began production during 1954, and the Hellenic Mining Co., Ltd., placed orders for the necessary equipment to allow for the transfer of the company's main operation to the Mitsero Agrokipia area. Enough reserves of iron pyrites to warrant installing a modern 720,000-ton-per-year treatment plant have been found during recent years by extensive prospecting. The value of mineral products exported amounted to £9,575,621 or 59 percent of the total value of all exports. During 1954, 687,954 metric tons of iron pyrites valued at £3,338,233 were exported. This was approximately 35 percent of the value of the mineral products exported. A total of 125,370 tons of cuperous pyrites valued at £1,004,226 also were exported.[53] It was reported that Cyprus Sulphur & Copper Co., Ltd., had signed a 3-year contract with German buyers for the sale of run-of-the-mine ore from the Kinousa workings at prices lower than some previous contracts. It is expected that a longer contract will permit more systematic planning.[54]

India.—Prof. G. P. Kane, president of the Indian Institute of Chemical Engineers, outlined several methods for the production of elemental sulfur in India. It was stated that the annual consumption of sulfur in India was approximately 60,000 metric tons, of which 35,000 tons was used in manufacturing sulfuric acid. The per capita consumption of sulfur in India is much lower than in the United Kingdom or the United States. Dr. Kane stated that 2 proposed oil refineries at Trombay could produce 5,000 to 10,000 tons of sulfur annually. The largest consumer of sulfur in India is the fertilizer plant at Sindri, Bihar, operated by the Government.[55]

Japan.—Musa Mining Co. reported it would develop a sulfur deposit in the northern part of Nemuro, Hokkaido, by open-pit mining methods. The crude ore is to be refined by the Masobello process in a plant having an annual capacity of 18,000 metric tons of refined sulfur. Road and rail transportation was being installed.[56] The native sulfur industry in Japan experienced rapid growth after 1948, when production amounted to 40,000 tons. In 1952 the industry was producing 173,600 tons. Production of pyrites in Japan increased from 1.1 million tons in 1948 to over 2.6 million tons [57] in 1952.

Turkey.—A sulfur ore-flotation plant at Keciborlu, which went into operation in 1954, will permit the mine to more than double its

[52] Sulphur Exploration Syndicate (London), Quart. Bull. 5, June 1954, pp. 52–54.
[53] Mining Journal (London), The Mining Industry in Cyprus During 1954: Vol. 245, No. 6260, Aug. 12, 1955, p. 176.
[54] Mining World, vol. 16, No. 2, February 1954, p. 71.
[55] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 3, March 1954, pp. 67–68.
[56] Mining World, vol. 16, No. 3, March 1954, p. 70.
[57] Chemical & Engineering News, Sulfur in Better Balance: Vol. 32, No. 15, Apr. 12, 1954, p. 1522.

annual production of commercial sulfur. Turkish sulfur requirements increased during the latter part of 1953.[58]

A contract for constructing a sulfuric acid plant to utilize gases produced at the Murgul Copper mine was awarded to a French firm.[59]

AFRICA

French Morocco.—In 1953 the production of iron pyrites in French Morocco totaled 2,037 metric tons. Société Minière des Rehamna, Rehamna mine, produced 1,910 tons of pyrites containing 40 percent sulfur. Société Minière des Grundafa, Ouchedenne mine, produced the balance—127 metric tons.[60]

Tunisia.—No production was reported for 1953. Stocks at the mine totaled 1,020 tons of iron pyrites.[61]

Union of South Africa.—Recovery of iron pyrites from gold mine tailings for use in manufacturing sulfuric acid was stimulated by the uranium-production program. Consumption of sulfur in 1953 totaled 154,000 short tons, of which over 91 percent was used in producing sulfuric acid. Recovery of iron pyrites increased from 34,327 tons in 1952 to 103,446 tons in 1953. The local sales (sulfur content) in 1952 totaled 14,782 tons valued at £56,905 f. o. r. compared with 40,611 tons at £242,822 f. o. r. in 1953. Approximately 50,000 tons of burned pyrite residue was exported to Rotterdam from the sulfuric acid plants of African Explosives near Durban. In the first quarter of 1954 stocks of pyrite residue were reported to contain 300,000 tons having an average iron content of 52.15 percent dry basis, with a moisture content of 20.78 percent. Sulfuric acid plants using pyrites recovered during gold-mining operations were placed in operation at the West Rand Consolidated mines, Daggafontein Gold Mines, Ltd., and Western Reefs Gold Mines, Ltd., during 1953.[62]

Daggafontein Gold Mines, Ltd., recovers iron pyrites by flotation from slimes produced by fine grinding of gold ore. The pyrite concentrate is burned in a fluosolids reactor. The calcined residue is returned to the gold reduction works for the extraction of its gold content.[63]

OCEANIA

Australia.—A bill that is in line with a program to supply 65 percent of the capacity of the Australian sulfuric-acid-producing plants with Australian raw material was passed by the Australian House and Senate, with the support of all parties on November 10, 1954.[64] The bill provided for a bounty on sulfuric acid produced from local pyrites equal to £A2 (£A1=$2.25) per ton of 100 percent sulfuric acid when the landed cost of brimstone is £A20½ (£A1=$2.25) per ton, which was the current figure. The incentive for acid manufacturers to

[58] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 3, March 1954, p. 68.
[59] Mining World, vol. 16, No. 2, February 1954, p. 6.
[60] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 5, May 1954, p. 52.
[61] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 5, May 1954, p. 52.
[62] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 2, August 1954, p. 76
[63] Chemical and Engineering News, Gold, Uranium, and Sulfuric Acid in South Africa: Vol. 32, No. 14, Apr. 5, 1954, pp. 1364–1365.
[64] Foreign Service Dispatch, Payment of Bounty of Sulfuric Acid Produced in Australia From Materials of Australian Origin: No. 226, Nov. 15, 1954.

convert their plants from brimstone to indigenous sulfur became less urgent in 1953 with the fall in the price of imported sulfur. Port Pirie's new 45,000-ton-annual-capacity sulfuric plant came into operation in October. The plant was to use imported brimstone until the new sintering plant would permit the use of gases recovered from smelting lead concentrates.[65]

[65] South African Mining and Engineering Journal, Advanced Review of Australian Mining Industry—1953: Vol. 64, part II, No. 3185, Feb. 27, 1954, p. 933.

Talc, Soapstone, and Pyrophyllite

By Donald R. Irving[1] and Francis P. Uswald[2]

THE COMBINED mine production of talc, soapstone,[3] and pyrophyllite and the quantity of these commodities sold by producers in 1954 decreased moderately from the quantities recorded in 1953, although the total value of sales increased to an alltime high. Pyrophyllite production also reached an alltime high. Compared with 1953, the 1954 imports for consumption decreased in quantity and value; exports were about the same in quantity and 3 percent less in value.

On September 21, 1954, the Office of Defense Mobilization announced the forwarding to General Services Administration of a revised purchase directive covering procurement of certain strategic and critical materials for the 1955 fiscal year. The directive provided for the purchase of block steatite talc toward the minimum National Stockpile objective and its acquisition toward the long-term stockpile objective by means of barter.

DOMESTIC PRODUCTION[4]

Compared with the near record production reported in 1953, mine production of crude talc, soapstone, and pyrophyllite decreased 6 percent in quantity and 8 percent in value in 1954, according to reports by producers.

Pyrophyllite production increased 3 percent in 1954 over 1953 and exceeded by 1 percent the previous high recorded in 1952.

In 1954 New York, California, and North Carolina continued to rank first, second, and third, respectively, in the quantity of talc, soapstone, and pyrophyllite produced. California continued to rank first in the value of crude talc, soapstone, and pyrophyllite. North Carolina remained the major pyrophyllite-producing State, followed by California. Increases in the number of crude-ore producers were reported as follows: California, 3; Montana, 1; Nevada, 1; and Texas, 1. Decreases in the number of crude-ore producers were reported as follows: New York, 1; North Carolina, 1; and Washington, 5.

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. The figures in table 2 show

[1] Assistant chief, Branch of Ceramic and Fertilizer Materials.
[2] Statistical clerk.
[3] Excludes soapstone sold in slabs or blocks, which is part of the stone industry.
[4] The production totals of talc, soapstone, and pyrophyllite for 1954 will be compared with the Bureau of the Census totals when they are available, and differences adjusted or explained.

TABLE 1.—Salient statistics of the talc, soapstone, and pyrophyllite industries in the United States, 1953–54

	1953		1954	
	Short tons	Value	Short tons	Value
Mined	[1] 631,538	[2] $3,524,035	592,086	[2] $3,231,036
Sold by producers:				
Crude to consumers	18,423	185,184	19,052	190,685
Sawed and manufactured	935	354,847	1,012	290,697
Ground [3]	589,516	10,840,283	552,807	11,276,116
Total sales	608,874	11,380,314	572,871	11,757,498
Imports for consumption: [4]				
Crude and unground	198	35,474	36	6,230
Cut and sawed	127	39,903	45	18,149
Ground, washed, or pulverized	22,478	641,332	22,076	653,850
Total imports	22,803	716,709	22,157	678,229
Exports:				
Talc, steatite, soapstone, and pyrophyllite, crude and ground [5]	23,230	698,232	23,607	855,386
Powders—talcum (in packages), face and compact	(6)	1,295,533	(6)	1,075,592
Total exports		1,993,765		1,930,978

[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: 1953: $7,974; 1954: $11,508. Quantities not available.
[5] Includes manufactures, n. e. s.
[6] Figure not available.

TABLE 2.—Talc, soapstone, and pyrophyllite[1] sold by producers in the United States, 1945–49 (average) and 1950–54, by classes

Year	Crude			Sawed and manufactured		
	Short tons	Value at shipping point		Short tons	Value at shipping point	
		Total	Average		Total	Average
1945–49 (average)	13,277	$114,034	$8.59	812	$226,346	$278.75
1950	18,805	186,120	9.90	805	312,776	388.54
1951	20,166	211,241	10.48	1,097	375,141	341.97
1952	19,029	203,895	10.71	976	309,271	316.88
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

Year	Ground [2]			Total		
	Short tons	Value at shipping point		Short tons	Value at shipping point	
		Total	Average		Total	Average
1945–49 (average)	456,348	$6,724,400	$14.74	470,437	$7,064,780	$15.02
1950	601,140	10,121,847	16.84	620,750	10,620,743	17.11
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	552,807	11,276,116	20.40	572,871	11,757,498	20.52

[1] Includes pinite, 1947–48.
[2] Includes some crushed material.

TABLE 3.—Pyrophyllite [1] produced and sold by producers in the United States, 1945–49 (average) and 1950–54

Year	Production (short tons)	Sales					
		Crude		Ground		Total	
		Short tons	Value	Short tons	Value	Short tons	Value
1945–49 (average)	96,547	6,847	$41,610	87,967	$1,009,108	94,814	$1,050,718
1950	116,800	5,690	30,016	112,119	1,504,141	117,809	1,534,157
1951	120,031	4,446	23,741	114,398	1,664,058	118,844	1,687,799
1952	125,496	4,720	29,922	119,767	1,569,471	124,487	1,599,393
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

[1] Exclusive of pinite.
[2] Includes sericite schist.

TABLE 4.—Crude talc, soapstone, and pyrophyllite produced in the United States, 1953–54, by States

State	1953		1954	
	Short tons	Value [1]	Short tons	Value [1]
California	[2] 126,442	$1,132,700	133,474	$1,211,201
Georgia	57,891	202,619	50,536	176,876
Maryland and Virginia	37,358	131,744	37,611	133,253
Nevada	10,906	72,971	5,866	53,582
New York	156,299	940,541	(3)	(3)
North Carolina	119,341	578,239	112,704	388,428
Pennsylvania [4]	2,463	4,926	1,898	8,541
Texas	16,210	70,658	19,362	127,855
Vermont	80,209	240,627	66,195	198,585
Washington	5,351	28,833	(3)	(3)
Other States [5]	19,068	120,177	164,440	932,715
Total	[2] 631,538	3,524,035	592,086	3,231,036

[1] Partly estimated.
[2] Revised figure.
[3] Included with "Other States."
[4] Sericite schist.
[5] Includes Arkansas, Montana, and States indicated by footnote 3.

TABLE 5.—Ground talc, soapstone, and pyrophyllite sold or used by grinders in the United States, 1953–54, by States

State	1953		1954	
	Short tons	Value	Short tons	Value
California	106,606	$2,759,314	120,556	$3,221,396
Georgia	57,581	594,900	50,248	505,219
Maryland and Virginia	35,524	320,285	37,468	343,205
New York	155,995	3,950,035	(1)	(1)
North Carolina	115,794	1,675,308	102,195	1,569,221
Pennsylvania	1,283	10,893	2,241	26,892
Texas	16,290	223,457	14,599	233,625
Vermont	74,778	712,303	61,605	849,698
Washington	2,563	35,294	(1)	(1)
Other States [2]	23,102	558,494	163,895	4,526,860
Total	589,516	10,840,283	552,807	11,276,116

[1] Included with "Other States."
[2] Includes Montana (1954), Nebraska, Oregon, Utah, and States indicated by footnote 1.

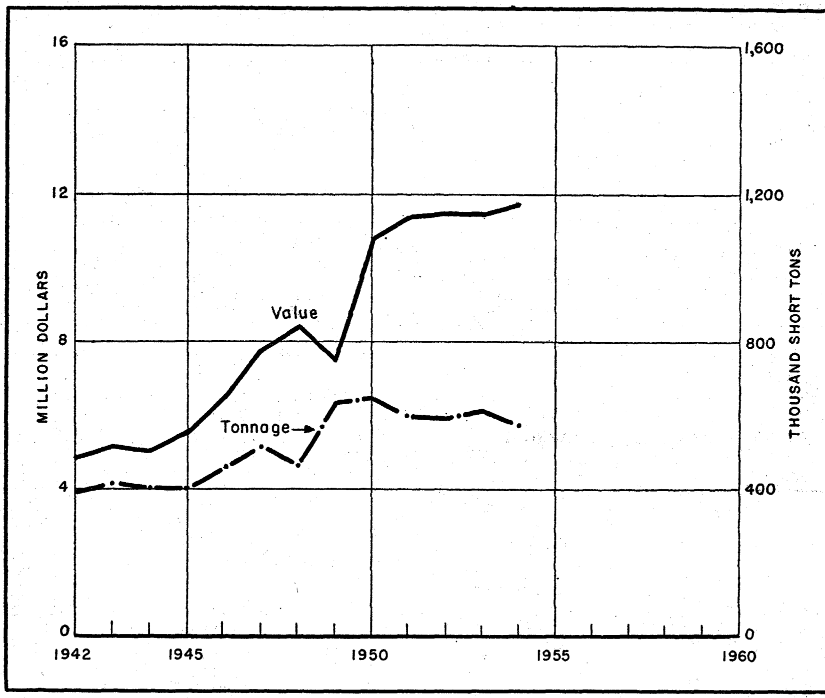

FIGURE 1.—Sales of domestic talc, pyrophyllite, and ground soapstone, 1942–54.

the proportion of material that enters trade in crude, sawed and manufactured, and ground form rather than the proportion of each grade sold by the primary producers.

New York ranked first in the quantity and value of combined sales of ground talc, soapstone, and pyrophyllite in 1954, followed by California and North Carolina.

CONSUMPTION AND USES

Sales to 6 industries—paint, ceramics, roofing, insecticides, rubber, and paper—accounted for 83 percent of the talc and soapstone sold or used by producers in 1954, compared with a like amount in 1953 and 85 percent in 1952.

Four industries—insecticides, rubber, ceramics, and refractories—consumed 89 percent of the pyrophyllite sold by producers in 1954, compared with 87 percent in 1953, and 86 percent in 1952.

TABLE 6.—Talc and soapstone sold or used by producers in the United States, 1952–54, by uses

Use	1952		1953		1954	
	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total
Ceramics	117,046	25	120,794	25	109,318	24
Paint	120,404	26	113,406	23	112,493	25
Rubber	33,305	7	32,137	7	30,621	7
Roofing	48,721	10	53,858	11	52,851	12
Insecticides	52,280	11	57,762	12	48,317	11
Paper	26,327	6	25,018	5	18,711	4
Asphalt filler	23,005	5	21,305	4	19,651	4
Textiles	12,029	3	9,811	2	8,494	2
Toilet preparations	8,361	2	8,126	2	9,718	2
Foundry facings	7,279	1	7,502	1	6,803	1
Rice polish	1,438	(1)	2,624	1	1,060	(1)
Crayons	703	(1)	660	(1)	612	(1)
Other	17,762	4	34,334	7	36,209	8
Total	468,660	100	487,337	100	454,858	100

1 Less than 1 percent.

TABLE 7.—Pyrophyllite sold or used by producers in the United States, 1952–54, by uses

Use	1952		1953		1954	
	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total
Insecticides	35,081	28	34,865	29	40,975	35
Rubber	31,171	25	29,271	24	25,603	22
Ceramics	26,115	21	26,213	21	24,205	20
Refractories	15,507	12	15,565	13	13,798	12
Plaster products	10,570	9	6,929	6	6,861	6
Paint	4,722	4	4,977	4	4,204	3
Roofing	840	1	1,500	1		
Other	481	(1)	2,217	2	2,367	2
Total	124,487	100	121,537	100	118,013	100

1 Less than 1 percent.

PRICES

Table 8 shows the prices of ground talc and pyrophyllite at the beginning of 1953 and 1954 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 buyers and sellers on the basis of a wide range of specifications.

TABLE 8.—Prices quoted on talc and pyrophyllite, carlots, 1953–54, per short ton

[Oil, Paint and Drug Reporter]

Mineral and grade	Jan. 5, 1953	Jan. 4, 1954	Dec. 27, 1954
GROUND TALC (BAGGED)			
Domestic, f. o. b. works:			
Ordinary:			
California	$25.00–$35.00	$32.00–$38.50	$32.00–$38.50
Vermont	14.00	14.00	14.00
Fibrous (New York):			
Off color	25.00– 30.00	25.00– 30.00	25.00– 30.00
325-mesh:			
99.5 percent	27.00	27.00	27.00
99.95 percent, micronized	36.00	36.00	36.00
Imported (Canadian), f. o. b. mines	15.25– 35.00	15.25– 35.00	15.25– 35.00
PYROPHYLLITE			
Standard, bulk, mines: [1]			
200-mesh	12.50	12.50	(2)
230-mesh	13.50	13.50	(2)
300-mesh	16.75	16.75	(2)
No. 3: 200-mesh, bulk, mines	11.00	11.00	(2)
Insecticide grade: 200-mesh, bags, mines	13.00– 13.50	13.00– 13.50	(2)
Rubber grade: 140-mesh, bags, mines	11.50– 12.00	11.50– 12.00	(2)

[1] Standard and No. 3, in paper bags, $3 to $3.50 per ton extra.
[2] Not quoted.

TABLE 9.—Prices quoted on talc, carlots, 1953–54, per short ton, f. o. b. works

[E&MJ Metal & Mineral Markets]

Grade [1]	Jan. 1, 1953	Jan. 7, 1954	Dec. 16, 1954
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	18.50– 20.00	[2] 18.00– 20.00	18.00– 20.00
Vermont:			
100 percent through 200-mesh, extra white, bulk basis [3]	12.50	12.50	12.50
99½ percent through 200-mesh, medium white, bulk basis [3]	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] Changed Aug. 6, 1953.
[3] Packed in paper bags, $1.75 per ton extra.

FOREIGN TRADE [5]

Imports.—The quantity and value of unmanufactured "talc, steatite or soapstone, and French chalk" imported for consumption in the United States decreased 3 and 5 percent, respectively, in 1954 compared with 1953. Italy was the chief supplier, with 75 percent of the quantity and 82 percent of the value. The value of imports for consumption of manufactures n. s. p. f. (not specifically provided for), except toilet preparations, increased 44 percent in 1954 over 1953 and came entirely from West Germany and Switzerland.

[5] 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.—Talc, steatite or soapstone, and French chalk imported for consumption in the United States, by classes in 1945–49 (average) and 1950–52, and by classes and countries in 1953–54

[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	
1945–49 (average)	115	$6,658	15,814	$378,957	80	$18,983	16,009	$404,598	$10,612
1950	177	10,052	23,054	637,262	156	44,364	23,387	691,678	7,574
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									
North America: Canada			2,737	38,277	1	293	2,738	38,570	898
South America: Brazil			([1])	4			([1])	4	
Europe:									
France			2,362	52,614	5	1,322	2,367	53,936	
Germany, West									4,207
Italy	56	15,619	16,585	525,104	98	27,929	16,739	568,652	1,800
Norway					5	1,527	5	1,527	
Switzerland									1,041
United Kingdom									17
Total	56	15,619	18,947	577,718	108	30,778	19,111	624,115	7,065
Asia:									
China									11
India	142	19,855	794	25,333			936	45,188	
Japan					18	8,832	18	8,832	
Total	142	19,855	794	25,333	18	8,832	954	54,020	11
Grand total	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	[2]653,850	45	18,149	22,157	[2]678,229	11,508

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

Exports.—Crude and ground talc, steatite, soapstone, and pyrophyllite exports increased 1 percent in quantity and 24 percent in value in 1954 compared with 1953. Exports of manufactures increased 63 percent in quantity and 15 percent in value during the same period. The value of exports of "powders—talcum (in packages), face and compact" decreased 17 percent in 1954 from the 1953 figure.

TABLE 11.—Talc, pyrophyllite, and talcum powders exported from the United States, 1945–49 (average) and 1950–54

[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	
1945–49 (average)	[1] 15,482	[1] $395,411	(2)	(2)	$2,782,442
1950	20,593	560,752	51	$25,492	1,233,609
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

[1] Excludes shipments under the Army Civilian Supply Program.
[2] Beginning Jan. 1, 1949, manufactures, n. e. s., 1 ton ($455).

TECHNOLOGY

The geology of the Silver Lake talc deposits in San Bernardino County, Calif., was described.[6] The geology of talc deposits in Germany and pyrophyllite deposits in Chile and India were reported.[7]

The talc industry of India and the uses of Indian talc in ceramics were discussed.[8]

The flotation of talc was discussed in articles that appeared during the year. Market specifications, reagent combinations, and flowsheets were included.[9] A patent was issued for a method of floating talc from nickel-copper-cobalt ores.[10]

The properties of phosphate-bonded talc, formed by dry pressing, hydrostatic pressing, and hot pressing, were compared with the properties of natural block talc.[11] Preliminary tests were made to determine the suitability of phosphate-bonded talc as a replacement for natural block talc in tube spacers for electronic power tubes.[12]

[6] Wright, L. A., Geology of the Silver Lake Talc Deposits, San Bernardino County, California: California Dept. Nat. Resources, Div. of Mines Spec. Rept. 38, 1954, 30 pp.

[7] Rost, Franz, [The Formation of the Talc Deposits at Schwarzenbach on the Saale, Oberfranken]: Fortschr. Mineralogie, vol. 32, 1953, pp. 69–73 (pub. 1954); Chem. Abs., vol. 49, No. 9, May 10, 1955, p. 6050c.
Cristi, J. M., and Pacheco, E. G., [Geology of the Arrayan Deposits of Pyrophyllite, Maule Province (Chile)]: Univ. of Chile, Inst. Geol., Pub. 3, 1953, 26 pp.; Chem. Abs. vol. 49, No. 2, Jan. 25, 1955, p. 795d.
Misra, R. C., Pyrophyllite and Its Occurrence in India: Indian Min. Jour., vol. 1, No. 1, January, 1953, pp. 44–47.
Singhal, B. B. S., The Pyrophyllite Deposits of Tikamgarth: Current Sci. (Bangalore), vol. 23, 1954, pp. 217–218; Chem. Abs., vol. 49, No. 3, Feb. 10, 1955, p. 1499f.
Mehta, D. R. S., The Pyrophyllite Deposits of Hamirpen and Jhansi Districts (U. P.): Indian Minerals (Delhi), vol. 8, No. 1, January 1954, pp. 37–41.

[8] Bhushan, Bhan, and Ray, H. N., Occurrence of Talc in India and Its Role in Ceramic Industry: Trans. Indian Ceram. Soc. (Benares, India), vol. 13, No. 4, 1954, pp. 211–220.

[9] Harrah, H. W., Eastern Magnesia Talc Company, Inc.: Deco Trefoil, May–June, 1954, pp. 7–14.
Thom, Clarence, and Gisler, H. J., Flotation of Non-Metallics: Canadian Min. and Met. Bull. (Montreal), vol. 47, No. 504, April 1954, pp. 240–250.

[10] Drake, Reginald T. N. (assigned to Sherritt Gordon Mines, Ltd.), Flotation of Talc From Sulfide Ores: U. S. Patent 2,693,877, Nov. 9, 1954.

[11] Comeforo, J. E., Breedlove, J. G., and Thurnauer, Hans, Phosphate-Bonded Talc: A Superior Block-Talc Substitute: Jour. Am. Ceram. Soc., vol. 37, No. 4, April 1954, pp. 191–195.

[12] Production Development Digest, Production Development Division, Signal Corps Supply Agency, Philadelphia, Pa., May 19, 1954; June 2, 1954.

The use of talc in various ceramic bodies was discussed in a number of articles published in 1954.[13]

Variations in the texture and chemical analyses of 17 commercial talcs were studied on the basis of phase, field, and atomic structure considerations, with the aid of chemical, X-ray, and differential thermal analyses. It was proposed that the variations are caused by solid solutions of the layer or group type instead of the atom or ion type.[14] X-ray analyses of 2 Austrian talcs and 1 German talc were compared.[15] Tests used in quality control of talc shipments were described in detail.[16]

WORLD REVIEW

Despite a 6-percent drop in the output of the United States, the world's largest producer, the estimated world production of talc, soapstone, and pyrophyllite reached a record high in 1954, exceeding the previous high recorded in 1951 by 6 percent and the 1953 figure by 9 percent. Excluding the United States, world production increased 18 percent. Japan and the European countries accounted for most of the increase.

Austria.—Talc exports for 1950–54, by countries of destination, are given in table 13.

Canada.—According to the official preliminary estimates, Canada produced 13,000 short tons of talc (value Can$160,000) in 1954 and 12,680 tons of soapstone (value Can$141,738), compared with final revised 1953 figures of 13,310 tons of talc (value Can$125,-209) and 14,098 tons of soapstone (value Can$160,546).[17] Imports of talc and soapstone in 1954 were given as 12,392 tons (value Can$397,-985) and exports of talc 3,609 tons (value Can$48,753). In 1953, the value of the Canadian dollar ranged from US$1.01 to US$1.03; in 1954, the value ranged from US$1.02 to US$1.03.

[13] Lamar, R. S., and Gaskins, W. W., Ultrafine Talcs in Low-Loss Steatite Bodies: Bull. Am. Ceram. Soc., vol. 33, No. 4, Apr. 15, 1954, pp. 111–116.
Lamar, R. S., and Warner, M. F., Reaction and Fired-Property Studies of Cordierite Compositions: Jour. Am. Ceram. Soc., vol. 37, No. 12, Dec. 1, 1954, pp. 602–610.
Noda, Tokiti, Ono, Kiko, and Omori, Osamu, Effect of Talc Content on the Translucency of Porcelain Bodies, I: Jour. Ceram. Assoc. Japan (Tokyo), vol. 62, No. 694, 1954, pp. 259–262; Ceram. Abs., October 1954, p. 184j.
Noda, Tokiti, and Hagino, Taira, Effect of Talc Content on the Translucency of Porcelain Bodies, II: Jour. Ceram. Assoc. Japan, vol. 62, No. 695, 1954, pp. 331–333; Ceram. Abs., November 1954, p. 203i.
Gad, G. M., [Constitution and Suitability of Egyptian Talc for the Manufacture of Clinoenstatite Insulators]: Keram. Ztschr. (Lubeck, Germany), vol. 6, No. 9, September 1954, pp. 441–442, 464.
Zapp, F., and others, [Effect of Small Additions of Steatite to Basic, Neutral, and Acid Sagger Bodies]: Sprechsaal Keramik-Glas-Email (Coburg, Germany), vol. 87, No. 5, March 1954, pp. 97–100; No. 6, March 1954, pp. 122–125.
Stafford, Ray, Talc, Its Use in Ceramics: Pacific Coast Ceram. News, vol. 3, No. 2, February 1954, pp. 27, 32.
[14] Pask, J. A. and Warner, M. F., Fundamental Studies of Talc; I, Constitution of Talcs: Jour. Am. Ceram. Soc., vol. 37, No. 3, Mar. 1, 1954, pp. 118–128.
[15] Bojarski, Z., X-ray Investigation of Talcs: Prace Inst. Ministerstwa Hutnic, vol. 6, 1954, pp. 57–64 (English summary); Chem. Abs., vol. 49, No. 3, Feb. 10, 1955, p. 1492c.
[16] Spore, W. D., Testing of Talc for Use in Dinnerware Bodies: Bull. Am. Ceram. Soc., vol. 33, No. 5, May 15, 1954, p. 134.
[17] Canada, Department of Trade and Commerce, Dominion Bureau of Statistics, Preliminary Report on Mineral Production, 1954, p. 38. Prepared in the Mineral Statistics Section of the Industry and Merchandising Division, Ottawa, Canada.

TABLE 12.—World production of talc, soapstone, and pyrophyllite, by countries,[1] 1945–49 (average) and 1950–54, in short tons [2]

(Compiled by Helen L. Hunt)

Country [1]	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Canada (shipments)	28,121	32,604	24,846	25,032	27,408	25,691
United States	471,886	616,680	640,456	600,908	631,518	592,086
Total	500,007	649,284	665,302	625,940	658,926	617,777
South America:						
Argentina	4,409	12,897	18,739	14,330	[3] 16,500	[3] 16,500
Brazil	9,712	13,924	12,461	21,464	[3] 22,000	[3] 22,000
Chile	569	157	28	(4)	(4)	(4)
Paraguay	-----	-----	-----	-----	99	132
Peru	-----	-----	144	137	-----	(4)
Uruguay	2,196	751	1,057	748	982	(4)
Total	16,886	27,729	32,429	[3] 36,700	[3] 39,600	[3] 39,600
Europe:						
Austria	34,424	64,685	80,231	56,021	56,477	68,310
Finland	190	331	5,512	6,614	4,065	8,133
France	80,548	96,360	113,798	120,864	114,530	130,844
Germany, West	19,070	30,093	38,871	30,412	32,991	53,817
Greece	926	2,756	2,894	1,323	(4)	[3] 3,300
Italy	56,961	74,534	83,771	88,555	88,496	95,302
Norway	49,381	70,657	84,304	70,629	67,443	66,050
Portugal	[5] 13	2	1	7	18	(4)
Rumania	[3] 440	(4)	(4)	(4)	(4)	(4)
Spain	24,600	27,702	39,721	30,709	31,357	[3] 33,000
Sweden	12,583	15,259	14,696	9,686	9,806	(4)
United Kingdom	3,439	1,904	2,800	2,897	4,413	(4)
Total [3]	300,000	400,000	480,000	440,000	435,000	495,000
Asia:						
Afghanistan	[6] 110	83	926	882	661	(4)
India	39,647	28,543	37,685	23,264	32,000	(4)
Japan	220,576	312,578	441,614	350,960	362,193	461,087
Korea, Republic of	3,526	8,251	3,536	4,149	26,983	20,965
Taiwan (Formosa)	[6] 84	772	2,267	1,205	1,944	7,791
Total [3]	355,000	360,000	530,000	460,000	535,000	660,000
Africa:						
Egypt	5,368	4,113	4,138	5,405	2,423	2,822
Kenya	419	368	371	259	171	109
Union of South Africa	4,103	4,385	6,242	9,562	7,974	7,974
Total	9,890	8,866	10,751	15,226	10,568	10,905
Oceania: Australia	6,980	10,859	14,726	8,518	11,127	14,699
World total (estimate) [1]	1,190,000	1,460,000	1,730,000	1,590,000	1,690,000	1,840,000

[1] In addition to countries listed, talc or pyrophyllite is reported in China and U. S. S. R., but data are not available; estimates included in total.
[2] This table incorporates a number of revisions of data published in previous Talc, Soapstone, and Pyrophyllite chapters.
[3] Estimate.
[4] Data not available; estimate by senior author of chapter included in total.
[5] Average for 1948–49.
[6] Average for 1 year only, as 1949 was first year of commercial production.

The Canadian talc and soapstone industry in 1953 was described as follows: [18]

Talc and soapstone shipped by producers in 1953 amounted to 27,408 tons valued at $285,755, compared with 25,032 tons valued at $280,612 in 1952. Most of the production in Ontario was high-grade milled talc. The output from Quebec included crayons, blocks and ground soapstone. Operations in British Columbia were discontinued.

[18] Canada, Department of Trade and Commerce, Dominion Bureau of Statistics, The Talc and Soapstone Industry, 1953: Ind. Merchandising Div., Mineral Statistics Section, Ottawa, Canada, 1954, 7 pp.

Employees numbered 54 persons to whom $132,934 were paid in salaries and wages. Fuel cost $10,476 and 1,209,695 k. w. h. of electricity were purchased for $22,231.

Imports of talc and soapstone amounted to 11,867 tons valued at $372,628 during 1953. Exports totalled 2,937 tons worth $38,193.

Plans were announced to explore a pyrophyllite deposit close to tidewater at Kyuquot Sound, on the northwest coast of Vancouver Island.[19]

France.—Exports of talc and soapstone, 1949–53, by countries of destination, are given in table 15.

Italy.—Talc and soapstone exports from Italy were largely to the United States, United Kingdom, and West Germany, as shown in table 16.

TABLE 13.—Talc exported from Austria, by countries of destination, 1950–54, in short tons[1]

(Compiled by John E. McDaniel)

Country	1950	1951	1952	1953	1954
Argentina	81	39	------	------	------
Belgium-Luxembourg	777	1,034	728	1,079	1,258
Czechoslovakia	658	101	------	------	------
Denmark	------	------	28	17	143
France	591	993	736	1,002	1,242
Germany:					
East	1,349	3,988	1,693	2,546	2,502
West	15,685	17,241	13,439	15,385	16,577
Hungary	2,982	4,043	3,412	2,183	3,508
Italy	------	23	53	295	627
Netherlands	1,608	1,597	2,198	715	666
Poland	5,244	7,624	9,714	10,558	19,914
Sweden	------	17	------	11	14
Switzerland	1,233	1,936	1,393	1,808	2.228
Trieste	------	------	26	17	44
United Kingdom	50	444	581	864	582
Yugoslavia	138	102	95	17	95
Other countries	12	------	------	3	2
Total	30,408	39,182	34,096	36,500	49,402

1 Compiled from Customs Returns of Austria.

TABLE 14.—Consumption of ground talc and soapstone in Canada, by uses, 1950–52, in short tons[1]

Use	1950	1951	1952
Paints	9,023	6,921	7,264
Roofing	9,739	8,861	8,255
Pulp and paper	1,634	1,974	2,568
Rubber	3,290	1,684	1,617
Toilet and medicinal preparations	861	778	807
Electrical apparatus	475	641	427
Clay products	716	894	1,164
Soaps and cleaning preparations	159	192	206
Textiles	571	520	533
Insecticides and miscellaneous chemicals	6,006	6,419	7,638
Polishes	25	12	16
Miscellaneous nonmetallic mineral products	21	97	3,157
Iron foundries	110	------	------
Tanneries	50	8	20
Asbestos products	------	------	1
Coal tar distillation	98	305	133
Total	32,778	29,306	33,806

1 Source: Canada, Department of Trade and Commerce, Dominion Bureau of Statistics.

19 Western Miner and Oil Review (Vancouver), vol. 27, No. 5, May 1954, p. 88.

Norway.—Exports of talc and soapstone, 1949–53, by countries of destination, are given in table 17.

TABLE 15.—Talc and soapstone exported from France, by countries of destination 1949–53, in short tons[1]

(Compiled by John E. McDaniel)

Country	1949	1950	1951	1952	1953
Belgium-Luxembourg	3,057	3,783	4,450	3,071	3,133
Finland	1,002	654	1,256		893
Germany, West	1,201	3,041	3,416	2,222	2,020
Netherlands	833	1,613	1,706	1,206	1,842
Sweden	397		1,166	856	5,163
Switzerland	6,572	7,045	9,277	5,909	276
United Kingdom	5,520	6,731	9,707	6,126	6,023
United States	1,225	2,181	1,775	1,579	2,413
Other countries	1,597	6,355	2,424	4,058	1,304
French Overseas Territories	2,174	2,326	4,114	862	4,125
Total	23,578	33,729	39,291	25,889	27,192

[1] Compiled from Customs Returns of France.

TABLE 16.—Talc exported from Italy, 1950–54, by countries of destination, in short tons[1]

(Compiled by John E. McDaniel)

Country	1950	1951	1952	1953	1954
Belgium-Luxembourg	281	374	292		
Canada	461	743	780		
France	637	1,291	416		
Germany:					
East		389	138		
West	3,758	4,874	3,930	3,590	4,251
Netherlands	115	230	405		
Portugal	2,287	147	175		
Switzerland	731	228	374		
Union of South Africa	1,120	1,290	375		
United Kingdom	6,227	7,754	6,172	9,150	7,486
United States	7,739	13,989	12,932	15,607	13,686
Other countries	6,970	4,567	3,270	8,190	8,418
Total	30,326	35,876	29,259	36,537	33,841

[1] Compiled from Customs Returns of Italy.

TABLE 17.—Talc and soapstone exported from Norway, 1949–53, by countries of destination, in short tons[1]

(Compiled by John E. McDaniel)

Country	1949	1950	1951	1952	1953
Belgium-Luxembourg	1,279	1,603	2,973	3,694	3,277
Denmark	4,550	5,365	6,216	4,902	5,733
Finland	2,237	3,661	4,218	2,744	393
France	576	274	699	668	423
Germany	4,227	5,534	4,489	4,561	4,494
Indonesia			2,061	2,142	1,499
Netherlands	8,601	9,319	8,132	6,099	7,662
Poland	110	219		226	510
Sweden	5,773	8,986	9,204	5,342	6,816
Switzerland			204	148	98
United Kingdom	10,207	12,434	16,961	12,263	12,607
Other countries	1,994	2,191	1,474	1,653	1,170
Total	39,554	49,586	56,631	44,442	44,682

[1] Compiled from Customs Returns of Norway.

Thorium

By John E. Crawford [1]

PROBABILITIES of thorium becoming a practical and economic source of fissionable material for power reactors were better in 1954. It was planned to use thorium in at least one reactor as a breeder of fissionable uranium–233. Should it be proved technically feasible to produce more nuclear fuel with thorium than was consumed in operating the reactor, the demand for this element might increase substantially.

In 1954 additional facilities for producing thorium compounds were put into operation by one of the larger domestic producers. Other companies maintained their interest in thorium and continued research and development.

Industrial nonenergy uses for thorium and thorium compounds remained relatively stable. Fluctuations in allocations of thorium by the Atomic Energy Commission to industry were normal. Indications were that thorium as an additive to magnesium alloys for high-temperature applications might become increasingly important, based upon the rather significant allocations made for this purpose in the two years, 1953 and 1954.

The Bureau of Mines, on behalf of the AEC, continued its program of exploration for thorium deposits in the United States during the year. Private organizations conducted some exploration and mined thorium-bearing monazite placer deposits in the northwestern United States and Florida. Plans were being made to develop recently discovered black-sand deposits in South Carolina and Idaho.

India, Brazil, and the Union of South Africa were probably the major foreign producers of thorium-bearing materials, although it was reported that such materials were being exploited in Australia, Ceylon, and elsewhere around the world. India expressed an aggressive spirit in developing peaceful nuclear uses for thorium.

PRODUCTION

Exploration and Mine Production.—The Bureau of Mines continued its search for thorium-uranium-bearing minerals in alluvial deposits on behalf of the AEC in 1954. Monazite-sand deposits were investigated in Florida, Georgia, Idaho, Montana, and South Carolina, and several thorite and uranothorite-bearing placer deposits in central Idaho were explored by bulldozer trenching and churn drilling in the summer of 1954. (See Rare Earths section, Minor Metals chapter.)

The Lindsay Chemical Co., West Chicago, Ill., began mining a lode deposit of thorite ore in Gunnison County, Colo.; and in Idaho, Baumhoff-Marshall, Inc., and the Idaho-Canadian Dredging Co. each operated a dredge to recover thorium-bearing monazite from placer deposits. The Humphreys Gold Corp., Jacksonville, Fla., and the

[1] Commodity-industry analyst.

Florida Ore Processing Co., Sharonville, Ohio, produced monazite from beach and dune sands in Florida as a byproduct of titanium-minerals production.

Dredging techniques for recovering monazite from Idaho placer deposits were described, and information about the size and type of dredges used was also provided.[2] It was reported that, from every 4,000 tons of gravel dredged from the Idaho placers, about 30 tons of heavy-sand concentrate was recovered, from which approximately 2 tons of monazite was produced. Such monazite concentrate, containing 65 percent or more thorium and rare earths, was said to have been worth about $375 a ton.[3]

A publication reported that Colonial Uranium Co., Grand Junction, Colo., was considering building a mill to produce commercial-grade thorium concentrates from thorite ores. The company surveyed the Gunnison-Powderhorn region for a millsite convenient to power and water and suitable for stockpiling and future expansion of facilities.[4]

The Federal Geological Survey released, in open file, a geologic map and cross sections of the Little Johnnie thorium deposit, Gunnison County, Colo., on July 19, 1954.[5]

The Porter Bros. Corp. developed a columbium-tantalum placer occurrence about 95 miles north of Boise, Idaho, that contained some uranium, thorium, and rare-earth minerals. Work continued on the construction of dredges to work the 11,500-acre deposit. A processing plant was also being prepared to separate the constituents of the material.[6]

Marine Minerals, Inc., was also constructing a dredge for recovering black sands containing monazite and other heavy minerals in a placer deposit near Aiken, S. C., and received assistance through tax amortization on June 9, 1954, from the Office of Defense Mobilization; accelerated amortization amounting to $755,950 was allowed under a certification of 65 percent of depreciable assets.

Refinery Production.—Domestic thorium and thorium compounds production statistics were classified, by the AEC as security information and therefore could not be published.

Producers of thorium compounds in the United States were:

Lindsay Chemical Co.,
West Chicago, Ill.
Maywood Chemical Works,
Maywood, N. J.
Rare Earths, Inc.,
Paterson, N. J.
Norton Co.,
Worcester, Mass.

The Lindsay Chemical Co. recovered thorium compounds and rare-earth compounds from domestic and South African ores and concentrates. (See Rare Earths section, Minor Metals chapter.) A new plant addition, largely for increasing thorium production, was put into operation in June 1954; full production was reached late in

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[2] Argall, George O., Jr., New Dredging Techniques Recover Idaho Monazite: Min. World, vol. 16, No. 2, February 1954, pp. 26–30.

[3] Mining Congress Journal, New "Golden" Age Dawns in Idaho's Rare Earths: Vol. 40, No. 3, March 1954, pp. 32–33.

[4] Engineering and Mining Journal, vol. 155, No. 10, October 1954, p. 132.

[5] Geological Survey, Geologic Map, Thorium Deposit, Gunnison County, Colo., Released for Public Inspection: Press release, July 19, 1954.

[6] Engineering and Mining Journal, vol. 155, No. 8, August 1954, p. 136.

1954. As a principal producer of thorium the Lindsay Chemical Co. expected to benefit from the increased use of thorium in atomic energy.[7]

Other thorium-compound producers listed above broadened their research and development programs.

The AEC and Westinghouse Electric Corp. (Lamp Division), Bloomfield, N. J., were the only significant refiners of thorium metal in 1954. Production was measured in pounds, part of which was used in Westinghouse's own operation and the remainder sold to industry.

It was reported that pure thorium metal in massive form had been produced in the United States for the first time. Thorium was produced in small quantities for many years as a dark-gray powder. The massive metal was found to be soft, ductile, and easily formed, had about the same density as lead, was unattacked by alkalis or concentrated nitric acid, and alloyed readily with a number of metals.[8]

The Bureau of Mines, under an agreement with the AEC, initiated action on a thorium-metals development program during the latter part of 1954 at its Albany, Oreg., station.

A new process was announced for recovering thorium and rare earths from monazite. The conventional process involved digestion of the monazite concentrates with sulfuric acid, followed by a water wash. Although the rare earths and thorium were carried in solution, their recovery was complicated because the phosphate also dissolved. The new process developed for the AEC by the Battelle Memorial Institute, Columbus, Ohio, required that the monazite concentrate first be treated with sodium hydroxide and the resulting hydrous metal oxide, free of phosphates, dissolved with hydrochloric acid. Subsequent separation and purification of the thorium and rare earths were said to be simplified.

Several steps involved in the procedure were described as follows:[9]

(1) Treatment of the monazite concentrates with a hot concentrated aqueous solution of sodium hydroxide, converting the metal phosphates of the sand to hydrous metal oxides and trisodium phosphate.

(2) Separation of the hydrous metal oxides from the dissolved sodium phosphate and excess sodium hydroxide.

(3) Dissolution of the hydrous metal oxides in hydrochloric acid.

(4) Precipitation of a thorium product by partial neutralization of the acid solution.

(5) Subsequent precipitation of a high-grade rare-earth hydroxide product by further neutralization of the chloride solution.

Thorium wire, which tends to seize in the die, was successfully drawn, using a thinned lacquer suspension of MoS and fumed Pb and Zn oxides as a lubricant. Thorium wire as small as 0.005 inch in diameter could also be drawn by enclosing the thorium wire in a copper jacket.[10]

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[7] Lindsay, Charles R., To the Shareholders of Lindsay Chemical Co.: Mar. 1, 1955, 4 pp.

[8] Mining Record, Thorium Becomes Uranium Isotope for Nuclear Fuel: Vol. 65, No. 48, Dec. 2, 1954, p. 9.

[9] Metal Industry (London), Extraction of Thorium: Vol. 85, No. 25, Dec. 17, 1954, p. 516.

Daily Metal Reporter, Battelle Develops Process for Recovery of Thorium: Vol. 54, No. 182, Sept. 22, 1954, pp. 1, 7.

E&MJ Metal and Mineral Markets, Recovery of Thorium and Rare Earths by New Process: Vol. 25. No. 38, Sept. 23, 1954, p. 8.

Chemical Engineering, vol. 61, No. 12, December 1954, pp. 122, 124.

Mining Journal (London), New Recovery Process May Enlarge Markets for Thorium and Rare-Earth Metals: Vol. 243, No. 6217, Oct. 15, 1954, p. 420.

Bearse, A. E., Calkins, G. D., Clegg, J. W., and Filbert, R. B., Jr., Thorium and Rare Earths From Monazite: Chem. Eng. Progress, vol. 50, No. 5, May 1954. 5 pp.

[10] Materials and Methods, Thorium Wire: Vol. 40, No. 4, October 1954, pp. 208, 210.

CONSUMPTION AND USES

Nonenergy Uses.—As indicated in table 1, the major use of thorium continued to be in the manufacture of gas mantles for incandescent gas and gasoline lamps and lanterns. About 48 percent of the total allocations of thorium for nonenergy purposes by the AEC in 1954 were for gas mantles, approximately 12 percent greater in quantity than was allocated in 1953. The mantle consists of a woven fabric of suitable material impregnated with a mixture of the nitrates of thorium and cerium, with small quantities of hardening salts. Once the coated material is ignited, the ash skeleton contains about 99 percent of thoria (ThO_2) and 1 percent of ceria (CeO).

The second greatest use of thorium in 1954—about 23 percent of the total allocations—was in the preparation of magnesium alloys; and the amount used was 29 percent greater than during the previous year. Thorium as an additive for magnesium alloys was first reported in 1953; it imparts outstanding workability at ambient and elevated temperatures. Two to three percent thorium in the alloy improves the ductility and stability of the metal after heating. It was believed that most of the alloy produced was for research and development purposes. Its probable application would be in jet-engine compressor components for military aircraft and in certain parts of guided-missile systems.

TABLE 1.—Allocations of thorium compounds to industry by the Atomic Energy Commission for nonenergy purposes in the United States, 1950–54, in pounds of contained ThO_2

Industry	1950	1951	1952	1953	1954
Magnesium alloys				3,600	4,647
Gas-mantle manufacture	48,471	31,132	25,427	8,707	9,765
Refractories and polishing compounds	1,889	3,382	1,157	236	24
Chemical and medical	2,097	6,246	11,064	5,179	3,738
Electrical	314	1,457	277	1,222	2,016
Total	52,771	42,217	37,925	18,944	20,190

Chemical and medical uses decreased nearly 28 percent in quantity compared with 1953. Thoria has been used as a catalyst in (1) petroleum cracking; (2) oxidizing ammonia to nitric acid; (3) transforming sulfur dioxide into sulfur trioxide; and (4) making water gas from carbon monoxide. It was also utilized in producing many organic reagents. Some special optical glasses required the addition of high-purity thorium oxide. In the medical field soluble thorium salts were used in creams and lotions to cure certain parasitic skin infections.

The electrical industry received 2,016 pounds in 1954, representing a 65-percent increase in quantity compared with 1953. Electrical equipment manufacturers incorporated thorium oxide with tungsten to produce light filaments having high resistance to mechanical shock and to control grain size of the tungsten. Tungsten-thorium filaments were used in vacuum tubes because of their electron emissive power. Thorium oxide in colloidal form was mixed with the "getter" employed in manufacturing such tubes, facilitating final evacuation and maintenance of vacuum. In metallic sheet form thorium was used as a starter in sunlamps and other lamps of special types.

Less than 1 percent of the total allocations made in 1954 were for use in refractories and polishing compounds. Thorium's high melting point of over 2,800° C., plus its chemical stability, makes it a most suitable refractory material.

Energy Uses.—The AEC announced that it was going to build a homogeneous thorium reactor (HTR). This reactor would determine the practicability of breeding fissionable uranium–233 from a blanket of thorium surrounding a core of fissionable fuel material in an appropriately designed reactor. Adjacent radiochemical processing plants would separate the uranium–233 from the thorium and fission products from the used fuel. Theoretically, the reactor should produce as much or more fissionable material as was burned up in the core as fuel.

The homogeneous thorium reactor was expected to produce about 65,000 kilowatts of energy some 16,000 kilowatts of which would be converted into electricity. The core diameter of the HTR was to be smaller than that of a full-scale plant, but the thickness of the thorium blanket and the concentration of the fertile material would be equivalent to that required for a central power station of the thorium breeder type.

The Oak Ridge National Laboratory was responsible for developing and designing the HTR. Construction was estimated to commence during fiscal year 1957 and be completed in fiscal year 1959.[11]

PRICES

Thorium metal (chief impurities—calcium, about 0.05 percent; iron, about 0.05 percent; thorium oxide, about 1.0 to 1.5 percent) was quoted during 1954, f. o. b. plant, as follows:

Item:	*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 in. and over	.75	.60
0.002 to 0.0049 in	.85	.70

The principal thorium compounds were quoted at the close of 1954, in 100-pound lots, f. o. b. plant, by one of the leading producers as follows:

	Price per pound
Thorium nitrate, mantle grade:	
Domestic price	$3.00
Export price	3.35
Thorium oxide, 97 percent ThO_2; rare-earth oxide content, 0.01 percent; particle size, 3 to 50 microns:	
Domestic price	8.25
Thorium oxide, photographic-lens grade, 99 percent ThO_2; rare-earth oxide content, 0.006 percent; particle size, 1 micron:	
Domestic price	9.35

For 50- to 99-pound lots, add 10 percent to all prices.
For 10- to 49-pound lots, add 20 percent to all prices.
For 1- to 9-pound lots, add 50 percent to all prices.

[11] Atomic Energy Commission, Sixteenth Semiannual Report: July 1954, p. 25.

FOREIGN TRADE

Import-export statistics regarding thorium, thorium compounds, and thorium ores and concentrates are not available for publication. All or nearly all of the thorium ores and concentrates imported during 1954 were from the Union of South Africa. India placed an embargo on thorium exports in 1946, and in 1950 Brazil limited monazite exports to Government-to-Government transactions. Therefore United States industry was cut off from two major sources of supply. It is doubtful if any thorium metal was imported.

WORLD REVIEW

Brazil and India may have been the leading world producers of thorium ore in 1954. Australia also produced thorium-bearing material, and the Union of South Africa and Ceylon began mining of thorium-bearing ores on a commercial scale.

Thorium mineralization in several other countries was investigated, and legislation was passed affecting the prospecting for and use of thorium.

NORTH AMERICA

Canada.—In the Province of Quebec near Oka the Molybdenum Corp. of America explored an occurrence containing thorium, columbium, tantalum, and uranium. Some 8,000 acres was taken under option by the company, and exploration drilling was conducted. Other firms also staked and leased land in the area.[12]

Grand Calumet Uranium Mines planned to diamond-drill a prospect on Grand Calumet Island, Quebec, showing thorium and other values.[13]

Dominion Magnesium, Ltd., produced thorium metal and master alloys containing the element.[14] The metal, 97–99 percent purity, was available in the form of sintered powder cake and powder, packed in 1-gallon cans. Also available were magnesium alloys containing 1.8 or 3.0 percent thorium.

SOUTH AMERICA

Brazil.—The Departmento Nacional da Producao Mineral received from the Brazilian Government $750,000 (United States currency) to conduct investigations of mineral deposits in Brazil, including exploration for thorium-bearing material in the States of Paraiba, Rio Grande do Norte, and Ceara.[15]

Monazite-bearing beach sands were worked at Espirito Santo and Bahia.[16]

EUROPE

Portugal.—The Portuguese Government in 1954 created an atomic energy commission, Junta de Energia Nuclear, which, it was expected,

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12 Northern Miner (Toronto), Uranium Find Near Montreal: Vol. 39, No. 49, Feb. 25, 1954, pp. 1, 4.
13 Canadian Mining Journal, vol. 75, No. 3, March 1954, p. 140.
14 Dominion Magnesium, Limited, Annual Report: Toronto, Ontario, Feb. 28, 1955.
15 Engineering and Mining Journal, vol. 155, No. 9, September 1954, p. 198.
16 Mining Journal (London), The Mining and Treatment of Rare Earths: Vol. 243, No. 6205, July 23, 1954, pp. 96–97.

would propose new legislation governing the prospecting for and mining of thorium; as well as uranium-ore deposits. Since 1949 prospecting for radioactive materials had not been allowed in the Portuguese empire.[17]

Sweden.—Effective January 1, 1954, the Swedish Government issued Proclamation 703, which allowed the processing of thorium and certain other strategic materials at universities, colleges, research institutes, or similar scientific institutions in Sweden. Thorium was authorized for use in manufacturing electrodes, gas discharge tubes and electronic tubes, incandescent mantles, highly refractory laboratory utensils, luminous powders, and other unspecified items, so long as the thorium content did not exceed 3 percent by weight.[18]

ASIA

Ceylon.—A pilot plant at Katakurunda treated monazite-bearing sands during 1954. In 1953 some 50 tons of monazite were produced by the pilot plant.[19] Ceylon was expected to export monazite containing 2 to 22 percent thorium.

India.—Monazite and other heavy minerals were recovered from the beach sands of Travancore about 100 miles along the coast on each side of Cape Comorin. Some of the sands were sun-dried and passed through a 30-mesh sieve to remove limestone fragments and waste. After being thoroughly dried the minus-30-mesh sand was run over electromagnetic separators to yield a magnetic product containing 91 to 98 percent ilmenite. The residues from the electromagnetic separators were then treated by more powerful electromagnets to produce a 60-percent monazite concentrate. The monazite fraction subsequently was subjected to further concentration on wet and dry vibrating tables, followed by high-intensity electromagnetic separation and dry tabling. The resulting product was a monazite concentrate of about 98-percent purity.[20]

Rare earths and trisodium phosphate were recovered from the monazite concentrates at the Indian Rare-Earths, Ltd., factory at Alwaye. The residues, containing thorium and other radioactive materials, were to be processed at an extraction plant being constructed at Trombay. Some of the thorium was to be made into a nitrate for the domestic gas-mantle industry, the remainder to be retained by the Indian Government for possible use in atomic energy studies.[21]

The Allahabad University announced a simpler method of extracting thorium from the monazite-bearing beach sands of India. The university investigated problems related to atomic energy research in India.[22]

It was reported that a nuclear reactor utilizing thorium would be constructed in India in the near future.[23]

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17 Mining World, vol. 16, No. 8, July 1954, p. 75.
18 Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 2, February 1954, pp. 27–28.
19 Work cited in footnote 16, p. 97.
20 Work cited in footnote 16, pp. 96–97.
21 Mining Journal (London), vol. 242, No. 6190, Apr. 9, 1954, p. 415.
Metal Industry (London), vol. 85, No. 24, Dec. 10, 1954, p. 497.
22 American Embassy, New Delhi, India, State Department Dispatch 1724, May 7, 1954, p 5.
23 American Embassy, New Delhi, India, State Department Dispatch 482, Oct. 28, 1954, p. 5.

AFRICA

Madagascar.—It was announced that the French Atomic Energy Commission, in cooperation with the Geological Service of Madagascar, discovered a high-grade thorium deposit at Behara-Esire, some 60 miles north of Fort Dauphin. The deposit covered an area 50 miles long by 12 miles wide and consisted of oxides of thorium and uranium. The French AEC, sole legal buyer, reportedly would pay about $1.25 per pound for the ore.[24] Thorium was also found in alluvial deposits and monazite sands near Fort Dauphin.

Chief producer of thorium-bearing material in Madagascar was P. Hibon, who reportedly sold thorium-uranium ores to the French Government.[25]

Southern Rhodesia.—In the Fort Victoria district adjoining the Selection Trust's petalite deposits an occurrence of monazite containing a high thorium content was reported. An investigation of the area was in progress.[26]

Union of South Africa.—An extensive monazite deposit was developed in the Van Rhynsdorp district of Namaqualand, Cape Province. The Union of South Africa Minister of Mines, upon the recommendation of the Government Atomic Energy Board, authorized the Anglo-American Corp. of South Africa to mine and concentrate the ore and export the products. The Government was to receive a guaranteed royalty. The annual output of the Anglo-American Corp. was estimated at 8,000 tons of concentrate, containing 55 percent rare earths and thorium oxide.[27]

OCEANIA

Australia.—Ocean-beach black-sand deposits extending some 50 miles north and south of the Queensland-New South Wales border were worked to recover monazite and other heavy minerals. Estimated reserves of monazite were 12,500 long tons. Ten mining companies worked the occurrences between Stradbroke Island, Queensland, and Byron Bay, New South Wales. Overburden was removed by bulldozer, dragline, or similar equipment, and the black sand was removed and loaded into railway cars with shovels or mechanical loaders. The material was then transported to Dunwich, Queensland, where the constituents of the sands were separated by several accepted techniques, including gravity, electrostatic, and electromagnetic methods.[28]

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[24] Engineering and Mining Journal, vol. 155, No. 8, August 1954, pp. 166, 168.
[25] Work cited in footnote 18, p. 27.
[26] Engineering and Mining Journal, vol. 155, No. 6, June 1954, p. 155.
[27] Mining and Industrial Magazine, "Rare Earths" and Nuclear Fission: Vol. 44, No. 9, September 1954, p. 339.
[28] Mining Journal (London), Mining and Treatment of Rare Earths in Australia: Vol. 243, No. 6206, July 30, 1954, pp. 130–131.

Tin

By Abbott Renick[1] and John B. Umhau[2]

THE TIN INDUSTRY in 1954 was characterized by several significant developments, including attainment of the United States stockpiling objective, congressional approval to continue operation of the Texas City tin smelter until June 30, 1955, and the announcement that, although the United States Government would not sign the proposed International Tin Agreement of 1953, it would retain stocks held and to be acquired in excess of the National Strategic Stockpile requirements in insulation, and would make withdrawals only by direction of the President.

The year was also notable for an exceptional stability in the price of tin metal, which was 90–95 cents per pound during the final 10 months of the year, an economic level for most major producers. The annual average for 1954 was 91.81 cents per pound, 4 percent below the 1953 average price of 95.77 cents per pound.

President Eisenhower in his Budget speech to the Congress on January 21, 1954, stated:

> By the end of the present fiscal year (June 30, 1954), the Government will have completed purchases of tin for the National Stockpile. World supplies are already adequate to meet current requirements. As a result there may no longer be a need for the continued operation of the Government tin smelter in 1955. Pending outcome of international negotiations, the Budget assumes withdrawal of the Government smelter from operations at the end of the fiscal year 1954.

During July the smelter was given complete sanction by Congress in the House of Representatives with passage by voice vote of Senate Concurrent Resolution 79, which stated that it was the sense of the Congress that the smelter should be continued in operation at least until June 30, 1955; that the Congress should designate a committee to study and investigate the tin situation and report to the Congress by March 15; and that not later than April 30, 1955, appropriate legislation should be adopted with respect to the tin program of the United States.

Probably the outstanding feature of the year and the most important item affecting tin producers was the anticipated ratification of the International Tin Agreement.[3] The agreement aims to stabilize market conditions for industry by establishing a buffer stock and acquiring 25,000 tons of tin metal to be contributed by producing countries. It also provides for setting up export controls when the buffer stock has absorbed a minimum of 10,000 tons and when such

[1] Commodity-industry analyst.
[2] Statistical assistant.
[3] Bureau of Mines, International Tin Agreement, 1953: Mineral Trade Notes, Spec. Suppl. 41 (to vol. 39, No. 1), July 1954, 2 pp.

controls are warranted by market conditions. The agreement establishes, as an initial basis for operation, a floor price of £640 per long-ton (US$0.80 per pound) and a ceiling price of £880 (US$1.10). Operation of the buffer stock will be entrusted to a manager and will depend primarily on the relation of the market price to the floor and ceiling prices.

By Executive Order 10539, the President transferred to Federal Facilities Corp. (FFC) all functions related to tin heretofore performed and exercised by the Reconstruction Finance Corporation (RFC). The transfer was effective at close of business on June 30, 1954. The management of the Longhorn tin smelter at Texas City, Tex., continued to be entrusted to the Tin Processing Corp., a subsidiary of the N. V. Billiton Maatschappij.

World mine production of tin declined 800 long tons to 178,800 tons in 1954, although 4 percent more than the 1935–39 average (171,400 tons). The 2 largest producing countries, Malaya and Indonesia, established postwar production records, whereas exports of tin from Bolivia were at the lowest level since 1939. World smelter production totaled 185,600 tons in 1954 or 1,700 tons more than in 1953. Free world mine and smelter production exceeded world consumption of tin by 32,000 and 40,000 tons, respectively, in 1954.

The United States mine output of tin in 1954 continued to be negligible. Nevertheless, the small tonnage mined, mostly in Alaska, established a new record high. Under the Defense Production Act of 1950, the Government extended assistance to tin mining in Alaska. The Joint Committee on Defense Production, United States Congress, conducted a comprehensive investigation covering activities of the various Government agencies participating in recommending and approving loans of funds to the United States Tin Corp., which culminated in the issuance, on November 17, 1954, of Defense Production Act Progress Report 29, entitled "United States Tin Corp. Loans."

Consumption of tin in 1954 in the United States decreased 3 percent from 1953; consumption of primary tin was virtually unchanged, whereas secondary decreased 10 percent. Tinplate production (4,900,000 short tons) increased 3 percent from the previous year. Domestic smelter output, all from the Government-owned plant at Texas City, Tex., decreased 10,000 long tons, with operations on a reduced scale pending decision as to its continuance. Secondary tin production was 5 percent less than in 1953.

Metal imports of tin decreased 12 percent and represented 75 percent of the total tin imported. Receipts of tin-in-concentrate decreased 38 percent from 1953. Imports of metal and concentrate were augmented by 5,800 long tons (gross weight—chief value tin) of tin alloys, mainly from Denmark in the form of 94-percent tin alloys.

At the end of 1954 tin stocks held by the Government and industry—comprising pig tin, tin-in-ore, raw materials in process, and others, but excluding the Strategic Stockpile—amounted to 40,800 long tons, a 34-percent decrease from the 62,100 tons reported on hand December 31, 1953.

TABLE 1.—Salient statistics of tin in the United States, 1945–49 (average) and 1950–54

	1945–49 (average)	1950	1951	1952	1953	1954
Production:						
From domestic mines [1] ____long tons__	14.8	94.1	88.0	98.7	56.0	204.68
From domestic smelters [2] _______do____	37,962	33,118	31,852	22,805	37,562	27,407
From secondary sources________do____	26,406	31,680	30,745	28,800	27,600	26,190
Consumption:						
Primary______________________do____	55,292	71,191	56,884	45,323	53,959	54,427
Secondary____________________do____	27,872	33,273	31,285	33,095	31,681	28,464
Imports for consumption:						
Metal________________________do____	31,674	82,838	28,255	80,543	[3] 74,570	65,552
Ore (tin content)______________do____	35,352	25,960	29,621	26,491	35,973	22,140
Exports (domestic and foreign)_____do____	485	799	1,513	380	203	822
Monthly price of Straits tin at New York:						
Highest___________cents per pound__	84.40	163.50	184.00	121.50	121.50	101.00
Lowest_______________________do____	69.10	74.125	103.00	103.00	78.25	84.25
Average______________________do____	76.62	95.557	128.31	120.44	95.77	91.81
World mine production________long tons__	121,300	169,300	[3] 169,400	[3] 174,100	[3] 179,600	178,800
World smelter production__________do____	129,300	178,800	170,900	171,200	183,900	185,600
World consumption______________do____	116,600	152,000	139,500	131,500	132,000	138,200

[1] Includes Alaska.
[2] Includes tin content of alloys made directly from ores.
[3] Revised figure.

GOVERNMENT CONTROLS

There were no controls over the use and inventories of tin or tin alloys in 1954. With an ample world supply, priority and allocation authority under the Defense Production Act of 1950, as amended, was not exercised. Except for sales to the Government stockpile all metal was sold on private account. The selling price of tin was not controlled or fixed by Government action in 1954. Stockpiling by the United States Government, however, absorbed 30 to 32 thousand long tons of tin and thus provided a support for the world tin price. Although importation of tin ore or concentrate and the smelting thereof has not been controlled by any Government regulation, virtually all tin concentrate imported was for the Government for smelting by the RFC and its successor, FFC. There were no restrictions on the quantity of tin exported, but shipments by destinations were governed by the Export Control Act of 1949, extended to June 30, 1956.

Section 168 of the Internal Revenue Code of 1954 authorized granting of rapid tax amortization to expand production capacity to provide for defense needs. Holders of certificates of necessity for accelerated tax amortization included projects for electrolytic tinplate, tin cans, and other tinware.

DOMESTIC PRODUCTION [4]

MINE OUTPUT

Domestic mine production of tin was again insignificant in terms of United States demand. Nevertheless, the 200 long tons produced, valued at $421,000, was the largest yearly output recorded and exceeded the previous peak of 168 tons mined in 1937, valued at $205,300. Part of the 1954 production, however, was derived from upgrading

[4] Production data for 1954 were collected jointly with the Bureau of the Census (U. S. Department of Commerce). Production totals will be compared with the Census totals when they are available and differences adjusted or explained.

concentrate produced in 1953 and not counted as production in that year. As usual, Alaska was the principal producer. The lode deposit of the United States Tin Corp. at Lost River in the Port Clarence district in the western part of Seward Peninsula was the source of virtually the entire United States production.

In July 1954 witnesses were heard by a congressional committee investigating loans made to the United States Tin Corp.[5] From May 15, 1951, to October 7, 1954, the corporation received $2,894,573 [6] in Government loans and funds.

At the end of 1954 projects of the Defense Minerals Exploration Administration included 4 tin contracts totaling $452,231, in which Government participation was $407,008. The total amount was unchanged from 1953. The exploration contracts in effect during 1953 and 1954 were as follows: Alaska Tin Corp., Ear Mountain, Port Clarence district, Seward Peninsula, Alaska, $18,000 (Government participation, $16,200); United States Tin Corp., Lost River, Alaska, $226,000 (Government participation, $203,400); Zenda Gold Mining Co., Cape Mountain, Alaska, $159,300 (Government participation, $143,370); and Keenan Properties, Lawrence County, S. Dak., $48,931 (Government participation, $44,037.90). Government participation in the above projects amounts to 90 percent of the estimated total cost. However, this program was amended on March 19, 1954, by DMEA Order 1. This modified amendment provided Government financial assistance to the extent of 75 percent of the allowable cost to explore for indicated or undeveloped sources of tin.

A Bureau of Mines atlas [7] summarizing all pertinent data available on the mines and mineral deposits in the Black Hills, S. Dak., that have been explored, developed, mined, or located, including a comprehensive bibliography, stated with reference to tin:

> Pegmatite dikes, which occur in both the northern and southern Black Hills, but principally in the southern Black Hills, were exploited early when tin was discovered in placer concentrates in 1876. Cassiterite was found in situ at the Etta mine at Keystone in 1883. A tin boom followed, and many small companies and one large company were formed to exploit the deposits. The largest company was the Harney Peak Tin Mining, Milling Manufacturing Co. This company secured control of most of the tin-bearing dikes but, because of the low grade of the deposits, failed in 1894. Tin production from all deposits has been about 180 tons.

A progress report [8] was issued which states that cassiterite is found in small quantities in the Peerless pegmatite near Keystone, Pennington County, S. Dak. According to Geological Survey Professional Paper 247, entitled "Pegmatite Investigations 1942–45 Black Hills, S. Dak." (p. 59):

> The tin mineral cassiterite occurs in a few pegmatites in each district of the Black Hills. In some properties tin can be recovered as a byproduct of other mining, but none of them has the combination of high grade and large quantity of ore necessary for commercial operation.

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5 Defense Production Act, Hearings Before the Joint Committee on Defense Production: Progress Report 28, 83d Cong., 2d sess., July 1954, 886 pp.

6 Joint Committee on Defense Production, Congress of the United States, United States Tin Corp. Loans: Defense Production Act Progress Report 29, 84th Cong., 1st sess., Nov. 17, 1954, 54 pp.

7 Bureau of Mines, Black Hills Mineral Atlas, South Dakota: Inf. Circ. 7688, 1954, p. 3.

8 Runke, S. M., and Cunningham, J. B., Progress Report on Pegmatite Investigations in South Dakota for Fiscal Years 1952-53: Bureau of Mines Rept. of Investigations 5061, 1954, p. 5.

SMELTER OUTPUT

Domestic tin-smelter production was 27,407 long tons compared with 37,560 tons in 1953. The entire output came from the Government-owned Longhorn tin smelter at Texas City. In addition to Longhorn tin, the smelter produced 477 long tons, gross weight, of Copan alloy (405 tons, tin content) in 1954. No Copan was produced in 1953.

The 1955 budget assumes withdrawal of the Government smelter from operation at the end of the fiscal year 1954 and "that production will cease" at that time.[9] Effective July 1, 1954, operation of the smelter was transferred from the RFC to the FFC, a new agency established in the Treasury Department by Executive Order 10539 of June 22, 1954. Senate Concurrent Resolution 79 (83d Cong., 2d sess.), approved July 13, 1954, stated that it was the sense of the Congress that the smelter should be continued in operation at least until June 30, 1955, and that a joint congressional committee be designated to study the tin situation to determine whether it would be advisable to maintain domestic tin smelting on a permanent basis. On August 21, 1950, Public Law 125, approved June 28, 1947, was further amended to authorize operation of the smelter until June 30, 1956.

Procurement of concentrate at the Longhorn tin smelter was on a reduced scale, and inventories of concentrate were maintained at a minimum pending decision as to continuance of smelting operations. Receipts were the smallest since inception of the smelter. In 1954 the smelter received 45,900 long tons of concentrate containing 21,800 tons of tin compared with 81,600 tons containing 38,200 tons of tin in 1953. Bolivia continued to be the main source of supply, but receipts therefrom (tin content) decreased 36 percent in 1954. However, the grade improved as the tonnage of low grade accounted for most of the decrease. In May imports of tin-in-concentrate totaled only 16 long tons, all from Thailand. During the first 6 months of 1954 concentrate from Thailand contained only 59.5 percent tin; the usual grade of such concentrate had exceeded 70 percent tin. Inventories of tin-in-concentrate decreased to 6,200 tons on June 1, 1954, the lowest recorded since the smelter began operations, and as a result no tin was produced by the smelter in July 1954.

On March 12, 1954, RFC and Indonesia reached an agreement on a third-year contract for 18 to 20 thousand long tons of tin; 8 to 10 thousand tons will be tin-in-concentrate. The firm price was replaced by an average market price based on New York quotations. On July 7, FFC negotiated a contract, which will run until April 1955, for the purchase of Bolivian concentrate containing 12,000 tons of tin at prevailing market prices. An agreement was reached with Thailand for procuring concentrate against which spot purchases were made. Small tonnages of concentrate continued to be received from Canada in 1954. The contract with Belgian Congo expired February 28, 1954. As of December 31, 1954, outstanding purchase contracts and the Thailand agreement indicated 6,155 long tons in concentrate was yet to be delivered. Table 3 shows a breakdown of receipts by countries and grades of concentrate in 1953 and 1954.

[9] Budget of the United States Government for the Fiscal Year Ending June 30, 1955, Jan. 21, 1954, pp. M94, 190–191.

TABLE 2.—Production of Longhorn tin at the Texas City, Tex., smelter, by months, 1945–49 (average) and 1950–54, in long tons

Month	1945–49 (average)	1950	1951	1952	1953	1954
January	3, 276	2, 627	3, 211	1, 802	3, 960	2, 750
February	3, 171	2, 362	3, 096	1, 800	3, 391	3, 009
March	3, 155	2, 729	3, 123	1, 800	3, 850	3, 559
April	3, 174	2, 484	3, 058	1, 800	3, 750	3, 006
May	3, 357	2, 852	3, 059	1, 800	3, 060	2, 054
June	3, 345	2, 204	2, 655	----------	3, 000	1, 205
July	3, 267	2, 256	2, 406	----------	3, 000	----------
August	3, 067	2, 396	2, 505	50	2, 600	2, 002
September	2, 954	2, 805	2, 155	2, 450	2, 700	2, 404
October	2, 995	3, 209	2, 055	3, 364	2, 751	2, 404
November	3, 081	3, 207	1, 806	4, 020	2, 750	2, 205
December	3, 174	3, 005	1, 805	3, 706	2, 750	2, 404
Total	38, 016	32, 136	30, 934	22, 592	37, 562	27, 002

In the fiscal year 1954 the Longhorn smelter treated 67,400 tons of material, of which 65,000 tons was concentrates and 2,400 tons slimes. 46,300 tons of the concentrates was Bolivian, and 18,700 was alluvial, with an average grade of 37.3 and 72.9 percent, respectively. The slimes containing about 25 percent tin, virtually all derived from Bolivian concentrate, had been carried as inactive inventory accumulated during wartime smelting. The smelter produced 32,500 long tons of tin metal at a cost of $77,660,000, of which $71,320,000 represented the cost of concentrate and $6,340,000 processing costs, a unit cost of 106.7 cents per pound of tin metal produced. In the fiscal year 1953 the cost of producing about 35,000 tons of tin metal was $93,241,000, of which $87,662,000 was the cost of ore and $5,579,000 the cost of processing. This was equivalent to a unit cost of 120.1 cents per pound of tin metal produced. Results during the fiscal year 1954 showed a net loss of $1,330,000 after all costs and expenses compared with a net loss of $1,869,000 for the preceding fiscal year (1953). 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 $13,184,000 less accumulated depreciation of $5,698,000, or $7,486,000 as of June 30, 1954.

TABLE 3.—Tin concentrate received at Longhorn smelter, 1953–54

[Reconstruction Finance Corporation and Federal Facilities Corporation]

Countries	1953				1954			
	Concentrate received (long tons)	Content		Percent of tin content of receipts	Concentrate received (long tons)	Content		Percent of tin content of receipts
		Long tons	Tin (percent)			Long tons	Tin (percent)	
Bolivia	54, 551	18, 707	34. 29	49	32, 325	11, 996	37. 11	55
Indonesia	13, 172	9, 676	73. 45	25	9, 895	7, 266	73. 43	33
Thailand	7, 334	5, 366	73. 17	14	1, 521	1, 056	69. 43	5
Belgian Congo	3, 969	2, 903	73. 14	8	1, 119	821	73. 37	4
Miscellaneous	2, 594	1, 595	61. 49	4	1, 021	629	61. 61	3
Total	81, 620	38, 247	46. 86	100	45, 881	21, 768	47. 44	100

Since its inception, the Texas City smelter has been operated by the Tin Processing Corp. (a Delaware corporation and a subsidiary of N. V. Billiton Maatschappij) as an independent contractor under an operating agreement with RFC and 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, 1955.

SECONDARY TIN

Total recovery of secondary tin decreased 5 percent in quantity and 9 percent in value in 1954 compared with 1953. Most of the tin recovered was contained in copper-, tin-, and lead-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. The tonnage of metallic tin recovered in 1954 was 3 percent more than in 1953. Total production declined each year from 1950 to 1954, mainly owing to the recovery of less tin from old copper-base scrap. This was the longest period of downward movement in production of secondary tin since 1928–32.

In 1954 the recoverable tin content of copper-base scrap processed decreased 9 percent, while the tin recovered from scrap processed into brass and bronze increased 3 percent. In 1954 the secondary tin content of brass and bronze produced exceeded the recoverable tin content of copper scrap by 1,170 long tons, and 450 tons was supplied from tin recoverable from white-metal scrap according to monthly lead-scrap consumers reports. The gross weight of secondary brass and bronze castings included 3,350 tons of tin in 1954, the smallest quantity ever shown in this category. The total tonnage of tin recoverable from white-metal scrap decreased 4 percent compared with 1953, and the quantity recovered in the form of solder, babbitt, and lead-base alloys decreased 16 percent. The secondary tin content of solder, babbitt, and lead-base alloys produced (as represented by shipments) was 830 long tons less than the indicated quantity of tin available from white-metal scrap processed in 1954. The differences between materials processed and produced are due mainly to factoring recoverable tin content and adjustments to balance totals. Secondary tin recovered in chemicals increased 19 percent in 1954.

The tin content of "genuine" babbitt from scrap was only 230 long tons in 1954—the lowest recorded for this item. The production of "genuine" babbitt reached a peak in 1944; at that time the secondary tin content was 2,000 tons. In 1954 the tonnage of high-tin babbitt scrap consumed was the smallest recorded.

Detinning plants treated 566,380 long tons of tinplate clippings in 1954—the largest tonnage on record, exceeding the previous peak of 526,320 tons in 1953 by 8 percent. In addition, old cans processed decreased from 10,850 tons in 1953 to only 6,350 in 1954; these were very small figures compared with the record use of 175,870 tons in 1943. Tin recovered from tinplate clippings in 1954 was 3,145 tons, 4 percent more than in 1953, while that from old cans—45 tons—decreased nearly 40 percent. Recovery of tin from the billions of old cans discarded annually is metallurgically feasible but, largely due to the collection and cleaning problem, has seldom proved profitable.

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, 1945–49 (average) and 1950–54, 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
1945–49 (average)	2,826	368	3,194	3,014	23,392	26,406	$42,569,930
1950	3,300	575	3,875	3,615	28,065	31,680	67,809,158
1951	3,150	415	3,565	3,300	27,445	30,745	88,363,153
1952	2,640	310	2,950	2,860	25,940	28,800	77,710,297
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

CONSUMPTION BY USES

Total consumption of tin in the United States was 3 percent less in 1954 than in 1953. The use of primary tin was virtually unchanged, whereas the use of secondary tin decreased 10 percent. Consumption (tin content of manufactured products) was 83,000 long tons in 1954 (54,000 primary and 29,000 secondary) compared with 86,000 tons in 1953 (54,000 primary and 32,000 secondary). The figures on secondary tin include 3,500 tons in 1953 and 3,300 tons in 1954 contained in imported tin-base alloys. The tinplate industry increased its use of tin 5 percent, and all other industries decreased their use 8 percent.

TABLE 5.—Consumption of primary and secondary tin in the United States, 1945–49 (average) and 1950–54, in long tons

	1945–49 (average)	1950	1951	1952	1953	1954
Stocks on hand Jan. 1 [1]	26,619	24,621	31,856	20,764	23,105	24,525
Net receipts during year:						
Primary	56,210	79,992	48,298	48,657	57,969	52,673
Secondary	2,661	3,371	3,273	2,338	2,582	2,351
Terne	427	997	594	622	604	[2] 226
Scrap	26,637	30,839	28,974	32,917	29,754	28,601
Total receipts	85,935	115,199	81,139	84,534	90,909	83,851
Available	112,554	139,820	112,995	105,298	114,014	108,376
Stocks on hand Dec. 31 [1]	26,065	31,856	20,764	23,105	24,525	23,326
Total processed during year	86,489	107,964	92,231	82,193	89,489	85,050
Intercompany transactions in scrap	2,398	2,168	2,726	2,397	2,566	2,159
Total consumed in manufacturing	84,091	105,796	89,505	79,796	86,923	82,891
Plant losses	927	1,332	1,336	1,378	1,283	[3]
Tin content of manufactured products	83,164	104,464	88,169	78,418	85,640	82,891
Primary	55,292	71,191	56,884	45,323	53,959	54,427
Secondary	27,872	33,273	31,285	33,095	31,681	28,464

[1] Stocks shown exclude tin in transit or in other warehouses on Jan. 1, as follows: 1950, 61 tons; 1951, 1,355 tons; 1952, 971 tons; 1953, 525 tons; 1954, 240 tons; and 1955, 1,340 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 92 percent of the tin used in 1954 and 1953. Tinplate, the largest use of primary tin, consumed about 60 percent of the totals for 1954 and 1953. Tonnagewise, the use of primary tin for tinplate increased 1,700 long tons in contrast to decreases in the other items. Solder, the second largest use of tin, consumed 810 tons less primary metal in 1954 than in 1953. Consumption in bronze decreased the most—2,900 tons (primary 500 and secondary 2,400). The total for babbitt, the lowest since 1938, decreased 400 tons and was divided about equally between primary and secondary. Increased usage in miscellaneous alloys resulted from the manufacture of Copan alloy at the Texas City tin smelter. Primary tin used for white metal increased 11 percent, while a larger tonnage went into jewelers metal and pewter.

TABLE 6.—Consumer receipts of primary tin, by brands, 1945–49 (average) and 1950–54, in long tons

	Banka	Chinese	English	Katanga	Longhorn	Straits	Others	Total
1945–49 (average)	2, 136	1, 642	(1)	5, 337	32, 802	10, 382	3, 911	56, 210
1950	1, 273	1, 500	5, 172	5, 661	4, 912	54, 350	7, 124	79, 992
1951	6, 159	352	1, 406	4, 602	20, 263	12, 163	3, 353	48, 298
1952	4, 208	(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

1 Included in others not separately reported.

In 1953 and 1954 the quantity of tin used to make tinplate was divided about equally between the hot-dipped and electrolytic varieties. Tinplate production (excluding waste-waste) rose to a new high in 1954, or 3 percent more than in 1953, the previous record year. Electrolytic tinplate production represented 72 percent (71 percent in 1953) and hot-dipped only 28 percent (29 percent in 1953) of the total output in 1954. Electrolytic tinplate requires considerably less tin per unit of product than hot-dipped plate. Production of tinplate by electrolytic lines was 6 percent above the high record established for this product in 1953. Hot-dipped tinplate production decreased 3 percent.

Nearly 90 percent of the tinplate used is for making cans, of which about 60 percent is for the food pack and 40 percent for nonfood products. Shipments to canmakers increased 5 percent in 1954. The tonnage of cans shipped for packing food in 1954 was about the same as in 1953, whereas cans for nonfood products increased 5 percent. Among the products packed in 1954, soft drinks and beer made the largest gains, whereas, with a smaller crop yield, the fruit and vegetable pack showed the largest decrease.

An informative article [10] published in October described the use of tin in metal containers. It stated:

> Tinplate is expensive relative to the total cost of a can; and the conservation of metals, especially tin, is an important problem in the metal containers industry. Only 5 percent of the cost of manufacturing a No. 2 sanitary can in plant A of this study was attributable to direct labor, whereas 75 percent of the cost was for materials, principally tinplate.

10 Nolan, Arthur, and Gentel, Thomas G., Metal Containers: Bureau of Labor Statistics Rept. 71, October 1954, p. 2.

TABLE 7.—Tin content of tinplate and terneplate produced in the United States, 1945–49 (average) and 1950–54

Year	Total tinplate (all forms)			Tinplate (hot-dipped)			Tinplate (electrolytic)			Tinplate waste-waste, strips, cobbles, etc.		
	Gross weight (short tons)	Tin content (long tons)	Pounds of tin per short ton of plate	Gross weight (short tons)	Tin content (long tons)	Pounds of tin per short ton of plate	Gross weight (short tons)	Tin content (long tons)	Pounds of tin per short ton of plate	Gross weight (short tons)	Tin content (long tons)	Pounds of tin per short ton of plate
1945–49 (ave.)	3, 368, 343	28, 861	19. 5	1, 758, 906	21, 066	26. 8	1, 485, 197	6, 923	10. 8	124, 241	872	16. 3
1950	4, 767, 274	35, 380	16. 6	1, 845, 009	21, 875	26. 6	2, 693, 777	12, 110	10. 1	228, 488	1, 395	13. 7
1951	4, 591, 431	30, 522	14. 9	1, 557, 006	17, 789	25. 6	2, 832, 044	11, 595	9. 2	202, 381	1, 138	12. 6
1952	4, 249, 393	[1]27, 316	14. 4	1, 308, 173	15, 012	25. 7	2, 712, 657	11, 022	9. 1	228, 563	1, 282	12. 6
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	------
	Total terneplate			Short ternes			Long ternes			Terneplate waste-waste		
1945–49 (ave.)	278, 246	597	4. 9	123, 791	282	5. 2	148, 673	304	4. 6	5, 782	11	4. 3
1950	274, 963	952	7. 8	60, 952	188	6. 9	209, 223	753	8. 1	4, 788	11	5. 1
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.

TABLE 8.—Consumption of tin in the United States, 1952–54, by finished products, in long tons of contained tin

Product	1952			1953			1954		
	Primary	Secondary [1]	Total	Primary	Secondary [1]	Total	Primary	Secondary [1]	Total
Tinplate	[2]27, 316	--------	[2]27, 316	[2]31, 327	--------	[2]31, 327	[2]33, 026	--------	[2]33, 026
Terne metal	85	495	580	333	310	643	190	204	394
Solder	7, 678	10, 245	17, 923	10, 110	10, 063	20, 173	9, 303	10, 086	19, 389
Babbitt	1, 968	2, 637	4, 605	2, 492	2, 191	4, 683	2, 279	1, 997	4, 276
Bronze and brass	3, 612	16, 740	20, 352	3, 777	15, 738	19, 515	3, 278	13, 336	16, 614
Collapsible tubes and foil	604	104	708	917	127	1, 044	860	107	967
Tinning	2, 095	221	2, 316	2, 473	179	2, 652	2, 447	130	2, 577
Pipe and tubing	139	18	157	97	80	177	96	92	188
Type metal	86	1, 602	1, 688	171	1, 619	1, 790	132	1, 325	1, 457
Bar tin	642	36	678	835	71	906	824	74	898
Miscellaneous alloys	[3]485	297	[3]782	294	279	573	[3]651	198	[3]849
White metal	81	53	134	516	150	666	573	35	608
Chemicals including tin oxide	414	596	1, 010	481	828	1, 309	590	820	1, 410
Miscellaneous	118	51	169	136	46	182	178	60	238
Total	45, 323	33, 095	78, 418	53, 959	31, 681	85, 640	54, 427	28, 464	82, 891

[1] Includes 5,180 long tons of tin contained in imported tin-base alloys in 1952, 3,530 in 1953, and 3,340 in 1954.
[2] Includes small tonnage of secondary pig tin and tin acquired in chemicals.
[3] Includes 213 tons of tin in Copan produced in 1952 and 405 in 1954.

According to statistics published by the American Iron and Steel Institute, 5 million short tons of tinplate (including short ternes) was shipped in 1954, or 7 percent more than in 1953 and 5 percent above the previous peak year of 1950. Of the total shipped in 1954, 82 percent was for cans and closures, 13 percent for export, and 5 percent for other classifications. In 1954 the portion for cans and closures was smaller than in 1953, for export larger, and for other markets unchanged. The total quantity of tinplate for sanitary cans in 1954 was virtually unchanged from 1952 and 1953, but the quantity for general-line cans increased 416,000 short tons in 1953 and 180,000 tons in 1954. The largest increase in metal-can shipments was for beer cans and soft drinks, which are general-line items made from electrolytic tinplate. Tinplate for general-line cans has increased nearly sixfold since 1946. Shipments of electrolytic tinplate for export, the highest recorded for this product, were 265,000 short tons in 1954. Table 9 shows a breakdown of tinplate shipments by market classification from 1946–54. In addition, in 1954 shipments of black plate were 673,000 short tons (750,000 in 1953), of which 356,000 tons (400,000 in 1953) was for cans.

TABLE 9.—Tinplate shipments by market classifications, 1946–50 (average) and 1951–54, 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
Sanitary cans:					
Hot-dip	1, 228	1, 067	875	798	716
Electrolytic	853	1, 429	1, 362	1, 446	1, 530
Total	2, 081	2, 496	2, 237	2, 244	2, 246
General-line cans:					
Hot-dip	185	104	92	82	118
Electrolytic	667	812	854	1, 280	1, 424
Total	852	916	946	1, 362	1, 542
Total	**2, 933**	**3, 412**	**3, 183**	**3, 606**	**3, 788**
Closures—crown, caps, and others:					
Hot-dip	26	20	4	12	6
Electrolytic	167	289	250	297	298
Total	193	309	254	309	304
Total cans and closures	3, 126	3, 721	3, 437	3, 915	4, 092
Other uses:					
Hot-dip	87	91	96	105	80
Electrolytic	63	122	116	137	164
Total	150	213	212	242	244
Export:					
Hot-dip	433	346	299	321	387
Electrolytic	79	235	235	183	265
Total	512	581	534	504	652
Total:					
Hot-dip	1, 959	1, 628	1, 366	1, 318	1, 307
Electrolytic	1, 829	2, 887	2, 817	3, 343	3, 681
Grand total	3, 788	4, 515	4, 183	4, 661	4, 988

Industrial receipts of tin in 1954 were 84,000 long tons (8 percent less than in 1953), of which 63 percent was primary pig tin. Receipts of primary tin decreased 9 percent, whereas other raw materials decreased 5 percent. "Straits," the principal brand of tin acquired, composed nearly three-fourths of the primary receipts in 1953 and 1954. Other brands received in 1954 included Katanga, 10 percent; English, 9 percent; Banka, 2 percent, and the remaining, 5 percent.

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—decreased from 62,100 long tons at the beginning of 1954 to 40,800 tons at the end. However, industrial stocks of virgin pig tin in the United States (excluding metal afloat) increased from 14,200 tons at the beginning of 1954 to 14,700 at the end. Plant stocks of pig tin were drawn upon to the extent of 1,500 tons, whereas tin in transit to plants and jobbers'-importers' stocks in the United States increased 2,040 tons. Tinplate mills decreased their stocks of pig tin 1,340 tons but increased their inventories of tin in process 300 tons. Tinplate mills held 70 percent of plant stocks of pig tin in this country at the end of 1954. Other industrial plants decreased their pig-tin stocks 230 tons but increased their in-process inventories 600 tons. The tin content of scrap at tin consumers' plants was reduced 430 tons to 3,380 tons at the end of 1954, the lowest since December 31, 1939.

At the Longhorn tin smelter 12,120 tons of dressing plant slimes containing 2,855 tons of tin was stored in 7 ponds as of December 31, 1950.[11] By June 30, 1954 all of this material had been treated except 3,302 long tons, and during the last 6 months of 1954 approximately 3,000 tons were processed.

According to a semiannual progress report by the Office of Defense Mobilization on the national stockpiling program:[12]

> The minimum national tin stockpile objective has been met and an additional 60,000 tons of tin on hand or to be acquired will be held as a Government inventory under the Defense Production Act.* * * Stockpile tin stored at one location was transferred to a site in a warmer climate in order to arrest the progress of tin disease. General Services Administration issued special instructions[13] for the guidance of its inspectors in their periodic inspection of the tin stockpile.

On September 21, 1954, the Director of Defense Mobilization announced a revised purchase directive providing for the acquisition of materials for the 1955 fiscal year. Under the long-term stockpile program tin was included among materials which may be transferred from expansion programs of the Defense Production Act to the stockpile. Tin was included in a suggested list of commodities that may be acquired with foreign currencies for the "supplemental" stockpile authorized under the Agricultural Trade Development and Assistance Act of 1954, approved July 10, 1954. The list also is intended as a

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11 Renick, Abbott, and Umhau, John B., Tin: Bureau of Mines, Minerals Yearbook 1950, p. 1205.
12 Office of Defense Mobilization, Stockpile Report to the Congress, January-June 1954: October 1954, p. 14.
13 General Services Administration, Federal Supply Service, Tin Disease, Part I—Tin Disease and the Stockpile, Part II—Inspection Responsibilities and Procedures: October 1954, 28 pp.

guide in bartering for surplus farm commodities held by the Commodity Credit Corporation. No tin was acquired under this authority in 1954.

TABLE 10.—Tin stocks in the United States, Dec. 31, 1950–54, in long tons [1]

	1950	1951	1952	1953	1954
Industry:					
Pig tin—virgin	20,576	10,043	11,819	[2] 13,680	12,162
In process [3]	11,280	10,721	11,286	[2] 10,845	11,164
Total at plants	31,856	20,764	23,105	24,525	23,326
Other pig tin:					
In transit in United States	1,355	971	525	240	1,340
Jobbers—Importers	384	82	531	260	1,200
Afloat to United States	3,500	895	5,300	2,700	5,200
Total—other pig tin	5,239	1,948	6,356	3,200	7,740
Total industry	37,095	22,712	29,461	27,725	31,066
Government (RFC—FFC):					
Pig tin [1] total	18,618	6,753	13,265	18,467	1,352
Concentrates—ores:					
In foreign ports or afloat	5,606	1,107	11,868	4,600	2,817
In United States	15,068	10,771	13,341	11,318	5,558
Total concentrates—ores	20,674	11,878	25,209	15,918	8,375
Total Government	39,292	18,631	38,474	34,385	9,727
Grand total	76,387	41,343	67,935	62,110	40,793

[1] Excludes Copan (gross weight, long tons) at end of year as follows: 1950, 939; 1951, 260; 1952, 191; 1953, 60; and 1954, 105.
[2] Revised figure.
[3] Includes secondary pig tin (long tons) as follows: 1950, 230; 1951, 341; 1952, 306; 1953, 326; and 1954, 277.

PRICES

The average price of Straits tin for prompt delivery in New York was 91.81 cents per pound in 1954 compared with 95.77 cents in 1953. From the 1953 low of 78.25 cents on July 21, the price moved upward; the low for 1954 was 84.25 cents on January 4, and $1.01 (the 1954 high) was reached on April 12, in response to developments in Indochina. Following the announcement by the United States Department of State on March 5 that the United States would withhold from the market excess Government tin stocks and hold them in insulation, the price increased 3 cents over the weekend. A dock strike delayed delivery of spot and prompt Straits between March 18 and April 3. From mid-April to the first part of August the price of tin fluctuated around 95 cents, and some firmness developed in the market in June and July, when participating countries signed the International Tin Agreement. The cease-fire in Indochina on July 27 caused temporary weakness in the price The market strengthened somewhat in September but began to decline late in the month and continued to drop until the close of the year, when the downtrend was reversed and at year end a price of 88 cents was quoted. In the last quarter of 1954 use of depressed transferable sterling in connection with tin was a factor that caused reduced prices.

On the London market the average price for standard tin was £720.3 per long ton in 1954 compared with £730.5 in 1953. The monthly

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average price fluctuated from the low of £656.1 in January to the high of £757.3 in July. The price reached £645 on January 18, the lowest for the year. The sharpest rise of 1954, in London, followed the March 5 announcement by the Department of State. On April 12 the price reached £825, the highest for the year. The 1954 average price of £720.3 was in the range wherein the buffer-stock manager, under the contemplated International Tin Agreement, may neither buy nor sell unless the council decides otherwise.

TABLE 11.—Monthly prices of Straits tin for prompt delivery in New York, 1953–54, in cents per pound [1]

Month	1953			1954		
	High	Low	Average	High	Low	Average
January	121.50	121.500	121.50	85.250	84.250	84.83
February	121.50	121.500	121.50	85.750	84.500	85.04
March	121.50	120.000	121.40	95.750	86.750	91.88
April	118.50	92.000	101.11	101.000	94.250	96.12
May	100.75	93.000	97.46	94.500	92.500	93.52
June	95.75	90.500	92.95	96.500	93.375	94.20
July	89.50	78.250	81.63	97.750	95.500	96.54
August	83.00	78.250	80.68	95.500	92.500	93.37
September	83.75	81.125	82.31	94.125	92.625	93.54
October	82.75	79.000	80.85	94.625	92.250	93.04
November	86.25	81.500	83.19	92.250	89.875	91.10
December	86.25	81.750	84.61	90.250	85.625	88.57
Total	121.50	78.250	95.77	101.000	84.250	91.81

[1] Compiled from quotations published in the American Metal Market.

On the Singapore market the monthly price of Straits tin ex-works was £694.5 for 1954 compared with £714 in 1953. The lowest monthly average in 1954 was £622.6 in January and the highest £735.9 in July. The lowest price for the year was £616.5 on January 19 and the highest £757.5 on April 13. In November the largest monthly turnover of tin occurred since trading was resumed on November 16, 1949.

FOREIGN TRADE [14]

Tin has been one of the principal imports of the United States and ranked eighth in value among all commodities in 1954. The relative position of tin in value among metals and minerals imported (net imports) in 1954 was exceeded only by copper. The principal items in the foreign trade of the United States in 1954 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.

[14] 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.

Imports of metallic tin in 1954 decreased 12 percent, or 9,000 long tons. Of the total imports, Malaya, the principal source, furnished 65 percent; the quantity originating in Malaya in 1954 was virtually the same as in 1953. Other important sources of metal in 1954 included the Netherlands (16 percent—receipts declined 3,000 tons), Belgium-Belgian Congo (11 percent—receipts declined 2,700 tons), and United Kingdom (7 percent—receipts declined 3,400 tons). Imports of tin concentrate were consigned to the Government-owned tin smelter at Texas City, Tex. Receipts of concentrate, in terms of metal, were 38 percent (13,830 tons), less than in 1953 and the smallest since 1943. Bolivia, the main source of tin concentrate, furnished 12,600 long tons in 1954, a decrease of about 6,000 tons compared with 1953. Bolivia provided almost two-thirds of the tin-in-concentrate imported from 1941 to 1954, inclusive. Imports of tin-in-concentrate from Bolivia in 1954 were the smallest since 1940 or before operation of the Texas City tin smelter was begun. Imports of metal and concentrate were augmented by 5,830 long tons (6,840 in 1953)—gross weight, chief value tin—of alloys (including alloy scrap) brought into the United States in 1954, mainly from Denmark in the form of 94-percent tin alloys. Canada was the principal destination of 800 long tons of metallic tin in 1954 (200 in 1953). (This export class now includes tin-in-concentrate and ores.)

The major tin-export item of the United States, as usual, was tinplate. Sales to Europe, South America, Africa, and Oceania increased considerably from the past year; however, deliveries to North America and Asia decreased. Tonnagewise, shipments to Brazil showed the largest increase and those to Turkey the largest decrease. Exports to Union of South Africa were the highest recorded. Hot-dipped tinplate exports totaled 286,850 long tons valued at $61,513,900, a 24-percent increase in quantity and 18 percent in value compared with 230,800 tons valued at $52,028,400 in 1953. The principal countries of destination were Netherlands, Australia, Brazil, Union of South Africa, and Argentina. Exports of electrolytic tinplate were 216,100 tons valued at $42,490,800, or 45 percent more in tonnage and 37 percent in value compared with 1953 (149,500 tons, valued at $30,999,400). The leading destinations were Brazil, Union of South Africa, and Netherlands. In 1954, 55 short tons (350 in 1953) of terneplate was imported, mainly from United Kingdom. Exports of short ternes, shipped mainly to Canada and Australia, were 3,830 long tons in 1954 compared with 1,830 in 1953.

According to the American Iron and Steel Institute, producers in 1954 shipped for export 652,000 short tons (503,700 in 1953) of tinplate, of which 387,000 tons was hot-dipped (320,100 in 1953) and 265,000 was electrolytic (182,600 in 1953).

TABLE 12.—Foreign trade of the United States in tin concentrate and tin, 1945–49 (average) and 1950–54

[U. S. Department of Commerce]

Year	Imports				Exports			
	Concentrates (tin content)		Bars, blocks, pigs, grain, or granulated		Ingots, pigs, bars, etc.			
					Domestic		Foreign	
	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value
1945–49 (average)	35,352	$57,797,194	31,674	$61,496,629	427	$606,996	58	$87,704
1950	25,960	47,163,305	82,838	152,952,294	287	594,587	512	990,000
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	[1]74,570	[1]175,950,269	128	297,695	75	141,901
1954	22,140	41,724,776	65,552	133,185,565	271	467,029	551	1,125,003

[1] Revised figure.

TABLE 13.—Tin concentrate (tin content) imported for consumption in the United States, 1953–54, by countries

[U. S. Department of Commerce]

Country	1953		1954	
	Long tons	Value	Long tons	Value
North America:				
Canada	280	$687,643	97	$199,079
Mexico	223	384,107	72	69,008
Total	503	1,071,750	169	268,087
South America: Bolivia	18,571	38,193,628	12,575	20,939,378
Europe:				
Netherlands			1	1,509
Portugal	795	1,972,923	162	313,279
Total	795	1,972,923	163	314,788
Asia:				
Burma			59	90,237
Hong Kong			4	5,258
Indochina	50	80,568		
Indonesia	8,678	22,861,512	7,228	15,827,484
Thailand	4,690	11,527,522	1,062	2,153,670
Total	13,418	34,469,602	8,353	18,076,649
Africa:				
Belgian Congo	2,638	6,868,748	880	2,125,874
Cameroon	43	125,000		
Egypt	5	11,154		
Total	2,686	7,004,902	880	2,125,874
Oceania: Australia	(1)	464		
Grand total	35,973	82,713,269	22,140	41,724,776

[1] Less than 1 ton.

TABLE 14.—Tin [1] imported for consumption in the United States, 1953–54, by countries

[U. S. Department of Commerce]

Country	1953		1954	
	Long tons	Value	Long tons	Value
South America: Bolivia	66	$168,535		
Europe:				
Belgium-Luxembourg	8,152	20,578,710	6,505	$14,082,962
Denmark	76	170,135	19	34,392
France			8	15,516
Germany, West	161	382,487	264	515,422
Netherlands	[2] 13,613	[2] 35,098,778	10,601	23,438,690
Portugal	20	49,262	216	437,456
United Kingdom	7,903	[2] 16,212,800	4,498	9,183,853
Total	29,925	72,492,172	22,111	47,708,291
Asia: Malaya	[2] 42,969	[2] 98,930,430	42,896	84,282,240
Africa: Belgian Congo	1,605	4,345,939	545	1,195,034
Oceania: Australia	5	13,193		
Grand total	[2] 74,570	[2] 175,950,269	65,552	133,185,565

[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, 1945–49 (average) and 1950–54, in long tons

[U. S. Department of Commerce]

Year	Tinplate, taggers tin, and terneplate		Tinplate circles, strips, cobbles, etc. (exports)	Waste-waste tinplate (exports)	Terneplate clippings and scrap (exports)	Tinplate scrap	
	Imports	Exports				Imports	Exports
1945–49 (average)	2,686	485,403	3,464	22,020	296	31,102	126
1950	3,829	442,851	6,981	54,622	144	42,394	562
1951	398	498,808	12,995	55,955	144	51,571	810
1952	2,277	[1] 534,964	9,945	(2)		42,659	3,570
1953	374	[1] 459,639	11,445	(2)		37,582	5,195
1954	127	[1] 636,027	11,773	(2)		29,171	944

[1] Due to changes in classifications data not strictly comparable to earlier years.
[2] Beginning Jan. 1, 1952, not separately classified; included with "tinplate."

TABLE 16.—Tinplate and terneplate exported from the United States, 1953–54, by countries of destination

[U. S. Department of Commerce]

Destination	1953		1954	
	Long tons	Value	Long tons	Value
North America:				
Canada	7,099	$1,333,224	4,445	$858,013
Cuba	16,384	3,688,854	17,715	3,771,255
Mexico	17,089	3,625,353	12,392	2,319,248
Other	2,926	662,250	2,476	525,690
Total	43,498	9,309,681	37,028	7,474,206
South America:				
Argentina	33,155	7,564,799	42,123	8,805,187
Brazil	50,101	10,908,611	90,381	17,684,164
Colombia	11,171	2,310,938	11,426	2,234,396
Peru	5,459	1,220,840	8,098	1,704,796
Uruguay	7,580	1,666,784	4,018	870,514
Venezuela	6,065	1,443,340	10,798	2,667,440
Other	1,324	290,536	1,326	257,493
Total	114,855	25,405,848	168,170	34,223,990
Europe:				
Austria	1,252	338,790	1,748	331,490
Belgium-Luxembourg	13,549	2,836,270	20,034	3,787,345
Denmark	7,216	1,627,728	12,140	2,444,715
Finland	1,276	268,628	1,018	199,383
Germany, West	184	38,580	2,777	456,504
Greece	5,140	970,871	7,383	1,051,895
Ireland	858	158,532	2,000	380,950
Italy	18,765	3,342,208	50,204	8,354,955
Netherlands	47,022	10,535,906	61,735	13,007,928
Norway	11,329	2,347,170	25,525	5,282,759
Portugal	9,936	2,182,563	13,992	2,645,651
Spain	9,209	2,038,380	496	97,489
Sweden	13,469	2,894,982	10,299	2,108,341
Switzerland	12,573	2,752,313	16,132	3,370,626
Turkey	29,135	5,748,192	20,370	3,545,317
United Kingdom	40	8,397	4,186	817,838
Yugoslavia	4,363	977,892	1,201	250,678
Other	375	81,970	331	63,514
Total	185,691	39,149,372	251,571	48,197,378
Asia:				
Hong Kong	2,560	330,932	3,220	333,788
India	14,434	1,731,792	6,720	961,449
Indonesia	6,473	1,481,558	10,242	1,776,027
Iran	5,434	921,297	4,539	727,556
Israel and Palestine	4,101	834,037	[1] 4,757	[1] 809,706
Japan	14,177	1,789,061	9,755	1,070,744
Lebanon	2,219	416,246	3,146	471,457
Malaya	2,051	264,075	7,994	932,419
Philippines	21,204	4,067,698	20,414	3,704,636
Taiwan	4,046	787,737	2,259	319,413
Thailand	2,266	380,081	1,622	181,642
Other	1,070	172,085	1,792	247,014
Total	80,035	13,176,599	76,460	11,535,851
Africa:				
Anglo-Egyptian Sudan	1,026	220,164	645	124,666
Belgian Congo	79	15,571	447	92,674
British East Africa	415	78,666	18	3,281
Egypt	2,241	401,008	3,874	557,698
French Morocco	1,111	232,007	372	67,005
Union of South Africa	14,018	2,970,678	48,538	10,107,598
Other	628	138,470	1,391	287,662
Total	19,518	4,056,564	55,285	11,240,584
Oceania:				
Australia	15,318	[2] 3,459,042	46,950	10,056,160
New Zealand	718	161,576	526	104,065
Other	6	1,581	37	7,425
Total	16,042	3,622,199	47,513	10,167,650
Grand total	459,639	[2] 94,720,263	636,027	122,839,659

[1] Israel. [2] Revised figure.

TABLE 17.—Foreign trade of the United States in miscellaneous tin, tin manufactures, and tin compounds, 1945–49 (average) and 1950–54

[U. S. Department of Commerce]

Year	Miscellaneous tin and manufactures						Tin compounds	
	Imports			Exports				
	Tinfoil, tin powder, flitters, metallics, tin and tinplate manufactures n. s. p. f. (value)	Dross, skimmings, scrap, residues, and tin alloys, n. s. p. f.		Tin cans, finished or unfinished		Tin scrap and other tin-bearing material except tinplate scrap (value)	Imports (pounds)	Export (pounds)
		Pounds	Value	Long tons	Value			
1945–49 (average)	$122,802	641,184	$222,463	24,248	$7,315,330	$1,139,111	8,598	(1)
1950	215,484	6,293,459	2,146,340	28,946	10,448,917	869,404	75,825	122,716
1951	365,741	2,566,000	1,897,991	33,171	14,048,409	2,403,354	102,212	136,179
1952	447,925	18,351,019	17,454,460	41,624	16,842,755	(2) 2,086,612	1,358	73,131
1953	605,609	(3) 15,924,059	(3) 11,894,770	29,841	12,916,664	(2) 2,418,061	5,115	183,328
1954	(4) 784,511	13,277,707	9,378,294	23,878	11,022,214	(2) 3,340,533	2,703	342,146

[1] Not separately classified 1946–48; 1945, 35,107 pounds; 1949, 41,004 pounds.
[2] Due to changes in classification data not strictly comparable to earlier years.
[3] Revised figure.
[4] Due to changes in tabulating procedures by the U. S. Department of Commerce data known not to be comparable to earlier years.

TECHNOLOGY

The Tin Research Institute, Inc., with headquarters at Greenford, Middlesex, England, maintained an office in Columbus, Ohio, and offered free service for technical inquiries and general information on tin. The institute maintained a technical library on tin and had a number of publications for free distribution. Among those made available in 1954 were: Tin and Its Uses, No. 30; The Properties of Tin; Improved Aluminum-Tin Bearing Alloys; Some Aspects of Tinning by Immersion Processes; and Report of the Work of the Tin Research Institute, 1954.

Another activity of the institute was holding conferences on tin research in various countries. During 1954 four conferences were organized—in Paris, Milan, Parma, and Dusseldorf.

The Bureau of Mines conducted a laboratory study of sulfidization of cassiterite and volatilization from low-grade Bolivia tin ore. The results of this investigation demonstrated the conditions under which cassiterite (SnO_2) may be converted to stannous sulfide by reaction with pyrite or sulfur vapor. Quantitative data were published [15] on the rate of sulfidization and on the vapor pressure of stannous sulfide.

The sole producer of tin in Canada has been the Consolidated Mining & Smelting Co. of Canada, Ltd., which recovers the tin at the Sullivan concentrator in the form of cassiterite. The tin separation was described in the Canadian Mining Journal.[16] It stated in part:

> * * * Current flotation tailing which forms the feed to the tin plant contains approximately 0.04 percent Sn, mainly in the form of clear white cassiterite. The balance is predominantly pyrrhotite with varying proportions of pyrite and siliceous gangue, residual amounts of lead and zinc and other minor metallic minerals.

[15] St. Clair, H. W., Shibler, B. K., and Solet, I. S., Sulfidization of Tin Oxide and Volatilization of Tin Sulfide: Bureau of Mines Rept. of Investigations 5095, 1954, 24 pp.
[16] Canadian Mining Journal, Featuring Cominco: Vol. 75, No. 5, May 1954, p. 221.

* * * With the present scheme of treatment, it is still possible to recover only the coarser cassiterite, that is to say, that larger than about 670-mesh. The overall recovery varies from 30 to 40 percent, with a final grade of about 60 to 65 percent tin, dependent on the feed and other factors.

An article on the pioneering days of tin dredging was published;[17] among other things, it stated:

Dredging, so far as mining is concerned, was involved in the first instance to recover from river beds gold not recoverable by any other means. New Zealand can claim the credit of originating the industry. As far back as 1862 a dredge of a very primitive design attained phenomenal success in the recovery of gold from the Clutha River on the S. E. Coast of the South Island of New Zealand.

* * * As far as can be ascertained the first bucket dredge designed for the recovery of alluvial tin was the property of the Gladstone Tin Development Co. of Tasmania. This dredge was built in 1905 to work alluvial tin deposits in the vicinity of Gladstone, in the North East corner of Tasmania.

* * * The largest tin dredge in the world today is the Petaling Tin, Ltd.'s No. 6 dredge operating in Malaya. This dredge was in course of erection when the Japanese invaded Malaya in 1942. The dredge was completed after the war and is now operating successfully.

The dimensions of the pontoon of this dredge are: Length, 304 ft. by 72 ft. wide by 14 ft. 6 in. deep * * * Petaling No. 6 is designed to operate to a depth of over 130 ft. below waterline and is fitted with 20-cu. ft. close-connected buckets. The bucket ladder is 211 ft. long between centres of the pivot shaft and bottom tumbler. The bucket band is made up of 123 cast manganese-steel buckets, each weighing approximately 3 tons. Under loaded conditions the ladder, buckets, and accessory plant weigh approximately 1,050 tons.

A comparison between the small dredges of the pioneering days and the large modern dredges is interesting.

The abstract of a technical paper on the preparation of tin of high purity stated:[18]

A technique was desired to eliminate impurities affecting the B-a transformation. $SnCl_4$ prepd. from "relatively pure" Sn and Cl_2 was filtered, repeatedly distd., distd. after adding Sn, and redistd. in a stream of dry Cl_2. After two further distns., the center fraction was mixed with ⅙ its vol. of concd. H_2SO_4, shaken, and sepd. from H_2SO_4 in a separatory funnel; a distn. fraction was collected at 113.8–113.9° (760 mm.) and converted to Na stannate in aq. soln. and made up to 60 g. of Sn/1000 ml. Spectroscopically pure Sn was obtained on a graphite cathode (Pt anode) by electrolysis at 25 amp./sq. dm. Graphite inclusions were sepd. by fusion under doubly distd. glycerol. Transformation of a 1-g. disk to the a- modification (gray tin) occurred after 4 hrs. at −30°.

An article[19] described the more important developments relating to tin. Among other things, the following topics were discussed in the article: Tin as a replacement for nickel in electro-castings and copper alloys, new tin-containing materials, unusual coating methods, corrosion resistance of tin-alloy coatings, basic research, and information relating to tin of practical engineering value.

Two technical papers dealing with tin were presented at the annual meeting of the American Institute of Mining and Metallurgical Engineers in New York City, February 1954.[20] The paper by R. C. Meaders stated:

From the standpoint of beneficiation, Bolivian ores range from the simple to the very refractory depending not only on the mineralogical composition, but also, and probably of more importance, on the grain size of the cassiterite.

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[17] Miles, T. A., The Pioneering Days of Tin Dredging: Min. Mag. (London), vol. 90, No. 1, January 1954, pp. 17-23; vol. 90, No. 2, February 1954, pp. 78-86.
[18] Smirous, Karel, Preparation of Tin of High Purity: Chem. Abs. vol. 48, No. 22, Nov. 25, 1954, p. 13513.
[19] Nekervis, Robert J., Tin and Its Alloys: Ind. Eng. Chem., vol. 46, No. 10, October 1954, pp. 2124-2127.
[20] Meaders, R. C., The Beneficiation of Cassiterite: AIME, Minerals Beneficiation Div., New York, N. Y., Feb. 17, 1954.
Mitchell, T. F., Progress in Flotation of Cassiterite: AIME, Minerals Beneficiation Div., New York, N. Y., Feb. 17, 1954.

A paper dealing with a study of tinless cans stated:[21]

> * * * For the foreseeable future most of the tin-free metal cans must be manufactured from steel or steel coated with other metals. No other metal is produced in sufficient quantity to meet the needs of 35.6 billion metal cans produced annually.

The use of "Mylar," a transparent polyester film for the possible conservation of tin, was the subject of a paper. The speaker presenting the paper stated:[22]

> Experimental work is being done in laminating "Mylar" polyester film to metals and then drawing the metals into shapes. In this process, "Mylar" protects the metal, eliminating the need for lacquering or tin plating.

As part of the Bureau of Mines activities a progress report was issued presenting the results of separating cassiterite from tin slime. It stated:[23]

> Recoveries of 40 to 50 percent of the total tin in the slime and electrochemical efficiency of 3 to 4 percent are attained. In line with previous investigations on the electro-winning of tin from lower grade ores it is believed that the above preliminary laboratory research has definite industrial possibilities. Further research is being conducted to improve the procedure and to recover tin from stannous chloride formed in treated slime.

A patent for a method of forming an oxide coating on tin was issued during 1954.[24]

WORLD REVIEW

INTERNATIONAL TIN STUDY GROUP—INTERNATIONAL TIN AGREEMENT

Representatives of eight major tin producing and consuming countries met in London in October 1946 and recommended the formation of a study group for tin; in consequence, the International Tin Study Group was organized at a meeting in Brussels in April 1947. A brief report of these meetings and those of the Interim Committee of the International Tin Council through 1954 were published.[25]

Later the Tin Study Group prepared what is known as the 1950 "Paris draft" of the International Tin Agreement and requested the United Nations to convene an intergovernmental conference on tin to discuss it. A United Nations Tin Conference was convened in Geneva. There were two sessions. The first, in November 1950, was adjourned. The second, in November–December 1953, established the 1953 text of an agreement. A document outlining the proceedings of the 1950 and 1953 sessions of the conference has been published by the United Nations.[26] It contains the conference agenda, lists of representatives, the summary record of the final plenary meeting, resolutions adopted, and the text of the 1953 International Tin Agreement. The agreement was open for signature in London from March 1 to June 30, 1954, subject to ratification under constitutional procedures of the

[21] Lueck, R. H., Brighton, K. W., and Pilcher, R. W., Metal Cans of the Future: Inst. Food Technol. 14th ann. meeting, Los Angeles, Calif., June 29, 1954 (unpub.).
[22] Lanning, D. D., and Mitchell, John R., "Mylar" Polyester Film: Am. Assoc. Textile Tech., New York, N. Y., Tech. Paper, January 1954.
[23] Kershner, K. K., and Cochran, A. A., Recovery of Ultrafine Mineral Values—a Progress Report: Bureau of Mines Rept. of Investigations 5076, 1954, 7 pp.
[24] Russell, John J., and Headland, Herbert N., Process Relates to the Electrodeposition of a Tin Oxide Coating on a Tin Article: U. S. Patent 2,687,994, Aug. 31, 1954.
[25] International Tin Study Group, Statistical Bulletin: Vol. 8, No. 1, January 1955 (inside cover page).
[26] United Nations, United Nations Tin Conference 1950 and 1953—Summary of Proceedings: United Nations, N. Y., Doc. E/CONF. 12/12, May 1954, 26 pp.

signatory governments. Before entering into force, the agreement had to be signed by at least 9 consuming countries holding not less than a total of 333 votes and producing countries not less than 900 votes. By June 30, 1954, enough producing and consuming countries had signed to bring the agreement into force upon ratification. Whereas the signing of the agreement was subject to deadline, none was fixed for its ratification. As of December 31, 1954, 4 consuming countries (Australia, Canada, Denmark, and the United Kingdom) with a total of 208 votes had ratified, and 3 producing countries (Bolivia, Malaya, and Nigeria) with a voting strength of 631 also had ratified. The only important consuming countries that had not signed the agreement were the United States and the Federal Republic of Germany.

The object of the agreement was to overcome pronounced fluctuations in price. It did not fix the price of tin, but it provided for a ceiling price of 110 cents a pound (where the buffer-stock manager must sell) and a floor price of 80 cents (where the manager must buy). The manager may sell in the 100–110 cents price range; he may buy in the 80–90 cents range; and he will neither buy nor sell in the 90–100 cents range unless the International Tin Council decides otherwise. During operation of the agreement a buffer stock will be established and, if necessary, exports restricted.

The U. S. Department of State announced on August 18, 1953, that the United States would take part in the second session of the United Nations Conference in November but would not be in a position to commit itself to a specific course of action, as it would be at a time when the United States was undertaking a basic and comprehensive review of its foreign economic policy. This task had been given to the Commission on Foreign Economic Policy (established by Public Law 215, 83d Cong., 1st sess., approved August 7, 1953) which reported to the President and the Congress in January 1954.[27]

The U. S. Department of Commerce met with representatives of the tin-consuming industry in Washington on February 25, 1954, for a discussion of the proposed International Tin Agreement. Following industry's consensus, the Department of State on March 5, 1954, announced the decision of the United States not to sign the International Tin Agreement drawn at Geneva in December 1953.

> * * * It made clear that the United States did not object if other countries decided to bring the Agreement into force.* * * In announcing its decision not to sign the Agreement, the United States made clear that it was aware of the importance attached to the Agreement by other governments. Since the Agreement can come into force and can be operated without United States participation, the State Department said it did not anticipate that the United States decision would prevent the Agreement from becoming effective and made clear that the United States would not object if other governments decided that this was in their interest.[28]

WORLD MINE PRODUCTION

World mine production of tin, exclusive of U. S. S. R., decreased 800 long tons in 1954. Of the total output Asia supplied 66 percent, South America 16 percent, Africa 14 percent, and other sources 4 percent. In 1953 and 1954 6 countries—Malaya, Indonesia, Bolivia, Belgian

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[27] Randal, Clarence B., Chairman, Commission on Foreign Economic Policy Report to the President and the Congress: Jan. 23, 1954, 94 pp.; Minority Report, Jan. 30, 1954, 22 pp., and Staff Papers, February 1954, 531 pp.

[28] U. S. Department of State for the Press, No. 115, Mar. 5, 1954.

Congo, Thailand, and Nigeria, in that rank—furnished nearly 90 percent of the total. Production rose in Malaya (4,200 long tons) and Indonesia (2,000 tons) to reach the highest since 1941. These gains offset losses in output in Bolivia, Belgian Congo, Thailand, and Nigeria. In 1954 production in Bolivia decreased 6,000 long tons and

TABLE 18.—World mine production of tin (content of ore), by countries, 1945–49 (average) and 1950–54, in long tons [1]

(Compiled by Berenice B. Mitchell)

Country	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Canada	335	356	155	95	488	174
Mexico	229	440	366	413	476	349
United States	15	94	88	99	56	[2] 200
Total	579	890	609	607	1,020	723
South America:						
Argentina	527	267	242	265	158	[3] 165
Bolivia (exports)	36,965	31,213	33,132	31,959	34,825	28,824
Brazil	234	180	197	229	209	[3] 180
Peru [4]	44	38	86	31		
Total	37,770	31,698	33,657	32,484	35,192	29,169
Europe:						
France	42	81	93	282	498	531
Germany, East	31	191	257	395	563	654
Italy	37					
Portugal [5]	556	690	933	1,146	1,168	935
Spain	616	633	940	733	795	654
United Kingdom	1,004	890	841	903	1,103	940
Total [6]	2,286	2,485	3,064	3,459	4,127	3,714
Africa:						
Belgian Congo [7]	14,568	13,464	13,669	13,795	15,293	15,084
French Cameroon	104	67	72	87	86	82
French Morocco	3		13	15	9	5
French West Africa	6	51	65	110	118	72
Mozambique	1	1	8	3		
Nigeria	9,750	8,258	8,529	8,318	8,228	7,926
Rhodesia and Nyasaland, Fed. of:						
Northern Rhodesia	6	4	2	11	7	1
Southern Rhodesia	104	65	40	30	30	14
South-West Africa	148	100	76	106	210	446
Swaziland	33	37	32	36	36	34
Tanganyika (exports)	113	97	67	47	45	39
Uganda (exports)	178	192	118	110	92	86
Union of South Africa	479	643	761	935	1,360	1,315
Total	25,493	22,979	23,452	23,603	25,514	25,104
Asia:						
Burma	1,092	1,520	1,400	1,600	1,400	950
China [3]	4,300	7,500	7,500	8,600	9,600	10,000
Indochina	22	49	92	156	264	110
Indonesia	16,582	32,102	30,986	35,003	33,822	35,861
Japan	105	326	426	638	732	715
Malaya	27,667	57,537	57,167	56,838	56,254	60,690
Thailand	3,257	10,364	9,502	9,479	10,126	9,776
Total	53,025	109,398	107,073	112,314	112,198	118,102
Australia	2,130	1,854	1,559	1,611	1,553	1,979
Total (estimate) [6]	121,300	169,300	169,400	174,100	179,600	178,800

[1] The table incorporates a number of revisions of data published in previous Tin chapters.
[2] Preliminary figure.
[3] Estimated by authors of the chapter; in a few instances from Statistical Bulletin, International Tin Study Group, The Hague.
[4] Minor constituent of other base-metal ores.
[5] Excluding mixed concentrates.
[6] Excluding production of U. S. S. R.
[7] Including Ruanda-Urundi.

was the lowest since 1939. Production in Nigeria was the lowest since 1935. Among the remaining tin-producing countries the output of Australia was the highest since 1947. In France, South-West Africa, and the United States new peaks were established in 1954, although the tonnages were relatively small.

WORLD SMELTER PRODUCTION

World smelter production of tin in 1954, exclusive of U. S. S. R., increased 1,700 long tons compared with 1953. Excluding strategic stockpile accumulations, world smelter production was 47,400 tons

TABLE 19.—World smelter production of tin, by countries, 1945–49 (average) and 1950–54, in long tons [1]

(Compiled by Berenice B. Mitchell and Jane Lancaster)

Country	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Canada	335	356	155	95		
Mexico	226	290	366	140	209	[2] 240
United States	37,962	33,118	31,852	22,805	37,562	27,407
Total	38,523	33,764	32,373	23,040	37,771	27,647
South America:						
Argentina	446	253	206	185	130	60
Bolivia (exports)	107	392	39	257	174	196
Brazil	182	118	133	116	553	[2] 480
Peru [3]	44	38	86	31		
Total	779	801	464	589	857	736
Europe:						
Belgium	6,904	9,512	8,360	10,585	9,039	11,377
Germany:						
East	(4)	191	316	563	[2] 480	[2] 600
West	426	586	581	758	694	
Italy	25					
Netherlands	9,115	21,027	20,977	27,913	26,950	28,442
Portugal	248	209	313	340	471	617
Spain	908	1,597	766	687	935	676
United Kingdom [5]	28,828	28,500	27,650	29,521	28,860	27,475
Total [6]	46,454	61,622	58,963	70,367	67,429	69,187
Africa:						
Belgian Congo	4,450	3,238	3,011	2,765	2,715	2,459
French Morocco				15		8
Southern Rhodesia	104	80	63	37	27	19
Union of South Africa	728	718	829	960	828	738
Total	5,282	4,036	3,903	3,777	3,570	3,224
Asia:						
China [2]	4,000	7,000	7,000	8,000	9,000	9,400
Indochina	10					
Indonesia	221	405	217	224	644	1,351
Japan	130	389	574	637	805	799
Malaya	31,267	68,747	65,914	62,829	62,410	71,166
Thailand	436	2		17		
Total	36,064	76,543	73,705	71,707	72,859	82,716
Australia	2,159	2,014	1,459	1,700	1,443	2,063
World total (estimate) [6]	129,300	178,800	170,900	171,200	183,900	185,600

[1] This table incorporates a number of revisions of data published in previous Tin chapters.
[2] Estimated by authors of the chapter; in a few instances from Statistical Bulletin, International Tin Study Group, The Hague.
[3] Tin content of dross.
[4] Data not available.
[5] Beginning January 1948 includes production from imported scrap and residues refined on toll.
[6] Excluding production of U. S. S. R.

over world consumption. The Malayan tin-smelting plants at Penang and Singapore, the world's most important sources of pig tin, increased their output 14 percent and supplied 38 percent (34 percent in 1953) of the total. Their production was the highest since 1941. Next in rank were the Netherlands, United Kingdom, United States, and Belgium. Smelters in these 5 countries supplied about 90 percent of the world's tin in 1953 and 1954. About half of the world smelter output in 1953 and 1954 was for the United States.

WORLD CONSUMPTION

World consumption of tin increased 5 percent in 1954 compared with 1953. Table 20 presents world consumption of tin by countries. In 1954 the United States, United Kingdom, France, West Germany, Japan, Denmark, and Canada consumed 103,000 tons of primary tin. This represented 74 percent of the total world consumption. Among these only Canada decreased its use of tin in 1954. The largest increase in tonnage of tin consumed in 1954 by any country was 2,530 long tons by United Kingdom. The United States consumed 41 percent of the total in 1953 and 39 percent in 1954. The sharp increase in consumption in Denmark in 1953 and 1954 was due mainly to the use of tin in the manufacture of high-grade tin alloys for export. Figures for U. S. S. R. are omitted from the total.

TABLE 20.—World consumption of tin, by countries, 1945–49 (average) and 1950–54, in long tons [1]

Countries	1945–49 (average)	1950	1951	1952	1953	1954
Argentina	1,148	1,300	1,350	1,300	1,400	1,500
Australia and New Zealand	2,538	2,552	2,760	2,660	2,620	2,083
Belgium and Luxembourg	1,291	1,363	1,770	1,224	1,164	1,807
Brazil	1,009	1,550	1,620	1,600	1,580	1,500
Canada	3,873	4,526	4,731	4,190	3,950	3,604
Czechoslovakia	688	1,300	1,500	1,600	1,700	1,680
Denmark	429	637	880	1,140	2,650	4,010
Finland	318	418	400	375	375	375
France	6,320	7,400	7,500	7,300	7,300	8,350
Germany, West	778	7,782	7,506	7,270	5,814	6,567
India	3,647	3,700	3,900	3,900	3,700	4,000
Italy	1,120	2,700	2,900	2,500	2,400	2,500
Japan	3,030	4,616	4,091	4,536	4,650	4,800
Netherlands	2,382	3,029	2,400	8,700	4,330	3,450
Poland	1,191	2,000	2,000	1,900	1,800	1,680
Sweden	832	1,000	950	850	800	780
Switzerland	572	750	800	750	720	720
Turkey	536	650	700	700	800	840
United Kingdom	23,288	23,254	23,892	22,554	18,634	21,163
United States	55,292	71,191	56,884	45,323	53,959	54,427
Others	6,318	10,282	10,966	11,128	11,654	12,391
World total [2]	116,600	152,000	139,500	131,500	132,000	138,200

[1] International Tin Study Group, Statistical Bulletin: July 1955, p. 26.
[2] Excludes U. S. S. R.

WORLD REVIEW BY COUNTRIES

Australia.—Production of tin-in-concentrate in Australia was 1,979 long tons and represented an increase of 27 percent from the previous year. The production of refined tin in Australia during 1954 was the highest since 1947; 2,063 tons compared with 1,443 tons in 1953. Consumption of primary tin was 2,300 tons, unchanged from the previous year. In addition to the 2,300 tons of primary tin consumed, 1,000 tons of tin is contained in the tinplate imported annually.

According to a report:[29]

The British Metal Corp. has announced that their interest in the Sydney Smelting Co., has been purchased by the other part-owner, Consolidated Tin Smelters, Ltd. The change in ownership took place on January 1, 1955. The British Metal Corp. has, of course, a financial interest in Consolidated Tin Smelters.

Belgian Congo.—Production of tin-in-concentrate in Belgian Congo totaled 15,084 long tons, virtually unchanged from 1953. Domestic smelter production was 2,459 tons, a 9-percent decrease from the previous year. In 1954 the Belgian Congo, including Ruanda-Urundi, contributed 60 percent of Africa's total mine production of tin. Tin contained in exports of concentrate totaled 10,777 tons, of which Belgium received 10,351 tons, the United Kingdom 342 tons, and other countries 84 tons. Exports of tin metal from Belgian Congo totaled 2,340 tons, of which the United States received 580 tons, Belgium 1,715 tons, and Union of South Africa 45 tons.

Stocks of tin metal decreased from 350 long tons at the beginning of the year to 35 tons at the end of the year. Stocks of tin-in-concentrate decreased from 1,062 tons at the beginning of 1954 to 534 tons at the end of the year.

Effective January 1, 1954, the Belgian Congo Government reduced export taxes on both tin metal and tin concentrate from 11 percent to 7 percent of the established value.

Bolivia.—Bolivia exported 17 percent less tin in 1954 than in 1953. Total tin contained in exports of concentrate and metal in 1954 was 28,824 long tons. This represented 16 percent of the world production of tin. Nearly 57 percent of the Bolivian output was consigned to United Kingdom and approximately 42 percent to the United States, leaving 1 percent for delivery to Argentina and Chile. The distribution of exports of tin from Bolivia, by groups, in 1953–54, follows:[30]

Group:	Long tons 1953	Long tons 1954
Corporacion Minera de Bolivia	29, 500	24, 744
Banco Minero		
Medium mines	2, 390	1, 718
Small mines	2, 761	2, 166
Total tin-in-concentrate	34, 651	28, 628
Oruro smelter (tin metal)	174	196
Total tin exports	34, 825	28, 824

A tin-purchase agreement between the United States and Bolivia was signed during June 1954. The agreement provided for the sale of 12,000 long tons of tin-in-concentrate. Under the terms of the contract, the total tonnage was to be delivered at Pacific ports by April 30, 1955, payments to be based on New York market prices, averaged, 30 days following each shipment.

The 1954 Annual Report to Stockholders of the Patino Mines & Enterprises Consolidated (Inc.) interpreted the results of nationalization. The report stated in part:

The Corporation's properties have now been operated by the Bolivian Government for nearly 2 years and a half. Let us review the results. In the first 10

[29] International Tin Study Group, Notes on Tin: No. 50, March 1955, p. 876.
[30] International Tin Study Group, Statistical Bulletin: May 1955, p. 9.

months of 1952, the last year of our operations in Bolivia, in spite of the abnormal conditions preceding "nationalization" under which the Corporation operated, our monthly average production of concentrates contained 877 long tons of fine tin. In 1953 the Government reported an average monthly production of concentrates containing 801 long tons of fine tin, and in 1954 of only 700 long tons of fine tin. In spite of the fact that the mines and machinery were in perfect order at the time of "nationalization" and development work and plans covering development for at least the next 4 years were available to the new "owners," and that there were large quantities of mining equipment on hand, production under Government management has suffered a 20-percent drop. On July 18, 1954, the President of Bolivia disclosed that the cost of production was US$1.25 per pound of fine tin, while the market price was only US$0.85, so that there was an apparent loss of about US$900 per long ton of fine tin. It is to be hoped that this appalling situation is promptly resolved by an increase in the price for tin and by reducing costs of production.

Receipts of Bolivian tin concentrates at the Texas City smelter during the calendar year 1954 were:

TABLE 21.—Receipts of Bolivian ore (concentrate) at the Texas City, Tex., smelter in 1954, in long tons

Grade	Concentrate tons	Tin		Percent of total content
		Percent	Tons	
High	8,344	58.25	4,860	41
Medium	8,651	45.97	3,977	33
Low	15,330	20.61	3,159	26
Total	32,325	37.11	11,996	100

Canada.—Canadian production of tin, all in concentrate, declined to 174 long tons valued at $226,200 compared with 488 tons valued at $581,746 in 1953. The concentrate was 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., at Kimberley, British Columbia, and were smelted in Canada from 1942 to 1952; thereafter, they were shipped mostly to the United States for refining.

Of the 3,836 long tons of tin metal valued at Can$7,441,782 imported into Canada in 1954, Belgium supplied 1,131 tons, Malaya 824, Netherlands 743, the United States 713, United Kingdom 415, and Portugal 10 tons. Imports in 1953 totaled 3,702 tons valued at Can$8,263,530. Consumption in 1954 was 3,600 tons compared with 3,900 tons in 1953.[31]

China.—A report entitled "Development of Mineral Resources in Asia and the Far East" stated:[32]

In the mineral production of China, of all the essential nonferrous metals, tin is the only one to attain world importance. Normally China produced about 7 percent of the world's total and the amount recently decreased to about 4 or 5 percent.

Tin mining in China has been active for almost two hundred and sixty years. Lode mining is entirely done by crude methods, but placer mines in Kwangsi are mostly operated mechanically. Washing gives concentrates with 70 percent tin. The concentrates are smelted in blast furnaces and moulded into tin bars of 99.8 percent to 99.98 percent purity.

[31] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 5, May 1955, p. 30.
[32] United Nations, Development of Mineral Resources in Asia and the Far East: E/CN.11/374, November 1953, pp. 307-308.

Of China's tin production, the lode ore forms the bulk, and less than one-third comes from placers. Yunnan is the chief producing region followed by Kwangsi, Kwangtung, and Hunan in the order of importance. Yunnan alone produces normally about 80 percent of the total output.

In 1946, the total tin reserves of China were estimated to be 1,873,370 metric tons by V. C. Juan.

Indonesia.—In 1954 Indonesia was the second largest tin producer in the world. Production of tin-in-concentrate totaled 35,861 long tons, a 6-percent increase from 1953. The Indonesian output of tin represented 21 percent of the world total. A recent report on Indonesia stated:[33]

Tin in Indonesia is found mainly in the three islands of Bangka, Billiton, and Singkep, which are situated between Sumatra and Kalimantan (Borneo). In addition, there are also small deposits around Bangkinang on the west coast of Sumatra and on the islands of Karimun and Kundur.

Tin production in Indonesia is much more centralized than in any other country. The Bangka tinfields are owned by the Government and are worked by a Government undertaking (Perusahaan Negeri Tambang Timah Bangka). The mines on Billiton are worked by the Gemeenschappelijke Mijnbouwmaatschappij Billiton (Billiton Joint Mining Co.) 62½ percent of the shares of that company are in the hands of the Government of Indonesia and 37½ percent in the hands of the N. V. Billiton Maatschappij of The Hague. The Singkep mines are owned by a subsidiary of the Gemeenschappelijke Mijnbouwmij. In March 1948, all tin mining (including Bangka) was brought under the central management of the Gemeenschappelijke Mijnbouwmaatschappij Billiton for a period of 5 years.

The Billiton Joint Mining Co. is controlled by a management board on which the majority of the members are appointed by the Government. The day-to-day conduct of mining operations is entrusted to the Billiton Co. of The Hague, however.

Exports of tin-in-concentrate from Indonesia in 1954, in long tons, were as follows:

United States	7, 570
Netherlands	26, 368
Total	33, 938

At the end of 1954 tin-in-concentrate and other stocks in Indonesia amounted to: 3,299 long tons on Bangka, 502 tons on Billiton, and 69 tons on Singkep, or a total of 3,870 tons.

The 1954 Annual Report to Stockholders of the N. V. Billiton Maatschappij stated, in part:

The results achieved in 1954 by N. V. Gemeenschappelijke Mijnbouwmaatschappij Billiton were satisfactory though, under the influence of lower sale proceeds and increased costs, they lagged behind those of 1953. Increased difficulty was experienced in importing mining equipment and other essential materials. As a result of the continued scarcity of foreign exchange in Indonesia the allocation of foreign currency was curtailed. Moreover, the high import duties levied in Indonesia are, to an increasing extent, exercising an adverse effect on cost prices.

Another matter of special concern is that of staff establishment. The Indonesian Government is aiming at a reduction of the number of foreign employees in the country, which is evident from the increasing difficulties experienced in sending employees to Indonesia and in obtaining reentry permits for employees who have spent their leave outside Indonesia. Further, the "screening procedure" adopted takes a very long time as a result of which the maintenance of an effective organization is seriously hampered. Though with the enterprises we manage in Indonesia we pay full attention to the training of labour and employees of Indonesian Nationality, the recruiting of foreigners still is imperative.

[33] Embassy of Indonesia, Washington, D. C., Report on Indonesia: Vol. 6, No. 5, January 1955, pp. 6–9.

Japan.—Production of tin in Japan totaled 715 long tons, virtually unchanged from 1953. Production of tin concentrates was chiefly from the Hyogo and northern Kyushu districts in southern Japan. Normally 50 percent of the output has been from the Akenobe mine of the Mitsubishi Mining Co. in Hyogo and the balance from the Mitate and Obira mines in Kyushu. Tin consumption in Japan in 1954 was 4,800 tons, virtually unchanged from the previous year.

The principal tin-smelting companies in Japan are the Shin-Kiura smelter and the Mitubishi-Osaka smelter (electrolytic). The actual capacity of these 2 smelters totals 2,500 long tons annually.[34]

Malaya.—During 1954 the security position in Malaya continued to improve, although precautions were taken to protect both the personnel and the mines.

Mine production of tin-in-concentrate was 60,690 long tons in 1954 compared with 56,254 tons in 1953, 84,082 tons in the peak year 1940, and an annual average of 55,309 tons during the prewar period 1935–39.

Ninety percent of the total Malayan production of tin in 1954 was obtained by dredging (52.2 percent) and gravel pumping (37.4 percent). The percentages from other methods of mining were hydraulicing, 2 percent; open cast mining, 2 percent; underground mining, 4 percent; and dulang washing, 2 percent.

In 1954 an analysis of output by dredges shows that 77 dredges recovered 31,669 long tons of tin, or 411 tons per dredge. As of December 31, 1953, 36,899 laborers were employed in tin mines compared with 39,715 on December 31, 1954.

The smelting of tin in Malaya was carried on by two large companies—the Eastern Smelting Co., Ltd., with a smelter in Penang, and the Straits Trading Co., Ltd., with a smelter in Singapore. A small quantity of concentrate was smelted by a Chinese smelter for local consumption. The total smelter production in Malaya was 71,166 long tons during 1954. This represented an increase of 8,756 tons (14 percent) from the previous year. The Malayan smelting industry supplied 39 percent of the world smelter production in 1954. The tin content of concentrate available from Malaya was 60,691 tons compared with 56,700 tons in 1953. Imports contained 9,809 tons of tin compared with 6,320 tons in 1953. Concentrate exported in 1954, containing 148 tons of tin (45 tons in 1953), was shipped largely to the United Kingdom. Table 22 shows imports of tin-in-concentrate into Malaya during 1954.

TABLE 22.—Imports of tin-in-concentrate into Malaya in 1954

Country of origin:	*Long tons*
Burma	947
Indochina	6
Indonesia	1
Thailand	8,751
Other countries	104
Total	9,809

In 1954 exports of tin metal totaled 70,280 long tons compared with 61,752 tons in 1953. Table 23 shows exports of tin metal from Malaya during 1954.

[34] Work cited in footnote 32, p. 344.

Stocks of tin metal at the end of 1954 totaled about 2,800 long tons compared with 2,100 tons at the beginning of the year; stocks of tin-in-concentrate decreased from 5,700 tons at the beginning to 4,500 tons at the end.

TABLE 23.—Malayan exports of tin metal, 1954

Destination:	Long tons
United States	40, 429
United Kingdom	4, 975
Republic of India	3, 968
Japan	3, 722
France	2, 944
Argentina	2, 306
Italy	2, 291
Netherlands	2, 218
Canada	1, 410
Australia-New Zealand	927
Poland	690
Mexico	430
All other countries	3, 970
Total	70, 280

Mexico.—The output of tin in 1954 totaled 349 long tons and consisted of 125 tons in concentrate, 119 tons in refined tin bars, and other smelter products. These statistics do not include unreported tin consumed locally. Exports of tin in 1954 totaled 192 tons; 57 percent went to United Kingdom, 24 percent to the United States, and the remainder to Denmark and Belgium.[35] The United States imported 72 tons of tin-in-concentrate from Mexico in 1954. During the past 15 years less than 50 tons of metallic tin all told has entered the United States from Mexico.

Nigeria.—Production of tin-in-concentrate totaled 7,926 long tons in 1954, a 4-percent decrease from 1953. In 1954 tin production was chiefly in the hands of 58 incorporated companies (mainly registered in United Kingdom) and 78 private operators (mainly Europeans in Nigeria). The Nigerian industry was not highly mechanized (there was only one dredge in the territory), and about half its output still comes from small mines worked by tributers. All of the production was exported as concentrate to United Kingdom smelters. The average grade of ground worked in 1954 was 0.73 pound of cassiterite per cubic yard.

Estimated reserves of cassiterite, as of March 31, 1954, amounted to approximately 98,000 long tons of proved and 33,000 tons of indicated mineral. Assuming a recovery of 70 percent metal after smelting, this would represent 92,000 tons of tin. On the basis of the present annual output, say 8,500 tons, this would give a life of 11 years for the known Nigerian deposits (assuming that no additional reserves were developed).[36]

Thailand.—Thailand ranked as the sixth largest tin-producing country in 1954; production of tin-in-concentrate was 9,776 long tons compared with 10,126 tons in 1953. In 1954 exports of tin contained in concentrate totaled 9,518 tons. Table 24 presents exports and countries of destination in 1953–54.

[35] Work cited in footnote 31, p. 30.
[36] International Tin Study Group, Notes on Tin: No. 47, December 1954, p. 817.

TABLE 24.—Concentrate exported [1] in 1953–54, in long tons

Country:	*1953*	*1954*
Malaya	7, 174	10, 386
United States	4, 762	2, 219
Brazil	2, 159	576
Netherlands	58	39
Total	14, 153	13, 220

[1] Metal content of Thailand concentrates is between 72–74 percent tin.

At the 1954 annual meeting of the Malayan Tin Dredging, Ltd., held in London the chairman informed shareholders of a new company—Aokam Tin, Ltd.—which was formed to operate in the sea off the coast of Thailand, as follows:

> The area covered by the leases is estimated to contain some 49 million cubic yards averaging 1.45 catty or 1.93 lbs., per cubic yard and to have a total content of 710,500 piculs or 42,292 tons of tin concentrate worth, with tin at £600 per ton, about £15,000,000. The tin values are contained in a deposit averaging about 15 feet thick at a depth in the sea of from 60 to 70 feet. Operations will be carried out by grab-dredging. Conservative estimates of cost indicate that after allowing for amortization over the duration of the leases, there should remain an annual mine profit, with a tin price of £600 per ton, equivalent to 37 percent on a capital of $6,000,000.

A tin-purchase agreement between the United States and Thailand was signed August 11, 1954. The agreement provided that the United States would purchase up to 2,400 long tons of contained tin-in-concentrate from Thailand during the 8-month period ending March 31, 1955.

The principal methods of mining alluvial tin deposits in Thailand are dredging, gravel pumping, and hydraulicking. Nearly 50 percent of the production now comes from dredges and 30 percent from gravel pumps and hydraulicking. Other mines and dulang washing produce 20 percent of the total production. Data on the number of producers, as of December 30, 1954, is set forth as follows:

Number of dredges operating	22
Gravel pumping and hydraulicking (number of mines operating)	65
Other mines	256
Number of dulang washers	3, 831

Union of South Africa.—Production of tin-in-concentrate totaled 1,315 long tons, a 3-percent decrease from 1953. Smelter production of tin metal decreased to 738 tons compared with 828 tons in the previous year. Tin concentrate exports totaled 1,024 short tons valued at £306,358 in 1953, compared with 77 tons valued at £25,852 in 1952. Exports of tin concentrate by country of destination are given in the following table.

TABLE 25.—Exports of tin concentrate from Union of South Africa [1]

Destination:	*1952* Short tons	*1952* Value f.o.b., £	*1953* Short tons	*1953* Value f.o.b., £
United Kingdom	77	25, 852	692	183, 190
Netherlands	----	------	329	122, 018
Germany	----	------	2	650
Sweden	----	------	1	500
Total	77	25, 852	1, 024	306, 358

[1] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 3, September 1954, p. 39.

United Kingdom.—Tin has been mined for over 2,000 years in Cornwall and to a lesser extent in Devon. Peak production was in 1860–80, with an average output of 9,000 long tons (tin content) yearly. Since 1880 production has fallen steadily to the present, when the total output approximates 1,000 tons a year.

Mine production in the United Kingdom in 1954 was 940 long tons, a 15-percent decrease from the preceding year. United Kingdom smelter production was the third largest in the world in 1954. Output of tin totaled 27,500 tons, a decline of 1,400 tons from the previous year. Year-end stocks of tin-in-concentrate were 2,473 tons, virtually unchanged from the beginning of the year, and of metal, 4,365 tons (3,085 at the beginning). The total stocks of tin in the United Kingdom, including tin metal and concentrate afloat and visible consumers' stocks, were 8,400 tons at the end of 1954—a 9-percent increase from 7,700 tons at the beginning of the year. Exports of tin metal from the United Kingdom in 1954 were 8,100 tons compared with 13,800 tons in the previous year.

Tin consumption in the United Kingdom in 1954 increased 2,500 long tons from the previous year. Table 26 presents tin consumption in the United Kingdom, by uses, in 1951–54.

The consumption of tin, in all categories, presents a considerable increase compared with the previous year. The principal increase was in the consumption of tin for tinplate, bronze, and solder, whereas white-metal alloys decreased 230 tons.

TABLE 26.—United Kingdom tin consumption, 1951–54, excluding tin scrap, long tons [1]

Use	1951	1952	1953	1954
Tinplate	9,417	11,491	8,911	9,896
Tinning:				
Copper wire	528	506	405	596
Steel wire	114	108	78	113
Other	833	787	796	856
Total	1,475	1,401	1,279	1,565
Solder	3,277	1,849	1,651	2,130
Alloys:				
White metal	4,372	3,457	2,901	2,671
Bronze and gunmetal	2,825	2,601	2,001	2,568
Other [2]	442	405	373	452
Total	7,639	6,463	5,275	5,691
Wrought tin: [3]				
Foil and sheets	474	299	255	326
Collapsible tubes	391	243	306	384
Pipes, wire, and capsules	88	63	71	64
Total	953	605	632	774
Chemicals [4]	971	632	766	959
Other uses [5]	165	113	120	148
Grand total	23,897	22,554	18,634	21,163

[1] British Bureau of Non-Ferrous Metal Statistics, Bulletin-Statistics for December 1954: Vol. 7, No. 12, p. 68.
[2] Includes siphon top alloy.
[3] Includes compo and "B" metal.
[4] Mainly tin oxide.
[5] Mainly powder.

The United Kingdom produced 12 percent of the world's tinplate and was the second largest exporter. The tinplate mills are grouped mainly in South Wales. In 1954 production of tinplate totaled 800,000 long tons. Of the total production in 1954, 71 percent was hot-dipped tinplate and 29 percent electrolytic tinplate. Exports of tinplate from the United Kingdom totaled 300,000 tons.

Union of Soviet Socialist Republics.—An estimate of probable production of tin in Soviet Russia in 1953 was published: [37]

Considerable obscurity surrounds the actual rate of productivity of the tin industry of the U. S. S. R. It was already claimed on one occasion a few years ago that the country was self-supporting in tin supplies. This suggested that Russia was perhaps producing 15,000 to 20,000 tons of metallic tin annually. The U. S. S. R., of course, is now able to draw extensively on Chinese ore and metal.

* * * * * * *

As a rough guess, one may feel perhaps justified in estimating the tin ore and virgin tin output of the U. S. S. R. in 1953 was as follows (in metric tons):

	Ore (fine)	*Metal*
Podolsk	------	3, 000
Khapcheranga	2, 000	1, 500
Olyvannaya	2, 500	2, 000
Shulilovo	2, 000	------
Ege-Khaya	1, 500	1, 300
Tetiukhe-Pristan	2, 500	2, 300
Other including Chinese ore imports	2, 000	1, 500
Total	12, 500	11, 600

Unofficial data on the production and consumption of tin and the output of tinplate in the U. S. S. R. were published.[38]

[37] Quin Press, Ltd., World's Non-Ferrous Smelters and Refineries: London, 5th ed., 1954, pp. 409-410.
[38] International Tin Study Group, Statistical Yearbook, 1954: The Hague, October 1954, p. 257.

Titanium

By Alfred F. Tumin [1]

INDUSTRIAL importance of titanium metal, minerals, and pigments continued to increase in 1954. Intensive research on titanium metal by Government and industry led to an improved quality of metal, a reduction in metal processing losses, and an introduction of several new titanium-base alloys. Improved production techniques and record high output brought about the first price reductions for titanium metal since initial commercial production began in 1948. Although production of titanium sponge metal was increased, technical problems in melting and processing as well as high cost delayed widespread use of titanium metal. In 1954 titanium metal was chiefly consumed in the manufacture of parts for military aircraft with smaller quantities used in the chemical and civilian aircraft industries.

The Federal Government continued to encourage development of the titanium-metal industry, as it signed titanium production contracts with members of industry; established interim expansion goals in the titanium melting and processing industries; purchased, at market price, titanium sponge produced in excess of 1954 consumption; and declared titanium sponge a strategic and critical material.

The rapid growth of the titanium-metal industry in the United States stimulated interest in foreign countries, mainly England and Japan.

As demand and price for rutile concentrate increased in 1954, research was expedited on development of a feasible method for chlorinating ilmenite concentrate on a commercial scale for the production of titanium metal. The domestic supply and consumption of ilmenite and rutile concentrates are shown graphically in figures 1 and 2.

Expansion programs progressed in the titanium pigments industry in 1954 as facilities were being enlarged to meet the increased domestic and foreign demand for titanium pigments. Both production and shipments of titanium pigments established high records in 1954.

DOMESTIC PRODUCTION [2]

Concentrates.—Production and shipments of ilmenite totaled a record high 547,700 and 531,900 short tons, respectively, in 1954, an increase from 1953 of 7 percent in production and 4 percent in shipments. Ilmenite data in 1954 included a mixed product containing ilmenite, rutile, and leucoxene.

[1] Commodity-industry analyst.

[2] Production data for 1954 were collected jointly with the Bureau of the Census (U. S. Department of Commerce). Production totals will be compared with the Census totals when they are available and differences adjusted or explained.

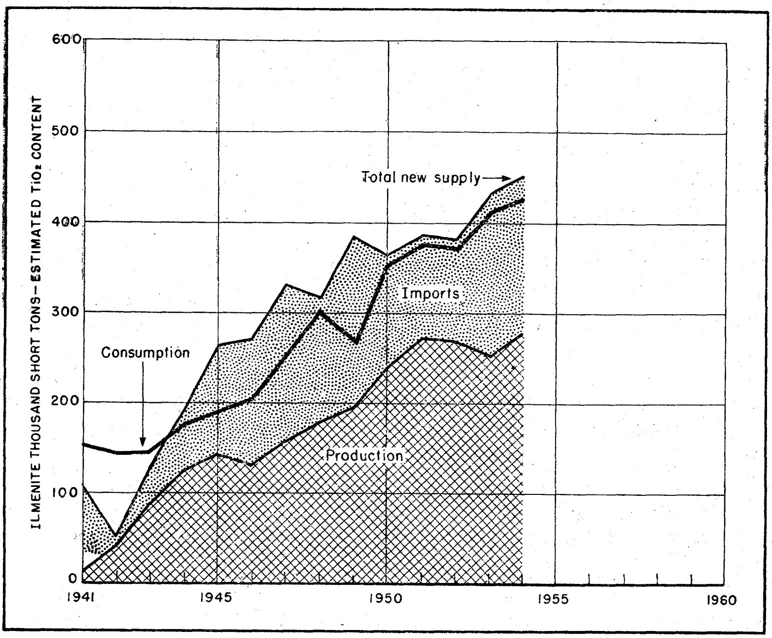

Figure 1.—Domestic production, imports, and consumption of ilmenite (includes titanium slag and a mixed product), 1941–54.

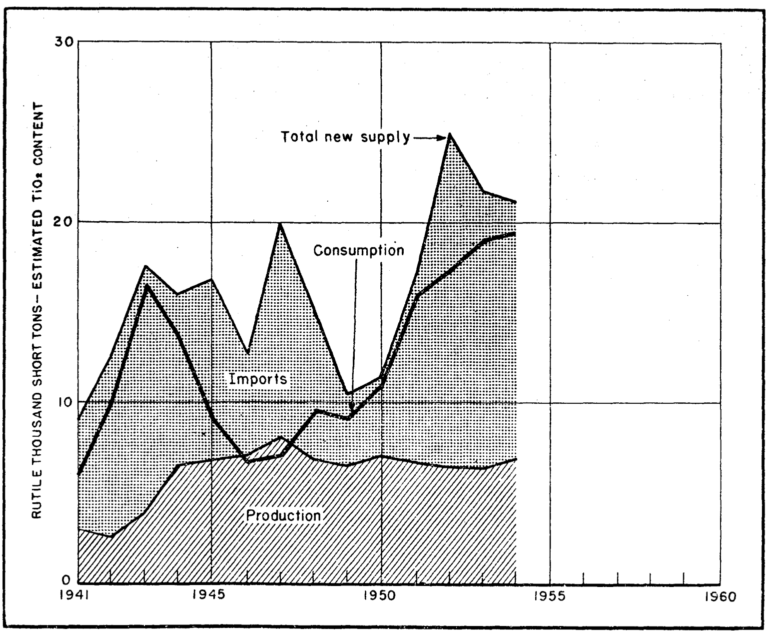

Figure 2.—Domestic production, imports, and consumption of rutile, 1941–54.

Increased output of ilmenite in 1954 from 1953 was reported by American Cyanamid Co., Piney River, Va.; E. I. du Pont de Nemours & Co., Inc., Starke, Fla.; National Lead Co., Tahawus, N. Y.; and the Titanium Alloy Manufacturing Co., Division of the National Lead Co., Jacksonville, Fla. Ilmenite was recovered also by Baumhoff-Marshall, Inc., Boise, Idaho; Florida Ore Processing Co., Melbourne, Fla. (included output of Hobart Brothers Corp., Winter Beach, Fla.); Grimes Creek Dredging Co., Grimes Creek, Idaho; Idaho-Canadian Dredging Co., Cascade, Idaho; and the Rutile Mining Co. of Florida, Jacksonville, Fla.

Rutile production and shipments were 9 percent and 13 percent higher, respectively, than in 1953. Production was by the Florida Ore Processing Co., Melbourne, Fla. (included output of Hobart Brothers Corp., Winter Beach, Fla.); Rutile Mining Co. of Florida, Jacksonville, Fla.; and the Titanium Alloy Manufacturing Co., Division of the National Lead Co., Jacksonville, Fla.

TABLE 1.—Production and mine shipments of titanium concentrates from domestic ores in the United States, 1945–49 (average) and 1950–54, in short tons

Year	Ilmenite [1]				Rutile			
	Production (gross weight)	Shipments			Production (gross weight)	Shipments		
		Gross weight	TiO_2 content	Value		Gross weight	TiO_2 content	Value
1945–49 (average)	343,711	340,602	159,601	$5,881,034	7,517	6,999	6,539	$681,264
1950	468,320	452,370	230,826	5,606,584	7,535	6,676	6,213	356,100
1951	535,835	510,840	261,982	7,689,272	7,189	10,919	10,166	545,000
1952	528,588	522,515	265,596	8,022,752	7,125	6,874	6,416	715,491
1953	513,696	512,176	258,247	7,222,641	6,825	6,476	6,043	702,791
1954	547,711	531,895	270,651	7,375,344	7,411	7,305	6,822	869,677

[1] Includes a mixed product containing altered ilmenite, rutile, and leucoxene for 1949–54, inclusive.

Rutile and brookite were removed from the Federal Government exploration program May 15, 1953; however, they were reinstated by the Defense Minerals Exploration Administration Order 1, as amended, on March 23, 1954. DMEA Order 1 provides Government aid up to 75 percent of total exploration cost of these titanium minerals.

The Internal Revenue Code of 1954 included, for the first time, a depletion allowance for ilmenite. The code stated that, for Federal income-tax purposes, the allowance of deduction for depletion of ilmenite, rutile, and other ores containing titanium, mined from deposits in the United States, was 23 percent of the gross income from the property, but such allowance was not to exceed 50 percent of the net income from the property.[3]

Metal.—Domestic production of commercially pure titanium-sponge metal totaled 5,370 short tons, more than double the 1953 output of 2,241 tons. This total production included material from E. I. du Pont de Nemours & Co., Inc., Newport, Del.; Titanium Metals

[3] Internal Revenue Code of 1954, United States Statutes at Large, 83d Cong., 2d Sess.: Vol. 68A, sec. 613, 1954, p. 208.

Corp. of America, Henderson, Nev.; Dow Chemical Co., Midland, Mich.; Cramet Inc., Chattanooga, Tenn.; and the Federal Bureau of Mines, Boulder City, Nev. Metallic titanium was produced commercially in 1954 solely by the reduction of titanium tetrachloride with molten magnesium in an inert atmosphere of helium or argon. Capacity output of 10 tons of titanium sponge per day was announced by Du Pont and Titanium Metals Corp. of America in the second half of 1954. Production of titanium sponge by the Bureau of Mines under Defense Materials Procurement Agency contract DMP–76 ceased September 7, 1954, about 2 months before the contract's termination date (October 31, 1954). Bureau of Mines production of acceptable titanium-sponge metal under the contract totaled 246 tons.

Titanium-sponge metal was placed on the Government list of strategic and critical materials on July 16, 1954. However, no titanium sponge was purchased for the National Stockpile in 1954 owing to the necessity of determining specifications and storage conditions for the material.

Under the Government expansion program, three contracts pertaining to the production of titanium metal were signed between GSA, representing the Government, and industry. These agreements are summarized as follows:

1. Horizons Titanium Corp., Princeton, N. J., contract (DMP–101) concerned the erection and operation of a pilot plant to study a new process for producing titanium metal and was signed July 1, 1954. Under the agreement, GSA will pay a maximum of $564,300 for the studies. However, if the process proves successful and the company later employs the method either to produce the metal itself or assigns production rights to another company, the cost to the Government will be refunded.

2. Dow Chemical Co., Midland, Mich., contract (DMP–99), signed July 8, 1954, called for the expansion of the company's 1954 titanium experimental facility, rated at 600 pounds per day, to 1 to 1½ short tons per day by January 1, 1956, and 5 tons per day by July 1956. The company employs a magnesium reduction process in producing titanium sponge. GSA will purchase under the contract, if the company does not find other markets, a maximum of 2 million pounds of titanium produced before July 1956. The material will be bought at market price for the first 6,000 pounds in any month and the balance at $5 per pound or at the lowest figure at which the company offers the metal to any other customer. The company agrees to maintain the rated capacity of 5 tons per day for 5 years and in case of a plant shutdown to reactivate the facility fully within 120 days.

3. The Electro Metallurgical Co. (Division of the Union Carbide & Carbon Corp.), contract (DMP–100), signed September 10, 1954, called for construction of a $31.5 million plant at Ashtabula, Ohio, to produce 7,500 short tons of titanium annually. The agreement stated that the company would use its own funds for the design, construction, and equipment of the facility. The company has the right to deliver to the Government whatever production it is unable to sell in the commercial market, up to a maximum of 7,500 tons annually. The Government has an option to buy 4,500 tons annually at the market

price prevailing at the time of delivery. The life of the agreement was to be 5 years from the time the plant began to produce titanium in commercial quantities. Initial production was to begin in 1956. The company pioneered a sodium-reduction method in place of the usual magnesium-reduction process.

The Electro Metallurgical Co. contract brought the total planned titanium-sponge capacity to 22,500 tons per year at the end of 1954. Other Government production contracts in effect in 1954 were: Du Pont, 2,700 tons annually; Titanium Metals Corp. of America, 3,600 tons annually; Cramet, Inc., 6,000 tons annually; and Dow Chemical Co., 1,800 tons annually. The Du Pont Co. was also producing 900 tons per year, independent of a Government contract.

The Western Pyromet Co., Richland, Calif., received from GSA, on August 18, 1954, the right to use a portion of the Government-owned magnesium plant at Manteca, Calif., for experimental and pilot operation on titanium production. The Government was to receive $2,000 a month during the research project.

Titanium sponge purchased by the Government in 1954 under a GSA purchase and resale program totaled 2,894 short tons. This program was established in 1951 to maintain capacity operation of sponge-manufacturing facilities during development of military applications. Titanium sponge purchased by the Government before 1954, which totaled 303 tons, was resold to industry in 1953.

At the end of 1954 the Government negotiated with all potential domestic producers prepared to enter the titanium-sponge production field, irrespective of the 25,000-ton expansion goal for titanium-sponge-metal production set on August 6, 1953. Such proposals were considered for specific approval in the light of facts and conditions prevailing at the time. In proceeding in this fashion, it was contemplated that the 25,000-ton figure may be exceeded, but no ceiling was placed officially on the additional facilities to which the Government was prepared to lend financial assistance.

The Office of Defense Mobilization announced on August 17, 1954, an interim expansion goal of 37,500 short tons per year for titanium-processing facilities to be reached by the end of 1956. A like tonnage was established by ODM for titanium-melting facilities in February 1954.

A Government Titanium Advisory Committee was established February 17, 1954, by the Office of Defense Mobilization, under Defense Mobilization Order V-2. The purpose of the committee was to facilitate the coordination of Federal policies and programs with respect to the supply of titanium and to serve as a focal point for collecting and disseminating technical information to industry.

In August 1954 a Steering Group on Titanium Research and Development was set up under the sponsorship of the Assistant Secretary of Defense for Research and Development. The functions of the group were to formulate Department of Defense policy on titanium and to deploy the Army, Navy, and Air Force efforts in ways that will achieve maximum results. The group finalized a proposal that was pending in 1954 with the Battelle Memorial Institute, Columbus, Ohio, for establishing at the institute a laboratory to provide technical advice to Government contractors, such as (1) collecting and disseminating information on research and development of titanium, (2) providing technical advisory service to producers and users of titanium, (3) providing advice and assistance to the Steering Group in its appraisal of the research and development program of the Defense Department, (4) helping in developing specifications, and (5) conducting short-range laboratory investigations.

The domestic output of titanium mill products (sheet, plate, etc.) totaled 1,299 short tons in 1954; it came from plants operated by Mallory-Sharon Titanium Corp., Niles, Ohio; Rem-Cru Titanium, Inc., Midland, Pa.; Republic Steel Corp., Cleveland, Ohio; and Titanium Metals Corp. of America, New York, N. Y. Reportedly, 1,214 tons of titanium mill products was consumed in 1954 in producing jet engines and gas turbines (650 tons), aircraft structural parts (500 tons), and machine parts—mainly ordnance forgings (40 tons), chemical processing equipment (20 tons), and marine hardware (4 tons).

Business and Defense Services Administration Order M–107, dated May 19, 1954, authorized producers of titanium mill products to release 10 percent of their monthly output to civilian users. This action was taken to permit the industry to expand titanium output and development along normal lines.

Mallory-Sharon Titanium Corp. titanium-melting facilities at Niles, Ohio, produced about 65 percent of its projected estimate of titanium mill products in 1954, as melting operations were halted by an explosion on June 11, 1954. The firm, however, reported the following increases in its titanium operations in 1954 from 1953: Value of titanium sales, 118 percent; weight of titanium shipments to customers, 151 percent; and weight of titanium ingots produced, 159 percent. The firm recycled over 22 tons of titanium scrap in 1954. Under Mallory-Sharon's expansion program, additional and improved facilities that will double the firm's annual titanium output were scheduled to be in operation by March 1, 1955. The new melting units will employ a combination of the best features found in "Method S" (Consumable Electrode-Double Melting) with those of new vacuum-melting techniques. In addition to the expanded melting units, two large hydraulic presses for the fabrication of pressed titanium sponge electrodes were being installed in 1954.[4]

A titanium pilot plant having a daily output capacity of 200 pounds of titanium was operated in 1954 by Kennecott Copper Corp.[5] at Battelle Memorial Institute, Columbus, Ohio. According to reports, results of research showed that the pilot plant can be operated continuously and that a uniform quality of titanium metal can be produced. Kennecott designed and began constructing a commercial-size dissociation unit in 1954, and plans called for operation of the unit as a part of the pilot plant in May 1955. The design of a semicommercial plant with an annual output capacity of 1,000 tons was also started by the firm in 1954. Construction of the plant is scheduled to begin when satisfactory operating conditions are established on the commercial-size deposition unit.

[4] P. R. Mallory & Co., Inc., Annual Report Year Ended December 31, 1954: Indianapolis, Ind., pp. 20–21.
[5] Kennecott Copper Corp., Annual Report for 1954: New York, N. Y., 12 pp.

Welding-Rod Coatings.—Production of titanium-coated welding rods was 184,200 short tons in 1954, a decrease of 25 percent from the 245,700 tons produced in 1953; 266,400 tons was coated in 1952 and 287,100 tons in 1951. Of the 1954 tonnage 46 percent was coated with natural rutile, 14 percent with manufactured titanium dioxide, 10 percent with a mixture of rutile and manufactured titanium dioxide, 29 percent with ilmenite, and 1 percent with titanium slag. A quantity of less than 1 percent was coated with a mixture of ilmenite and rutile.

Pigments.—Owing to increased industrial demand in 1954, production and shipments of titanium pigments increased 3 and 2 percent, respectively, from 1953, and both established high records.

Expansion programs were under way in the titanium-pigment industry in 1954 by the American Cyanamid Co., Glidden Co., and National Lead Co. The American Cyanamid Co. continued constructing its new $14 million titanium-pigment plant at Savannah, Ga. Plans called for the facility to be completed and placed in operation by mid-1955. The company reported the sale of its Gloucester City, N. J., titanium-pigment plant to New Jersey Zinc Co., New York, N. Y., in March 1954. According to the purchase agreement, the New Jersey Zinc Co. will gain possession of the plant as soon as the Georgia plant is in operation.[6]

The Glidden Co. disclosed plans in July 1954 for constructing a $10 million titanium-pigment plant rated about 18,000 tons per year at Hawkins Point, Md., and completion by the end of 1955.

In July 1954 the National Lead Co. announced construction of additional facilities at its St. Louis, Mo., plant.[7] The new facilities, scheduled for initial operation in July 1955, will add 36,000 tons to the company's annual production of titanium pigments. Reportedly, the new addition is designed to permit greater manufacturing flexibility, such as the manufacture of either calcium-base or pure pigment instead of the past restricted production of calcium-base pigments. Upon completion of the expansion program by National Lead, 300 employees will be added to its work force of 1,200 workers.

CONSUMPTION AND USES

In 1954 the consumption of ilmenite concentrates totaled 679,900 short tons (with an estimated titanium dioxide content of 353,100 tons) and decreased slightly from 1953 revised figures of 687,200 tons (with an estimated titanium dioxide content of 354,600 tons). Lower consumption of ilmenite concentrates was offset by increased use of titanium slag in the pigment industry. Titanium-slag consumption increased about 37 percent in 1954 from 1953 and set another high record. A mixed product containing ilmenite, rutile, and leucoxene, also consumed in 1954, is included with ilmenite consumption. About 99 percent of the ilmenite consumed in 1954, as in preceding years, went into the manufacture of titanium dioxide for titanium pigments. About 64 percent of the titanium pigments was used in the paint,

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[6] E&MJ Metal and Mineral Markets, This Week in the Markets: Vol. 25, No. 11, March 18, 1954, p. 3.
[7] American Metal Market, National Lead to Build New Titanium Dioxide Plant at St. Louis: Vol. 61, No. 128, July 7, 1954, p. 1.

enamel, and lacquer industries, and the remainder went into paper, rubber, floor coverings, coated fabrics, textiles, printing ink, and other miscellaneous commodities. The other 1 percent of ilmenite was used in making titanium alloys, carbide, and welding-rod coatings.

Rutile consumption of 20,663 short tons (with an estimated titanium dioxide content of 19,431 tons) exceeded the high record established in 1953 of 20,019 tons (with an estimated titanium dioxide content of 18,888 tons). Rutile was used mainly for welding-rod coatings, titanium metal, alloys, and carbide, with smaller quantities consumed for ceramics, chemicals, and fiberglass. The increase in consumption was caused by expansion of the titanium metal industry.

Consumption of titanium concentrates in the United States, by products, can be found in table 2.

TABLE 2.—Consumption of titanium concentrates in the United States, 1945–49 (average), 1950–52 total, and 1953–54, by products, in short tons

Product	Ilmenite [1]		Titanium slag		Rutile	
	Gross weight	Estimated TiO_2 content	Gross weight	Estimated TiO_2 content	Gross weight	Estimated TiO_2 content
1945–49 (average)	468,564	242,280			8,902	8,271
1950	679,244	351,675			11,721	10,869
1951	713,363	373,037			17,227	16,018
1952	682,850	351,553	24,236	16,746	18,317	17,353
1953						
Pigments (mfg. TiO_2) [2]	[3] 676,238	[3] 348,984	73,324	52,368		
Welding-rod coatings [2]	990	584			10,476	9,812
Alloys and carbide	[3] 9,974	[3] 4,979			[3] 3,849	[3] 3,676
Ceramics	5	3			317	295
Miscellaneous	19	11	[4] 204	[4] 143	[5] 5,377	[5] 5,105
Total	[3] 687,226	[3] 354,561	73,528	52,511	[3] 20,019	[3] 18,888
1954						
Pigments (mfg. TiO_2) [2]	673,506	349,857	100,670	70,993		
Welding-rod coatings [2]	845	501			8,817	8,169
Alloys and carbide	5,535	2,779			2,627	2,510
Ceramics	9	5			372	348
Miscellaneous	8	4	[4] 155	[4] 109	[5] 8,847	[5] 8,404
Total	679,903	353,146	100,825	71,102	20,663	19,431

[1] Includes a mixed product containing altered ilmenite, leucoxene, and rutile used to make pigments and metal for the years 1949 to 1954.
[2] "Pigments" include all manufactured titanium dioxide, consumption of which in welding-rod coatings was 2,209 tons in 1952, 1,986 tons in 1953, and 1,192 tons in 1954.
[3] Revised figure.
[4] Includes consumption for welding-rod coatings and research purposes.
[5] Includes consumption for chemicals, metal, and fiberglass.

Three new titanium-base alloys reported available for commercial use in 1954 are discussed individually as follows:

1. Rem-Cru Titanium, Inc., Midland, Pa., announced[8] in January 1954 the production of the first high-strength weldable titanium alloy containing 5 percent aluminum and 2.5 percent tin. This alloy, having a yield strength of 110,000 pounds per square inch, was designed to combine the weldability of unalloyed titanium with improved strength at room and elevated temperatures. The alloy

[8] Rem-Cru Titanium, Inc., Midland, Pa., Rem-Cru A.110—a New All-Alpha Titanium-Base Alloy: Rem-Cru Titanium Review, vol. 2, No. 1, January 1954, pp. 1, 2.

TABLE 3.—Distribution of titanium pigment shipments, by industries, 1945–49 (average) and 1950–54, in percent of total

Industry	1945–49 (average)	1950	1951	1952	1953	1954
Distribution by gross weight:						
Paints, varnishes, and lacquers	78.1	74.5	73.3	70.9	67.1	64.3
Paper	6.0	6.2	5.9	7.0	9.7	10.1
Floor coverings (linoleum and felt base)	3.5	4.2	4.4	5.0	4.8	4.5
Rubber	2.3	3.0	2.5	2.8	3.4	3.1
Coated fabrics and textiles (oilcloth, shade cloth, artificial leather, etc.)	1.8	1.5	1.5	2.1	2.0	2.4
Printing ink	.9	.9	1.3	1.0	1.2	1.2
Other	7.4	9.7	11.1	11.2	11.8	14.4
Total	100.0	100.0	100.0	100.0	100.0	100.0
Distribution by titanium dioxide content:						
Paints, varnishes, and lacquers	71.4	66.9	64.9	62.9	58.8	55.4
Paper	8.5	9.1	8.9	10.4	14.1	14.1
Floor coverings (linoleum and felt base)	4.4	5.2	5.7	5.6	5.4	5.2
Rubber	3.0	3.9	3.4	3.6	4.5	4.0
Coated fabrics and textiles (oilcloth, shade cloth, artificial leather, etc.)	2.3	2.0	2.1	2.9	2.6	3.2
Printing ink	1.5	1.4	1.8	1.6	1.6	1.6
Other	8.9	11.5	13.2	13.0	13.0	16.5
Total	100.0	100.0	100.0	100.0	100.0	100.0

was recommended by the company for use in welded rings, compressor blades, and all parts requiring maximum elevated-temperature strength.

2. Armour Research Foundation, Illinois Institute of Technology, Chicago, Ill., under contract with Army Ordnance, Watertown Arsenal Laboratory, Watertown, Mass., developed a titanium alloy [9] that contains 6 percent aluminum and 4 percent vanadium. Tests by Watertown Arsenal showed that the titanium alloy, heat-treated to a tensile strength of 190,000 pounds per square inch, maintained a ductility of 14-percent elongation, 45-percent reduction in area, and Charpy impact values of 11 foot-pounds at 40° F. In comparison, properties of heat-treated 410 chromium stainless steel showed a maximum heat-treated strength of about 190,000 pounds per square inch with 10-percent elongation, 20-percent reduction in area, and 20- to 30-foot-pound Charpy impact. The alloy, considered suitable as a replacement for steel in military weapons, was produced on a commercial scale by Mallory-Sharon Titanium Corp., Niles, Ohio, and Titanium Metals Corp. of America, New York, N. Y.

3. Battelle Memorial Institute, Columbus, Ohio, under a research program sponsored by the United States Air Force, disclosed a titanium-base alloy containing 3 percent manganese and 1 percent each of iron, chromium, vanadium, and molybdenum. Precise heat treatments produced a wide range of mechanical properties, with a maximum yield strength of 220,000 pounds per square inch. The alloy, adapted for fastener applications where welding is not a problem, was also produced commercially by Mallory-Sharon Titanium Corp.[10]

[9] Materials & Methods, Tougher, Stronger Titanium Alloy: Vol. 40, No. 1, July 1954, p. 11. Two Titanium Alloys Now in Quantity Production: Vol. 41, No. 4, April 1955, pp. 146. 148. Titanium Metals Corp. of America, Titanium Engineering Bulletin 1, New York, N. Y., 1954, 12 pp.

[10] Frost, Paul D., Metallurgical Considerations in Titanium Bolt Manufacture: Rept. of First Nat. Symposium for Titanium Standard Parts, October 11 and 12, 1954, pp. 69–90 (printed and distributed by National Standards Assoc., 527 Washington Loan & Trust Bldg., Washington 4, D. C.). Light Metal Age, New Titanium Alloy Reported at Battelle: Vol. 11, Nos. 11 and 12, December 1954, p. 43.

Studies on the fabrication of titanium metal [11] were conducted by the Chase Brass & Copper Co., Waterbury, Conn. (a subsidiary of Kennecott Copper Corp.), in 1954. According to the firm, the first titanium tubing was extruded commercially for the United States Government as a result of its development work. Other accomplishments included titanium wire drawn from extruded rod, the construction of a special high-temperature furnace for studying properties of titanium at high temperatures (2,900° F.,) and the construction of a titanium-melting furnace for the purpose of obtaining experience in the casting of titanium.

Commercially pure titanium was precision rolled to 0.0005 inch by the American Silver Co., Inc., on 2-high, 4-high, and Sendzimir rolling mills in 1954. The Sendzimir is a cluster-type mill capable of rolling 300 feet per minute. Final slitting to close tolerance widths was performed by precision gang slitters. Titanium foil was used for fire shields, brackets, and shims for aircraft; valve parts and tank and tube liners in the chemical industry; and instrument parts where strength and resistance to corrosion are required. Data on production, properties, welding, brazing, annealing, and forming of titanium foil and a list of suggested applications were published in 1954.[12]

Titanium metal was utilized in 1954 in constructing United States Air Force supersonic jets—the North American Super Sabre F–100, the Convair F–102, and the Douglas X–3; also in key applications in the Boeing B–52 and the luxury commercial airliner, the Douglas DC–7.[13] Titanium metal was used in nonstructural aircraft parts, mainly where heat and corrosion protection are required, such as shrouds and firewalls that protect controls and equipment from excessive heat, and ammunition boxes and gun blast tube housings that must withstand the corrosive gases of shell explosions. Titanium was also used in jet engines for compressor disks, blades, spacer rings, and many other forged and machined parts.[14]

Titanium Metals Corp. of America, New York, N. Y., reported in May 1954 a new application for titanium as a skin covering for helicopter rotor blades. The titanium blades reduced the weight of the helicopter 68 pounds and resulted in increased payload. The value of the weight saved in the titanium-skinned blades is more than two-thirds the cost of the blades in production.[15]

Titanium control valves were manufactured by the Minneapolis-Honeywell Regulator Co. in 1954. The titanium valve resisted a corrosive solution that had an inlet pressure of 3,000 p. s. i. with a 2,700 p. s. i. pressure drop across the valve. The port of the valve is 1 inch in diameter. A stainless steel valve used in the same application lost control after 70 hours of service. The titanium valve operated 1,680 hours without overhauling—24 times longer than stainless steel.[16]

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[11] Work cited in footnote 4.

[12] American Silver Co., Inc., Titanium Foil: Tech. Data Sheet 100; Flushing, N. Y., December 21, 1954, 2 pp.

[13] Rem-Cru Titanium, Inc., Titanium—1954–55, An Inventory of Progress: Rem-Cru Titanium Rev., vol. 3, No. 1, January 1955, p. 2.

[14] Modern Metals, Titanium in Jet Engines: Vol. 10, No. 11, December 1954, pp. 42–43.

[15] American Metal Market, Titanium Blades Lighten Helicopter by 68 pounds; Means Increased Payload: Vol. 61, No. 85, May 5, 1954, pp. 1, 3.

[16] Rem-Cru Titanium, Inc., Giant Titanium Valve Meets Corrosion Challenge: Rem-Cru Titanium Review, vol. 2, No. 4, October 1954, p. 1.

STOCKS

Year-end stocks of ilmenite, titanium slag, and rutile (titanium dioxide content basis) were sufficient to sustain industry at the 1954 rate of consumption for 11.2, 9.7, and 10.2 months, respectively. Stock reports for ilmenite, titanium slag, and rutile showed an increase of 4, 5, and 3 percent, respectively, in 1954 from 1953. Mine, distributors', and consumers' stocks of titanium concentrates can be found in table 4.

TABLE 4.—Stocks of titanium concentrates in the United States at end of year 1953–54, in short tons

Stocks	Ilmenite		Titanium slag		Rutile	
	Gross weight	Estimated TiO_2 content	Gross weight	Estimated TiO_2 content	Gross weight	Estimated TiO_2 content
1953 [1]						
Mine	56,738	24,010			655	611
Distributors [2]	421	253			4,240	4,060
Consumers	553,116	284,763	77,926	55,002	11,972	11,374
Total stocks	610,275	309,026	77,926	55,002	16,867	16,045
1954						
Mine	72,554	30,677			761	709
Distributors	715	425			1,934	1,855
Consumers	562,728	296,626	81,803	57,483	14,637	13,890
Total stocks	635,997	327,728	81,803	57,483	17,332	16,454

[1] Revised figures reflecting inventory corrections reported by industry.
[2] Includes rutile content of mixed zirconium-titanium concentrates.

PRICES

Concentrates.—The E&MJ Metal and Mineral Markets quoted the following nominal prices for ilmenite and rutile concentrates in 1954: Ilmenite, 59.5 percent TiO_2, f. o. b. Atlantic seaboard, $18 to $20 per gross ton throughout 1954; rutile, 94 percent TiO_2, 5 to 6 cents per pound at the beginning of 1954, 5½ to 6 cents in May, 5¾ to 6¼ cents in July, 6 to 6½ cents in August, 6½ to 6¾ cents in October, and 6¾ to 7 cents from November to the end of 1954. Price quotations for titanium dioxide in concentrates, metallurgical grade, were published in the Oil, Paint and Drug Reporter in December 1954 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 titanium dioxide, $7.50 per ton higher).

Manufactured Titanium Dioxide.—Market prices for manufactured titanium dioxide remained the same in 1954 as in 1953. Price quotations on manufactured titanium dioxide at the end of 1954, 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

Titanium Tetrachloride.—The price of titanium tetrachloride, the basic material consumed in the production of titanium sponge-metal, was quoted in the Oil, Paint and Drug Reporter in 1954 as follows:

	Jan. 1, 1954, to May 2, 1954	*May 3, 1954, to Dec. 31, 1954*
Tank cars, per pound, works	$0. 44½	$0. 39¾
Drums, carlots, works	. 45½	. 40¾
Less than carlots, works	. 48½–. 56½	. 43¾

Metal.—The first price reductions for ductile titanium-sponge metal in the titanium-metal industry were announced by E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., in 1954. Prices for titanium sponge were quoted by the titanium-metal industry in 1954, per pound, as follows:

	Jan. 1, 1954, to Mar. 31, 1954	*Apr. 1, 1954, to Nov. 30, 1954*	*Dec. 1, 1954, to Dec. 31, 1954*
Grade A–1 (0.30 percent iron, max.)	$5. 00	$4. 72	$4. 50
Grade A–2 (0.50 percent iron, max.)	--------	4. 46	4. 00

Before April 1, 1954, titanium sponge had been $5 a pound since the first commercial production of titanium metal in 1948.

The price of titanium powder (96 to 98 percent Ti) was quoted by Metal Hydrides, Inc., Beverly, Mass., at $9 per pound in lots less than 5,000 pounds and $7.95 per pound in lots of 5,000 pounds or more.

Titanium Metals Corp. of America, New York, N. Y., and Rem-Cru Titanium, Inc., Midland, Pa., announced in 1954 price reductions that ranged from 8 to 14 percent on titanium-mill-product extras. TMCA reduced its prices on titanium sheet and plate extras on February 11, 1954, and on titanium strip extras on April 26, 1954. Rem-Cru cut its prices for bar and billet extras on February 19, 1954. Mill products (base price), as published at the end of 1954 in Steel Magazine, per pound, in lots of 10,000 pounds and over, commercially pure and alloy grades, f. o. b. mill, were:

Sheet	$15
Strip	15
Sheared mill plates	12
Wire	11
Forging billets	9
Hot-rolled and forged bars	9

Low-carbon ferrotitanium, as quoted in Steel Magazine, was:

Low-carbon, (Ti, 20–25 percent; Al, 3.5 percent max.; Si, 4 percent max.; C, 0.10 percent max.). Contract, ton lots 2 inch x D, per pound of contained titanium	$1. 50
Less-than-ton lots per pound	1. 55
(Ti, 38–43 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

Prices quoted by the Titanium Alloy Manufacturing Division of the National Lead Co. for high-carbon and medium-carbon ferrotitanium were as follows:

High-carbon (Ti, 15–18 percent; C, 6–8 percent)	$187
Medium-carbon (Ti, 17–21 percent; C, 2–4.5 percent)	210

The above prices were 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.

The last price change announced by the Titanium Alloy Mfg. Div. of the National Lead Co. was in June 1953, when the price of medium-carbon ferrotitanium was raised from $195 to $210 per ton and the price of high-carbon ferrotitanium was raised from $177 to $187 per ton.

FOREIGN TRADE [17]

Imports.—Technical difficulties in the manufacture of Canadian titanium slag resulted in lower United States imports of titanium concentrates in 1954 than in 1953. Titanium slag, averaging 70 percent titanium dioxide, constitutes a 39 percent (gross weight) of the material reported as ilmenite concentrate imported in 1954 compared with 49 percent in 1953. In 1954 imports of ilmenite concentrate from India increased 14 percent, whereas receipts of rutile concentrate from Australia decreased 7 percent from 1953.

United States receipts of commercially pure titanium metal from Japan amounted to 386,100 pounds ($1,375,200) in 1954; this was an increase of 314,800 pounds from 1953. Titanium potassium oxalate, compounds, and mixtures containing titanium were imported in 1954 from Canada (100 pounds), United Kingdom (9,000 pounds), and West Germany (1,400 pounds). Ferrotitanium imports from the United Kingdom totaled 10,000 pounds in 1954.

Titanium ores and concentrates entered the United States in 1954 tariff free, but the duty on titanium metal continued to be 20 percent ad valorem.

Exports.—Shipments of titanium products from the United States in 1954 consisted largely of titanium pigments. Domestic exports of titanium dioxide and pigments totaled 63,802 short tons in 1954, an increase of 60 percent from the high record in 1953. Canada was by far the chief recipient of titanium pigments, with 22,572 tons. Other countries that received 1,000 tons or more were as follows: Australia 3,386, Belgium-Luxembourg 2,799, Brazil 2,056, Cuba 1,362, France 2,052, Italy 1,298, Mexico 2,495, Netherlands 4,333, New Zealand 1,010, Philippines 1,107, Sweden 1,086, Union of South Africa 1,248, United Kingdom 5,144, Venezuela 1,365, and West Germany 3,287. The remainder was distributed among 33 countries. Titanium concentrates were shipped in 1954 to Canada (571 tons), France (45 tons), Mexico (37 tons), and the United Kingdom (10 tons). Exports of titanium metal and alloys in crude form and scrap totaled 48 tons in 1954, with the United Kingdom the major recipient (47 tons). Titanium semifabricated forms were exported in 1954 to Canada (37 tons) and the United Kingdom (127 tons); a quantity of less than a half ton was distributed among the following countries:

[17] 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.

Australia (60 pounds), France (387 pounds), Sweden (415 pounds), and Switzerland (38 pounds). Exports of titanium ferroalloys totaled 172 tons in 1954, as shipments to Canada, the major recipient, totaled 148 tons. The remaining quantity (25 tons) was shipped to France (11 tons), Italy (12 tons); Belgium-Luxembourg and Chile each received less than 1 ton.

TABLE 5.—Titanium concentrates[1] imported for consumption in the United States, 1945–49 (average) and 1950–54, by countries, in short tons

[U. S. Department of Commerce]

Country of origin	1945–49 (average)	1950	1951	1952	1953	1954
ILMENITE						
North America: Canada	4,084	1,357	[2] 3,776	[3] 38,451	[3] 139,585	[3] 107,521
South America: Brazil	3,844	----	1	----	----	----
Europe:						
France	----	1	----	----	----	----
Norway	27,080	27,155	----	----	----	----
Total	27,080	27,156	----	----	----	----
Asia:						
Ceylon	(4)	----	----	----	----	----
India	226,974	187,834	185,145	145,562	147,005	167,484
Malaya	667	----	56	----	----	----
Total	227,641	187,834	185,201	145,562	147,005	167,484
Africa: Egypt	144	----	----	----	----	----
Oceania: Australia	682	112	100	----	54	----
Total as reported	263,475	216,459	189,078	184,013	286,644	275,005
Australia: In "zirconium ore" [5]	525	----	----	----	----	----
Grand total	264,000	216,459	189,078	184,013	286,644	275,005
Value of "as reported"	$1,737,278	$1,198,545	$1,323,438	$2,478,077	$5,463,526	[6] $4,993,402
RUTILE						
South America: Brazil	53	----	----	----	----	----
Europe: Norway	(4)	----	----	----	----	----
Asia: India	23	----	----	----	----	----
Africa: French Cameroon [7]	(4)	----	----	----	----	----
Oceania: Australia	5,353	3,427	11,023	19,394	16,098	14,965
Total as reported	5,429	3,427	11,023	19,394	16,098	14,965
Australia:						
In "zirconium ore" [8]	1,970	1,133	210	156	84	95
In "ilmenite" [9]	1,012	----	----	----	----	----
Grand total	8,411	4,560	11,233	19,550	16,182	15,060
Value of "as reported"	$309,847	$149,733	$491,383	$1,728,803	$1,791,494	$1,323,183

[1] Classified as "ore" by the 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] Due to changes in tabulating procedures by the U. S. Department of Commerce data known not to be comparable to earlier 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 1945–49.
[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.

TABLE 6.—Exports of titanium products from the United States, 1945–49 (average) and 1950–54, by classes

[U. S. Department of Commerce]

Year	Ore and concentrates		Metal and alloys in crude form and scrap		Primary forms, n. e. c.		Ferroalloys		Dioxide and pigments	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1945–49 (average)	1,244	$169,231	(1)	(1)	(1)	(1)	492	$78,198	21,351	$5,172,008
1950	600	57,753	(1)	(1)	(1)	(1)	171	42,741	32,660	8,799,758
1951	646	63,050	(1)	(1)	(1)	(1)	175	107,718	39,242	13,274,143
1952	870	110,737	(2) 762	(2) $31,134	3	$38,979	325	88,664	35,636	10,691,698
1953	(3) 1,368	(3) 109,878	(3) 2	(3) 11,858	31	(3) 798,077	185	48,722	39,780	11,715,798
1954	663	85,896	48	1,107,582	164	3,567,054	172	39,885	63,802	23,281,039

[1] Not separately classified.
[2] Believed to include material other than commercially pure titanium metal.
[3] Revised figure.

TECHNOLOGY

Beneficiation tests on material from a deposit in Magnet Cove, Ark, indicated the feasibility of recovering at least 50 percent of the titanium and columbium by gravity processes. Rutile was reported floatable with a wide variety of collectors, such as fatty acids, soaps, amines, and sulfonated oils, but the gangue carbonates were almost equally responsive to the same reagents.[18]

Research on electroplating titanium from aqueous, nonaqueous, and fused-salt electrolytes showed that metals were produced only in fused-salt electrolytes, the major product being a spongelike metal. All other electrolytes gave only partial reduction of the metal ions.[19]

Experimental measurements were reported of heats of formation at ordinary temperature of 11 titanates—ilmenite, perovskite, barium metatitanate, strontium metatitanate, barium-strontium metatitanate, barium orthotitanate, strontium orthotitanate, barium-strontium othotitanate, geikielite, magnesium-titanium spinel, and magnesium dititanate. The experimental method was solution calorimetry. The solution calorimeter was operated at 73.7° C. and used a strong hydrofluoric-hydrochloric acid mixture as the calorimetric fluid and reaction medium.

The newly measured heat data were combined with previously published entropy and high-temperature heat-content values to obtain heats and free energies of formation at all temperatures between 298° and 1,880° K. This made it possible to evaluate readily the thermodynamic stabilities and potential reactivities of the titanates at processing temperatures.[20]

Tests on the effect of gaseous contaminants in a helium atmosphere on the properties of arc welds in titanium metal showed (1) welds in titanium made in a pure helium atmosphere have tension and bend properties comparable with those of the parent material, (2) severe

[18] Nieberlein, V. A., Fine, M. M., Calhoun, W. A., and Parsons, E. W., Progress Report on Development of Columbium in Arkansas for 1953: Bureau of Mines Rept. of Investigations 5064, 1954, pp. 5–11.
[19] Creamer, R. M., Chambers, D. H., and White, C. E., Some Aspects of the Electrodeposition of Titanium and Zirconium Coatings: Bureau of Mines Rept. of Investigations 5093, 1954, 39 pp.
[20] Kelley, K. K., Todd, S. S., and King, E. G., Heat and Free Energy Data for Titanates of Iron and the Alkaline-Earth Metals: Bureau of Mines Rept. of Investigations 5059, 1954, 37 pp.

embrittlement occurs when oxygen or nitrogen comprise 10 percent of the gaseous mixture, (3) considerably less than 1 percent of either nitrogen or oxygen should be present if properties are to approach those of welds made in pure helium, (4) helium atmospheres should have a relative humidity of less than 5 percent for the resultant welds to be comparable to those made in pure helium, and (5) hydrogen, even as high as 10 percent by volume in the mixture, has little effect on tensile and bend properties of titanium welds.[21]

Studies of the Kroll process to obtain data on the mechanism of titanium reductions and to determine the cause of zonal variation of hardness of crude titanium sponge showed that, after 5 percent reduction, titanium formed as a ring attached to the wall of the reactor and extended upward from the point initially marking the juncture of the upper surface of the magnesium with the wall. With increasing additions of titanium tetrachloride the ring of deposited metal continued to extend farther up the wall and also outward toward the center of the retort. When 30 to 40 percent of magnesium requirements were utilized, the spongy titanium formed a layer that bridged completely across the reactor. Consideration of data proved that zonal variations of hardness in the crude sponge were caused largely by impurities in the magnesium. Of the principal impurities (iron, manganese, and oxygen) that remained after the titanium sponge had been melted to form an ingot, manganese had the least effect on the hardness.[22]

General information on the operations of a commercial titanium-metal plant was released by the Titanium Metals Corp. of America in 1954. Its Henderson, Nev., titanium plant is the first fully integrated titanium establishment with facilities for chlorination of titanium ore and recovery of magnesium and chlorine by electrolysis of magnesium chloride.[23]

Of the major titanium concentrates, rutile was reported the least troublesome in the production of titanium metal by the chloride process. The chlorination of ilmenite encountered the problem of handling impurities such as iron, magnesia, calcium oxide, silica, and alumina. Iron was the most objectionable impurity, as it consumed a large quantity of chlorine, formed ferric chloride which tended to clog offtake lines, and formed sludge in the condensed titanium tetrachloride. Similar impurities were also found in using titanium slag as feed material, which prevented effective chlorination of titanium values.[24]

A vacuum-melting process that permitted the removal of hydrogen from titanium metal down to as low as 50 parts per million was described by the Titanium Metals Corp. of America. Other features were reported, such as improved metal homogeneity, more stable

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[21] Barrett, J. C., and Lane, I. R., Jr., Effect of Atmospheric Contaminants on Arc Welds in Titanium: Welding Jour, vol. 33, No. 3, March 1954. Research Supplement 121-s to 128-s.

[22] Wartman, F. S., Baker, D. H., and others, Some Observations on the Kroll Process for Titanium: Jour. Electrochem. Soc., vol. 101, No. 10, October 1954, pp. 507-513.

[23] Maddex, P. J., Titanium-Metal Production Expanded at Henderson Plant: Jour. of Metals, vol. 6, No. 6, June 1954, pp. 734-736.

Powell, R. L., Chemical Engineering Aspects of Titanium Metal Production: Chem. Eng. Prog., vol. 50, No. 11, November 1954, pp. 578-581.

[24] Opie, W. R., Titanium Extraction by Chloride Process Presents a Variety of Problems: Jour. Metals vol. 6, No. 7, July 1954, pp. 807-810.

electrical arcs, ability to accommodate higher power input, and production of smooth titanium ingots.[25]

Two methods of applying powder metallurgy to titanium fabrication were reported in 1954 by the Brush Laboratories Co., Cleveland, Ohio. A hot-pressing process employed a combination of pressure, high vacuum, and high temperature. Parts weighing as much as 125 pounds and as large as 9 inches in diameter have been produced by this method. By this process about 4.5 pounds of titanium sponge was necessary to produce 1 pound of finished titanium machined part. In a press forming method, blanks or slugs were first pressed from powder and sintered in a high vacuum, then placed in tool steel dies and formed into the precise shape required. The latter process utilized about 1.7 pounds of titanium sponge to produce 1 pound of finished machined part.[26]

Research in 1954 by Quebec Iron & Titanium Corp., Sorel, Canada, to find a method for lowering the cost of its titanium-slag operation and improve operating efficiency, resulted in the following reported accomplishments:

(1) It was determined that upgrading of the ore and pretreatment increased the capacity of the furnace and resulted in better quality of products; (2) improved methods of charging the furnace and of controlling its operation were developed which further increased capacity and greatly lengthened the life of the refractories; (3) it was proved that the iron from the treatment furnace could be desulphurized in the ladle, rather than by the more costly method of electric furnace refining; (4) major alterations were devised in the materials handling system, and in gas recovery and distribution. The latter permits byproduct fuel gas to be used as a source of heat in pretreating the ore.[27]

A method for utilizing scrap-titanium sheet was reported by an aircraft firm in 1954. A solid 6-inch-thick nugget of titanium formed by resistance spot-welding 89 pieces of scrap titanium sheet submerged in a liquid (water) coolant, was found to be at least as strong as the parent metal and machinable.[28]

Characteristics of 48 binary and 22 ternary titanium alloy systems were made available to industry in a reference report.[29] The publication contains information compiled by Battelle Memorial Institute, Columbus, Ohio, for Wright Air Development Center, Dayton, Ohio, from published and unpublished data, as of March 1953, and includes phase diagrams and an appendix that presents lattice parameter curves for terminal and intermediate solid solutions.

References to Government titanium research reports that were made available to industry are listed in a bibliography published in 1954.[30] Research described in the reports covers all characteristics of titanium; such as physical, chemical, and electrical properties.

Data on the preparation and properties of titanium, its hydrides, oxides, halides, nitride and carbide, alkaline-earth titanates, and calculations and values of thermodynamic properties of these listed

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[25] Chemical Engineering, Vacuum Gives Better Titanium: Vol. 61, No. 8, August 1954, p. 112.

[26] Sadler, Kenneth B., The Application of Powder Metallurgy to Titanium Fabrication: Report of First Nat. Symposium for Titanium Standard Parts, October 11 and 12, 1954, pp. 201–202 (printed and distributed by National Standards Assoc., 527 Washington Loan & Bldg., Washington 4, D. C.).

[27] Kennecott Copper Corp., Annual Report for 1954: New York, N. Y., p. 10.

[28] Modern Metals, Salvaging Titanium Sheet Scrap: Vol. 10, No. 4, May 1954, pp. 48, 49.

[29] Constitution of Titanium Alloy Systems, 1954, 261 pp. Available from the Office of Tech. Services, Dept of Commerce, Washington 25, D. C., Code No. PB 111508 ($8).

[30] U. S. Department of Commerce, Titanium: Rept. CTR. 306, September 1954, 26 pp. Available from the Office of Tech. Services, Dept. of Commerce, Washington, D. C. ($0.50).

substances, including 553 references to publications on titanium, were published in 1954.[31]

A new sulfation process that incorporates the use of sulfation vessels instead of conventional large digesters in producing titanium pigments was reported by Laporte Titanium, Ltd., at Stallingborough, England. The trough-shaped sulfation vessel receives a continuous and accurately blended stream of ilmenite and oleum, and water. As the temperature rises owing to exothermic reaction of the water with the 20 percent of oleum, the water boils off almost instantaneously leaving a dry brown powder, which consists of titanyl sulfate, ferrous sulfate, and some sulfuric acid. The reaction is said to be 96 percent complete. Advantages of this method of sulfation over conventional digesters are better reaction control (since the water and oleum are fed separately to the vessel), less serious emission of acid fumes, and less space required. The acid mist from the sulfation vessels is vented to exhaust through columbium-stabilized stainless steel ducting.[32]

WORLD REVIEW

A new high peak was established in 1954 in world production of ilmenite and rutile concentrates. The United States, the world's largest producer of ilmenite, supplied 50 percent of the ilmenite concentrates in 1954; and Australia remained the leader in the production of rutile, as output totaled 87 percent of the world production. Production figures for Canada include chiefly titanium slag, a product of ore containing ilmenite and hematite.

Africa.—The Titanium Corp. of South Africa, Umgababa, Natal, operated in 1954 an electromagnetic plant capable of producing 335 short tons of ilmenite a day. It was also reported that at full operation the firm will produce annually 67,200 tons of ilmenite, 6,700 tons of zircon, and 3,900 tons of rutile.[33] Reportedly, a total reserve of 25,800,000 tons of ore has been proved at the Umgababa deposit containing 2,200,000 tons of ilmenite, 305,700 tons of zircon, and 190,400 tons of rutile. The ore is alluvial and eluvial, and covers, in the form of sand and debris, a number of hillocks rising 120 to 250 feet above sea level. Milling tests conducted on a pilot-plant scale were reported to give excellent results. Concentrates are to be shipped to the Port of Durban, 25 miles from the deposit, for export to the United States and Britain.[34]

A 30-year agreement was signed in 1954 by the Government of Gambia and the British Titan Products Co., Ltd., under which the British firm will develop titaniferous mineral resources of Gambia through a subsidiary, Gambia Minerals, Ltd.[35]

Gambia, with an area of 4,003 square miles and 279,000 people, introduced its first basic legislation in 1954 governing prospecting and mining activities in the British West African colony and protectorate. The discovery of ilmenite was reported to be the primary

[31] Skinner, G., Johnston, H. L., and Beckett, C., Titanium and Its Compounds: 1954, 174 pp. Distributed by Herrick L. Johnston Enterprises, 540 W. Poplar St., Columbus, Ohio.
[32] Industrial Chemist, The Production of Titanium Dioxide: Vol. 30, No. 359, December 1954, p. 603.
[33] Chemical and Engineering News, South African Titanium Operations: Vol. 32, No. 21, May 24, 1954, p. 2120. South African Firm Produces Cheap Ilmenite: Vol. 32, No. 44, November 1, 1954, p. 4397.
[34] Mining World, Titanium Corp. Completing Concentrator Near Durban: Vol. 16, No. 6, May 1954, p. 61.
[35] Engineering and Mining Journal, Gambia: Vol. 155, No. 10, October 1954, p. 185.

TABLE 7.—World production of titanium concentrates (ilmenite and rutile), by countries, 1945–49 (average) and 1950–54, in short tons [1]

(Compiled by Pearl J. Thompson)

Country	1945–49 (average)	1950	1951	1952	1953	1954
ILMENITE						
Australia, sales [2]	(3)	56	1,403	52	------	(3)
Brazil	2,987	------	------	------	------	------
Canada	5,528	[4] 3,502	[4] 21,203	[4] 42,192	[4] 146,614	[4] 124,162
Egypt	536	287	359	2,202	843	248
India	258,869	238,183	250,975	251,883	240,946	186,612
Japan [5]	------	------	------	------	2,028	2,627
Malaya [6]	10,386	27,905	48,712	24,302	29,758	50,114
Norway	74,874	115,908	116,139	130,370	141,220	164,448
Portugal	496	73	186	476	746	543
Senegal	6,768	869	4,311	5,095	3,858	13,779
Spain	231	702	772	1,410	1,582	1,269
United States [7]	343,711	468,320	535,835	528,588	513,696	547,711
World total ilmenite (estimate)	705,000	856,000	980,000	987,000	1,081,000	1,092,000
RUTILE						
Australia	[8] 13,400	[8] 19,825	[8] 39,170	[8] 41,800	42,604	50,018
Brazil [6]	43	6	------	19	------	------
French Cameroon	978	28	119	324	58	[6] 179
French Equatorial Africa	------	7	------	------	------	------
India	258	41	51	164	117	117
Norway	45	34	20	47	3	(3)
Senegal	------	------	3	29	------	------
United States	7,516	7,535	7,189	7,125	6,825	7,411
World total rutile (estimate)	22,200	27,500	46,600	49,500	49,600	57,800

[1] This table incorporates a number of revisions of data published in previous Titanium chapters.
[2] Due to high chromium content in the ore, sales are shown.
[3] Data not available; estimate by author of chapter included in total.
[4] Includes Ti slag containing approximately 70 percent TiO_2.
[5] Represents titanium slag.
[6] Exports.
[7] Includes a mixed product containing altered ilmenite, leucoxene, and rutile for 1949–54.
[8] Estimated rutile content of all rutile-bearing concentrates.

factor initiating the new Gambian regulation that is to be similar to those in effect in Sierra Leone, also in British West Africa.[36]

Australia.—New tariff duties were imposed on Australian imports of titanium pigments in April 1954. The protective duties were established to enable the titanium-pigment industry, comparatively new in Australia, to be fully established. The new rates for titanium oxide and titanium white per long ton were quoted at A£28 ($63) under the British preferential tariff, A£48 ($107) under the most favored nation tariff, and A£56 ($125) under the general tariff.[37]

Production of titanium pigments in Australia totaled 3,808 short tons in 1953 compared with 2,400 tons in 1952, coming from The Australian Titan Products Pty., Ltd., Burnie, Tasmania. Plans were under way in 1954 to double the firm's rated annual output capacity of 4,480 tons, an expansion about 4 times the designed capacity of the plant when initial output began in 1949.[38] Apparent consumption of titanium pigments in Australia totaled 4,400 tons in 1951, 4,173 tons in 1952, and 9,202 tons in 1953.[39] Imports of

[36] U. S. Department of Commerce, Gambia Introduces Mining Ordinance: Foreign Commerce Weekly, vol. 52, No. 1, July 5, 1954, p. 17.
[37] Metal Industry, the Industrial Week—Australia: Vol. 84, No. 16, April 16, 1954, p. 316.
[38] Metal Industry, Tasmania: Vol. 85, No. 10, September 1954, p. 14.
[39] The Australian Mineral Industry—1953 Review, 1954, pp. 153–157.

titanium pigments, as shown in table 8, increased over 200 percent in 1953 from 1952.

TABLE 8.—Imports of titanium pigments into Australia, 1951–54, short tons

Source	1951	1952	1953	1954
United Kingdom	1,192	681	2,425	(1)
Federal Republic of Germany	263	344	1,168	(1)
United States	101	289	960	(1)
Other countries	336	461	841	(1)
Total	1,892	1,775	5,394	5,129

[1] Data not available.

Australian production of rutile concentrate in 1954 established a record high of 50,017 short tons containing 48,171 tons of estimated titanium dioxide content. Output was increased to meet foreign demand. Australian price of rutile increased from A£29 ($65) per ton, f. o. b. Brisbane in January 1954 to A£50–A£55 ($112–$123) a ton at the end of 1954. Rutile was produced by the following companies in Australia in 1954: Titanium & Zirconium Industries Pty., Ltd., 240 Queen Street, Brisbane (Stradbroke Island, Queensland); Mineral Deposits Syndicate, Box 44, P. O. Southport, Queensland; Associated Minerals Consolidated, Ltd., Ferry Road, Southport, Queensland; Rutile Sands Pty., Ltd., Box 1078 N, G. P. O. Brisbane (Currumbin, Queensland); New South Wales Rutile Mining Co. Pty, Ltd., Box 47, P. O. Coolangatta, Queensland (Cudgen, New South Wales); Zircon Rutile, Ltd., 374 Little Collins St., Melbourne, C. 1 (Byron Bay, New South Wales); National Minerals, Ltd., Greenway St., Wickham, New South Wales; Titanium Alloy Manufacturing Co. Pty., Ltd., Box 71, P. O. Tweed Heads, New South Wales; Metal Recoveries Pty., Ltd., Mooball, North Coast, New South Wales; J. A. Foyster, Esq., Cudgen, via Kingscliff, New South Wales (Cudgen, New South Wales); Titanium Minerals, Ltd., Box 834, G. P. O. Sydney (Woodburn, New South Wales); Trem Watson Metallurgists, 74 Finlayson St., Lane Cove, New South Wales (Shell Harbor, New South Wales); and R. S. Freeman, Pacific Highway, Woolgoolga, New South Wales. Associated Minerals Consolidated, Ltd., reported in 1954 a 50-percent increase in its annual production capacity; its new production rate for rutile concentrates will be 6,000 tons a year.

Australian exports of rutile concentrates are shown in table 9.

Australian consumption of rutile and ilmenite concentrates in 1953 amounted to 1,344 and 8,120 short tons, respectively. Rutile was chiefly consumed in the manufacture of welding-rod coatings and ilmenite in the titanium pigment industry.[40]

[40] Work cited in footnote 37.
The Australian Mineral Industry, Quarterly Review: Vol. 7, No. 1, August 1954, pp. 7, 9, 10, 15. Quarterly Review: Vol. 7, No. 3, February 1955, pp. 8, 14. Quarterly Review: Vol. 7, No. 4, May 1955, pp. 88, 89.

TABLE 9.—Exports of rutile concentrates from Australia, 1950–54, by countries of destination, in short tons [1] [2]

(Compiled by John E. McDaniel)

Country	1950	1951	1952	1953	1954
France	684	3,758	3,066	2,106	----------
Germany	1,142	----------	----------	----------	----------
Italy	812	----------	----------	----------	----------
Netherlands	604	2,574	1,633	3,504	----------
Sweden	2,044	2,897	1,856	2,824	----------
United Kingdom	6,588	11,130	10,161	9,701	11,078
United States	3,636	11,048	20,599	15,026	16,148
Other countries	1,617	7,838	4,857	7,244	22,521
Total	17,127	39,245	42,172	40,405	49,747
Value (US$)	$756,289	$1,911,034	$3,586,251	$4,072,517	$3,891,725

[1] Compiled from Customs Returns of Australia.
[2] This table incorporates a number of revisions of data published in the previous Titanium chapter.

Australian reserves of high-grade heavy minerals were estimated in short tons as follows: Rutile 844,500, zircon 1,086,400, ilmenite 741,400, and monazite 14,000. Production of these minerals has been centered chiefly in a 50-mile strip south of Brisbane. The sands are reported also to contain variable percentages of quartz, garnet, magnetite, chromite, leucoxene, cassiterite, gold, and platinum. Ilmenite is not considered of economic value in these sands owing to a chrome content ranging up to 7.0 percent that renders it unsuitable for the manufacture of titanium pigments. An article [41] published in 1954 discussed the Australian heavy-mineral industry as to mode of mineral occurrence, evaluation of deposits, and general method of working the deposits and gave examples of industry practice in concentrating the minerals. Seven references to publications on Australian mineral resources and concentration practices were also included in the article.

Titanium Alloy Manufacturing Co. Pty., Ltd., a subsidiary of the National Lead Co., New York, N. Y., reported that it conducted a successful rutile exploration program in Australia. Construction of mining and concentrating facilities at the new properties that began in 1954 was scheduled for completion about mid-1955.[42]

Canada.—The Quebec Iron & Titanium Corp. at Lac Tio, Allard Lake, Quebec, mined 261,133 short tons of ilmenite-hematite ore in 1954, averaging about 35 percent titanium dioxide and 40 percent iron. The quantity of titaniferous iron ore crushed and shipped by the firm in 1954 totaled 308,975 and 303,735 tons, respectively. Shipments were destined to the firm's smelter at Sorel, Canada, where the ore was upgraded (see Technology section) to produce a titanium slag that contained about 70 percent titanium dioxide and a marketable iron product. Data on the corporation's smelting operations are shown in table 10.

[41] Lyons, Leo A., Rutile—Australian Beach Yields Wonder Metal: Min. World, vol. 16, No. 7, June 1954, pp. 56–60.
[42] National Lead Co., 63d Annual Report for 1954: New York, N. Y., p. 18.

TABLE 10.—Quebec Iron & Titanium Corp. smelting operations, 1951–54, in short tons

Item	1951	1952	1953	1954
Ore mined and crushed	379,931	265,719	158,218	308,974
Ore treated	49,615	104,166	332,863	282,752
Titanium slag produced	19,330	42,141	141,833	122,960
Titanium slag shipped	8,041	38,908	145,402	119,292
Iron and steel produced	14,422	32,422	106,875	90,562
Iron and steel shipped	5,701	33,630	94,587	100,509

Lower production of titanium slag in 1954 was caused by a shutdown of 2 of the 5 furnaces at the treatment plant for research purposes. Reportedly the shutdown of the furnaces was not due to any lack of demand for the firm's products but to permit investigative work necessary to obtain greater operating efficiency and lower production costs.

Baie St. Paul Titanic Iron Ore Co., Ltd., St. Urbain, Quebec, shipped 1,202 short tons of ilmenite concentrate in 1954, compared with 4,731 tons in 1953.

Titanium-mineral exploration programs were conducted in 1953 and 1954 by a number of Canadian companies. Results of the findings, such as location, mineral and chemical analyses, and reserve information, were published.[43]

Dominion Magnesium, Ltd., continued to produce small quantities of titanium metal on an experimental basis at its refinery at Haley, Ontario, using imported titanium dioxide as a raw material. In Quebec, Shawinigan Water & Power Co. announced during 1954 that it was engaged in a pilot project for producing small quantities of titanium metal by electrolytic means, using titanium slag produced by the Quebec Iron & Titanium Corp. smelter. The Electro-Metallurgical Division of Union Carbide of Canada also announced in 1954 that it had a pilot project at Welland, Ontario, to produce about 70 tons of titanium metal annually, using a process employed by the parent firm in the United States. In the field of titanium fabrication, Canadian Steel Improvements, Ltd., of Etobicoke, near Toronto, a subsidiary of A. V. Roe, Ltd., has been developing a new method of titanium melting and alloying in connection with its production of titanium alloys to supply titanium blades and other components to the jet-aircraft industry.[44]

Ceylon.—The Ceylon Ministry of Industries at Colombo offered for sale 112,000 short tons of mineral-bearing beach sands in 1954 from a deposit at Pulmoddai, about 34 miles north of Trincomalee, Ceylon. Reportedly, the sand contains 70–75 percent ilmenite, 10–12 percent rutile, 6–8 percent zircon, 2–3 percent magnetite, and a trace of monazite; the titanium dioxide content of the ilmenite ranged from 53 to 58 percent. The sand also contains small quantities of quartz, garnet, spinel, hypersthene, etc. A typical screen analysis of the sand, as reported, is as follows: Plus 40, 0 percent; minus 40 plus 60, 0.2 percent; minus 60 plus 80, 1.5 percent; minus 80 plus 100, 2.0 per-

[43] Buck, K. W., A Survey of Developments in the Titanium Industry During 1954: Canadian Dept. of Mines and Tech. Surveys, Mines Branch, Min. Res. Inf. Circ. 14, April 1955, 26 pp.
[44] Consular Report, Titanium: Dispatch 147, Consulate General, Toronto, Canada, Feb. 28, 1955, pp. 18, 19 (Unpub.).

cent; minus 100 plus 150, 52.0 percent; minus 150 plus 200, 22.3 percent; and minus 200, 20 percent. It is claimed that Ceylon has at least 5,600,000 tons of ilmenite.[45]

Finland.—The Government-owned Otanmaki Oy Co., in central Finland about 15 miles southwest of Kajaoni, produced ilmenite concentrate in 1954. An analysis of the ilmenite concentrate produced by the Otanmaki Co. was reported as follows: TiO_2, 44–66 percent; Fe_2O_3, 10 percent; FeO, 41.3 percent; CaO, 0.5 percent; MgO, 0.5 percent; Al_2O_3, 0.5 percent; SiO_2, 0.5 percent; V_2O_5, 0.25 percent; MnO, 0.5 percent; Cr_2O_3, 0.1 percent; P, 0.005 percent. Mining and concentration activities at the Finnish mine began in 1953 and reached full-scale operation in July 1954. The type of ore mined contained about 35 percent Fe, 12–15 percent TiO_2, 0.6 percent S, 0.3 percent V, and small quantities of P and Ni. Reportedly, the total quantity of ore in the main ore bed is about 50 million tons. In addition, there are two smaller ore bodies in the vicinity of the present mine. Ilmenite concentrate is transported from the mine to the port of Oulu for loading at a special ore port built jointly by the city of Oulu and by Otanmaki Oy. Long-term delivery agreements for ilmenite concentrate have materially stabilized the financial position of the company.

Exports of ilmenite concentrate from Finland totaled 50,297 short tons in 1954 and included shipments to Czechoslovakia (5,820 tons), France (5 tons), East Germany (12,279 tons), Hungary (308 tons), Italy (2,887 tons), Netherlands (458 tons), and United Kingdom (28,540 tons). Finnish exports of 9,211 tons of ilmenite concentrate in 1953 were destined to Czechoslovakia (2,653 tons), Netherlands (6 tons), Poland (1,167 tons), and West Germany (5,286 tons).[46]

Germany.—Titangesellschaft m. b. H., Leverkusen, Germany, a subsidiary of the National Lead Co., New York, N. Y., operated at capacity throughout 1954. Reportedly the subsidiary's expansion program in 1954 will make available additional tonnage of titanium pigments to the world market. Technological improvements in quality and the cost of improved capacity were financed by Titangesellschaft's reinvestment of earnings.[47]

India.—Travancore Titanium Products, Ltd. (TTPL), at Trivandrum, Travencore-Cochin State, inactive since October 10, 1952 resumed operations in January 1954 after the Government of India agreed to grant the company tariff protection and the British Titan Products Co., Ltd., agreed to buy all of the plant's production not sold on the Indian market. TTPL obtained a loan of 1,500,000 rupees ($315,000) from the Industrial Finance Corp. (Government of India) for working capital and secured an export order from the United Kingdom for titanium dioxide (anatase). TTPL, India's only titanium-pigment manufacturer, produced 1,534 short tons of titanium-dioxide (anatase) in 1954 and exported 489 tons of it, valued at 1,037,000 rupees ($217,770), presumably to the United Kingdom. The plant's output capacity is estimated at 2,000 tons of titanium dioxide (anatase) per year.

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[45] Consular Report, Tenders for Purchase and Removal of 100,000 Long Tons of Mineral-Bearing (Predominantly Ilmenite) Beach Sands: Despatch 17, American Embassy, Colombo, July 13, 1954, (Unpub.).
[46] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 5, November 1954, pp. 14–15.
State Department Dispatch 556, Mineral Industries, Including Iron and Steel, Finland 1954, Part II—Iron and Steel: American Embassy, Helsinki, April 20, 1955, (Unpub.).
[47] Work cited in footnote 42.

Indian imports of titanium pigments totaled 174 short tons for February 1, 1954, to September 30, 1954, valued at 385,000 rupees ($80,850). Under Indian Tariff Commission Item 30 (14), imports of titanium dioxide were assessed in 1954 at 25⅕ percent ad valorem plus ¼ of the total duty for titanium dioxide of British manufacture and 35⅕ percent ad valorem plus ¼ of the total duty for non-British manufacture.

Consumption of titanium dioxide (anatase) in India totaled 952 short tons in 1954; an increase of 20 percent is anticipated for 1955 according to reports. Prices for titanium dioxide (anatase) in 1954, as quoted by TTPL, were 135 rupees ($28) per cwt. in port towns and 130 rupees ($27) cwt., f. o. b. Trivandrum. The State Government of Travancore-Cochin reduced the price of ilmenite purchased by TTPL in 1954 to 27 rupees ($5.67) per ton; however, this is still 9 rupees ($1.89) higher than the basic price in 1953.[48]

Japan.—Production of titanium-sponge metal in Japan totaled 673 short tons in 1954 as compared to 77 tons in 1953. Japanese exports of titanium sponge in 1954 totaled 473 tons, an increase of 423 tons from 1953; recipients of titanium sponge from Japan were the United States (254 tons), United Kingdom (219 tons), and Western Germany (220 pounds).[49] The Japanese titanium-metal industry began to favor shipments to the United Kingdom in 1954 because of the lower tariff rate of 10 percent compared with 20 percent in the United States. Companies that produced titanium sponge in Japan in 1954 are listed in table 11.[50]

TABLE 11.—Japan's titanium sponge production and exports, by companies, 1952–54, in short tons

Company	Production			Exports		
	1952	1953	1954	1952	1953	1954
Osaka Titanium Mfg. Co	9	66	338	1	50	259
Toho Titanium Industry Co., Ltd		5	263			187
Nippon Soda Co., Ltd		6	37			27
Nippon Electric Metallurgical Co., Ltd		(1)	28			
Mitsui Mining & Smelting Co., Ltd		(1)	7			
Total	9	77	673	1	50	473

1 Less than 1 ton.

A text published in 1954 discussed the status of the titanium-metal industry in Japan, England, and the United States and compared titanium-sponge production costs in Japan with those of the United States.[51]

Titanium-dioxide production in Japan totaled 13,820 short tons in 1954 and came from Ishihara Industrial Co. (550 tons), Sakai Chemical Industry Co. (275 tons), Tochigi Chemical Industry (220 tons), Teikoku Chemical Industry (165 tons), Titanic Industry (165

48 Consular Report, Tariff Commission Inquiry Opens into Claims of Travancore Titanium Products, Ltd., Trivandrum, for Continued Tariff Protection: Dispatch 548, American Consulate, Madras, India, February 1, 1955 (Unpub.).

49 Metal Industry, Japan: Vol. 86, No. 9, March 4, 1955, p. 178.

50 Tanaka, H., World Titanium Situation: Pub. by Japan Titanium Society, Kobikikan 7, Ginza East 6-chome, Chuo-ku, Tokyo, August 1954, 107 pp.
Consular Report, Monthly Economic Notes: Dispatch 276, Kobe, Japan, March 9, 1955 (Unpub.).
Light Metals Society, Light-Metals Statistics in Japan: No. 255, May 1955, pp. 10–18. Pub. by Kiyotaka Fujii, Hibiya Asahi Seimei Bldg., No. 2-1, Yuraku-cho, Chiyoda-ku, Tokyo, Japan.

51 Work cited in footnote 50.

tons), Furukawa Mining Co (120 tons), and Mitsui Metal Co. (35 tons). Figures in parentheses are estimated monthly output and not individual breakdowns of the 1954 production total. The supply and demand of titanium oxide in Japan for 1950–54 are shown in table 12.[52]

The titanium dioxide industry in Japan consumed both ilmenite and titanium slag in 1954 in producing titanium pigments, namely, anatase and rutile. The quoted market prices in Japan for anatase and-rutile-grade pigment were 27 and 30 cents per pound, respectively, in 1954.

TABLE 12.—Titanium dioxide production, imports, consumption, exports, and stocks in Japan, 1950–54, in short tons

Year	Supply				Demand			Stocks
	Productive capacity	Actual output	Imports	Total supply	Home consumption	Exports	Total demand	
1950	5,027	2,163	337	2,500	2,428	25	2,453	64
1951	9,193	4,456	302	4,758	3,285	823	4,108	714
1952	11,376	5,000	820	5,820	5,651	108	5,759	775
1953	11,839	6,793	1,065	7,858	7,505	536	8,041	592
1954	19,180	13,820	318	14,138	8,630	5,218	13,848	882

Malaya.—Exports of ilmenite concentrates from Malaya can be found in table 13.

TABLE 13.—Exports of ilmenite from Malaya, 1950–54, by countries of destination, in short tons [1] [2]

(Compiled by John E. McDaniel)

Country	1950	1951	1952	1953	1954
Belgium	2,240	2,424	335	3,607	47
Czechoslovakia		1,680	3,360		
France	7,203	6,511	8,076	2,576	7,464
Germany	227	1,680	4,474		
Italy		1,120			
Japan	5,303	14,493	3,136	10,527	14,648
Netherlands	454	5,264		1,456	1,466
United Kingdom	10,709	13,445	5,817	11,592	22,516
United States		56			52
Total	26,136	46,673	25,198	29,758	46,193

[1] Compiled from Customs Returns of Malaya.
[2] This table incorporates a number of revisions of data published in the previous Titanium chapter.

Mexico.—The Republic Steel Corp., Cleveland, Ohio, announced in December 1954 that representatives of the corporation discovered the largest rutile deposit in the Western Hemisphere in the Province of Oaxaca about 26 miles from Port Angel. Personnel of the firm staked out about 38 claims in a mountainous strip 7 miles long and up to 1½ miles wide. Reportedly, the lode contains over 25 million short tons of rutile.

According to reports, the Las Minas de Tisur mine was to be the first to go into operation in 1954. The ore mined at the Tisur mine is to be crushed to 40-mesh or rough table-salt fineness and concentrated to 95 percent titanium dioxide. Crushing, grinding, and spiral gravity methods to be used in concentrating the ore were developed

[52] Sangyo Keizai Overseas Edition (Japanese newspaper), Titanic Oxide Assumes Role of One as New Star Exports: Vol. 4, No. 5, Mar. 1, 1955, pp. 6.

in 1954 by the firm with the cooperation of the Federal Bureau of Mines, College Park, Md. Republic also announced plans in 1954 for the construction of a concentrating plant at the Tisur mine that is to have an output capacity of 275 tons of rutile concentrates per day. The corporation intends to ship 2,200 tons of rutile concentrates averaging 95 percent titanium dioxide to the United States by the end of 1955.[53]

The Mexican Government, in addition to promising Republic Steel Corp. an exemption from surface taxes until 1957, has agreed to improve all roads in the area and to rebuild and extend the docking facilities at Puerto Angel (Port Angel).[54]

United Kingdom.—Titanium Metal & Alloys, Ltd., 2, Metal Exchange Building, Leadenhall Avenue, London, E. C. 3, jointly owned by Henry Gardner & Co., Ltd., and Samuel Osborn & Co., Ltd., was formed in 1954 for the purpose of producing titanium mill products. Reportedly, this is the first and only firm equipped in England in 1954 to semi-fabricate titanium metal and its alloys.[55]

William Jessop & Sons, Ltd., Brightside Works, Sheffield, England, purchased proprietary furnace designs and operating techniques for melting titanium from Titanium Metals Corp. of America, Henderson, Nev., in accordance with an agreement signed June 29, 1954. The American firm uses a vacuum double-melting technique, and its furnace is capable of producing a 4,000-pound titanium ingot. The agreement provides only for furnace details and techniques of a given date and imposes upon the buyer that all information purchased be treated as confidential. A similar agreement was also signed in 1954 by TMCA and an undisclosed British firm.[56]

The British Titan Products Co., Ltd., announced plans in 1954 for the expanding titanium-pigment manufacturing capacity both in England and in Australia. The company's expansion plans call for a $12.5 million extension of its plant at Grimsby, England, and an expenditure of $2 million for developing properties abroad and enlarging its Australian subsidiary, Australian Titan Products of Tasmania. It was reported that these two companies produce four-fifths of all titanium oxide in the Commonwealth. The other titanium-pigment producer in Britain (Laporte Titanium, Ltd.) stated that its plants at Luton and Stallingborough, North Lincolnshire, reached full capacity in 1954. The company titanium-pigment output capacity is rated at 11,000 short tons a year.[57] A description of Laporte's modern titanium-pigment facilities and its process for producing manufactured titanium dioxide was published in 1954.[58]

British Treasury Order 7, effective as of September 27, 1954, and published as Statutory Instruments 1954, No. 1234, provided for exemption of all grades of titanium dioxide from duties chargeable under the Import Duties Act, 1932, for a period of 6 months.[59]

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[53] Steel, Titanium for Everyone—Repub ic's Rutile Points Way: Vol. 135, No. 26, December 27, 1954, pp. 27–29.
Rohan, T. M., Titanium—Develop Mexican Jackpot: Iron Age, vol. 174, No. 27, December 30, 1954, pp. 20–21.
[54] Stapleton, Bill, A Mine for the Jet Age: Collier's, vol. 155, No. 5, March 4, 1955, pp. 88–91.
[55] Light Metals (London), Titanium Fabrication in Britain: Vol. 17, No. 191, February 1954, p. 44.
[56] American Metal Market, British Firms Purchase Furnace Design, Process From Titanium Metals: Vol. 61, No. 162, August 24, 1954, pp. 1, 3.
[57] Chemical and Engineering News, International: Vol. 32, No. 11, March 15, 1954, pp. 1028, 1032.
[58] Work cited in footnote 31.
[59] Chemical Age (London), Import Duties Exemption Order: Vol. 71, No. 1838, October 2, 1954, p. 735.

Tungsten

By R. W. Holliday [1] and Mary J. Burke [2]

NOTEWORTHY in 1954 was the contrast between lowered consumption and increased supply of tungsten concentrate. Domestic production reached a new record; imports to the United States exceeded those for every year except the all-time high of 1953. Reduced consumption of tungsten was due largely to the decline in production of steel. Other factors were lowered munitions requirements and increased replacement of tungsten alloys with carbide inserts. Because under the Domestic Tungsten Program [3] the base price of $63.00 per short-ton unit for domestic concentrate was 2 to 4 times the world market price, virtually all domestic production went to the Government, and consumers relied upon foreign sources of supply.

Purchases under the Domestic Tungsten Program continued through 1954, bringing total deliveries to 1,460,051 short-ton units, according to General Services Administration. At the 1954 rate of delivery, the 3 million units [4] authorized would be purchased by September 1956.

TABLE 1.—Salient statistics of tungsten ore and concentrate in the United States,[1] 1945–49 (average) and 1950–54, in thousand pounds of contained tungsten

Year	Production	Shipments from mines	General imports [2]	Consumption	Industry stocks at end of year: Producers	Consumers and dealers	Total
1945–49 (average)	4,003	3,925	8,311	8,445	520	4,067	4,587
1950	3,965	4,588	8,342	6,597	216	5,121	5,337
1951	5,914	5,973	7,533	11,410	234	4,038	4,272
1952	7,233	7,244	16,985	8,634	208	2,816	3,024
1953	9,259	9,128	[3] 29,130	7,734	363	4,335	4,698
1954	13,166	13,030	22,949	4,037	362	3,913	4,275

[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 [5]

Domestic production of tungsten concentrates in 1954 stimulated by the Government purchase program exceeded the previous record high of 1943 by nearly 2 million pounds, metal content. This was the fifth consecutive year of increased production and surpassed 1953 by 42 percent. Although California mills produced the most concentrate, Nevada was the leading tungsten-mining State, followed by

[1] Commodity-industry analyst.
[2] Statistical clerk.
[3] These specifications were listed in the Tungsten Chapter: Minerals Yearbook, 1952, pp. 1070–1072.
[4] 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.
[5] Production data for 1954 were collected jointly with the Bureau of the Census (U. S. Department of Commerce). Production totals will be compared with the Census totals when they are available and differences adjusted or explained.

428641—58——78

California and North Carolina. These 3 States produced 83 percent of the total, and the next 3 States in order of output—Colorado, Montana, and Idaho—supplied 15 percent. The Hamme mine of Tungsten Mining Corp., Vance County, N. C., and the Pine Creek mine of United States Vanadium Co. in California were the most productive domestic tungsten mines.

Large operations continued to supply the major share of United States production; 48 percent came from the 5 largest mines and 24 percent from the next 5 largest. Smaller but widely varied output by more than 700 other producers furnished the remaining 28 percent. Mines lacking milling facilities provided over 10 percent of the United States production, although generally handicapped by greater transportation costs or other conditions not favorable to small operations.

Most tungsten ore mined in the United States was less than 2.5 percent WO_3, although hand sorting or other primitive means of concentration might, in some instances, raise the grade of ore shipped. The lower limit, except for byproduct recovery or reworking of tailings and dumps, was probably not much below 0.3 percent WO_3. California, Nevada, and Montana produced mainly scheelite (calcium tungstate), while production in Idaho and North Carolina was mainly hübnerite (manganese tungstate). Colorado produced ferberite (iron tungstate) in Boulder County and hübnerite, as a byproduct by Climax Molybdenum Co. at Climax in Lake County. Jigging, tabling, and flotation were the important processes in preliminary concentration, while chemical methods and magnetic separation were applied in producing much of the finished concentrate. Government specifications [6] required a content of 55 percent tungsten trioxide or more and provided penalties for certain impurities beyond specified amounts.

The Defense Minerals Exploration Administration announced that 391 tungsten applications had been received, as of December 31, 1954. From this number 96 contracts were executed, and 31 were still in force at the year end. Certifications of discovery, including 3 on contracts still in force, numbered 19. Total Government participation authorized was \$2,585,303, and total authorized cost of the projects was \$3,463,090.

Brief descriptions of 1954 activities at the most productive domestic tungsten mines are given below; more detailed accounts are contained in Minerals Yearbook, volume III, in the respective State chapters.

Bradley Mining Co.—The Ima mine, Lemhi County, Idaho, produced about 10 percent more than the 53,792 tons of ore produced in 1953, and an additional 10 to 15 percent increase was scheduled for 1955. At the Springfield mine, Valley County, Idaho, mining of the talus deposit and gravity concentration were completed during the summer. The Yellow Pine mine, Valley County, Idaho, did not operate during 1954, but exploration indicated additional tungsten-ore possibilities.

Climax Molybdenum Co.—The Climax mine, Lake County, Colo., used a caving method to mine molybdenum ore from which tungsten mineral was obtained. The following is from the company annual report for 1954.

> Production of byproduct tungsten in 1954 amounted to 632,000 pounds contained in concentrate as compared with 413,000 pounds in 1953. This increase

[6] Work cited in footnote 3.

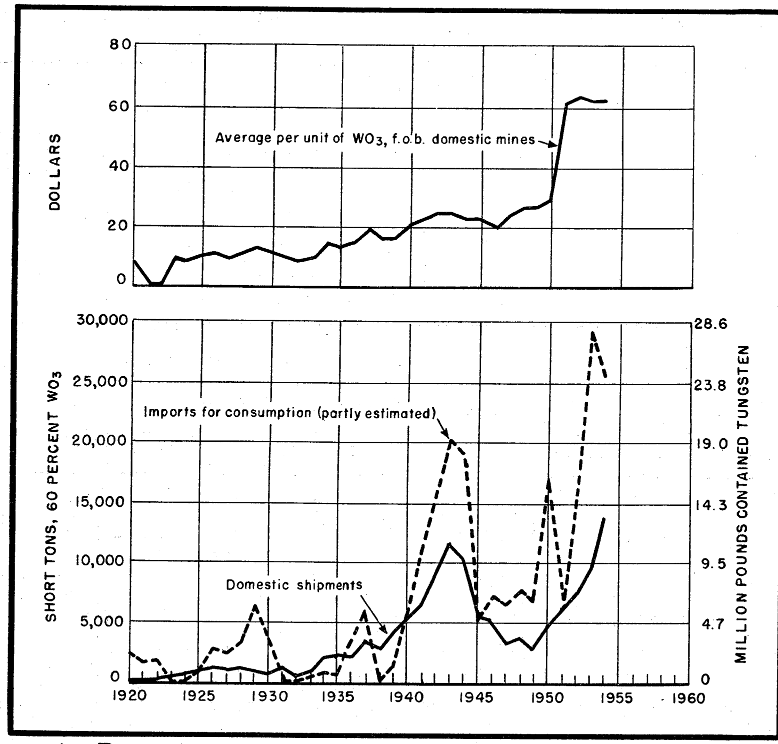

FIGURE 1.—Domestic shipments, imports, and average price of tungsten ore and concentrate, 1920–54.

TABLE 2.—Tungsten concentrate produced and shipped in the United States, 1953–54, by States [1]

State	Produced				Shipped from mines			
	1953		1954		1953		1954	
	Tungsten content (1,000 pounds)	Units	Tungsten content (1,000 pounds)	Units	Tungsten content (1,000 pounds)	Units	Tungsten content (1,000 pounds)	Units
Alaska	3	171	(2)	15	3	171	-----	-----
Arizona	128	8,055	126	7,951	128	8,055	125	7,890
California	2,269	143,017	3,342	210,674	2,259	142,395	3,343	210,743
Colorado	708	44,620	884	55,694	777	49,016	883	55,643
Idaho	430	27,132	488	30,752	420	26,461	448	28,231
Montana	29	1,830	641	40,427	13	820	645	40,681
Nevada	3,611	227,685	5,189	327,125	3,514	221,528	5,073	319,854
New Mexico	-----	-----	(2)	25	-----	-----	(2)	25
North Carolina	2,041	128,645	2,398	151,166	1,974	124,465	2,416	152,296
Oregon	(2)	1	-----	-----	(2)	1	(2)	(3)
South Dakota	2	136	(2)	8	2	136	(2)	8
Utah	33	2,078	80	5,031	33	2,078	80	5,031
Washington	5	333	18	1,153	5	322	17	1,058
Total	9,259	583,703	13,166	830,021	9,128	575,448	13,030	821,460

[1] Concentrate has been credited to State in which it was mined, although subsequent beneficiation and sale may have been elsewhere.
[2] Less than 1,000 pounds.
[3] Data not available.

TABLE 3.—Tungsten concentrate shipped from mines in the United States,[1] 1945–49 (average) and 1950–54

Year	Quantity		Reported value f. o. b. mines [2]		
	Units	Tungsten content (pounds)	Total	Average per unit of WO_3	Average per pound of tungsten
1945–49 (average)	247,430	3,924,703	$5,811,681	$23.49	$1.48
1950	289,225	4,587,687	8,170,924	28.25	1.78
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	821,460	13,029,999	51,433,168	62.61	3.95

[1] Includes Alaska.
[2] Values apply to finished concentrate and in some instances are f. o. b. custom mills.

TABLE 4.—Tungsten ore and concentrate shipped from mines in the United States, by States, 1945–49 (average) and 1950–54, shipments for maximum year, and total shipments, 1900–54, in short tons of 60 percent WO_3[1]

State	Maximum shipments		Shipments by years							Total shipments, 1900–54	
	Year	Quantity	1945–49 (average)	1950	1951	1952	1953	1954		Quantity	Percent of total
								Quantity	Percent of total		
Alaska	1916	47	6	13	10	8	3	-------	-------	211	0.13
Arizona	1936	489	31	1	11	71	134	132	0.97	4,262	2.54
California	1943	3,871	1,090	2,025	3,007	2.980	2.382	3,512	25.65	51,310	30.57
Colorado	1917	2,707	189	196	336	625	817	927	6.77	27,957	16.66
Connecticut	1916	3	-------	-------	-------	-------	-------	-------	-------	11	.01
Idaho	1943	4,648	597	222	377	333	441	471	3.44	17,204	10.25
Missouri	1940	13	1	(2)	-------	-------	-------	-------	-------	37	.02
Montana	1954	678	25	-------	1	-------	14	678	4.95	1,238	.74
Nevada	1954	5,331	1,633	1,123	1,482	2,329	3,683	5,331	38.94	51,391	30.62
New Mexico	1915	45	-------	-------	-------	-------	-------	(2)	-------	103	.06
North Carolina	1954	2,538	542	1,240	1,041	1,254	2,074	2,538	18.54	11,085	6.60
Oregon	1952	4	1	-------	1	4	(2)	(2)	(3)	8	(3)
South Dakota	1917	270	1	-------	-------	(2)	2	(2)	-------	1,298	.77
Texas	1946	1	(2)	-------	-------	-------	-------	-------	-------	1	(3)
Utah	1954	84	7	-------	(2)	3	35	84	.61	361	.22
Washington	1938	303	1	-------	9	4	5	18	.13	1,362	.81
Total	1954	13,691	4,124	4,820	6,275	7,611	9,590	13,691	100.00	167,839	100.00

[1] Shipments are credited to the State where final concentrate was produced, except for 1953 and 1954, when shipments are credited to State where ore was mined.
[2] Less than 1 ton.
[3] Less than 0.01 percent.

resulted from an improved utilization of existing plant facilities, which permitted the treatment of a tonnage of tailings, greater than was thought possible a year ago. Some improvement in recoveries was attained, and research to discover means of further increasing recoveries is being continued.

Gabbs Exploration Co.—Mining during the year at the Gabbs mine, Nye County, Nev., included operations on the newly opened 300-foot level. Installation of a flotation unit and an acid-treatment plant (for fines and impounded tailings) contributed to a production nearly three times that of the preceding year. Over 20,000 tons of ore was mined during the year.

Getchell Mine, Inc.—This firm, in Humboldt County, Nev., is a former prominent gold producer that converted to the mining and milling of tungsten ores.[7] Over 600 tons per day was provided from the Getchell mines, and an additional tonnage approaching 200 tons per day was milled on a custom basis in 1954. The plant includes flotation, tables, and an acid-leach plant.

Hetzer Mines, Inc.—The Hetzer mill at Nederland, Boulder County, Colo., treated ore from numerous mines in the area, but the Cold Spring mine was principal producer. In September, Cold Spring Tungsten, Inc., purchased all stock of the Hetzer Mines, Inc., and took over operation of the mill.

Minerals Engineering Co.—During the year this firm, incorporated in Grand Junction, Colo., emerged as a leading producer of tungsten concentrate, mining and milling 130,357 tons at the Ivanhoe and Lost Creek mines. In addition to this operation in Beaverhead County, Mont., the company owns (jointly with Sylvania Electric Products, Inc.) the Salt Lake Tungsten Co., in Salt Lake City, Utah. Low-grade concentrate from adjoining States and from Montana were converted to synthetic scheelite at the Salt Lake City plant.

Nevada-Massachusetts Co.—The mill and various underground and open-pit mines are in Pershing County, Nev. Substitution of screens for classifiers, plus other minor flowsheet changes, enabled the mill to reach a new high in tons of ore milled. Construction of a 3,000-foot belt conveyor, from crusher to mill, was begun. Total ore production was 189,249 tons, of which about 25 percent came from open-pit operations.

Nevada Scheelite Division of Kennametal, Inc.—The Leonard mine, Mineral County, Nev., produced mainly from the 300- and 400-foot levels, and diamond-drill exploration to the 500-foot level reportedly has increased ore reserves. The mill treated about 120 tons of ore plus tailings daily.

Strawberry Tungsten Mines, Inc.—The mine and mill (near Yosemite National Park) are in Madera County, Calif. During the summer working season about 125 tons of ore per day was mined and milled.

Surcease Mining Co.—Recoveries of scheelite concentrate from the Atolia mine and mill in San Bernardino County, Calif., were 8 percent higher in 1954 than in 1953 because of a greater tonnage of lower grade ores. A new flotation-plant addition to the gravity mill was nearly completed during the year. Underground mines supplied 60 percent of the 43,213 tons treated and open-pit operations or tailings the remainder.

Tungsten Mining Corp.—The Hamme mine, Vance County, N. C., increased production to 289,235 tons and continued as the leading domestic producer. Concentrate production of 3,028 tons (mostly hübnerite) exceeded that of 1953 by 18 percent. A chemical plant for treating low-grade and scheelite ores was under construction and was expected to be in operation early in 1955. Mine production came from above the 1,100-foot level, but the Central and Sneed shafts indicated mineralization below 1,500 feet.[8]

United States Vanadium Co.—The Pine Creek mine, Inyo County, Calif., was the Nations second largest tungsten producer, and the Pine Creek mill, also in Inyo County, Calif., was an important market

[7] Mining World, How Getchell Gold Mill Recovers Tungsten: Vol. 16, No. 1, January 1954, pp. 38–42.
[8] Sweet, James R., Tungsten Mining in North Carolina: Min. Cong. Jour., vol. 40, No. 8, August 1954, pp. 81–86.

for custom ores and low-grade concentrate. The main raise from a tunnel at an elevation of 9,300 feet to the "A" level (1,500 feet above) was completed, and exploration and development from the raise were under way. In the plant, facilities were installed to permit handling various reagents in bulk rather than in package form.

Wah Chang Mining Corp.—Until July 1, 1954, the Lincoln Mine Division, Wah Chang Mining Corp., Tempiute, Lincoln County, Nev., operated as the Black Rock Mining Corp. Production of ore, mined and milled, increased to 173,716 tons. A 2,900-foot mill level tunnel was begun in November and was scheduled for completion in 1955. Another diesel generator added to the power plant increased output capacity to 3,600 kw.

The Benton Division, Wah Chang Mining Corp., Mono County, Calif., also formerly operated as the Black Rock Mining Corp., continued to operate at full capacity, treating 130,529 tons of underground and open-pit ore. Shrinkage stopes and room-and-pillar methods were used underground.

CONSUMPTION AND USES

Consumption of concentrate was lower than in any year since 1938.

TABLE 5.—Distribution of tungsten concentrate consumed

	Tungsten (pounds)	Short tons (60 percent WO_3)	Percent of total
Manufacturers of steel ingots and ferrotungsten	1,260,495	1,325	31
Manufacturers of hydrogen-reduced metal powder [1]	1,784,856	1,875	44
Manufacturers of carbon-reduced metal powder, tungsten chemicals, and consumption of firms producing several products [1]	992,027	1,042	25

[1] Includes the entire consumption of firms that use tungsten concentrates primarily for the purpose listed, except the quantities used to produce ferrotungsten.

Because of supply uncertainties, utilization of tungsten has historically been somewhat restricted. Search for substitutes has accompanied or preceded investigation of new uses. Cemented tungsten carbide inserts placed at cutting edges or points of wear has, over the last 30 years, tended to lower consumption of tungsten in alloys. Despite limitations, however, and the inclination to use other materials, tungsten has a wide variety of applications.

It is used in steel, in nonferrous alloys, as a carbide, as a pure metal and in miscellaneous lesser applications. For its high-temperature characteristics it is used in shaping metals, in electric lamp filaments, in valve parts, and in jet engines; for its great weight it is used in counterbalances, vibration dampeners, and gyroscopes; for its hardness it is used in rock drilling,[9] hard facing, wear resistant parts of machines,[10] taps, reamers, dies, hack saw blades, shovel teeth; and

[9] Hubbell, A. H., Survey of Mining Practice: Eng. and Min. Jour., vol. 155, No. 2, February 1954, pp. 113–117.
Gisner, Bo, Notes on Hard Metals for Rock Drills: Manual on Rock Blasting, vol. 11, K. H. Fraenkel, Editor, pp. 14:01-1 to 14:01-20, 1954. (Published by Aktiebolaget Atlas Diesel—Stockholm and Sandvikens Jernuerks Aktiebolag-Sandviken Sweden).
O'Hara, T. A., Manufacture of Tungsten Carbide-Tipped Drill Steel: Min. Eng., vol. 6, No. 3, March 1954, pp. 294–298.

[10] Lennon, F. J., Cemented Carbides—Wear-Resistance Uses Grow: Iron Age, vol. 174, No. 16, Oct. 14, 1954, pp. 142–144.

for its electrical and thermionic properties it is used in resistor elements, magnetos, switch contacts, sparkplugs, street-light signals, vending and bookkeeping machines, and radio and television tubes.

TABLE 6.—Tungsten consumed for all purposes as compared with steel production, 1916–54

Year	Tungsten consumed from concentrate (million pounds)	Total steel production (million tons)	Tungsten per ton of steel (pounds)	Alloy steel production[1] (million tons)	Tungsten per ton of alloy steel (pounds)[1]
1916–19 (average)	[2] 11.0	46.8	0.24	(3)	(3)
1920–29 (average)	[2] 3.2	47.8	.07	(3)	(3)
1930–38 (average)	[2] 3.2	36.1	.09	(3)	(3)
1939	(3)	(3)	(3)	(3)	(3)
1940	10.0	67.0	.15	4.7	2.1
1941	16.7	82.8	.20	7.8	2.1
1942	17.4	86.0	.20	11.2	1.6
1943	19.3	88.8	.22	12.7	1.5
1944	19.2	89.6	.21	10.2	1.9
1945	14.1	79.7	.18	8.1	1.7
1946	6.5	66.6	.10	5.5	1.2
1947	7.8	84.9	.09	6.9	1.1
1948	8.9	88.6	.10	7.9	1.1
1949	5.0	78.0	.06	5.4	.9
1950	6.6	96.8	.07	7.7	.9
1951	11.4	105.2	.11	9.2	1.2
1952	8.6	93.2	.09	8.2	1.0
1953	7.7	111.6	.07	9.3	.8
1954	4.0	88.3	.05	6.3	.6
1940–44 (average)	16.5	82.8	.20	9.3	1.8
1945–49 (average)	8.5	79.6	.11	6.8	1.3
1950–54 (average)	7.7	99.0	.08	8.1	.9

[1] Other than stainless steel.
[2] Apparent consumption.
[3] Not available.

Manufacturers of steel ingots and ferrotungsten consumed 31 percent of the concentrate used during the year. If concentrate is added directly to the steel, scheelite is required; if it is first converted to ferrotungsten, scheelite is preferred but considerable amounts of wolframite can be used if there is a difference in price or other justification. For production of some alloys tungsten is added in the form of pure metal. The greatest amount of concentrate was consumed in manufacturing hydrogen-reduced metal powder, which was converted either to tungsten carbide or to use as a metal. For production of hydrogen-reduced metal powder, wolframite-type minerals were preferred; but the specification is not rigid because any concentrate, if adequately processed, can be used for any requirement. There are limitations in practice, however, including the following:

1. Plants that are designed for processing scheelite are not readily adaptable to treating the wolframite-type minerals and vice versa.
2. Removal of impurities may be costly. Copper and phosphorus are objectionable to manufacturers of steel, while molybdenum is objectionable in pure-metal uses.

Conversion of concentrate to finished products centered in two general areas: 75 percent in New York, Pennsylvania, and New Jersey and most of the remainder in Ohio and Illinois.

STOCKS

Stocks held by consumers and dealers were 10 percent lower at the year end than on December 31 of the preceding year but 3 percent higher than the preceding 10-year average. Stocks held by producers were virtually unchanged.

PRICES

During 1954 domestic tungsten concentrate that met standard specifications of the Domestic Tungsten Program was purchased by the General Services Administration [11] at a base price of $63.00 per short ton unit.

As reported to the Bureau of Mines, the average price for domestic concentrate shipped was $62.61 per short-ton unit in 1954.

Imported concentrate, including duty, was quoted at $31.93 in January, $23.93 in March, $37.93 in April, $29.93 in July, and $33.43 in December. The average quoted price for the year, including duty, was $31.36.

On the London market, quotations for tungsten concentrate fluctuated between 100 and 225s. per long-ton unit of WO_3. Prices at 170–155s. were declining, on January 1, 1954, and continued downward to 100–110s. during the week of March 4, 1954. By April 29 the price was 225s., dropped to 150s. in July, and finished the year at 195–200s. These prices equalled a range of $12.54 to $28.21 per short-ton unit.

FOREIGN TRADE [12]

Because of the price support for domestic tungsten, nearly all concentrate consumed in the United States during the year was supplied from less expensive foreign sources. General imports declined 21 percent from the alltime high of 1953. Increased imports from Bolivia and expiration of the tungsten agreement between Korea and the United States put Bolivia in first place ahead of Korea as a supplier of concentrate to the United States. Imports of more than 1 million pounds came from each of 8 countries and smaller amounts from 15 countries. Sale of concentrate to the United States Government under long-term contracts will continue on a diminishing scale until about 1960.

Reexports of concentrate totaled 149 tons and exports 39 tons compared with 22 and 13 tons, respectively, in 1953.

Imports for consumption of ferrotungsten are listed in table 8. Exports to Canada and Peru were 10,950 pounds.

Department of Commerce reporting of imports for consumption, as of January 1, 1954, combined tungsten metal, tungsten carbide, and combinations containing tungsten or tungsten carbide, which had previously been reported separately. In 1954 imports of these 3 classes for consumption totaled 154,100 pounds, contained metal, as compared with 82,100 pounds in 1953.

Exports of tungsten-metal powder totaled 45,500 pounds; distribution was to Canada (44,200 pounds), to Australia (800 pounds), to Switzerland (400 pounds), and to the United Kingdom (100 pounds).

[11] Work cited in footnote 3.

[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.

Additional tungsten-bearing materials imported for consumption in 1954 were tungstic acid (1,971 pounds metal content), tungsten nickel, etc., and other tungsten alloys not specifically provided for (63,700 pounds content). Scrap (314,600 pounds valued at $624,800) was imported free under rate provision 18.

Tungsten metal and alloys in crude form and scrap (377,200 pounds gross) and semifabricated forms (49,700 pounds gross) were exported.

TABLE 7.—Tungsten ore and concentrate imported into the United States, 1953–54, 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
1953					
North America:					
Canada	[3] 5,900,981	[3] 1,874,675	[3] 6,122,432	[3] 1,902,713	[3] $5,281,956
Mexico	2,648,534	824,735	2,627,911	813,260	1,572,678
Total	8,549,515	2,699,410	8,750,343	2,715,973	6,854,634
South America:					
Argentina	997,829	513,504	997,829	513,504	1,768,715
Bolivia	6,826,538	3,256,566	6,837,122	3,273,147	12,147,453
Brazil	[3] 4,834,699	[3] 2,724,679	[3] 4,816,637	2,715,841	7,926,046
Peru	1,508,917	818,040	1,404,064	784,060	2,489,967
Total	14,167,983	7,312,789	14,055,652	7,286,552	24,332,181
Europe:					
Finland	32,136	15,933	32,136	15,933	47,769
France	1,453,281	753,472	1,127,600	592,552	1,780,250
Germany, West	[3] 207,709	[3] 117,924	[3] 207,709	[3] 117,924	[3] 321,185
Netherlands	[3] 66,928	[3] 38,733	[3] 66,928	[3] 38,733	[3] 108,464
Portugal	5,477,561	3,007,744	4,854,443	2,712,669	8,054,917
Spain	[3] 5,898,960	[3] 3,164,517	[3] 5,912,247	[3] 3,172,236	[3] 10,813,846
United Kingdom	65,000	34,083	65,000	34,083	88,882
Yugoslavia	34,943	17,735	34,943	17,735	47,244
Total	13,236,518	7,150,141	12,301,006	6,701,865	21,262,557
Asia.					
Burma	[3] 3,582,739	[3] 1,732,824	[3] 3,078,197	[3] 1,649,831	[3] 3,018,190
Hong Kong	355,500	188,235	186,542	99,388	270,737
India	22,512	11,821	22,512	11,821	25,931
Korea, Republic of	12,191,233	5,901,998	12,191,233	5,901,998	24,186,934
Malaya	118,882	65,650	107,150	59,602	124,719
Thailand	3,352,737	1,882,604	3,010,431	1,704,271	5,450,355
Total	19,623,603	9,783,132	18,596,065	9,426,911	33,076,866
Africa:					
Belgian Congo	[3] 563,181	[3] 313,651	[3] 563,181	[3] 313,651	[3] 1,019,671
British East Africa	49,959	27,068	49,959	27,068	85,115
Egypt	35,835	18,057	25,835	13,487	29,987
French Morocco	22,046	11,365			
Nigeria	5,040	2,844			
Southern Rhodesia	353,400	193,202	327,331	178,571	434,809
Union of South Africa	298,878	143,386	100,733	51,903	117,627
Total	1,328,339	709,573	1,067,039	584,680	1,687,209
Oceania:					
Australia	2,916,826	1,439,039	2,664,441	1,308,072	4,296,066
New Zealand	67,690	36,396	67,690	36,396	92,529
Total	2,984,516	1,475,435	2,732,131	1,344,468	4,388,595
Grand total	[3] 59,890,474	[3] 29,130,480	[3] 57,502,236	[3] 28,060,449	[3] 91,602,042

For footnotes, see end of table.

TABLE 7.—Tungsten ore and concentrate imported into the United States, 1953–54, 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
1954					
North America:					
Canada	2,198,226	1,221,468	2,177,523	1,219,952	$3,885,458
Mexico	1,531,891	814,089	1,494,762	794,482	2,203,573
Total	3,730,117	2,035,557	3,672,285	2,014,434	6,089,031
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			
Federation of Rhodesia and Nyasaland	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	44,113,852	22,948,564	46,305,390	24,092,078	[4] 75,878,843

[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 to earlier years.

TABLE 8.—Ferrotungsten imported for consumption in the United States, 1953–54, by countries

[U. S. Department of Commerce]

Country	1953			1954		
	Gross weight (pounds)	Tungsten content (pounds)	Value	Gross weight (pounds)	Tungsten content (pounds)	Value
Europe:						
Germany, West	6,614	5,040	$16,127			
Netherlands	9,921	8,165	21,061	10,479	8,801	$15,526
Portugal	461,716	365,868	1,013,397	333,166	269,895	496,810
Sweden	63,582	53,426	142,111	6,831	5,003	10,772
United Kingdom	211,917	170,800	493,994	256,194	207,576	299,943
Total	753,750	603,299	1,686,690	606,670	491,275	823,051
Asia: Japan				11,023	8,929	14,367
Grand total	753,750	603,299	1,686,690	617,693	500,204	837,418

TECHNOLOGY

Interest in tungsten mining continued at a high level during 1954. The guaranteed price of $63.00 per short-ton unit for domestic production, combined with Government assistance in exploration, prompted reexamination of many old workings in addition to new exploration. Uranium prospecting also stimulated the search for tungsten. Diamond drilling, trenching, and tunneling were commonly employed in exploration.

Mining.—Tungsten mining methods included placer, open-pit, and underground practices, such as square-set, shrinkage, sublevel, and room and pillar. Improved earthmoving equipment and improved beneficiation technique permitted less selective mining and were important influences in the industry.

The scale of operations also varied from spare-time activity of individuals to production approximating 1,000 tons of ore per day. By far the greatest tonnage came from underground mines, although substantial quantities were produced by surface methods in the Atolia district, California; from the Minerals Engineering Co.'s Ivanhoe mine in Montana; and from reworking of dumps and tailings. Several mines, especially in Nevada, combined open-pit and underground methods.

Milling.—An important portion of the 1954 tungsten output came from chemical treatment of low-grade flotation products. By this processing, higher recoveries and working of lower grade ore were possible. Largest of the firms that accepted low-grade concentrate on a custom basis were United States Vanadium Co. in the California-

Nevada area, Salt Lake Tungsten Co. in the intermountain area, and the Wah Chang Corp., Glen Cove, N. Y. Other firms operated or were constructing chemical plants for treatment, principally leaching, of their own concentrate.

At Climax, Humphrey spirals were used to separate hübnerite from mill tailings. Concentrate from the spirals was treated further by flotation, tabling, and magnetic separation.

In Boulder County, Colo., gravity methods, especially jigs and tables, were most frequently used to recover ferberite, the principal tungsten mineral.

At the Hamme mill in North Carolina a high-grade (70–73 percent WO_3) hübnerite concentrate was produced by crushing, grinding, screening, jigging, tabling, flotation, and magnetic separation. The crushing plant was reported to have a capacity of 800 tons in 16 hours. Bendelari jigs in parallel handled 40 to 45 percent of the total tungsten mineral recovered.[13] Table concentrate was upgraded by flotation in a bulk sulfide process. Jig and flotation concentrate was fed to a magnetic separator, which produced the final concentrate plus a reject containing scheelite, metallic iron, rhodochrosite, sulfides and some hübnerite. The reject was shipped for further treatment.

Nevada and California produced scheelite as the major tungsten mineral. Treatment of ore at the Getchell mill was described [14] and is outlined briefly below as a more or less typical example of scheelite milling.

About 75 percent of the feed was from Getchell properties, and the rest was hauled from within a radius of 200 miles for custom treatment. The mill was originally built for cyanide treatment of gold ores but converted to tungsten during the Korean war. Custom ore was crushed and sampled separately for better control of mill feed.

After being crushed to minus-¾-inch size, the custom and company ores were combined, put through surge bins, and fed to the grinding circuit, which consisted of a rod mill, classifier, and ball mill.

Flotation of classifier overflow produced a scheelite concentrate.

Flotation of sulfides, usually accomplished as the first step after grinding, was eliminated in the Getchell mill circuit and the same result obtained by a flotation step in the acid-treatment plant.

Final scheelite flotation concentrate was tabled to yield a 30 to 40 percent WO_3 product.

A two-cycle acid-leach process, with an intermediate flotation step for removal of sulfides, completed the operation and raised the grade to about 65 percent WO_3. The first leach dissolved calcite, and the second leach dissolved phosphorus.

The Salt Lake Tungsten Co., United States Vanadium Co. and Wah Chang Corp. were equipped to treat low-grade concentrate by chemical means. Availability of these facilities permitted many mills to attain better recoveries by use of flotation.

A review of the California-Nevada tungsten industry was published [15] and a report on beneficiation of tungsten ores was issued.[16]

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[13] Hamme, John V., Steadily Growing Southeastern Tungsten Production: Min. Eng., vol. 6, No. 10, October 1954, pp. 978–982.

[14] Work cited in footnote 7.

[15] Henricksen, Ray M., California-Nevada Tungsten: Mines Mag., vol. 44, No. 4, April 1954, pp. 35–40. (An address before the Colorado Mining Association Convention, Denver, Colo., Jan. 30, 1954.)

[16] Staff, Mineral Dressing Department, American Cyanamid Co., Beneficiation of Tungsten Ores: Mines Mag., vol. 44, No. 9, September 1954, pp. 24–25, 43.

Bureau of Mines publications included three reports of investigations.[17]

WORLD REVIEW

World production of tungsten concentrate in 1954 remained at the high post-Korea rate primarily because of large exports to the United States. Industries in this country accounted for an estimated one-half of Free World consumption while virtually all domestic production and a large proportion of foreign production went into Government stockpiles. Of the world output, excluding China, U. S. S. R. and North Korea, 77 percent was imported into the United States or produced by domestic mines. Production by the United States increased, during the year, by slightly more than 4,000 tons, and Korean production declined by slightly less than 4,000 tons of concentrate. Both of these changes were related to purchase programs of the United States Government. Other changes were less substantial, but the tendency in most countries was toward a slight decline.

Africa.—Of the general imports coming into the United States more than 7 percent was from Africa and comprised slightly over half of the total African production. The largest producer was Belgian Congo, with 1,685 short tons of concentrate containing 60 percent WO_3, and the next largest was Union of South Africa. Southern Rhodesia, South-West Africa, and Uganda each produced more than 200 tons. Production in Union of South Africa increased by 250 tons of concentrate because of operations at the O'okiep Copper Co.

Argentina.—No tungsten mineral was imported into the United States from Argentina in 1954, although a production of 717 short tons of 60 percent WO_3 was reported.

Australia.—Output of 2,563 short tons of concentrate containing 60 percent WO_3 was reported. In June 1954 it was noted that King Island Scheelite, Ltd., on King Island, Tasmania was treating 5,000 tons of ore per week.

Bolivia.—Production from the Aramaya mines continued under nationalized operation at a rate 17 percent greater than during 1953 (the first year of nationalization). Construction of a 600-meter aerial tramway was completed, and a magnetic separator was on order. In 1954, Bolivia was the leading exporter of tungsten to the United States.

Brazil.—Imports of tungsten from Brazil approximately equaled imports from the continent of Africa. Much of the production came from small, primitive mining operations. Of interest is the establishment by the General Electric S. A. of a small plant for producing metallic tungsten from Brazilian wolframite. The company has operated a lamp factory and filament-drawing division since 1950 but before 1954 relied upon imported tungsten metal.

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[17] Floyd, P. H., and Stickney, W. A., Beneficiation of Ferberite-Scheelite Ore From Germania Consolidated Mines, Inc., Stevens County, Wash.: Bureau of Mines Rept. of Investigations 5039, 1954, 6 pp., 1 fig.
Engel, A. L., and Shedd, E. S., Treatment Tests of Scheelite Ores From California, Nevada, and Utah: Bureau of Mines Rept. of Investigations 5087, 1954, 24 pp.
Floyd, P. H., and Wessel, F. W., Beneficiation of Scheelite Ore From the Sangdong Mine, Korea: Bureau of Mines Rept. of Investigations 5088, 1954, 13 pp., 3 figs.

TABLE 9.—World production of tungsten ores, by countries, in short tons[1] of concentrate containing 60 percent WO_3, 1945–49 (average) and 1950–54

(Compiled by Pauline Roberts)

Country	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Canada	322	237	2	1,245	2,037	1,668
Mexico	100	74	358	488	752	601
United States (shipments)	4,124	4,820	6,275	7,611	9,591	13,691
Total	4,546	5,131	6,635	9,344	12,380	15,960
South America:						
Argentina	363	26	165	474	661	717
Bolivia (exports)	3,006	2,739	2,996	4,086	4,216	4,900
Brazil (exports)	1,512	837	1,567	1,967	2,146	[2] 1,650
Peru	534	569	517	644	1,001	[3] 948
Total	5,415	4,171	5,245	7,171	8,024	[2] 8,200
Europe:						
Finland	[4] 30	22	9	52	24	139
France	494	503	866	1,043	1,227	1,043
Italy	9	2	6	6	6	33
Norway	1	-----	-----	13	9	-----
Portugal	2,078	2,756	5,675	5,824	5,589	4,721
Spain	648	937	2,814	6,040	3,252	2,260
Sweden	443	399	422	371	485	[2] 440
U. S. S. R.[2]	3,814	8,300	8,300	8,300	8,300	8,300
United Kingdom	98	84	67	61	67	([5])
Yugoslavia	-----	-----	-----	-----	132	[2] 110
Total (estimate)	7,615	13,000	18,200	21,700	19,100	17,000
Asia:						
Burma	796	1,025	1,816	2,425	2,205	[2] 1,300
China[2]	7,441	13,228	17,416	22,046	18,739	19,842
Hong Kong	-----	-----	25	115	176	32
India	6	2	17	11	17	([5])
Indochina	2	-----	-----	-----	-----	-----
Japan	66	26	183	531	819	892
Korea:						
Korea, Republic of	2,168	992	1,433	4,519	8,267	4,630
North Korea		[2] 1,100	[2] 1,300	[2] 1,300	[2] 1,650	[2] 1,650
Malaya, Federation of	54	30	60	87	162	127
Thailand	[2] 750	[2] 1,300	[2] 1,500	[2] 1,750	1,929	1,323
Total (estimate)	11,285	17,700	23,800	32,800	34,000	29,800
Africa:						
Algeria	-----	-----	24	54	33	-----
Belgian Congo[6]	464	441	720	1,113	1,403	1,685
Egypt	3	-----	8	23	15	4
French Morocco	([5])	8	42	20	13	14
Nigeria	6	6	25	25	20	1
Southern Rhodesia	104	71	255	463	419	281
South-West Africa	7	4	36	130	165	228
Tanganyika (exports)	[4] 24	17	17	15	13	6
Uganda (exports)	139	240	176	157	197	204
Union of South Africa	277	106	207	290	425	675
Total	1,024	893	1,510	2,290	2,703	3,098
Oceania:						
Australia	1,335	1,361	2,076	2,393	2,456	2,563
New Zealand	32	26	39	69	[2] 44	[2] 33
Total	1,367	1,387	2,115	2,462	2,500	2,596
World total (estimate)	31,300	42,300	57,500	75,800	78,700	76,700

[1] This table incorporates a number of revisions of data published in previous Minerals Yearbook Tungsten chapters.
[2] Estimate.
[3] Exports.
[4] Average for 1948 and 1949.
[5] Negligible.
[6] Including Ruanda-Urundi.

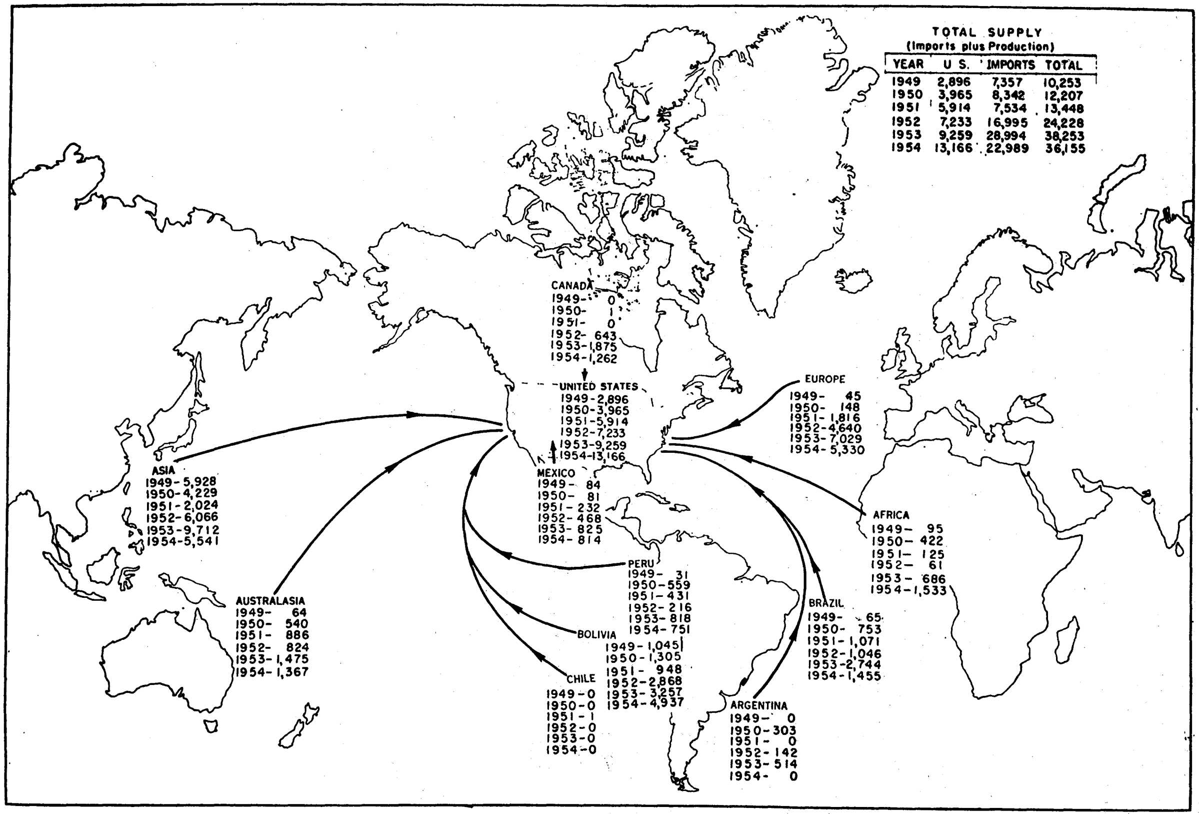

FIGURE 2.—Domestic production and imports of tungsten by source areas, 1949–54, in thousand pounds.

Burma.—The bulk of Burma's tungsten, with Mawchi mines out of production because of military activity, was reported from the Tavoy district. Exports to the United States were 493,450 pounds (contained tungsten), and total production for 1954 is estimated to be 1,300 tons of concentrate.

Canada.—The Department of Mines and Technical Surveys, Ottawa, reported the following preliminary data, in short tons:

Item:	*1954*	*1953*
Production (shipments), WO_3	1,000	1,223
Imports, gross weight, scheelite	4	127
Imports, gross weight, ferrotungsten	43	31
Exports, scheelite, W content	619	850
Consumption, scheelite	7	27
Ferrotungsten	31	40
Metal, carbide and sodium tungstate	47	63

Lowered production resulted from closing of the Red Rose mine of the Western Tungsten Copper Mines, Ltd., near Hazelton, British Columbia. Strict enforcement of the United States Government purchase contract was reported to have forced the closing because of excess ferberite in the scheelite ore.

China.—Reliable information on production and trade was not available. Apparently, sporadic attempts were made [18] to return Chinese tungsten to Free World markets, but lowered United States consumption, low world price, and cancellation of United States contracts in Canada, Korea, and elsewhere tended to discourage such attempts.

Korea.—With expiration of the United States Government purchase agreement, South Korean tungsten production virtually came to a standstill at the end of March. The Sangdong and Dalsung mines were reported to be capable of producing 30,000 metric tons of concentrate annually.[19]

At year end, a number of lots of Korean concentrates were being offered at auction on the world market.

Mexico.—Output declined 20 percent below the 1953 production. Market conditions rather than inability to produce were responsible.

Peru.—At Pasto Bueno mine a 250-ton-per-day concentration plant using gravity and flotation methods was formally dedicated July 21. Improvements included construction of a 50-mile highway and a hydroelectric power plant.

Portugal.—Production of tungsten concentrate in 1954 was 868 short tons less than in 1953. Factors in Portuguese production are the world price and the export tax.

Spain.—Production declined over 30 percent below 1953 although exports to the United States were virtually unchanged.

Thailand.—Production declined 31 percent from the 1953 level, reportedly because of low prices.

[18] Metal Bulletin, More Trade With China: No. 3910, July 16, 1954, pp. 13–14.
[19] Mining World, Tungsten—Key to South Korea's Mining: Vol. 16, No. 13, December 1954, pp. 44–46.

Uranium and Radium

By John E. Crawford [1] [2]

COMMERCIAL electrical power generation from nuclear fuel approached reality in 1954. Ground was broken at Shippingport, Pa., for the first full-scale nuclear power station in the United States. Industrial and Atomic Energy Commission officials were optimistic in their expectations of similar plants being built in the near future.

The Atomic Energy Act of 1954, approved August 30, 1954, was the implement that would allow greater industrial participation in developing peaceful uses for atomic energy. The act also authorized the President to enter into international nonmilitary agreements concerning the utilization of atomic energy for peaceful purposes. This represented the first revision of the original Atomic Energy Act of 1946 and was a major step toward more liberal distribution of technical information on atomic energy and its best utilization.

The AEC released information about its 5-year plan for assisting industry in developing experimental nuclear power reactors. Several plants were authorized in 1954 under the program.

The explosion of the first hydrogen or thermonuclear device at Elugalab Atoll in the Eniwetok area of the Pacific Ocean, November 1, 1952, was described to the public in 1954, and motion pictures of the explosion and its results, entitled "Operation Ivy," were shown in theaters and on television. A new series of thermonuclear tests, "Operation Castle," was conducted at the Pacific proving grounds early in 1954. Results of the tests exceeded estimated effects, and worldwide publicity was given the magnitude of the explosions and the area of radioactive fallout.

Planned expansion of fissionable materials production centers was nearly completed. Operations to separate uranium–235 or plutonium at Hanford, Wash., Oak Ridge, Tenn., Aiken, S. C., Paducah, Ky., and Portsmouth, Ohio, continued satisfactorily.

The AEC's two uranium refineries were scheduled for a forthcoming expansion. This would involve the Fernald, Ohio, plant operated by the National Lead Co. of Ohio and the St. Louis, Mo., plant operated by Mallinckrodt Chemical Works. Additional facilities were to be constructed at nearby Weldon Spring, Mo., and operated by Mallinckrodt. Meanwhile, natural uranium metal and uranium hexafluoride were produced in quantities to meet established requirements of the AEC.

[1] Commodity-industry analyst.
[2] Assistance of Ethel M. Tucker is acknowledged.

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In 1954 over 900 mines produced uranium ores in the western United States, and the domestic uranium-mining industry was estimated to have an annual value of over $100 million. Production of ore was much greater in 1954 than in 1953, and the United States was probably 1 of the 3 top uranium producers of the world. With the entry of many companies and individuals into the exploration and mining field, speculation and stock offerings reached an alltime high. Uranium was mined and shipped from California, Nevada, and Washington for the first time.

New ore-buying stations were established at Riverton, Wyo., and White Canyon, Utah, and a new mill was completed and put into operation at Shiprock, N. Mex., by Kerr-McGee Oil Industries, Inc. Of the 8 other industry-operated mills on the Colorado Plateau, capacities of 7 were being expanded.

The first estimate of uranium requirements for nuclear power purposes was made in 1954. Based on AEC studies, some 17,000 tons of U_3O_8 or 14,000 tons of natural uranium metal, might be needed for industrial power reactors by 1975 or 1980. It was believed that high-grade uranium concentrates probably could be made available at not more than $10 per pound.

There were no significant developments in the radium industry. Operations of the one domestic producer of radium salts were unchanged; distributors for foreign producers continued to offer material in the domestic market. Prices were steady during 1954. The uses for radium remained predominantly in the medical field for cancer therapy, although industrial uses were evident. Some substitution of radioisotopes for radium probably was effected, as such materials were made more available and at reduced prices.

GOVERNMENT REGULATIONS

On August 30, 1954, President Eisenhower signed the Atomic Energy Act of 1954, a revision of the original act passed in 1946. The new law provided for greater industrial participation in development of peaceful uses of the atom; made certain inventions in the atomic energy field patentable; gave the AEC greater freedom in releasing important nuclear energy information to industry; and authorized bilateral cooperation with foreign nations, including transfer of information and source of fissionable material suitable for nonmilitary research and industrial purposes.

Public Law 585, 83d Congress, approved August 13, 1954, amended the mineral-leasing laws and the mining laws to provide for multiple mineral development of the same tracts of public lands and for other purposes. The AEC consequently announced the termination of Domestic Uranium Program Circular 7, effective December 12, 1954. The circular provided for the issuance of uranium-mining leases on certain public lands that at the time of leasing were not subject to the location of mining claims because they were affected by the mineral-leasing laws.

Government participation in uranium exploration through Defense Minerals Exploration Administration amounted to $325,673 in 1954 and represented 16 executed contracts. This amount also included additional sums awarded to Jesse and Grant Shumway and Red Canyon mines, both of Utah, whose contracts had been executed during 1953 but to whom additional assistance was granted in 1954 (see table 1). The total amount of Government participation in contracts involving uranium to date is $1,595,307.

The Office of Defense Mobilization, Executive Office of the President, issued six certificates of necessity involving uranium projects during 1954, as indicated in table 2. Projects certified included mining, ore processing, and nuclear reactor fuel-element fabrication facilities. The total amount certified for accelerated amortization was slightly more than $9 million.

There were 310 miles of access roads serving uranium mines under construction during 1954 (see table 3). Of the total, 243 miles was completed at an estimated cost of $590,175.

TABLE 1.—Defense Minerals Exploration Administration contracts involving uranium executed and amended during 1954, by States

State and contractor	County	Contract: Date	Contract: Total amount	Government participation (percent)
COLORADO				
Aztec Mining Co	San Miguel	Oct. 6, 1954	$6,660	75
Lowell A. Griffith	Montrose	Sept. 9, 1954	18,350	75
Ray Ryan	do	Oct. 7, 1954	66,939	75
San Juan Uranium Corp	La Plata	Sept. 13, 1954	10,500	75
J. R. Simplot Co	Montrose	Sept. 8, 1953 (Amended Jan. 27, 1954).	[1] 34,329	90
United States Uranium Co	do	Dec. 13, 1954	31,683	75
IDAHO				
Wilhite & Seay	Lemhi	Sept. 28, 1954	16,000	75
MONTANA				
Radon Research Corp	Jefferson	May 10, 1954	34,175	75
NEVADA				
Platora Uranium Corp	Humboldt	Oct. 28, 1954	20,750	75
NEW MEXICO				
Four Corner Exploration	McKinley	May 10, 1954	12,189	90
Uranium Development Corp	Valencia	Jan. 8, 1954	11,641	90
Richard Vopat, et al	McKinley	May 10, 1954 (Amended July 9, 1954).	[2] 11,008	90
SOUTH DAKOTA				
Urova Co	Fall River	July 28, 1954	7,160	75
UTAH				
Intermountain Mining	Grand	Sept. 20, 1954	9,275	75
Jesse and Grant Shumway	San Juan	Feb. 6, 1953 (Amended Apr. 19, 1954).	[1] 5,180	90
Mid-Continent Uranium Corp	Grand	Oct. 7, 1954	101,450	75
Red Canyon Mines	San Juan	Nov. 16, 1953 (Amended Apr. 15, 1954).	[1] 3,750	90
United States Uranium Co	do	Oct. 4, 1954	17,574	75

[1] Does not include amount of contract executed in 1953.
[2] Total amount of contract.

TABLE 2.—Certificates of necessity involving uranium, certified by Office of Defense Mobilization for assistance through tax amortization during 1954, by States

Company	Type of project	Date certified	Percentage of depreciable assets certified	Amount allowed for accelerated amortization
IDAHO				
Porter Bros. Corp	Facilities to mine uranium-bearing euxenite and other minerals.	July 15, 1954	80	$1,038,321.60
MASSACHUSETTS				
Metals & Controls Corp	Reactor fuel-element fabrication.	Aug. 19, 1954	60	21,000.00
MISSOURI				
Mallinckrodt Chemical Works	Extraction plant to treat uranium-bearing euxenite concentrates.	Oct. 4, 1954	80	499,200.00
NEW MEXICO				
Anaconda Copper Mining Co	Ore-processing plant	June 10, 1954	80	5,506,000.00
Kerr-McGee Oil Industries, Inc.	do	Nov. 15, 1954	80	2,040,000.00
UTAH				
Utex Exploration Co	Mining equipment	June 10, 1954	80	50,219.20
Total				9,154,740.80

TABLE 3.—Construction in 1954 of defense access roads serving uranium mines and cumulative total for 1952–54

[Bureau of Public Roads]

State	Total work involved			Projects completed			Work accomplished on incomplete projects		
	Total estimated cost	Access funds	Miles	Total estimated cost	Access funds	Miles	Total estimated cost [1]	Access funds [1]	Miles under contract
1954									
Arizona	$350,900	$350,900	82.0	$44,710	$44,710	82.0			
Colorado	226,026	226,026	16.1	99,122	99,122	16.1	$8,720	$8,720	
New Mexico	211,202	211,202	36.4	55,382	55,382	36.4			
Utah	[2] 1,541,915	1,354,295	175.9	390,961	380,010	108.7	58,360	58,360	67.2
Total	[3] 2,330,043	[3] 2,142,423	310.4	590,175	579,224	243.2	67,080	67,080	[4] 67.2
Cumulative total, 1952–54	[3] 6,369,897	[3] 6,072,608	952.5	5,854,077	5,685,288	886.3			

[1] Funds based on percent of work completed.
[2] Includes $95,861 Federal aid funds.
[3] Differences between total estimated cost and amount of access funds represents Federal aid funds, State, and county funds.
[4] No work started on 18.7 miles.

DOMESTIC PRODUCTION

URANIUM

Mine Production.—Uranium-ore production in the United States in 1954 exceeded the output in the previous year, and domestic ore reserves, the compilation of which was a responsibility of the AEC, more than doubled. There were 900 or more active uranium mines in the United States at the close of 1954—an increase of at least 50 percent over 1953.

Ore mined in the United States was from bedded sedimentary rock. Some primary uranium was recovered from vein-type deposits, but this was a small percentage of the total. Deposits contained from a few tons to as much as 1 million tons of ore; most, however, had less than 100,000 tons, and only 2 were indicated as having over 1 million. The ore-bearing strata ranged up to 25 feet in thickness. Many shallow deposits were mined from adits or inclines driven at angles up to 25°. Deposits at depths of 150 feet or more were developed through vertical shafts. Calyx drill holes 36 inches in diameter were used for this purpose in some localities. Very little, if any, water has been encountered in uranium mining operations on the Colorado Plateau. Because of the small size of the lenses and pods of ore, barren pillar support was used with timbering where necessary. In some few operations roof bolts were used.[3]

Eleven States were in the uranium-mining picture—Arizona, California, Colorado, Florida, Nevada, New Mexico, Pennsylvania, South Dakota, Utah, Washington, and Wyoming. Three of the aforementioned States—California, Nevada, and Washington—shipped uranium ore for the first time.[4] In addition, uranium was recovered as a byproduct from the manufacture of phosphate chemicals from Florida phosphate rock. Most of the domestic production originated on the Colorado Plateau, chiefly in southwestern Colorado and southeastern Utah. In the Big Indian Wash area of San Juan County, Utah, the site of the much publicized discovery by Charles Steen in 1952, exploration and mining operations were conducted by many firms, the most prominent of which were: Utex Exploration Co., Homestake Mining Co., Cal Uranium Co., North American Uranium Co., Continental Uranium Co., and Standard Uranium Co.[5] The Utah operations of the Homestake Mining Co. were described in an article published during the year. Homestake was in the process of driving a 3,400-foot adit to the ore-bearing horizon of the Chinle formation on the Little Beaver claims and was developing the La Sal property by sinking a shaft some 600 feet deep to reach ore in the Chinle formation.[6] The La Sal shaft was to be the deepest in the Big Indian District of Utah. The Cal Uranium Co. 280-foot San Juan shaft, in the same area, was the first deep shaft in the Utah section of the Plateau. The San Juan shaft was completed early in 1954.[7] The Uravan mineral belt of the Colorado Plateau continued to be a significant contributor to the Nation's supply of uranium. The Golden Cycle Corp. and Worcester mines sank shafts on AEC leases, and Shuttuck-Den Mining Co. did likewise on its property. The 646-foot Bowen shaft of the Golden Cycle Corp. on Atkinson Mesa was the deepest uranium-mining operation on the Colorado Plateau. The first shipment of ore from the Bowen mine was made in April 1954. The Shattuck-Den Mining Co. 515-foot, 2-compartment shaft was on Club Mesa west of Uravan, Colo. The Worcester mines mined uranium from a 296-foot shaft on the Dolores bench.[8] In the Arizona section of the Plateau the Vanadium Corp. of America

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3 Toole, R. H., Uranium Mining Still at High Pace: Min. Eng., vol. 7, No. 3, March 1955, pp. 236–238.
4 Nininger, Robert D., Uranium: Eng. and Min. Jour., vol. 156, No. 2, February 1954, pp. 92, 93.
5 Waylett, William J., Uranium: Min. World, vol. 17, No. 5, April 15, 1955, pp. 61–63.
6 Mining World, Homestake Develops Two New Utah Uranium Mines: Vol. 16, No. 12, November 1954, pp. 46–49.
7 Mining World, Uranium Mining Goes Deeper: Vol. 16, No. 13, December 1954, pp. 40–43.
8 Work cited in footnote 7.

produced uranium ore at its Monument No. 2 mine in Navajo County. The Monument No. 2 was the largest of 40 mines operated by Vanadium Corp. of America.[9] On the Colorado Plateau in New Mexico, the Anaconda Copper Mining Co. mined ore at the Jackpile mine, Woodrow mine, and Section 9 mines on and near the Laguna Indian Reservation, Valencia County. The big Jackpile mine was an open-pit operation. This method was selected because: (1) Greater and more selective ore recovery was possible; (2) no ground support was necessary; (3) the trend of the ore was more discernible, and outlying tongues of ore could be mined by adits from pit wall; (4) unskilled Indian labor was better utilized; (5) mining was safer; and (6) waste-dumping sites were made available. The Woodrow mine was developed by underground methods after drilling 2 shafts almost 100 feet deep with 36-inch calyx equipment. The limestone mines in section 9 were of a small open-pit type.[10] Also on the plateau in New Mexico, uranium mining was conducted by the Santa Fe Railroad subsidiary Haystack Mountain Development Co., Holly Uranium Co., Alvis-Denison Construction Co., and others.

There were increased exploration and mining activities in areas outside of the Colorado Plateau. In Utah the Vanadium Corp. of America produced some primary and secondary uranium ore from the Prospector mine, the Freedom mine, and the Bullion-Monarch Mining Co. property in the Marysvale district. In the Black Hills region of South Dakota and Wyoming the Homestake Mining Co., Sodak Mining Co., and Pictograph Mining Co. were actively engaged in exploring for and mining uranium. Kerr-McGee Oil Industries, Inc., maintained several small mines in the Pumpkin Buttes area of Wyoming, while the Lucky Mc Mining Co. established ore reserves in the Gas Hills region of Wyoming.[11] The Miracle Mining Co. shipped ore to the Vitro Uranium Co. mill at Salt Lake City, Utah, from its Mann property at Miracle Hot Springs 35 miles northeast of Bakersfield, Kern County, Calif.[12] The property was sold to the Wyoming Gulf Sulphur Co. in the latter part of 1954.[13] It was stated that about 60 occurrences of uranium were reported in California, but only the Miracle Hot Springs property shipped commercial-grade material to the AEC. A map of California that showed occurrences of radioactive minerals was published by the California Division of Mines in its Mineral Information Service circular (vol. 7, No. 10) dated October 1, 1954.[14] Platora Uranium Corp. was the first company to ship uranium ore from Nevada from its Moonlight mine in Humboldt County. Other firms exploring for and developing uranium occurrences in Nevada included the Western Uranium Corp., Belmont district; Toiyabe Uranium Co., Round Mountain, Nye County;[15] TVG Mines Co., Fish Lake Valley;[16] Pequop Uranium and Thorium

[9] Work cited in footnote 5.
[10] Argall, George O., Jr., Why Anaconda's Uranium Mines are Unique: Min. World, vol. 16, No. 10, September 1954, pp. 54–59.
[11] Work cited in footnote 5.
[12] Mining World, vol. 16, No. 10, September 1954, p. 105.
Dane, Edith, Kern County Makes First Shipment of Uranium Ore to Salt Lake AEC: California Min. Jour., vol. 24, No. 1, p. 24.
Mines Magazine, vol. 44, No. 7, July 1954, p. 8.
[13] Engineering and Mining Journal, vol. 155, No. 11, November 1954, pp. 127–128.
[14] Mining and Industrial News, California Mines Division Issues Map of Uranium Areas: Vol. 22, No. 11, November 1954, p. 9.
[15] Mining World, vol. 16, No. 13, December 1954, p. 76.
[16] California Mining Journal, vol. 24, No. 3, November 1954, p. 23.

Co., Elko County;[17] Comstock Uranium-Tungsten Corp., King's River district; Eldorado Mining Co., Veetch Canyon, Lander County; Kings River Uranium Corp., Kings River Valley area, and the American Western Exploration Co. and American Northland Oil Co., both in the Kings River area.[18]

In 1954 uranium-mining operators in Arizona formed the Arizona Ore Producers Association, with headquarters at Globe.[19] Some mining was undertaken on a small scale in the Sierra Ancha mining district, Gila County. The Red Bluff mine of the Pittston Co. about 35 miles northwest of Globe produced over 500 tons of ore in 1954 which was said to have been shipped to an AEC buying station.[20] Other successful mining operations included the Sierra Ancha Mining Co., the Continental Uranium Co., and C. W. Via's Melinda mine, all within 45 miles of Globe, Ariz.

A small initial shipment of uranium ore was made from the Midnight mine on the Spokane Indian Reservation, Stevens County, Wash. Autunite and torbernite were found in granite and its contact with argillite. About 3,000 tons of ore-grade material was stripped of overburden during the latter part of 1954.[21]

In Alaska the Territorial Commissioner of Mines announced in March 1954 that a uranium claim was staked in the Brooks Range on Seward Peninsula.[22] In the fall of 1954 uranium occurrences were reported in the Shirley Lake region near the Skwentna River 110 miles northwest of Anchorage and in the Nixon Fork country near McGrath.[23]

The Territorial Commissioner of Mines published a bulletin on prospecting in Alaska. Information about uranium mineralization in the Territory was included in the bulletin. Copies were available from the Territorial Department of Mines, P. O. Box 1391, Juneau, Alaska.[24]

Mill Production.—Mill-processing capacity was exceeded by ore production in 1954; as a result, stockpiles of uranium ore were established at several places. New areas from which uranium was recovered were provided with a market to stimulate production, and the purchased ore was stockpiled until such time as enough reserves were thus proved to warrant construction of a mill at the site.[25]

The Kerr-McGee Oil Industries, Inc., processing mill at Shiprock, N. Mex., was completed and began operation November 1, 1954. Kerr-McGee signed a contract with the AEC for construction and operation of the Shiprock facility in 1953. The plant treated ore from the Shiprock area by the acid-leach method. The company also took over operation of the ore-buying station at Shiprock, which had been operated by the American Smelting & Refining Co. since 1952.[26]

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17 Mining and Industrial News, vol. 22, No. 10, October 1954, p. 8.
18 Mining and Industrial News, vol. 22, No. 12, December 1954, p. 2.
19 Pay Dirt, No. 198, Dec. 17, 1954, p. 5.
20 Mining Congress Journal, vol. 40, No. 6, June 1954, p. 103.
21 Mining World, vol. 16, No. 13, December 1954, p. 81. Engineering and Mining Journal, vol. 155, No. 12, December 1954, p. 144.
22 Mining Congress Journal, vol. 40, No. 5, May 1954, p. 76.
23 Engineering and Mining Journal, vol. 155, No. 12, December 1954, p. 124.
Mining World, vol. 16, No. 13, December 1954, p. 67.
24 Engineering and Mining Journal, vol. 155, No. 3, March 1954, p. 124.
25 Atomic Energy Commission, Seventeenth Semiannual Report: January 1955, p. 4.
26 Mining Congress Journal, vol. 40, No. 11, November 1954, p. 103.

The Utex Exploration Co., owner and operator of the Mi Vida mine in the Big Indian Wash area of Utah's San Juan County and the Combined Metals Reduction Co. joined resources and formed a new company, Uranium Reduction Co., to construct a mill at Moab, Utah. The concentrating facility, if approved by the AEC, would treat ore from both Colorado and Utah, including the entire output of the Mi Vida mine.[27]

The Grand Junction Operations Office of the AEC announced that the Anaconda Copper Mining Co. would construct additional facilities at its Bluewater ore-processing plant near Grants, N. Mex. When expansion is completed the Bluewater plant will treat sizable quantities of uranium-bearing limestone ores by the carbonate-leaching process, as well as sandstone-type ores by the acid-leaching method.[28]

The Climax Uranium Co., a subsidiary of Climax Molybednum Co., signed a 5-year contract with the AEC which included doubling the capacity of its uranium mill at Grand Junction, Colo. The mill will employ an improved recovery process developed by Climax.[29]

Vitro Uranium Co., a division of the Vitro Corp. of America, received from the AEC in 1954 a 5-year extension of the original contract made with AEC in 1951 for uranium-ore processing at Grand Junction, Colo. The new contract adjusted terms to compensate for variations in ore content and process charges, allowed extensive process improvements, and provided for expansion of the mill's capacity.[30]

The AEC agreed to amend its contract with the Vanadium Corp. of America for recovering uranium concentrates at its Durango, Colo., mill. The amendment extended the term of the contract to 1958 and called for the expansion of mill capacity.[31]

The AEC appointed the H. K. Ferguson Co. to make an addition to the Government-owned mill at Monticello, Utah, operated by the Galligher Co.[32]

Indications were that the AEC would soon consider favorably the construction of new mills to serve ore producers in the Monogram Mesa and Gypsum Valley area of Colorado and the Black Hills area of South Dakota and Wyoming.[33]

The two commercially applicable processes for recovering uranium concentrates from ore in 1954 were essentially based on the solution of uranium by acid or carbonate leaching. In acid-leaching circuits sulfuric acid was generally used because of its economic advantages over nitric and hydrochloric acids. Both nitric and hydrochloric acid can dissolve the uranium in the ore as well, if not better, than sulfuric acid, but it was preferred because of the large amounts of acid that are required and because sulfuric acid was cheaper and more generally available. Some mills recovered hydrochloric acid from salt-roasting vanadiferous uranium ore and used it in the leaching process. They were not self-sufficient, however, and the mills had to buy sulfuric acid as well.

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[27] Mining Congress Journal, vol. 40, No. 7, July 1954, p. 63.
[28] Work cited in footnote 26, p. 97.
[29] Work cited in footnote 26, p. 100.
[30] Chemical and Engineering News, vol. 32, No. 22, May 31, 1954, p. 2194.
[31] Mining and Industrial News, vol. 22, No. 7, July 1954, p. 11.
[32] Work cited in footnote 25, p. 4.
[33] Work cited in footnotes 4, p. 63, and 25, p. 4.

Sodium carbonate solution was chosen over other possible carbonate-leaching agents because of its lower cost, solubility, and stability.[34]

Descriptions of the milling circuit at the Bluewater, N. Mex., plant of Anaconda Copper Mining Co. were published. The articles explained Anaconda's method of carbonate leaching of uranium ores, which was selected over acid leaching because (1) the plant investment was lower, (2) a high-grade uranium concentrate solution with a minimum of impurities could be recovered, (3) precipitation of the final uranium product was simplified, (4) overall recovery was satisfactory, and (5) mill operation and maintenance expenses were estimated to be less. The ore was crushed, ground, and wet-ground, after which it was pressure-leached in 12-foot-diameter, 12-foot-high tanks equipped with steam coils at top and bottom. Pulp was cooled at 250° F. and 15 pounds per square inch pressure for about 6 hours. After the leaching cycle was completed, the pulp was discharged under pressure to a Burt filter system, and the uranium-bearing leach solution separated from the pulp which was discarded. The pregnant solution was clarified in a plate and frame press and sock-type filter, eliminating slimes and yielding a clear effluent. The uranium-bearing effluent was then ready to yield its uranium content in a batch-precipitation process. A measured quantity of sodium hydroxide was added to the uranium-bearing solution, neutralizing the bicarbonate present to carbonate. After agitation for a 10-minute period more sodium hydroxide was added to the solution, while the temperature of the mixture was maintained near the boiling point and agitation continued. Precipitation of sodium diuranate followed. The resultant pulp was filtered through a plate and frame leaf press. The filtrate, barren of uranium, was pumped to a holding tank. The precipitate, known as "yellow cake," was washed with water and steam, and dried under air pressure, after which it was removed from the leaves of the filter press, pan-dried on steam coils, and packed in drums for shipment to AEC feed-materials refineries. This is a description of the mill's operations before the expansion program begun late in 1954; some modifications of the above process probably will result from the expansion.[35]

To receive consideration from the AEC for authorizing the construction and operation of a uranium ore-processing mill, an organization had to (1) have access to an ore supply for a 5-year period equivalent to at least one-half the mill's capacity; (2) demonstrate technical abilities in metallurgical and associated fields; (3) be financially responsible for constructing a mill; and (4) give a firm proposal to the AEC illustrating details on costs of plant and operation, as well as process and related technical data. If the AEC was satisfied on the foregoing points, negotiation of a contract between the AEC and the company was undertaken. The contract would make the Commission the purchaser of uranium concentrates for a period of 5 years at a fixed price.[36]

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[34] Kentro, D. M., Processing Uranium Ores: Min. Cong. Jour., vol. 40, No. 12, December 1954, pp. 58–71.
Swainson, S. J., Methods of Processing Uranium Ores: Min. Cong. Jour., vol. 40, No. 1, January 1954, pp. 49–50.
Lenneman, William J., How to Extract Uranium From Ores; Eng. and Min. Jour., vol. 155, No. 9, September 1954, pp. 104–109.

[35] Argall, George O., Jr., Milling Uranium Ores; How Anaconda Does the Job at Its Bluewater Plant: Min. World, vol. 16, No. 9, August 1954, pp. 37–39.
Hutte, John B., New Mexico Uranium: Eng. and Min. Jour., vol. 155, No. 8, August 1954, pp. 96–99.

[36] Engineering and Mining Journal, How to Get Into Milling: Vol. 155, No. 9, September 1954, p. 103.

In Florida some uranium was recovered as a byproduct of phosphate-fertilizer-chemicals and feed-supplements production. The economic phosphate deposits of the Lakeland-Plant City-Bartow area of west-central Florida were the source of the uranium. International Minerals & Chemical Corp., Bartow, Fla., and Virginia-Carolina Chemical Corp., Nichols, Fla., recovered uranium from phosphatic materials. The U. S. Phosphoric Products Division of the Tennessee Corp., East Tampa, Fla., planned construction of a byproduct recovery unit in 1955. The Blockson Chemical Co., Joliet, Ill., continued to recover uranium during the course of its phosphate chemical production from Florida phosphates. Texas City Chemicals, Inc., Texas City, Tex., also operated a uranium-from-phosphate recovery unit at its dicalcium phosphate fertilizer and feed-supplement plant.[37]

Refinery Production.—The uranium refineries, called feed-materials-production centers by the AEC, continued the uninterrupted production of natural uranium metal and uranium hexafluoride from foreign and domestic concentrates during 1954. The refineries at St. Louis, Mo., and Fernald, Ohio, were operated by the Mallinckrodt Chemical Works and the National Lead Co. of Ohio, respectively. It was announced on October 12, 1954, that the Fernald plant would undergo a $20 million expansion program. The Singmaster & Breyer Co. of New York, N. Y., was selected by the AEC as the architect-engineer for the new construction work. The facilities at St. Louis were to be expanded at a cost of $6.5 million, and a new plant was to be constructed at the Weldon Spring Ordnance Works, 27 miles west of St. Louis, at a cost of $33.3 million. The St. Louis area plants were to be designed by the Blaw-Knox Construction Co. of Pittsburgh, Pa., and built by the Fruin-Colnon Contracting Co. and the Utah Construction Co., with offices in St. Louis. The Mallinckrodt Chemical Works will operate the Weldon Springs center upon its completion.[38]

No details of refinery operations were published in 1954. Much of the process technology was classified "security information." It is understood, however, that the concentrates were treated to recover a bright orange uranium trioxide (UO_3) powder, reduced to a purified brown uranium dioxide (UO_2), and converted into uranium tetrafluoride (UF_4), referred to in the uranium industry as green salt. The uranium tetrafluoride was used to make uranium metal in a series of fairly routine but detailed metallurgical steps. It was also the source of the other final product of the refineries, uranium hexafluoride (UF_6), made by reacting more fluorine with the tetrafluoride.

Production of Fissionable Uranium.—The production of fissionable uranium–235 continued at Oak Ridge, Tenn. The first unit of a newly constructed plant at Paducah, Ky., was also in full operation, and parts of a second unit at Paducah were producing. Construction work at the Paducah site neared completion, and expansion of the Oak Ridge facilities progressed.

The work on the new Portsmouth, Ohio, plant continued satisfactorily.[39] Union Carbide & Carbon Corp. operated the plants at Oak

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[37] Work cited in footnote 25, p. 5.
[38] Work cited in footnote 25, pp. 9–10.
[39] Work cited in footnote 25.
Atomic Energy Commission, Sixteenth Semiannual Report: July 1954, p. 9.

Ridge, Tenn., and Paducah, Ky., for the AEC, and the Goodyear Atomic, Corp., a subsidiary of the Goodyear Tire & Rubber Co., was to manage the Portsmouth installation for the AEC when completed. The construction program at Portsmouth was under the direction of Peter Kiewit Sons Co., Omaha, Nebr.[40]

Uranium–235 was produced at the 2 plants by the gaseous diffusion process, which utilized the slight differences in atomic weights of uranium–235 and uranium–238 to enrich the element in the fissionable isotope, uranium–235. The uranium hexafluoride gas was processed through many miles of "cascades," systems of pumps, piping, and barriers, through which the hexafluoride was slowly cycled and recycled. Tons of feed material were required to produce grams of uranium–235.

The American Cyanamid Co. operated a facility for the recovery of fissionable material, including uranium–235, from used fuel elements at the AEC's National Reactor Testing Station, Arco, Idaho. The chemical processing plant was to be modified in the near future.[41]

RADIUM

Refinery Production.—The only domestic producer of radium in 1954 was the Canadian Radium & Uranium Corp., New York, N. Y. The company refinery was at Mount Kisco, N. Y.

Two firms distributed radium and radium compounds produced in foreign countries in the United States: they were the Radium Chemical Co., Inc., New York, N. Y., sales agent for the Union Minière du Haut Katanga, a Belgian firm, and the United States Radium Corp., New York, N. Y.

The Bureau of Mines transferred permanently slightly more than 1 gram of radium salts in 1954. The AEC at Oak Ridge, Tenn., received 450.55 milligrams; the National Institute of Health, Bethesda, Md., 577 milligrams; and the National Bureau of Standards, Washington, D. C., 2.18 milligrams.

CONSUMPTION AND USES

URANIUM

Production Reactors.—Production reactors utilizing natural uranium metal as a fuel recovered plutonium. The reactors were at the AEC's Hanford, Wash., plant operated by the General Electric Corp. and the new Savannah River center near Aiken, S. C., managed by E. I. du Pont de Nemours & Co. At Hanford, construction of additional reactor capacity was about complete. The plant at Savannah River, while not finished, was in partial use.[42]

The plutonium-production process involved the reaction of the uranium-235 content of the natural uranium rods. Some of the neutrons liberated from fissioning uranium–235 atoms struck other uranium–235 atoms, causing their disintegration and continuation of the reaction. Other of the neutrons struck the more prevalent uranium–238 atoms and transformed them into plutonium. The

[40] Engineering News Record, AEC Reviews 16 Months at Portsmouth: Vol. 152, No. 9, Mar. 4, 1954, pp. 36–38.
[41] Atomic Energy Newsletter, vol. 23, No. 3, March 1954, p. 2. Nucleonics, vol. 12, No. 7, July 1954, p. 89.
[42] Atomic Energy Commission, Sixteenth Semiannual Report: July 1954, p. 9.

uranium fuel rods were removed from the reactor after a specific period of time and were subjected to detailed chemical treatment for removing the plutonium content. This operation was handled by remote control, as the rods were dangerously radioactive. Tons of uranium were probably used in producing grams of plutonium, but actual consumption and production statistics were not available from the AEC.

Plutonium was required in manufacturing atomic bombs and other nuclear weapons developed by the Department of Defense and the AEC.

Propulsion Reactors.—The first nuclear-powered submarine, *U. S. S. Nautilus* constructed by the Electric Boat Division, General Dynamics Corp., Groton, Conn., was commissioned September 30, 1954, and sea trials were expected to begin early in 1955. The submarine was to be powered by an STR, Mark II, reactor. The second nuclear-powered submarine, the *U. S. S. Sea Wolf,* also was being constructed by the Electric Boat Division. The reactor was to be an SIR, Mark B type. At the Knolls Atomic Power Laboratory an advanced type of reactor was being developed for application to a high-performance submarine.[43]

The efforts of Admiral H. G. Rickover, Chief, Naval Reactors Branch, AEC, to initiate action on the nuclear-powered submarine program were described.[44]

The AEC authorized the Westinghouse Electric Corp. to conduct research and development on nuclear propulsion for large surface-type naval vessels. Design studies were being undertaken on large nuclear-powered ships by the Newport News Shipbuilding & Dry Dock Co., Newport News, Va., and the Shipbuilding Division, Bethlehem Steel Co., Quincy, Mass.[45]

It was announced that studies and design data indicated that it might be technically feasible to propel a locomotive by a nuclear reactor system. The investigation was an unclassified project financed by the University of Utah without Government support and with the cooperation of the Union Pacific, Southern Pacific, Western Pacific, New York Central, and the Denver & Rio Grande railroads. Firms that contributed information included the General Motors Corp., Commonwealth Edison, Babcock & Wilcox Co., General Electric Co., Worthington Pump Co., and Westinghouse Electric Corp. The cost of such a locomotive was estimated at about $1.2 million, exclusive of engineering and development costs. The unit would develop 7,000 horsepower. The reactor would be of the water-boiler type, using as a fuel 9 kilograms of uranium–235 in an aqueous uranyl sulfate solution at a temperature of 460° F. The heat would be removed by circulating water, which would be turned to saturated steam at 250 pounds per square inch. The steam would be fed directly to the blades of a steam turbine that would, in turn, drive four direct-current generators. Engineering problems yet to be considered include: Extraction of considerable heat from a small volume; operational stability; a leakproof system; contamination of turbine and difficulty of maintenance; and specialized nature of reproc-

[43] Work cited in footnote 25, p. 28.
[44] Time (magazine), The Man in Tempo 3: Vol. 53, No. 2, Jan. 11, 1954, pp. 36–39.
[45] Work cited in footnote 25, p. 28.

essing and charging fuel. The Association of American Railroads planned to study the work of the University of Utah to determine the overall economics of nuclear-powered railroad transportation.[46]

A test area for ground studies of a prototype aircraft-propulsion reactor was scheduled for preparation at the National Reactor Testing Station, Idaho. Research and development work was already begun on the project in laboratories elsewhere.[47]

The Navy Department's Bureau of Aeronautics entered into a contractual agreement with the Consolidated Vultee Aircraft Corp. and the Glenn L. Martin Co. to conduct research on seaplane frames suitable for nuclear propulsion units.[48]

AEC contractors participating in the joint AEC–Air Force program of research and development for aircraft nuclear propulsion were: General Electric Co., Evendale, Ohio; Carbide & Carbon Chemicals Co., Oak Ridge National Laboratory, Oak Ridge, Tenn.; and United Aircraft Corp. Pratt & Whitney Aircraft Division, East Hartford, Conn.[49]

Power Reactors.—The AEC reported that its program for the development of reactors for industrial and military power generation purposes gained momentum during 1954.[50]

To accelerate industry's participation in atomic power research, the AEC announced early in 1954, a 5-year, $200 million reactor development program. It was hoped that the program would result in more economic power generation from nuclear sources. It allowed increased participation by contractors in the research and development of the Commission and encouraged additional groups to join in the work. As part of the program, five major types of reactors were to be constructed. All were considered promising technical approaches to economic nuclear power. The reactors approved for construction were: (1) A fast breeder reactor, (2) a homogeneous reactor, (3) a sodium graphite reactor, (4) a boiling-water reactor, and (5) a pressurized-water reactor.

The fast breeder reactor was considered for construction at either Argonne National Laboratory or the National Reactor Testing Station in Idaho. Its completion date was estimated to be in 1958. The reactor, to be called Experimental Breeder Reactor (EBR) No. 2, was designed as a large central-power-station breeder reactor in power, control, fuel handling, and other features. Most equipment was to be full scale. Initially uranium–235 and later plutonium was to be used as fuel. The blanket surrounding the core was to be composed of uranium–238, which would be transmuted into plutonium. The plutonium would be recovered and subsequently used as fuel in the core. Thus the reactor should produce as much or more fuel in the blanket than consumed in the core. It was designed to produce 15,000 kilowatts of electrical energy.

[46] Chemical and Engineering News, Atomic Locomotive; How Soon?: Vol. 32, No. 9, Mar. 1, 1954, pp. 816–817.
Industrial and Engineering Chemistry, Atoms and the Iron Horse: Vol. 46, No. 4, April 1954, pp. 11a–13a.
Mining Congress Journal, Atomic-Powered Locomotives: Vol. 40, No. 3, March 1954, p. 80.
Nucleonics, Nuclear-Powered Locomotive's Economic Feasibility Questioned by Railroad Men: Vol. 12, No. 3, March 1954, p. 78.
Atomic Energy Newsletter, vol. 11, No. 1, Feb. 23, 1954, p. 2.
[47] Nucleonics, vol. 12, No. 3, March 1954, p. 74.
[48] Nucleonics, vol. 12, No. 7, July 1954, p. 6.
[49] Work cited in footnote 25, p. 29.
[50] Work cited in footnote 25, p. 19.

The Homogeneous Thorium Reactor (HTR) was planned by the Oak Ridge National Laboratory. It would be constructed to study the feasibility of using thorium as a breeder material in a blanket surrounding the core of the reactor. The initial fuel charge would be uranium–235, but if uranium–233 could be produced successfully and recovered from the blanket it would replace the uranium–235 as fuel. The HTR would produce 16,000 kilowatts of electrical energy. The thickness of the thorium blanket and the concentration of fertile material would be the same as required for a full-size power station. Two chemical plants would also be built to extract fission products from the fuel and to separate uranium–233 from the thorium blanket. Construction of the HTR and associated units may begin during the fiscal year 1957 and be completed in the fiscal year 1959.

Another homogeneous reactor, Homogeneous Reactor Experiment (HRE) No. 2, was being constructed at Oak Ridge. This reactor was to utilize a uranyl sulfate fuel solution, which allowed simplified design, economical chemical processing, and elimination of fuel-element fabrication. Research with the HRE No. 2 was expected to determine the effect of irradiation on the corrosion of materials and on the chemical stability of the fuel solution. The reactor, to be put in operation in 1956, would have a heat output of 5,000 kilowatts. Information obtained from operation of the HRE No. 2 was to be applied to the design and construction of the Homogeneous Thorium Reactor described above.

The sodium graphite reactor, known as the Sodium Reactor Experiment, was designed by North American Aviation, Inc., in cooperation with the AEC. North American agreed to pay $2.5 million of the $10 million needed to construct and operate the SRE from 1954 through 1958. The full-scale reactor would use slightly enriched uranium, or uranium–233 and thorium, as fuel. In the latter instance it was believed that the unit would act as a breeder and produce more uranium–233 than it would burn. The reactor's coolant would be liquid sodium or a liquid sodium-potassium alloy, and would be graphite-moderated. Tests with the SRE were planned to include fuel-element performance, maximum permissible fuel element and structure temperatures, corrosion, and radioactivity transfer. The reactor was expected to produce 20,000 kilowatts of heat, some of which would be converted to electricity.

The boiling-water reactor, known as the Experimental Boiling Water Reactor (EBWR), was scheduled for construction in 1955 and completion late in 1956. The reactor design called for natural uranium metal enriched with uranium–235 as fuel and ordinary water as the coolant and moderator. The EBWR was planned to produce 20,000 kilowatts of heat and 5,000 kilowatts of electricity. Tests were expected to determine whether the reactor could be operated without danger and mechanical injury to the turbine, condenser, pumps, etc. from the radioactive cooling water, which would be used directly in the generating system, without benefit of a heat-transfer system.[51]

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[51] Work cited in footnote 25, pp. 19–26, and footnote 42, pp. 19–25.
Atomic Energy Newsletter, vol. 11, No. 3, Mar. 23, 1954, p. 3.
Scientific American, vol. 190, No. 5, May 1954, p. 48.
Nucleonics, vol. 12, No. 4, April 1954, p. 78; vol. 12, No. 5, May 1954, pp. 72–74.

The Pressurized-Water Reactor (PWR) was the first of the five reactors authorized by the Commission. Ground was broken for construction of this initial civilian nuclear power plant at Shippingport, Beaver County, Pa., on September 6, 1954. The reactor was expected to require fuel of 15–20 tons of natural uranium enriched with 1.5–2.0 percent of uranium–235 and was to be moderated and cooled by ordinary water under pressure. Some 300,000 kilowatts of heat and 60,000 kilowatts of electrical energy were the planned output. This was in agreement with the following AEC basic specifications given by the Westinghouse Electric Corp. for building the reactor: (1) Generation of at least 60,000 kilowatts of useful electric energy; (2) use of light water for coolant and moderator and slightly enriched uranium for fuel; (3) 600 pounds per square inch or better steam production; (4) fuel-element life as long as possible between chemical-processing periods; (5) refueling with minimum shutdown period; (6) simplified reactor-control system; (7) central-station-type turbine and electric generating equipment; (8) conventional central-station steam, electric, and other auxiliary systems; (9) commercial standards of equipment; (10) use of concrete for shielding; (11) minimum possible construction cost of plant; and (12) minimum possible operating cost of the plant consistent with other requirements. Duquesne Light Co. was made responsible for the construction of, and will own, the steam-electric portion of the plant. The reactor portion, which was being designed and constructed by Westinghouse Electric Corp., was to remain under AEC ownership but was to be operated by Duquesne. It was hoped that the power station would be operational in 1957.[52]

The AEC took action to allow greater industrial participation in the study of peaceful uses of nuclear energy. A limited clearance procedure was established to assist company personnel in obtaining pertinent technical data from the AEC. An unclassified training program was approved which was to begin at the Argonne National Laboratory in March 1955. The international school's course included a 4-month course on general reactor technology followed by 1 month of applied engineering. Sessions were expected to be repeated later. The Oak Ridge School of Reactor Technology continued its classified courses for selected college graduates and personnel from industry and Government.[53]

In 1954 the AEC approved 11 new teams for study of methods of producing economic power from nuclear energy. The studies were not to involve the construction of reactors but were to consist of the review of available information about nuclear power systems from which con-

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[52] Works cited in footnote 42, pp. 21–22, and footnote 25, p. 22.
Chemical and Engineering News, Ground Breaking for Atomic Power: Vol. 32, No. 38, Sept. 20, 1954, pp. 3716, 3718.
Engineering News Record, Plans Readied for First Atomic Power Plant: Vol. 152, No. 23, June 10, 1954, p. 27.
Chemical Engineering, Power From the Atom—It's Almost Here: Vol. 61, No. 9, September 1954, pp. 118, 120, 122.
Weaver, Charles H., Power From Atomic Energy: Iron and Steel, vol. 31, No. 7, July 1954, pp. 119, 121, 125, 126.
[53] Chemical and Engineering News, ORNL Teaches Reactor Engineering: Vol. 32, No. 5, pp. 406–407.

clusions could be drawn regarding practical types of power reactors that might be built for civilian application. The new groups were:[54]

1. Babcock & Wilcox Co., New York, N. Y.
2. American Machine & Foundry Co., New York, N. Y.
3. Bendix Aviation Corp., Detroit, Mich.
4. Westinghouse Electric Corp., Pittsburgh, Pa.
5. Pacific Northwest Power Co. Group, Spokane, Wash., comprising:
   - Montana Power Co.
   - Washington Water Power Co.
   - Pacific Power & Light Co.
   - Portland General Electric Co.
   - Mountain States Power Co.
6. Bethlehem Steel Co.
7. Consumers Public Power District of Nebraska.
8. Kaiser Engineers.
9. Pennsylvania Power & Light Co.
10. Rocky Mountain Nuclear Power Study Group, comprising:
    - Arizona Public Service Co.
    - Ebasco Services, Inc.
    - Fluor Corp., Ltd.
    - Idaho Power Co.
    - Minnesota Mining & Manufacturing Co.
    - Phillips Petroleum Co.
    - Public Service Co. of Denver.
    - Riley Stoker Co.
    - Utah Power & Light Co.
11. Vitro Corp. of America.

In August 1954 the Department of Defense and the AEC announced that they were planning to construct a full-scale, prototype, "package" power reactor at Fort Belvoir, Va. The proposed project would (1) demonstrate features and characteristics of a small nuclear power plant that might be used in an Arctic environment, (2) determine the economic and operating features of such a unit, (3) determine the reliability of the reactor's operation during an extended period, and (4) provide a training center at the station for military personnel. It was decided to build the experimental reactor after objective evaluations of military power requirements, and how they might best be met by using nuclear power stations, were undertaken. Studies indicated that remote Arctic bases had high power costs owing to the cost of fuel delivery and required standby capacity. Such Arctic bases, it was estimated, could well utilize a small, relatively lightweight, nuclear power plant at logistic and economic savings. Subsequently the Oak Ridge National Laboratory suggested that a small, readily transportable, heterogeneous, pressurized, water reactor appeared to offer the best chance for efficient service in a minimum of time.[55] On December 15, 1954, the AEC announced that a lump-sum contract had been awarded to the American Locomotive Co., New York, N. Y., to design, build, and test-operate the 2,000-kilowatt (electricity) prototype, "package," nuclear power plant at Fort Belvoir, Va. The design of the reactor was based on results of the Oak Ridge National Laboratory's studies. The contract price was stated to be $2,096,753.[56]

Much publicity was given to the potentialities of nuclear energy as a source of power during 1954. Types of reactors were discussed

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[54] Work cited in footnote 25, pp. 26–27, and footnote 42, pp. 26–27.
[55] Lampert, James B., The Army Package Power Reactor: Remarks delivered before Third Annual Conference of the National Industrial Conference Board on Atomic Energy in Industry, Oct. 15, 1954, 6 pp.
[56] Atomic Energy Commission, Army Package Reactor Contract Awarded to American Locomotive Co.: Press release, Dec. 15, 1954, 3 pp.

including heterogeneous versus homogeneous and fast versus thermal types, plant and fuel costs, equipment, heat transfer or removal, control, breeding, and chemical processing of fuel elements were also of interest.[57]

Research Reactors.—In February 1954 the AEC, at the University Research Reactor Conference in Oak Ridge, described its policy of lending fissionable materials to universities for use in research reactors. This policy allowed for fissionable materials to be provided schools when it was not needed for military use or other use by the Commission, assuming that: (1) The organization could finance the construction and operation of a reactor; (2) the reactor would be designed and operated by competent people; (3) the reactor would be used in a planned research program; (4) the loan met the requirements of the Atomic Energy Act.[58]

The University of Michigan announced that, with a grant of $1 million from the Ford Motor Co., it would construct a research reactor at Ann Arbor. The AEC approved the allocation of fissionable uranium for the project.[59] It was reported that the Massachusetts Institute of Technology also had decided to build a $1 million research reactor.[60]

Pennsylvania State University initiated construction of a nuclear "swimming-pool"-type reactor at State College, Pa. It was the second privately owned reactor for which the AEC had authorized the use of fissionable fuel material.[61] The first independent research reactor to be constructed continued to perform satisfactorily at North Carolina State College, Chapel Hill, N. C. The Department of Defense asked the Congress for $1 million to construct a "swimming-pool"-type research reactor at the Naval Research Laboratory in Washington, D. C. The reactor would aid in determining the best materials for shielding purposes. Its power output would be limited to about 100 kilowatts.[62] A new reactor was being constructed at the Los Alamos Scientific Laboratory. The unit, called the Omega West Reactor, was designed to operate at 1 to 4 megawatts of power and will be similar to the Low-Intensity Training Reactor at Oak Ridge National Laboratory. It was to replace the fast "Clementine" reactor dismantled in 1953 and serve as a research tool for personnel of the Los Alamos Scientific Laboratory. The CP–5 research reactor at Argonne National Laboratory in Chicago became operational on February 10, 1954. The heavy-water-moderated, 1-megawatt-power reactor was to replace the CP–3 reactor, which was to be torn down in the near future. North American Aviation, Inc., in cooperation with the University of California in Los Angeles, designed a reactor for cancer research and neutron and gamma-ray therapy. The reactor

[57] Smyth, Henry D., Remarks for Delivery at the National Meeting of the American Institute of Chemical Engineers: AEC press release, Mar. 9, 1954, 16 pp.
Lane, James A., Growth Potential of U. S. Nuclear Power Industry: Nucleonics, vol. 12, No. 6, June 1954, pp. 12–17.
Chemical Engineering Progress, Nuclear Engineering: Vol. 50, No. 5, May 1954, pp. 217–220.
Ward, Carlton J., Jr., A Look at Atomic Energy: Mines Mag., vol. 44, No. 9, September 1954, pp. 17–21.
Cisler, Walker L., Atomic Energy and Its Industrial Applications: Min. Cong. Jour., vol. 40, No. 6, June 1954, pp. 30–33.
[58] Work cited in footnote 42, p. 44.
[59] Mines Magazine, vol. 44, No. 7, July 1954, p. 8.
[60] Atomic Energy Newsletter, vol. 11, No. 11, July 1954, p. 1.
[61] Business Week, No. 1275, Feb. 6, 1954, p. 134.
Breazeale, W. M., Penn State To Build Reactor: Nucleonics, vol. 12, No. 2, February 1954, p. 72.
[62] Chemical and Engineering News, vol. 12, No. 15, April 1954, p. 1421.

when completed was to be used for experimental work with animals, for radiation treatment of human beings, and to train medical students, health physicists, and others in techniques of reactor operation.[63]

In May 1954 the AEC released a description of the Materials Testing Reactor (MTR) at the National Reactor Testing Station, Idaho Falls, Idaho. It was also indicated that the MTR facilities would be made available to the public. The MTR research reactor was used to determine the effects of intense neutron radiation on materials and fuel elements to be used in future reactors that will be operated at high fluxes and specific power.[64]

Isotopes.—Radioactive isotopes were produced in uranium-fueled reactors during 1954 for research, industrial, and medical purposes. The AEC made 12,585 shipments of radioisotopes in 1954. Iodine–131 continued to comprise nearly half of all shipments, representing 40 percent of the total in 1954 (see table 4).

The graphite reactor at the Oak Ridge National Laboratory was the source of most radioisotopes produced during 1954. Special radioisotopes were produced in the Brookhaven National Laboratory reactor, the Low-Intensity Test Reactor (LITR) at Oak Ridge National Laboratory, the Materials Testing Reactor (MTR) at the National Reactor Testing Station, and the CP–5 reactor at the Argonne National Laboratory.

The application of radioisotopes to problems in coating materials with paints, varnishes, and other such finishes was reviewed at a seminar on protective coatings, December 9, 1953.[65]

The Small Business Administration, Washington, D. C., issued a circular describing the use of radioisotopes in small business practices. The radiation characteristics of radioisotopes were explained and listed as the ability to (1) cause desirable biological changes, (2) pene-

TABLE 4.—Radioisotopes shipped by the U. S. Atomic Energy Commission by kinds, 1946–54, in number of shipments [1]

[Atomic Energy Commission]

Radioisotope	Shipments Aug. 2, 1946 to Dec. 31, 1953	Shipments Jan. 1, 1954 to Dec. 31, 1954	Total shipments Aug. 2, 1946 to Dec. 31, 1954
Iodine 131	18,713	5,023	23,736
Phosphorus 32	12,059	2,405	14,464
Carbon 14	1,649	269	1,918
Sodium 24	1,928	448	2,376
Gold 198	1,570	622	2,192
Hydrogen 3	149	94	243
Strontium 89, 90	646	130	776
Cobalt 60	811	134	945
Cesium 137	411	104	515
Iridium 192	32	99	131
Polonium 210	56	57	113
Other	13,593	3,200	16,793
Total	51,617	12,585	64,202

[1] Distributed from Oak Ridge National Laboratory to all radioisotope users.

[63] Work cited in footnote 42, pp. 45–46.

[64] Engineering News-Record, Test Reactor Aids Atomic Power-Plant Design: Vol. 152, No. 24, July 17, 1954, pp. 40–42.

[65] Heiberger, Phillip, Isotopic and Chromatographic Techniques Applied to Protective Coatings Technology: Paint, Oil and Chem. Rev., vol. 117, No. 2, Jan. 28, 1954, pp. 14–17, 26–28, 32.

TABLE 5.—Radioisotopes shipped from Oak Ridge National Laboratory by years, 1946–54

[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			

trate material and be detected, (3) induce chemical reactions, and (4) cause fluorescence and ionize gases. Specific uses of radioisotopes which were described included iodine–131 for detecting leaks in waterlines; manganese–54 to measure uniformity of mixing; cobalt–60 for radiography testing, measuring thickness and defects of metal castings, indicating liquid height, and measuring wear of firebrick lining in metal furnaces; carbon–14, strontium–yttrium–90, and cobalt–60 for thickness measurements made with transmission-type radioisotopes gage; strontium–yttrium–90 for measuring coating thickness with backscatter-type radioisotopes gage; tungsten–185 for measuring cutting tool wear and life; and iron–59 for engine-friction and lubrication studies.[66]

The Aluminum Co. of America used radioactive aluminum as a tracer to study flow patterns, temperature, force distribution, and other metallurgical changes that take place in the extrusion of aluminum. The General Electric Co. developed a new low-erosion phenolic molding compound as a result of using radioactive tracers to determine die wear of large metal molds by injected plastic compounds.[67]

Benefits from radiographic inspection of steel foundry castings with iridium–192 at Dominion Foundries & Steel, Ltd., Hamilton, Canada, were published.[68]

The possibilities were discussed of using tantalum—182 or another appropriate radioisotope to trace special composition steel melts from the mill, through fabrication stages, to the finished end-item. Where critical compositions were involved, such as in steels for reactor construction, close scrutiny of the steel's production was necessary to insure that no substitutions were made. Radioactive isotopes as tracers were indicated as offering several advantages over customary chemical analysis, including time involved, plant space required for testing, and a more definite melt identification.[69]

The Radio Corp. of America demonstrated an experimental atomic battery powered by radioactive strontium–90. The very small battery produced enough electricity to operate a transistor. It was indicated that when this type of battery is developed to a commercial scale it will be able to supply power for portable and pocket-size radio

[66] Small Business Administration, Technical Aids for Small Business: No. 31, Radioisotopes and Small Business, January 1954, 8 pp.

[67] Materials and Methods, Isotopes Lead to Improvement of Materials: Vol. 40, No. 1, July 1954, pp. 11, 206, 208.

Iron and Steel Engineer, Isotopes Use Increased in Metals Studies: Vol. 31, No. 7, July 1954, pp. 130, 133.

[68] Behal, V. G., Practical Foundry Application of Radioisotopes: Canadian Metals, vol. 17, No. 8, July 1954, pp. 22, 23.

[69] Douglas, David L., Radioactive Tracers for Tagging Special Steel Melts: Nucleonics, vol. 12, No. 1, January 1954, pp. 16–18.

receivers, hearing aids, and signal-control and similar devices for periods of 20 years or more without replenishment or attention.[70]

Tracerlab, Inc., the first firm to process radiosiotopes for non-AEC use, opened new facilities on the west coast early in 1954. The Western Division laboratory and offices of Tracerlab were to provide for radiochemical research, isotope processing, and radiation instrument development facilities west of the Mississippi River.[71]

The Ford Motor Co. used radioactive isotopes to trace the flow of iron ore through a blast furnace. Seventy-six tons of iron ore, containing fine iron powder obtained from concentrating low-grade ore, was tagged with a radioisotope at the Benson Ford furnace, River Rouge plant, Dearborn, Mich. Tests showed that only 60 percent of the powder was retained during the smelting operation, too low for economical operation.[72]

It was reported that 5 of the known 800 radioisotopes had practical medical applications. They were (1) iodine–131, (2) phosphorus–32, (3) gold–198, (4) strontium–90, and (5) cobalt–60.[73] In addition, it was expected that highly radioactive cesium–137 would soon be put to work in treating persons for cancer. Oak Ridge National Laboratory produced 2 ounces of cesium–137, which displayed more radioactivity than 1 pound of radium worth more than $1 million. Cesium-137 was said to have a half-life of 37 years.[74] Thulium–170 was utilized by the Argonne National Laboratory to operate a small, inexpensive portable X-ray unit. The entire unit weighed less than 10 pounds and required no electric power. The total cost of the initial model was $40, exclusive of irradiation charges for the thulium. Thulium–170 has a half-life of 129 days, but scientists said the radioisotope in the X-ray unit would be usable for 1 to 2 years, depending on strength required for application.[75]

The Department of the Navy was reported to have awarded a contract to Tracerlab, Inc., for 9,000 self-luminous deck and personnel identification markers activated with strontium–90. Radium was previously used in such markers, but strontium–90 is preferred because less danger of radiation was indicated, all colors of the visible spectrum could be produced, a greater brightness was obtained, and the material had a longer useful life.[76]

A method for determining the effectiveness of waterflooding operations in oil wells was described. The process involved injecting radioactive isotopes into the well and following their progress down the borehole with a scintillation counter.[77]

Rutgers University planned to open a radioisotope center to train students and industry representatives in the use of radioactive isotopes in research. Industrial concerns in New Jersey were said to be financing construction and operation of the center.[78] The General Motors

[70] Wall Street Journal, RCA Demonstrates Atomic Battery Powered by a Radioactive Material: Vol. 143, No. 18, Jan. 27, 1954, p. 15.

[71] Chemical and Engineering News, Isotopes, Instruments Go West: Vol. 32, No. 14, Apr. 5, 1954, pp. 1330–1331.

[72] Mining Engineering, vol. 6, No. 4, April 1954, p. 355.

[73] Atomic Energy Newsletter, vol. 11, No. 8, June 1, 1954, p. 2.

[74] Science News Letter, vol. 65, No. 21, May 22, 1954, p. 327.

[75] Chemical and Engineering News, Radioactive Thulium for X-Rays: Vol. 32, No. 18, May 3, 1954, p. 1769.

[76] Atomic Energy Newsletter, vol. 11, No. 9, June 15, 1955, p. 3.
Chemical Week, Radium's Got a Rival: Vol. 75, No. 7, Aug. 14, 1954, pp. 60, 62.

[77] Edwards, J. M., and Holter, E. L., Application of Radioactive Isotopes in Water-Flooding Operations: Mines Mag., vol. 44, No. 11, November 1954, pp. 149–51.

[78] Chemical and Engineering News, vol. 32, No. 31, Aug. 2, 1954, p. 3082.

Research Laboratory indicated that it would build and operate a radioactive isotope research laboratory at its technical center near Detroit, Mich. Work would be related to radioisotope tracer studies of engine combustion, durability of paints and other finishes, tool wear, and durability and lubrication of metal parts.[79]

Weapons.—The Government released information regarding the November 1, 1952, explosion of a hydrogen device at the Eniwetok test site in the Pacific Ocean. The test, known as "Operation Ivy," was the first full-scale experiment with a thermonuclear weapon. The public was shown motion pictures of the hydrogen blast and its effects upon the island on which it was detonated.[80]

During the spring of 1954 the Department of Defense and the AEC conducted another test of thermonuclear weapons in the Eniwetok area. The test series was called "Operation Castle." [81] Reports indicated that detonations of hydrogen bombs took place on March 1 and March 26, 1954, which met, if not exceeded, the AEC's expectations.[82]

Discussions of thermonuclear weapons were published in many leading magazines, journals, and papers during 1954.[83]

Three laboratories contributed significantly to the AEC's atomic weapons program during 1954. They were the Los Alamos Scientific Laboratory, the Sandia Corp., and the University of California Radiation Laboratory. The Los Alamos Scientific Laboratory was awarded a special citation on July 8, 1954 for its achievements in thermonuclear weapons research.[84]

Production of atomic weapons apparently proceeded satisfactorily in 1954.

Nonenergy Uses.—The AEC authorized the use of 2,520 pounds of U_3O_8 contained in uranium compounds for nonenergy purposes in 1954, indicated in table 5, approximately 2 percent less than the 2,581 pounds allowed for use in nonenergy fields in 1953. Almost all of this amount (2,462 pounds) was used in the chemical industry and was 3 percent less than the amount (2,539 pounds) used for this

TABLE 6.—Consumption of uranium compounds for nonenergy purposes in the United States, 1950–54, in pounds of contained U_3O_8

[U. S. Atomic Energy Commission]

Industry	1950	1951	1952	1953	1954
URANIUM (U_3O_8 EQUIVALENT)					
Chemical (including catalytic)	2,835	2,016	3,048	2,539	2,462
Ceramic (including glass)	938	875	1,627	----------	----------
Electrical	33	88	226	42	58
Total	3,806	2,979	4,901	2,581	2,520

[79] Materials and Methods, GM Plans to Build Isotope Laboratory: Vol. 40, No. 5, November 1954, p. 210.
[80] Atomic Energy Newsletter, vol. 10, No. 13, Feb. 9, 1954, p. 1.
Time, H-Crater: Vol. 63, No. 9, Mar. 1, 1954, p. 51.
[81] Work cited in footnote 25, p. 14.
[82] Bulletin of the Atomic Scientists, vol. 10, No. 4, April 1954, p. 141.
Atomic Energy Newsletter, vol. 11, No. 2, Mar. 9, 1954, p. 1; vol. 11, No. 3, Mar. 23, 1954, p. 1.
Time, The Atom: Vol. 63, No. 12, Mar. 22, 1954, p. 22.
[83] Time, The Atom: Vol. 63, No. 15, Apr. 12, 1954, pp. 21–24; The Making of the H-Bomb, pp. 72–73.
Metal Progress, The H-Bomb and Its Detection: Vol. 65, No. 6, June 1954, pp. 102–103.
Bulletin of the Atomic Scientists, The Hydrogen Bomb and the Great Unsolved Problems: Vol. 50, No. 5, May 1954, pp. 146–147, 168.
The Evening Star (Washington, D. C.), Facts on H-Bomb Bared: Apr. 1, 1954, pp. A-1, A-4, A-5.
[84] Work cited in footnote 25, p. 14.

purpose in 1953. The remaining 58 pounds was used in the electrical industry and was a slight increase over the 42 pounds used in 1953.

RADIUM

Medical, Scientific, and Industrial Uses.—Radium salts were leased for medical, scientific, and industrial purposes during 1954 by the one producer and the distributors of the material. Some sales were also made. Statistics relative to the sales and leases of radium salts in the United States were not available for publication, nor were data about the amount of radium used in each of the three categories—medical, scientific, and industrial.

Probably the most important use of radium continued to be in medicine as a method of treating persons suffering from cancer. The element was sealed in tubes and needles for direct application, or its gaseous decay product, radon, was captured and encapsulated for similar application.

Some radium was also employed for industrial radiography in 1954, where its use has been especially notable in the inspection of metal castings. Other possible uses of radium in 1954 included (1) the mixture of small concentrations of radium salts with zinc sulfide to make luminescent paints; (2) the mixture of radium and beryllium as a neutron source; and (3) radium foil as an ionization agent in static elimination equipment.

A paper describing the use of radium and polonium in preventing mold growths on optical instruments in tropical environments was published. Ionizing radiations from radium and polonium were found effective in preventing the growth and sporulation of a number of species of fungi.[85]

PRICES

URANIUM

Uranium Ore.—Prices that the AEC paid for uranium ores in 1954 were unchanged from 1953. The ore-buying schedule of the AEC is guaranteed through March 31, 1962. The bonus plan for initial production of uranium ores from new domestic mines covers a period through February 28, 1957.

AEC Domestic Uranium Program Circulars 2, 5, and 6, which describe specifications uranium-bearing material must meet to be salable to the AEC and list prices paid for uranium ore, follow.

CIRCULAR 2. **§ 60.2 Bonus for the Discovery and Production of High-Grade Domestic Uranium Ore.**—(a) *Discovery and Production Bonus.*—To stimulate prospecting for, discovery of, and production from new high-grade domestic uranium deposits and in the interest of the common defense and security the United States Atomic Energy Commission will pay, in addition to the guaranteed minimum price established in § 60.1, a bonus of $10,000 for delivery to the Commission, after the effective date of this section, of the first 20 short tons (2,000 pounds avoirdupois dry weight per ton) of uranium-bearing ores or mechanical concentrates assaying 20 percent or more U_3O_8 by weight from any single mining location, lode or placer, which has not previously been worked for uranium (or in the case of production from lands not covered by such a mining location, from an area comparable thereto, as determined by the Commission). This bonus offer does not apply to delivery of ores of the Colorado Plateau area commonly known as carnotite-type or roscoelite-type ores; under § 60.3, the Commission has

[85] Berk, Sigmund, and Leitell, Leonard, Radioactive Materials in Prevention of Mold Growth in Optical Instruments: Ind. Eng. Chem., vol. 46, No. 4, April 1954, pp. 778–784.

established guaranteed minimum prices for delivery of such ores including a development allowance and premiums for better grade.

NOTE: The term "domestic" in this section, referring to uranium, uranium-bearing ores and mechanical concentrates, means such uranium, ores and concentrates produced from deposits within the United States, its territories, possessions and the Canal Zone.

(b) *Nature of Bonus.*—The bonus of $10,000 offered in this section is a bonus to encourage the discovery of new uranium resources. However, it will be paid, not for discovery alone, but only in connection with delivery to the Commission pursuant to § 60.1, of ores produced from the location, as an independent and additional part of the price established by the Commission under that section.

(c) *Who May Claim.*—The person lawfully entitled to deliver ore to the Commission pursuant to § 60.1, may claim the bonus offered in paragraph (a) of this section. A bonus will be paid only once for production of ores from any single lode or placer location (or, in the case of production from lands not covered by such a location, from an area comparable thereto, as determined by the Commission). The Commission expressly reserves the right to determine whether production from a given location is the first production from such location for the purposes of this section or whether such location or property has previously been worked for uranium, whether production is such as to which a bonus has already been paid, or whether for any other reason a bonus is not payable. In making this determination the Commission will be guided by the mining laws of the United States which provide, generally, that lode locations may extend in lode or vein formation up to 1,500 feet along the vein and in width 300 feet on each side of the middle of the vein, the end lines of the location being parallel to each other; and that placer locations may not be greater than 20 acres for each location or 160 acres in a single location for up to eight locators. The fact that a bonus has already been received will not prevent the payment of another bonus to the same person with respect to production from a different location.

(d) *Notice of Discovery and Production.*—Notice of the discovery of a uranium deposit and of production therefrom believed to meet the requirements of paragraph (a) of this section should be forwarded to the Commission by letter or telegram, to the address specified in paragraph (f) of this section, together with an offer to deliver such ore to the Commission under § 60.1. In addition to the information and the 10-pound sample required under § 60.1, the following must be furnished:

(1) A brief description of the location or property indicating its size and relationship to mineral monuments or the public land surveys;

(2) Name of owner of record of property;

(3) Location of Recorder's Office where ownership is recorded.

NOTE: The reporting requirements hereof have been approved by the Bureau of the Budget pursuant to the Federal Reports Act of 1942.

(e) *Inspection of Claim.*—Upon receipt of a notice of discovery and sample, forwarded as required in § 60.1, an analysis of the sample will be made. If the sample and supporting data indicate the claim is likely to meet the requirements of paragraph (a) of this section, an inspection of the property and verification of the weights and assays of material produced will be undertaken by the Commission. On the basis of a report of such inspection and verification, if favorable, the Commission will determine the quantity of ore produced. If this determination indicates that the production requirements established in paragraph (a) of this section have been met, the Commission will pay the bonus in addition to the price established under § 60.1, when delivery of such ore is completed.

(f) *Inquiries and Communications.*—Inquiries about this section and all other communications should be addressed as follows:

United States Atomic Energy Commission,
Post Office Box 30, Ansonia Station,
New York 23, N. Y.
Attention: Division of Raw Materials.

(g) *Licenses.*—Arrangements will be made by the Commission for the issuance of licenses, pursuant to the Atomic Energy Act of 1946, covering deliveries of source material to the Commission under this section. (Sec. 5 (b), 60 Stat. 761)

Effective date. This circular will become effective at midnight, April 11, 1948.

Dated at Washington, D. C., this 9th day of April 1948.

By order of the Commission.

WALTER J. WILLIAMS,
Acting General Manager.

CIRCULAR 5. **§ 60.5 Guaranteed Minimum Price for Uranium-Bearing Carnotite-type or Roscoelite-type ores of the Colorado Plateau Area.**—(*a*) *Guarantee.*—To stimulate domestic production of uranium-bearing ores of the Colorado Plateau area, commonly known as carnotite-type or roscoelite-type ores, and in the interest of the common defense and security, the United States Atomic Energy Commission hereby establishes the guaranteed minimum prices specified in § 60.5a effective during the period March 1, 1951, through March 31, 1962, for the delivery of such ores to the Commission at Monticello, Utah, in accordance with the terms of this secton and § 60.5a.

NOTE: In §§ 60.1 and 60.2 (Domestic Uranium Program, Circulars No. 1 and 2), the Commission established guaranteed prices for other domestic uranium-bearing ores, mechanical concentrates, and refined uranium products.

(*b*) *Effect on §§ 60.3 and 60.3a.*—Sections 60.3 and 60.3a, which also apply to carnotite and roscoelite ores, are not revoked by the issuance of this section and § 60.5a and sellers may elect to deliver ore under the provisions of §§ 60.3 and 60.3a rather than under this section and 60.5a, at their option, during the unexpired terms of §§ 60.3 and 60.3a (through April 11, 1951). It is believed, however, that in most cases the provisions of this section and § 60.5a will be more favorable to producers.

(*c*) *Definitions.*—As used in this section and in § 60.5a, the term "buyer" refers to the U. S. Atomic Energy Commission, or its authorized purchasing agent. The term "ore" does not include mill tailings or other mill products. The term "seller" refers to any person offering uranium ores for delivery to the Commission. Weights are avoirdupois dry weights, unless otherwise specifically provided.

(*d*) *Deliveries of not to Exceed 1,000 Tons per Year.*—To aid small producers, any one seller may deliver without a written contract but otherwise in accordance with this circular up to, but not exceeding, 1,000 short tons (2,000 pounds per ton) of ores during any calendar year.

(*e*) *Deliveries in Excess of 1,000 Tons Per Year.*—Sellers desiring to deliver in excess of 1,000 short tons (2,000 pounds per ton) of ores during any calendar year will be required to enter into a contract with the Commission providing for, among other things, a rate of delivery and the total quantity of ore to be delivered.

(*f*) *Delivery.*—Seller, at his own expense, shall deliver and unload all ores at the buyer's depot at Monticello, Utah. Deliveries shall be in lots of not less than 10 short tons (2,000 pounds per ton) unless special arrangements have been agreed upon by buyer, but such lots may be delivered in more than one load. Days and hours during which ore may be delivered will be posted at the depot.

(*g*) *Weighing, Sampling and Assaying.*—Buyer will bear the cost of weighing, sampling, and assaying. The net weight of each load will be determined by the buyer's weighmaster on scales which will be provided by the buyer at or in the vicinity of the purchase depot and such weight will be accepted as final. A weight ticket will be furnished seller or his representative for each load. Each lot of ores will be sampled promptly by the buyer according to standard practice and such sampling will be accepted as final. Seller or his representative may be present at the sampling at his own expense. The absence of seller or his representative shall be deemed a waiver of his right. Buyer will make moisture determinations according to standard practices in ore sampling. All final samples will be divided into four pulps and distributed as follows: (1) The seller, or his representative, will receive one pulp; (2) the buyer will retain one pulp; (3) the other two pulps will be reserved for possible umpire analysis. The buyer's pulp will be assayed by the buyer. The seller may, if he desires, and at his own expense, have his pulp assayed by an independent assayer. In case of disagreement on assays as to any constituent of the ores, an umpire shall be selected in rotation from a list of umpires approved by the buyer whose assays shall be final if within the limits of the assays of the two parties; if not, the assay which is nearer to that of the umpire shall prevail. The party whose assay is the farther from that of the umpire shall pay the cost of the umpire's assay for the constituent of the ores which is in dispute. In the event that the umpire's assay is equally distant from the assay of each party, costs will be split equally. In case of seller's failure to make or submit assays, buyer's assays shall govern. After sampling,the ores may be placed in process, commingled, or otherwise disposed of by buyer.

(*h*) *Payment.*—Buyer will make payment promptly but payment will not be made until an entire minimum lot of ten short tons (2,000 pounds per ton) has been delivered and accepted, unless special arrangements have been agreed upon by buyer, in which case there may be an extra charge for assaying and sampling. Moisture determinations, analyses and settlement sheets, together with the check in payment, will be mailed to seller.

(*i*) *Inquiries.*—All inquiries concerning the provisions of this section and § 60.5a, offers to deliver ores, or questions about the Commission's domestic uranium program in the Colorado Plateau area should be addressed to:

United States Atomic Energy Commission, Post Office Box 270, Grand Junction, Colorado; Telephone: Grand Junction 3000.

(*j*) *Licenses.*—Arrangements will be made by the Commission for the issuance of licenses, pursuant to the Atomic Energy Act of 1946, covering deliveries of source material to the Commission under this section and § 60.5a.

(*k*) *Limitation of commitment.*—Commitments by the Commission to accept delivery of ores are limited to the provisions of this section and § 60.5a as amended from time to time, or to written contracts between the Commission and sellers. Other commitments purporting to be made by the Commission's field personnel or other agents of the Commission will not bind the Commission unless they are in accord with the provisions of this section and § 60.5a or other official circulars.

§ 60.5a. Schedule I; minimum prices, specifications, and conditions.—(a) *Prices.*—Payment for delivery of the ores will be computed on the following basis:

(1) *Uranium.* (i) Ores assaying less than 0.10 percent: no payment. Any such ores which are delivered to the purchase depot shall, unless otherwise specifically agreed to by buyer, become the property of the buyer as liquidated damages for buyer's expense of weighing, sampling, and assaying, and after sampling may be placed in process, commingled, or otherwise disposed of by buyer. If seller has any question as to the quality of his ore, it is suggested that before shipment and delivery to the purchase depot a representative sample be submitted to the buyer or to one of the umpires for assay at seller's expense. The buyer at its discretion may assay a limited number of samples without charge.

(ii) Ores assaying 0.10 percent U_3O_8 and more, as follows:

U_3O_8 assay:	*Payment per pound U_3O_8*
0.10 percent	$1.50
.11 percent	1.70
.12 percent	1.90
.13 percent	2.10
.14 percent	2.30
.15 percent	2.50
.16 percent	2.70
.17 percent	2.90
.18 percent	3.10
.19 percent	3.30
.20 percent and more	3.50

(iii) Premiums on uranium: $0.75 per pound for each pound of U_3O_8 in excess of 4 pounds U_3O_8 per short ton (2,000 pounds per ton) of ore and an additional premium of $0.25 per pound for each pound in excess of ten pounds U_3O_8 per short ton. Fractional parts of a pound will be paid for on a pro rata basis to the nearest cent.

(2) *Vanadium.* V_2O_5 at $0.31 per pound up to, but not exceeding, ten pounds of V_2O_5 for each pound of U_3O_8 contained in ores. No factor will be included for V_2O_5 in excess of ten pounds for each pound of U_3O_8, although buyer may, from time to time, publicly announce that, for limited periods by written agreements with individual producers, V_2O_5 in excess of ten-to-one will be paid for. Any such announcement will be made by posting a notice to this effect at the Monticello depot and through such other channels as are deemed suitable to achieve maximum dissemination among producers. Excess V_2O_5 shall be deemed to be buyer's property.

(3) *Allowances.* (i) A development allowance of $0.50 per pound U_3O_8 contained in ores assaying 0.10 percent U_3O_8 or more in recognition of the expenditures necessary for maintaining and increasing developed reserves of uranium ores. Fractional parts of a pound will be paid for on a pro rata basis to the nearest cent. Sellers accepting this allowance are deemed to agree to spend such funds for the development or exploration of their properties. Sellers delivering less than 1,000 short tons per calendar year will not be required to submit an accounting record of expenditures for development or exploration pursuant to this agreement but sellers delivering in excess of 1,000 short tons per calendar year will be required, under the terms of their contracts, to submit proof satisfactory to the Commission that funds equivalent to the amount received as development allowance have been spent for development or exploration either during the contract period or within six months thereafter, unless otherwise provided in the contract.

(ii) A haulage allowance of 6¢ per ton mile for transportation of ore paid for under §§ 60.5 and 60.5a from the mine where produced to the purchase depot specified by the Commission, up to a maximum of 100 miles. The haulage distance from the mine to the purchase depot will be determined by the Commission and its decision will be final. Tonnages for purposes of this allowance shall be calculated on the basis of natural weights rather than dry weights.

(4) *Adjustment of assays.* Assays shall be adjusted to the nearest 0.01 percent for purposes of payment.

(b) *Quality and Size.*—Ores will not be accepted by buyer under §§ 60.5 and 60.5a which, in buyer's judgment:

(1) Contain less than 0.10 percent U_3O_8;

(2) Contain more than three parts of lime ($CaCo_3$) to one part of V_2O_5, or a total of more than 6 percent lime in the ore;

(3) Contain impurities deleterious to buyer's extraction process or for any other reason are not amenable to it;

(4) Contain lumps in excess of twelve inches in size.

NOTE: The Commission will be interested in discussing arrangements for delivery to it of types of uranium-bearing materials other than those for which guaranteed prices have been established, such as tailings, mill products, and ores of types not acceptable under §§ 60.5 and 60.5a.

(60 Stat. 755–775; 42 U. S. C. 1801–1819. Interpret or apply sec. 5, 60 Stat. 761, 42 U. S. C. 1805)

Effective March 1, 1951 through March 31, 1962.
Dated at Washington, D. C., this 26th day of February 1951.

By order of the Commission.

M. W. BOYER,
General Manager.

[F. R. Doc. 51-3190; Filed, Mar. 12, 1951; 8:45 a. m.]
[Amended—F. R. Doc. 53-8782; Filed, Oct. 15, 1953; 8:45 a. m.]

Circular 6. § 60.6 **Bonus for initial production of uranium ores from new domestic mines.**—(a) *What This Section Does.*—This section provides for bonus payments for initial and certain other production of uranium-bearing ores. It is intended to encourage and assist the development of new sources of domestic uranium production in the interest of the common defense and security.

(b) *Production Bonus Established.*—The U. S. Atomic Energy Commission will pay a bonus under the conditions set forth in this section for delivery to a Commission ore-buying station or a qualified uranium mill (hereafter called station or mill) of uranium ores from an eligible mining property up to the maximum quantities specified in this section.

(c) *Term of This Section.*—This section will apply to deliveries made under its terms between March 1, 1951, and February 28, 1957, inclusive.

(d) *Payment of the Bonus.*—Bonus payments will be computed on the following basis:

Ores assaying less than 0.10 percent U_3O_8: no payment.
Ores assaying 0.10 percent U_3O_8 and more, as follows:

U_3O_8 assay:	*Payment per pound of U_3O*
0.10 percent	$1.50
.11 percent	1.70
.12 percent	1.90
.13 percent	2.10
.14 percent	2.30
.15 percent	2.50
.16 percent	2.70
.17 percent	2.90
.18 percent	3.10
.19 percent	3.30
.20 percent and more	3.50

Fractional parts of a pound will be paid for on a pro rata basis to the nearest cent. Assays will be adjusted to the nearest 0.01 percent for purposes of payment. Weights are avoirdupois dry weights. Bonus payments made under this section will be in addition to any other payments for delivery of the ore. They will be paid directly by the Commission and not by the station or mill.

(e) *Maximum Quantity of Uranium Ores for Which Bonus Payments Will Be Made.*—Subject to the conditions of this section, bonus payments will be made on deliveries of uranium ore from an eligible mining property to a station or mill until bonus payments have been made on 10,000 pounds of contained uranium oxide less the number of pounds, if any, accepted by stations or mills (or any other uranium ore processing plants) from that mining property between April 9, 1948; and February 28, 1951, inclusive.

(f) *Ores for Which Bonus Payments Will Be Made.*—Ores for which bonus payments will be made must have been delivered to and paid for by either a station or mill. However, in special cases, bonus payments may be made for ores which have been accepted by the station or mill but for which payment is still pending. Bonus payments will not be made for ores which a station or mill refuses to accept. The weights and final assays made to ascertain the amount of payment due from the station or mill shall be used to determine the amount of bonus payments under this section.

(g) *Which Mining Properties Are Eligible.*—In order for a mining property to be eligible for bonus payments under this section,

(1) As required by paragraph (e) of this section, the total quantity of uranium oxide as contained in ore accepted by stations or mills (or any other uranium ore processing plants) from that property between April 9, 1948, and February 28, 1951, inclusive, must have been less than 10,000 pounds; and

(2) The property must be within the United States, its territories, possessions or the Canal Zone; and

(3) The property must be certified by the Commission as eligible using the following criteria as guides:

(i) *Purpose of the bonus.* The purpose of the bonus is to encourage and assist the development of new sources of domestic uranium production.

(ii) *Character of mining property.* The mining property may consist of a placer or lode location, or if not covered by location, a tract which the Commission finds to be comparable or otherwise appropriate. However, an entire holding consisting of contiguous locations or tracts will be regarded as only a single eligible unit of mining property if the locations or tracts are held in common in the manner set forth in the following paragraph.

(iii) *Title or interest of the holder of the property.* The title or interest in the mining property should be one of ownership or lawful possession of mining rights. This type of holding will generally be that of an owner or leaser (lessee). It is recognized that there are various arrangements such as split check leases, piece rate contracts and the like whereby persons either as employees or independent contractors conduct mining operations on designated areas of property held by another who also supplies certain of the mining services or equipment or both and who receives in return a percentage of the proceeds of the ore produced. In the case of such arrangements, the person who grants the right to conduct these mining operations will be considered as the holder of the mining property although others perform mining operations on it.

(iv) *Minimum size of mining property.* The mining property, if it is made up of a location or locations, should contain at least 15 acres. The minimum size of lands on Indian reservations will be established by the Commission after consultation with the Bureau of Indian Affairs of the Department of Interior. The minimum size of other mining properties will be established by the Commission in individual cases in the light of the purpose of the bonus.

(v) *Subdivision or consolidation of property.* Since the division of existing mining properties into smaller units might have the effect of increasing bonus payments without advancing the purpose of the bonus program, division of a single unit of mining property on or after March 1, 1951, will not be recognized in determining its eligibility for bonus payments under this section. In addition, consolidation or merger of contiguous mining properties on or after March 1, 1951, will not affect the eligibility of the separate properties for bonus payments.

(vi) *Special cases.* Since the above criteria are merely guides to assist the Commission in its decisions, areas which fail to meet all of the criteria may be certified by the Commission as eligible in special cases where it is determined that the deviations are not substantial or that their disqualification would cause serious inequities. In determining whether or not serious inequities would result, the physical characteristics and location of the deposit may be a factor. Under appropriate circumstances, a segment of a certified property may itself be certified as eligible. On the other hand, technical compliance with all the above criteria will not necessarily make a property eligible.

Properties leased to private operators by the Commission will not be eligible for bonus payments except under special circumstances and as provided for in the lease.

(h) *Determination by the Commission.*—The Commission expressly reserves the right to decide the amount of any bonus payments to be made, whether the property should be certified as an eligible mining property, the person to whom the bonus should be paid and whether for any reason a bonus is not payable. These decisions shall rest in the sole discretion of the Commission and shall be final and conclusive. The Commission further reserves the right to establish procedures to carry out the bonus program. Any bonus payments made hereunder with respect to particular ores shall be the only such bonus payments made for those ores. The Commission will not consider any other application for bonus payments on those ores.

(i) *Application for Certification.*—Applications for certification of a property as eligible should be made to:

U. S. Atomic Energy Commission,[1]
Grand Junction Operations Office,
P. O. Box 270,
Grand Junction, Colorado.

The application should include a description of the mining property indicating its size, location, ownership, interest of the applicant and public recording. There should also be included a statement by the applicant that to the best of his knowledge the total quantity of uranium oxide contained in ore accepted by stations or mills (or any other uranium ore processing plants) from that property between April 9, 1948, and February 28, 1951, inclusive, was less than 10,000 pounds. A form prescribed by the Commission and obtainable at a station or mill should be used for supplying the above information. Certification by the Commission will be a prerequisite to payment of the bonus, but after certification, payments will be made for ores which are delivered before certification and which meet the requirements of this section. Normally certification will not be made before uranium deposits have been discovered on the property, but the Commission may issue certifications prior to discovery in special cases. The Commission reserves the right to revoke a certification if it determines that its issuance was based on fraud, misrepresentation or mistake or if the requirements of this section are not complied with. The Commission may require such information and right to make such inspections of the mining property as it finds necessary for the purpose of determining its eligibility for bonus payments and the amounts to be paid.

NOTE: Misrepresentation or falsification of facts in an application for certification or for bonus payments may subject the offender to criminal penalties under pertinent provisions of the United States Code including section 1001 of Title 18. Any such offenses also will disqualify the offender from receiving bonus payments.

(j) *Application for Bonus Payment.*—Application for a bonus payment should be made on a prescribed form (obtainable at a station or mill) at intervals not more frequent than once a month during a period when ore deliveries from the property are believed to meet the requirements of this section. Applications may be addressed as follows:

U. S. Atomic Energy Commission,
Grand Junction Operations Office,
P. O. Box 270,
Grand Junction, Colorado.

In addition to the application, the Commission may require such other information as it finds necessary.

(k) *Who May Apply for Bonus Payments.*—The person (other than a royalty payee or the like) who has lawfully received payment from a station or mill for the delivery of ore from a certified mining property may apply for bonus payments under this section. However, in special cases, the applications of persons whose ores have been accepted by the station or mill but for which payment is still pending will be considered.

(l) *Mill processing ores from its own mines.*—In the event that an operator of a mill processes in the mill ores which it obtains from mining properties operated by it, the Commission will pay the bonus, under the conditions set forth in this section to the same extent as if the mining properties were operated by another person who delivered ore to the mill and received payment for it from the mill. In such case, however, the weights and assays used to fix the amount of payment due as a bonus under this section shall be determined in accordance with practices satisfactory to the Commission.

[1] Appears in Federal Register as Colorado Raw Materials Office.

(m) *Definitions.*—As used in this section,

(1) "Commission" means the Atomic Energy Commission created by the Atomic Energy Act of 1946, or its duly authorized representative.

(2) "Person" means any individual, corporation, partnership, firm, association, trust, estate, public or private institution, group, or combination thereof. The term "person" shall not include the U. S. or any agency thereof or any officer or employee of the Commission.

(n) *Commission Ore-Buying Stations and Qualified Uranium Mills.*—(1) *Stations.* The following are Commission ore-buying stations (that is, ore-buying stations operated on behalf of the Commission):

American Smelting & Refining Co., Monticello, Utah.
American Smelting & Refining Co., Marysvale, Utah.[2]

(2) *Mills.* The following are qualified uranium mills:

United States Vanadium Company, Uravan, Colo.
United States Vanadium Company, Rifle, Colo.
Climax Uranium Co., Grand Junction, Colo.
Vanadium Corporation of America, Durango, Colo.
Vanadium Corporation of America, Naturita, Colo.
Vitro Chemical Co., 600 West 33d St. South, Salt Lake City, Utah.[3]

(3) *Modifications.* These lists may be modified from time to time by public announcement of the Commission.

(o) *Inquiries and Communications.*—Inquiries about this section and all other communications should be addressed as follows:

U. S. Atomic Energy Commission, Grand Junction Operations Office, P. O. Box 270, Grand Junction, Colo.[1]

(p) *Records, Rules, and Regulations.*—The Commission may require applicants for bonus payments under this section to keep for Commission inspection such records concerning production and deliveries of uranium ores for which application is made as it finds proper and may issue such additional rules and regulations relating to bonus payments as it finds necessary or desirable.

(60 Stat. 755–775; 42 U. S. C. 1801–1819)

Dated at Washington, D. C., this 27th day of June 1951.
By order of the Commission.

M. W. Boyer,
General Manager.

[F. R. Doc. 51-7522; Filed, June 29, 1951; 8:53 a. m.]
(Amended F. R. Doc. 53-8783; filed Oct. 15, 1953; 8:45 a. m.)

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[1] Appears in Federal Register as Colorado Raw Materials Office.
[2] Additional ore-buying stations as follows: American Smelting and Refining Co., Edgemont, S. Dak.; American Smelting and Refining Co., Shiprock, N. Mex.
[3] Additional qualified uranium mill as follows: Anaconda Copper Mining Co., Grants (Bluewater) N. Mex.

Special Nuclear Material.—Under the Atomic Energy Act of 1954 the AEC was allowed to distribute special nuclear material to licensees. Special nuclear material was defined as plutonium, natural uranium enriched with uranium–233 or uranium–235, any other material artificially enriched by one or more of the foregoing, except source material, or any other material which the Commission designated as special nuclear material. The AEC was authorized to make a reasonable charge for special nuclear material distributed for medical therapy or research and development use and was required to establish written criteria for determining whether a charge would be made. The AEC was required to make a reasonable charge for special nuclear material distributed to commercial facilities under section 103, Atomic Energy Act of 1954. The AEC, acting under sections 103 and 104 of the act, were to take into consideration, in addition to the cost of producing the fissionable material, its proposed use, its energy value, and the assistance such a loan would make in developing peaceful applications of nuclear energy. It was indicated that there would be an important relationship between costs of special nuclear material provided by the AEC and prices paid by the AEC for special nuclear material produced by licensees. Section 52 of the act required the AEC to pay a fair price for special nuclear material produced by licensees, and section 56 provided that in setting a fair price the AEC was to consider the value of the material for its intended use by the Government and might give such weight to the actual cost of the licensees' production of such material as the AEC found equitable. The fair price established by the AEC applied to all licensed producers of the same material. The AEC was permitted to establish guaranteed fair prices for a period not to exceed 7 years for all special nuclear material which industry might deliver to the AEC. This was considered necessary so that licensees would know in advance what price they might receive for such material produced by them.[86]

RADIUM

Salts.—Throughout 1954 E&MJ Metal and Mineral Markets quoted the price of radium at $16 to $21.50 per milligram of the element in purified salts, depending on quantity.

The price of radium was quoted in terms of the actual weight of the element in a purified radium salt. Radium preparations of all kinds were usually sold on the basis of Government certification as to radium content as determined by gamma-ray measurements. In the United States this work was carried out by the National Bureau of Standards, Washington, D. C.

FOREIGN TRADE [87]

The Shinkolobwe mine of the Union Miniére du Haut Katanga in Belgian Congo continued to supply the United States with a significant quantity of uranium ores and concentrates. Canada shipped uranium concentrates to the United States produced from the Port Radium property of Eldorado Mining & Refining Co., Ltd., and from properties in the Beaverlodge area, Saskatchewan. The Union of South Africa provided this country with uranium concentrates recovered at eight plants treating residues of gold-mining operations.

In 1954, 57,879 milligrams of radium salts was imported for consumption in the United States (see table 6) representing a 32-percent decrease from the amount imported in 1953. It was the smallest quantity of radium salts imported in the 5-year period 1950–54, and less than the 1945–49 average of 67,134 milligrams.

WORLD REVIEW

The world, and particularly the heavy centers of population (notably Europe), became more conscious of the necessity for collaboration in the study and application of nuclear energy. Countries where coal, oil, and waterpower were limited expressed a particular desire to determine the practicability of using uranium as a fuel for electrical power-generation purposes. Nuclear technology research proceeded with marked success in several countries.

[86] Mitchell, William, Remarks for Delivery Before the National Industrial Conference Board's Special Meeting on Atomic Energy in Industry: Atomic Energy Commission, Oct. 13, 1954, 10 pp.
[87] 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.—Radium salts imported for consumption in the United States, 1945–49 (average) and 1950–54

[U. S. Department of Commerce]

Year	Radium salts			Radioactive substitutes (value)
	Milligrams	Value		
		Total	Average per gram	
1945–49 (average)	67,134	$1,185,542	$17,659	$1,329
1950	80,969	1,235,511	15,300	6,106
1951	89,805	1,225,564	13,600	5,399
1952	173,711	2,873,688	16,500	85,849
1953 [1]	85,055	1,474,625	17,337	169,762
1954	57,879	856,822	14,804	149,759

[1] Revised figures.

The European Atomic Energy Society was established to act as a forum to promote development of industrial uses of atomic energy. Participation in the society was limited to those nations that had established nuclear energy projects. They were Belgium, France, Italy, Netherlands, Norway, Sweden, Switzerland, and the United Kingdom.[88]

The European Nuclear Research Council, with headquarters at Geneva, Switzerland, initiated construction of a large nuclear research center nearby. Twelve European countries were participating in this organization to promote cooperation in nuclear energy research: Belgium, Denmark, France, West Germany, Italy, Netherlands, Norway, Sweden, Switzerland, United Kingdom, Yugoslavia, and Greece.

An exhibition toured Europe during 1954 to demonstrate peaceful uses of atomic energy. Countries visited included Belgium, France, West Germany, Netherlands, and Italy.[89]

India led other Asian countries in attempting to develop its resources of radioactive raw materials, produce fissionable material, and study the peaceful applications of nuclear energy.

Belgian Congo continued to be a significant producer of uranium. Canada, the Union of South Africa, and Australia also conducted major uranium-mining programs.

Exploration programs for uranium and the development of existing occurrences were underway in many other countries.

NORTH AMERICA

Canada.—Decontamination and reconstruction of NRX reactor, Chalk River, Ontario, shut down in December 1952 as a result of an accident, was completed and the reactor put back into operation in February 1954.[90] The control system and the reactor structure were revised while reconstruction was in progress. This was the first time that a nuclear reactor of high power rating had been disassembled

[88] Chemical and Engineering News, Europe Forms Atomic Energy Body: Vol. 32, No. 35, Aug. 30, 1954, p. 3424.

[89] Chemical and Engineering News, Atomic Energy Exhibit Tours Europe: Vol. 32, No. 35, Aug. 30, 1954, p. 3424.

[90] Atomic Energy Control Board of Canada, Eighth Annual Report, 1953–54: Ottawa, Canada, 16 pp.

after several years' operation and then restored to service.[91] The Commercial Products Division of Atomic Energy of Canada, Ltd., announced on March 1, 1954, that high-specific-activity, pile-produced radioisotopes were again available from the NRX reactor at Chalk River, Ontario.

During the spring of 1954 Atomic Energy of Canada, Ltd., published a 200-page report containing 15 papers presented at an Atomic Power Symposium at Chalk River, Canada, September 1953. Papers published included those on engineering problems of reactor design, operation of a reactor, uses for fission products, reactor structural materials, power systems, and power resources.[92]

Articles on uranium and atomic energy in Canada were presented at the 1954 meetings of the Prospectors and Developers Association in Toronto and the Canadian Institute of Mining at Montreal.[93] Other such articles were published during the year.[94]

The Government-owned Eldorado Mining & Refining, Ltd., refinery at Port Hope received extensive installations for a new refining process to increase the recovery of uranium. It was proposed that the new facility would be in operation in June 1955.[95]

Rexspar Uranium & Metals Mining Co., Ltd., developed a uranium occurrence about 2 miles from Birch Island station on the Canadian National Railroad mainline between Kamloops and Jasper, British Columbia. Intensive prospecting and geological mapping of the area were carried out during 1954 as well as surface and underground diamond drilling. The development work indicated approximately 700,000 tons of minable grade uranium ore.[96] Adjacent to the Rexspar Uranium & Metal Mining Co. property, Deer Horn Mines, Ltd., acquired 16 claims on which radioactivity was discovered. Some diamond drilling was planned.[97] The Barymin Co., Ltd., staked 50 to 60 claims for uranium in an area approximately 15 or 20 miles northeast of Atlin, British Columbia. Preliminary reconnaissance indicated the presence of uranium oxide in amounts from 0.12 to 0.32 percent.[98] Indications of uranium mineralization also were found in other areas of British Columbia, including Bridge River, Hazelton; North Thompson River, south of Nelson; and along the Columbia River.[99]

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[91] Atomic Energy Newsletter, vol. 11, No. 1, Feb. 23, 1954, p. 4.
Nucleonics, vol. 12, No. 3, March 1954, p. 76.
Gilbert, F. W., Decontamination of the Canadian Reactor: Chem. Eng. Progress, vol. 50, No. 5, May 1954, pp. 267–271.

[92] Canadian Mining Journal, Atomic Power Symposium: Vol. 75, No. 4, April 1954, p. 86.
Canadian Chemical Processing, Report on Atomic Power Symposium: Vol. 38, No. 4, April 1954, pp. 88, 90.

[93] Canadian Mining Journal, The Importance of Uranium: Vol. 75, No. 4, April 1954.
Convey, John, The Development of the Uranium and Atomic Energy Industry in Canada: Canadian Min. and Met. Bull., vol. 47, No. 509, September 1954, pp. 562–570.
Lang, A. H., Summary of Uranium Deposits: Precambrian, vol. 27, No. 7, July 1954, p. 8.

[94] Convey, John, Uranium Development in Canada: Western Miner & Oil Review, vol. 27, No. 9, September 1954, pp. 38–43.
Business Week, Canada Looks to the Atom for Power: No. 1287, May 1, 1954, pp. 146–148, 150.
Engineering and Mining Journal, vol. 155, No. 11, November 1954, p. 120.

[95] Department of Mines and Technical Surveys, Ottawa, Uranium in Canada: 1954 (Prelim.), p. 4.

[96] Scott, J. W., The Rexspar Uranium Property: Western Miner and Oil Review, vol. 27, No. 12, December 1954, pp. 40–42.
Canadian Mining Journal, vol. 75, No. 3, March 1954, p. 106; vol. 75, No. 4, April 1954, p. 122; vol. 75, No. 8, August 1954, p. 98.
Precambrian, vol. 27, No. 5, May 1954, p. 25.

[97] Canadian Mining Journal, Deer Horn Mines: Vol. 75, No. 1, January 1954, p. 90.

[98] Atomic Energy Newsletter, vol. 12, No. 3, Sept. 21, 1954, p. 2.
Mining Journal (London), vol. 243, No. 6215, Oct. 1, 1954, p. 365.

[99] Western Miner and Oil Review, vol. 27, No. 4, April 1954, pp 158, 160.

Uranium occurrences were reported in the Rennie-West Hawk Lake area and in the Tooth Lake area of Manitoba. Uranium minerals were present in zones near porphyritic granodiorite and gneissic outcrops.[1]

Extensive uranium deposits were said to have been located in the Harvey and York Mills districts, New Brunswick. Radioactivity was indicated over a 22-square-mile area.[2] An occurrence of uranium near Hampton, New Brunswick, was explored in 1954, and prospecting in the area resulted in the discovery of uranium at several widely separated localities. Mineralization near Harvey and some near Upsalquitch was explored by drilling.[3]

In the Northwest Territories the Eldorado mine of Eldorado Mining & Refining, Ltd., at Port Radium continued production. Some uranium was recovered from old tailings, and much underground exploration was done. In the Marian River region northwest of Yellowknife, Northwest Territories, diamond drilling was conducted on two uranium occurrences. Plans were made for sinking a shaft on the Rayrock property in the same region. About 40 miles east of Great Bear Lake and at Stark Lake some exploration drilling was carried out.[4]

Much uranium exploration was conducted in Ontario during 1954. Probably the most significant activity was in the Blind River region, Long Township, Ontario, where Algom Uranium Mines, Ltd., and Pronto Uranium Mines, Ltd., continued drilling their holdings in the area and began underground development. Uranium occurred in the pyritized sections of a quartz-pebble conglomerate of the Mississagi formation, part of the Bruce series of Huronian sediments. All the bedrock in the area, including the uranium-mineralized zones, were of pre-Cambrian age. Uraninite, as well as minor quantities of brannerite and monazite was apparently responsible for most of the radioactivity. Some secondary uranium minerals were also present. Pronto Uranium Mines, Ltd., sank its mine shaft through the ore zone and approached the 575-foot objective. The company began to construct a mill with an initial capacity of about 1,000 tons of ore per day. It was scheduled for completion in September 1955, and production was expected to begin soon thereafter. Proven ore reserves on the Pronto property were placed at 2.5 million tons. The organization negotiated with Eldorado Mining & Refining, Ltd., official uranium-ore-purchasing agents for the Government, regarding a contract for Government purchase of uranium oxide from the Pronto mill. Algom Uranium Mines, Ltd., developed two separate ore bodies in the Blind River area. At Algom's Quirke Lake property sinking of the 790-foot production shaft proceeded past the 200-foot mark. A mill site was selected at Quirke Lake. The proposed mill would have a daily capacity of 3,000 tons of ore. Ore reserves at the Algom's Quirke Lake property were estimated to be 6.5 million tons. The second ore body was developed by Algom at Nordic Lake. Drilling at Nordic Lake indicated some 2.4 million tons of ore. A

[1] Engineering and Mining Journal, vol. 155, No. 8, August 1954, p. 156.
[2] Western Miner and Oil Review, vol. 27, No. 9, September 1954, p. 49.
[3] Work cited in footnote 96, p. 5.
[4] Work cited in footnote 95, p. 3.

3,000-ton-a-day-capacity mill was also considered by Algom for the Nordic Lake occurrence.[5]

New Jersey Zinc Co. acquired majority control of several Canadian uranium companies with holdings in the Blind River district, Ontario. The companies were Big Game Mines, Gui-Por Uranium Mines & Metals, Calder-Bousquet Gold Mines, and Moon Lake Uranium Mines. A 1- to 2-year exploration program was planned to define the extent of the uranium mineralization.[6] Other companies exploring for uranium on claims in the Blind River region in 1954 were (1) Lake Nordic Uranium Mines, Ltd., (2) Buckles Algoma Uranium Mines, Ltd., (3) McIntyre-Aquarius Mines, (4) Pater Uranium Mines, and (5) Stanleigh Mining Corporation, Ltd.[7]

In the Bancroft area of southeastern Ontario the Croft Uranium Mines, a subsidiary of Macassa Mines, was reported to have started shaft sinking on its property.[8] Exploration by surface drilling and adit outlined a possible 500,000 tons of uranium ore extending to a depth of 500 feet.[9] Adjoining the Croft property, the Kenmac Chibougamau Mines planned exploration of radioactive anomalies.[10] The Faraday Uranium Mines conducted underground exploration-development of its prospects in the Bancroft area.[11] Centre Lake Uranium Mines in the same area completed a shaft and began lateral work at the 100- and 200-foot levels on its property.[12] Dyno Mines diamond-drilled its uranium showings, and Newkirk Mining Corp. planned a similar program on its claims in the Bancroft area. As a result of information obtained from an airborne radiometric survey, Conwest Exploration Co., Orchan Uranium Mines, Iso Uranium Mines, El Sol Gold Mines, Bonville Gold Mines, and Quejo Mines acquired holdings in the area.[13]

In the Province of Quebec, near the village of Oka, the Molybdenum Corp. of America optioned a lease on 8,000 acres. It was indicated that the Molybdenum Corp. took samples having a significant uranium content in the area. Other companies that staked and leased claims in the vicinity of Oka were Beattie-Duquesne Mines, Headway Red Lake Mines, Coulee Lead & Zinc Mines, Nipiron Mines, Langley Bay Uranium Mines, and Steeloy Mining Corp, as well as numerous

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[5] Joubin, Franc R., Uranium Deposits of the Algoma District, Ontario: Canadian Min. and Met. Bull., vol. 47, No. 510, pp. 673–679.
McMillan, Warren, Uranium Development in Algoma: Western Miner and Oil Review, vol. 27, No. 11, November 1954, pp. 76–78.
Traill, R. J., A Preliminary Account of the Mineralogy of Radioactive Conglomerates in the Blind River Region, Ontario: Canadian Min. Jour., vol. 75, No. 4, April 1954, pp. 63–68.
Atomic Energy Newsletter, vol. 11, No. 6, May 4, 1954, p. 2; vol. 11, No. 11, July 13, 1954, p. 4.
Mining World, vol. 16, No. 7, June 1954, p. 45.
Engineering and Mining Journal, vol. 155, No. 12, December 1954, p. 146.
Canadian Mining Journal, vol. 75, No. 6, June 1954, pp. 122, 124.
Cole, George E., Algom Production Plans: Western Miner and Oil Review, vol. 27, No. 8, August 1954, p. 48.
Western Miner and Oil Review, vol. 27, No. 10, October 1954, p. 52.

[6] E&MJ Metal and Mineral Markets, vol. 25, No. 25, June 24, 1954, p. 3.
Precambrian, 60 Claims Held by Moon Lake Uranium to Be Developed: Vol. 27, No. 7, p. 46.

[7] Mining World, vol. 16, No. 13, December 1954, p. 68.
Canadian Mining Journal, Pater Uranium Mines: Vol. 75, No. 6, June 1954, p. 122.
Western Miner and Oil Review, vol. 27, No. 12, December 1954, p. 74.

[8] Engineering and Mining Journal, vol. 155, No. 7, July 1954, p. 145.

[9] Engineering and Mining Journal, vol. 155, No. 8, August 1954, p. 152.

[10] Engineering and Mining Journal, vol. 155, No. 11, November 1954, p. 160.

[11] Engineering and Mining Journal, vol. 155, No. 12, December 1954, p. 146.

[12] Engineering and Mining Journal, vol. 155, No. 4, April 1954, p. 158.

[13] Canadian Mining Journal, vol. 75, No. 3, March 1954, p. 126.
Engineering and Mining Journal, vol. 155, No. 3, March 1954, p. 160.

syndicates and individuals. The region was settled farming country, but many landowners held only surface rights to their property.[14]

In the Malartic district, Beraud township, northwestern Quebec, a discovery of uranium in pegmatite material attracted much attention. The Canadian Malartic Gold Mines Co. was reported to have examined the occurrence. O'Brien Gold Mines, Powell Rouyn Gold Mines, New Jersey Zinc Exploration, Newmont Mining Corp., Falconbridge Nickel Mines, and Barnat Mines explored adjacent ground.[15] In Kensington township Opawica Explorers, Ltd., conducted exploration-drilling of a uranium-columbium prospect. The radioactive minerals were identified as eschynite, fergusonite, and uraninite.[16] Ascot Metals Corp. planned exploration of uranium occurrences in McDougall and Henvey townships.[17] Some 75 miles northwest of Ottawa and 17 miles north of Fort Coulonge, in Huddersfield township, Consolidated Halliwell Mines undertook a diamond-drilling program to delimit a radioactive zone on its property adjacent to Yates Uranium Mines, Inc., claims.

The Beaverlodge area, Saskatchewan, was the source of some uranium production during 1954. Eldorado Mining & Refining, Ltd., recovered uranium from its Ace-Fay mine. The Fay shaft was deepened to 1,200 feet, but the Eldorado organization let a contract to have the shaft deepened another 1,000 feet. The lowest developed level was the sixth at 800 feet, and an underground crusher was erected below the seventh level. It was planned to open up six or more levels below the seventh. Sinking of Eldorado's Verna shaft on the Ace group was completed at 900 feet. Four levels will be opened, and the ore body will be explored by drifting and diamond drilling.[18 19] Extensive diamond drilling was carried out on the adjoining property leased from Radiore Uranium Mines, Ltd. Eldorado increased the capacity of its 500-ton-per-day Beaverlodge mill 40 percent in 1954 to handle ore shipments on a custom basis from other mines in the area. Rix-Athabasca Uranium Mines, Ltd., and Nesbitt LaBine Uranium Mines shipped ore to the Eldorado mill for treatment, and other companies including Consolidated Nicholson Mines, Black Bay Uranium, Ltd., and Uranium Ridge Mines, negotiated with Eldorado for custom milling of their future ore production. Gunnar Gold Mines, Ltd., on the south shore of Crackingstone Peninsula, Lake-Athabaska, Beaverlodge area, developed its open-pit mine and began construction of a uranium-ore concentrator with a daily capacity of 1,250 tons of ore. The acid-leach section of the mill would use 12,000 to 14,000 tons of sulfur a year in the form of sulfuric acid. A high-grade uranium product was to be recovered from the leach liquors. Gunnar contracted with the Government-owned

[14] Engineering and Mining Journal, vol. 155, No. 4, April 1954, p. 152.
Mining Congress Journal, vol. 40, No. 6, June 1954, p. 37.
Business Week, Canada Looks to the Atom for Power: No. 1287, May 1, 1954, pp. 146–148, 150.
Engineering and Mining Journal, vol. 155, No. 11, November 1954, p. 120.
Atomic Energy Newsletter, vol. 11, No. 2, Mar. 9, 1954, p. 1; vol. 11, No. 5, Apr. 20, 1954, p. 3.
Chemical Age (London), vol. 70, No. 1808, Mar. 6, 1954, p. 583.
Canadian Mining Journal, vol. 75, No. 11, November 1954, p. 142.
Northern Miner (Toronto), Uranium Find Near Montreal: Vol. 39, No. 49, Feb. 25, 1954, pp. 1, 4.
[15] Northern Miner (Toronto), Uranium Find in N. W. Quebec: Vol. 39, No. 43, Jan. 14, 1954, p. 3.
Atomic Energy Newsletter, vol. 10, No. 12, Jan. 26, 1954, p. 4.
[16] Mining World, vol. 16, No. 1, January 1954, p. 65.
[17] Mining World, vol. 16, No. 12, November 1954, p. 71.
[18] Canadian Mining Journal, vol. 75, No. 7, July 1954, p. 96.
[19] Work cited in footnote 95, p. 2.

Eldorado Mining & Refining, Ltd., for sale of uranium concentrate to that concern for a 5-year period, October 1, 1955, to October 1, 1960, with a total value of $77 million.[20] A description of the geology and mineralogy of the uranium deposit of Gunnar Gold Mines, Ltd., was published. The Gunnar occurrence was believed to be the only example of disseminated pitch blende ore in the Beaverlodge area, Saskatchewan.[21] Lorado Uranium Mines, Ltd., also in the Beaverlodge area, conducted underground development of its Alco property with showings of good-grade uranium ore.[22] Goldfields Uranium Mines, Ltd., drilled a newly acquired uranium prospect near Price Lake in the Beaverlodge area. Results indicated uranium values ranging up to 0.05 percent U_3O_8. The Brunston Mining Co. and El Bonanza Mining Corp. explored uranium prospects in the Beaverlodge area in 1954.[23] Also active were Caba Uranium, Ltd., National Exploration, Ltd., Menefee Uranium Mines, Ltd.,[24] Dorado Uranium Mines, Ltd.,[25] Iso Uranium Mines, Nu-Age Uranium Mines, Chimo Gold Mines,[26] Core Uranium, Ltd.,[27] and New Mylamaque Exploration, Ltd.[28]

In the Lac La Ronge area of Saskatchewan, La Ronge Uranium Mines, Ltd., was reported to have developed a flat-lying pegmatite sill containing 9,400,000 tons of approximately 0.08 percent U_3O_8 ore.[29]

The sill was believed to average 162 feet in thickness, with little overburden. A pilot mill was erected at the property in 1954 by La Ronge Uranium Mines, Ltd., to test a new low-cost process for treating the large tonnage of low-grade radioactive material.

A paper presented at the Toronto meeting of the Society of Economic Geologists, November 1953, described the geology and mineralogy of the Lac La Ronge radioactive occurrence.[30] An article was published during 1954 on the beneficiation of low-grade Saskatchewan uranium ores.[31]

Mexico.—Uranium exploration in Mexico was governed by mining laws of that country, under which the Mexican Government had the authority to expropriate land on which uranium was found. The provisions of the laws were such that the radioactive mineral deposits would become the property of the Government, the discoverer would receive no reward, and the property owner would receive no compensation for seizure of his land.[32]

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[20] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 3, March 1955, p. 30.
[21] Fraser, J. A., and Robertson, S. C., Preliminary Description of the Geology and Mineralogy of the Gunnar Deposit, Saskatchewan: Canadian Min. Jour., vol. 75, No. 7, July 1954, pp. 59–62.
[22] Western Miner and Oil Review, vol. 27, No. 12, December 1954, p. 82.
Engineering and Mining Journal, vol. 155, No. 8, August 1954, p. 157.
Atomic Energy Newsletter, vol. 11, No. 10, June 29, 1954, p. 4.
[23] Mining World, vol. 16, No. 9, August 1954, p. 60.
[24] Western Miner and Oil Review, vol. 27, No. 7, July 1954, p. 86–89.
[25] Engineering and Mining Journal, vol. 155, No. 6, June 1954, p. 154.
[26] Atomic Energy Newsletter, vol. 11, No. 1, Feb. 23, 1954, p. 4; vol. 11, No. 5, Apr. 20, 1954, p. 3.
[27] Western Miner and Oil Review, vol. 27, No. 6, June 1954, p. 66.
[28] Metal Bulletin (London), No. 3926, Sept. 14, 1954, p. 27.
[29] Canadian Mining Journal, vol. 75, No. 7, July 1954, p. 96; vol. 75, No. 9, September 1954, pp. 116, 118.
Engineering and Mining Journal, vol. 155, No. 7, July 1954, p. 148.
[30] Mawdsley, J. B., Radioactive, Pronouncedly Differentiated Pegmatite Sill, Lac La Ronge District, Northern Saskatchewan: Econ. Geol., vol. 49, No. 6, September–October 1954, pp. 616–624.
[31] Korchinski, I. J. O., Craig, G. A., Cavers, S. D., and Van Cleave, A. B., Beneficiation of Low-Grade Saskatchewan Uranium Ores: Precambrian, vol. 27, No. 5, May 1954, pp. 8–9, 11–13, 28.
[32] Mining Journal (London), vol. 243, No. 622, Nov. 19, 1954, p. 576.
Science News Letters, No Uranium Prospectors Comb Mexican Hills: Vol. 66, No. 5, July 31, 1954, p. 72.

SOUTH AMERICA

Argentina.—Argentina's Comision Nacional de la Energia Atomica indicated in 1954 that it would purchase all types of domestically mined uranium-bearing material assaying 0.2 percent U_3O_8 or better. The Commission mined uranium ore near Malargue in the Province of Mendoza and at San Santiago in the Province of La Rioja. Small, privately operated mines in the Provinces of San Luis and Mendoza produced some uranium ore.[33]

The Argentinian Government stated in 1954 that it planned to build a prototype nuclear power reactor. The reactor was to be fueled with natural uranium, moderated with beryllium oxide, and cooled with heavy water. It would produce 17,000 kilowatts of power.[34]

The Atlas Corp., a United States organization, sought the approval of the Government of Argentina for a plan to conduct an air and ground survey for uranium and other materials in that country.[35]

Bolivia.—United States Atomic Energy Commission geologists, in cooperation with the Bolivian Government, made radioactivity surveys in certain areas of Bolivia. Partial results of the survey were released by Bolivian officials in 1954. Uranium mineralization was reported to have been found at (1) Llallagua, of the Catavi group of mines, controlled by Corporation Minera de Bolivia; (2) Lasna, of the Quechisla mining group in southern Bolivia; (3) Chulchucani, near the city of Potosi; and (4) at Tapacari, Province of Cochabamba. No indication was made of the grade of the uranium occurrences. It was mentioned that nearly all of the Altiplano and the East Cordillera of Los Andes were systematically examined, and in addition preliminary aerial surveys were made of the Nuflo Chavez and Velasco Provinces, Department of Santa Cruz.[36]

Brazil.—The Departamento Nacional da Producão Mineral conducted an exploration program for uranium and other materials in part of the Rio Ribeira Valley between Parana and São Paulo, and in a 42,000-square kilometer area of the States of Paraiba, Rio Grande do Norte, and Ceara.[37] An occurrence of high-grade uranium associated with thorium and niobium was reported to have been discovered at Barriero de Araxa, State of Minas Gerais.[38] Uranium-zirconium deposits in the Pocos de Caldas region of Minas Gerais were considered of economic significance, and a deposit bearing uraninite near Ico, State of Ceara, was mined during the year.[39]

The Brazilian Government announced that uranium-processing plants for the production of uranium metal from the ore would be constructed in the Pocos de Caldas region of Minas Gerais. Enough uranium was to be produced to fuel experimental reactors being planned by the Government.[40]

Chile.—Uranium mineralization was reported in the Provinces of Coquimbo and Atacama of northern Chile. The recovery of ura-

[33] Engineering and Mining Journal, vol. 155, No. 4, April 1954, p. 174.
[34] Nucleonics, vol. 12, No. 7, July 1954, p. 7.
[35] Mining World, Odlum Negotiates for U_3O_8 Concession in Argentina: Vol. 16, No. 12, November 1954, p. 57.
[36] Engineering and Mining Journal, vol. 155, No. 10, October 1954, pp. 171–172.
[37] Engineering and Mining Journal, vol. 155, No. 9, September 1954, p. 198.
[38] Mining Journal (London), vol. 243, No. 6212, Sept. 10, 1954, p. 287.
[39] Engineering and Mining Journal, vol. 155, No. 10, October 1954, p. 172. Mining Journal (London), vol. 243, No. 6218, October 22, 1954, p. 454.
[40] Mining World, vol. 16, No. 10, September 1954, p. 100.

nium from such deposits would be controlled by a new Government bureau, Empresa de Minerais Radioactivos, under terms of a bill presented in the Chilean Congress during 1954.[41]

Peru.—The Peruvian Government in 1954, with the assistance of United States Atomic Energy Commission geologists, continued reconnaissance for radioactive materials.[42] Uranium was said to have been found in the mountains of central and southern Peru and near Ica, about 300 miles south of Lima.[43]

Private industry in Peru was authorized by law in 1953 to develop and mine uranium and other radioactive substances and to sell such materials directly to the Government. To facilitate operations the Board of Control of Radioactive Substances, responsible directly to the President of Peru, was established February 25, 1954. The Board announced in 1954 the prices that the Peruvian Government would pay for uranium ores with a minimum U_3O_8 content of 0.50 percent, produced by private industry in that country. The base price was indicated as $7.70 per kilo of U_3O_8, plus a bonus of $2.75 per kilo payable on the first 5,000 kilos of U_3O_8 produced by 1 company or individual. A deduction of $15 per metric ton of ore is made to cover treatment charges.

At a press conference on October 5, 1954, Jorge Sarmiento, president, Board of Control of Radioactive Substances, mentioned that an agreement was signed September 14, 1954, in Washington, D. C., and August 19, 1954, in Lima Peru, with the United States Atomic Energy Commission for export and sale to the United States of uranium ores and concentrates produced in Peru.[44]

EUROPE

The European Council for Nuclear Research at an April 1954 meeting named Felix Block, director of the organization. Also elected were Eduardo Amaldi, assistant director; C. J. Bakker, liaison with chiefs of research groups; and Sir Ben Lockspeiser, in charge of the group studying administrative and financial matters. The Council planned to spend $30 million on laboratory facilities on a 43-acre site near Geneva, during a 7 year-construction period. The estimated year operating costs of about $2.3 million were to be shared by the 12 sponsoring European countries. The fundamental nuclear research to be conducted under the direction of Niels Bohr would be confined to nonmilitary studies.[45]

In contrast to the European Council for Nuclear Research, which was intended for purely scientific studies, the European Atomic Energy Society was formed in 1954 to promote development of industrial uses of atomic energy. Sir John D. Cockcroft, of Britain's atomic energy agency, was appointed president of the Society, and Bertrand Goldschmidt of France was named vice president. Eight countries participated, including Belgium, France, Italy, The Netherlands, Norway, Sweden, Switzerland, and the United Kingdom. The aims of the group were: (1) To promote regular meetings for scientists

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[41] Metal Bulletin (London): No. 3892, May 11, 1954, p. 27.
[42] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 3, March 1954, pp. 28–29.
[43] Engineering and Mining Journal, vol. 155, No. 1, January 1954, p. 162.
Metal Bulletin (London), No. 3925, Sept. 10, 1954, p. 23.
[44] Engineering and Mining Journal, vol. 155, No. 11, November 1954, pp. 125–126.
[45] Nucleonics, vol. 12, No. 7, July 1954, p. 86.

and engineers working in fields of peaceful application of nuclear energy; (2) to promote circulation of reports and other information; (3) to work for standardization of nomenclature and symbols; (4) to promote study of hazard and safety measures; (5) to promote publication of work, possibly encouraging establishment of an international journal in the field; and (6) to establish a center of information on availability of nuclear energy materials and equipment.[46]

An exhibition toured Europe to demonstrate peaceful uses of atomic energy. Exhibits included models of British nuclear power stations; demonstrations of various uses of radioisotopes in agricultural, industrial, and medical fields; and motion pictures that showed the present and future peaceful application of atomic energy. Countries visited included Italy, France, Greece, Holland, and Belgium.[47]

Belgium.—The Belgian Government agreed to supply Switzerland with 10 metric tons of uranium, the ore was to be mined by Union Miniére du Haut Katanga in the Belgian Congo and processed in Great Britain before shipment.[48]

In 1954 construction was begun on Belgium's first experimental research reactor, a graphite-moderated, water-cooled, natural-uranium-fueled type. The fuel elements, weighing approximately 30 tons, were furnished by the United States and the graphite by Great Britain. The reactor was designed to produce about 3,500 kilowatts, and was at Mol in the Province of Antwerp. It was indicated that the cost of constructing the reactor was supported by the proceeds from sale of the Belgian Congo uranium ore to the United States and Great Britain.[49]

The president of Union Miniére du Haut Katanga announced that company trade in uranium ore was a relatively small part of its total business. He also stated that large profits were not realized because the Government took a sizable share in taxes.[50]

The Union Miniére du Haut Katanga joined the United States Atomic Industrial Forum during 1954; it was the first foreign organization to join the American industrial association devoted to advancing peacetime development of atomic energy.[51]

Bulgaria.—The old uranium mines and a new occurrence at Bukhova were reported to have been worked. Another large uranium mine between Madan and Zilatograd in the Rhodope mountains was developed. The ore was transported by rail to the Soviet Union.[52]

Czechoslovakia.—Near Susice and Prackovice in the central Prerov region an extensive uranium deposit was said to have been exploited by Soviet specialists and engineers.[53]

France.—Commencing November 1, 1954, the French Commissariat à l'Énergie Atomique purchased uranium ore from private individuals. The material was mostly from the Brittany, Normandy,

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[46] Chemical and Engineering News, vol. 32, No. 35, Aug. 30, 1954, p. 3424.
Nucleonics, vol. 12, No. 7, July 1954, p. 5.
[47] Chemical and Engineering News, vol. 32, No. 35, Aug. 30, 1954, p. 3424.
[48] Engineering and Mining Journal, vol. 155, No. 11, November 1954, p. 186; vol. 155, No. 12, December 1954, p. 172.
[49] Nucleonics, vol. 12, No. 8, August 1954, p. 56.
Engineering and Mining Journal, vol. 155, No. 4, April 1954, p. 184.
Bulletin of the Atomic Scientists, vol. 10, No. 4, April 1954, p. 143.
[50] Metal Bulletin (London), No. 3937, Oct. 22, 1954, p. 21.
[51] Engineering and Mining Journal, vol. 155, No. 12, December 1954, p. 170.
Mining Engineering, vol. 6, No. 12, December 1954, p. 1153.
[52] Engineering and Mining Journal, vol. 155, No. 6, June 1954, p. 166.
[53] Mining World, vol. 16, No. 11, October 1954, p. 76.

and Massif Central area. The ore was accepted only in lots of 20 tons or more. The base price paid was 4,000 francs for each contained kilo of uranium. In addition, for ore from the region south of the Massif Central area, a bonus of 1,000 francs was paid for each kilo of uranium in excess of a content of 4 percent uranium. The purchase agreement covered a 5-year period.[54]

Pitchblende deposits that were discovered near the village of Lacheau, Puy-de-Dome Department, in central France were expected to be richer than other uranium deposits in the country.[55]

Development of the second French reactor, Saclay, was described. It reached criticality on October 27, 1952. Some 6½ tons of heavy water was required, as well as slightly less than 3 metric tons of natural uranium, divided among 136 fuel rods. Cadmium plates were used to control the reactor and compressed gas for cooling purposes. Operation of the reactor proved that a compressed-gas current could be heated in a reactor. It also offered a subject for nuclear research and served as a source of radiations.[56] The other French reactor, Zoe, was completed in December 1948 and has been in operation since that date.[57] It was indicated that 2 production reactors were planned that would supply 75 pounds of plutonium per year. The reactors, which would generate 100,000 kilowatts, may be built in the Rhone Valley.[58] France's atomic energy program also included consideration of a nuclear-propelled submarine.[59]

Germany, East.—Uranium-mining operations in East Germany were believed to be shifting from the Erzgebirge region near the Czechoslovak border to Katzendorf and Sorge-Settendorf in the State of Thuringia. Much of the Erzgebirge mining area previously guarded closely was opened to the public. Remaining mines in the Erzgebirge area were in a 20-mile long valley formed by the Schwartzwasser River between the towns of Aue and Johanngeorgenstadt. According to a West German survey the Thuringian deposits at Katzendorf covered an area of about 500 acres. Ore was apparently some 12 to 60 feet below the surface. It was indicated that some 1,800 tons of ore was produced daily at Sorge-Settendorf.[60]

Near Aue, Saxony, the East German Government planned to construct 2 reactors that would consume about 12 metric tons of uranium a year. Invitations were sent to all Soviet-bloc governments to participate in the venture.[61]

Wismut Aktiengesellschaft, a Soviet corporation, was responsible for production of uranium ore in East Germany. Wismut's efforts to increase output by employing slave-type labor and forcing extreme production quotas on individuals caused many persons to flee to West Germany.[62]

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[54] Engineering and Mining Journal, vol. 155, No. 12, December 1954, p. 170.
[55] Atomic Scientists Journal (London), vol. 3, No. 5, May 1954, p. 272.
Chemical Age (London), vol. 70, No. 1807, Feb. 27, 1954, p. 524.
[56] Kowarski, L., Development of the Second French Reactor: Nucleonics, vol. 12, No. 8, August 1954, pp. 8-11.
[57] Atomic Scientists Journal (London), vol. 3, No. 6, July 1954, p. 347.
[58] Nucleonics, vol. 12, No. 6, June 1954, p. 69.
[59] Nucleonics, vol. 12, No. 12, December 1954, p. 72.
[60] Mining Record, vol. 65, No. 36, Sept. 9, 1954, p. 3.
Engineering and Mining Journal, vol. 155, No. 9, September 1954, p. 228.
[61] Mining World, vol. 16, No. 11, October 1954, p. 76.
Nucleonics, vol. 12, No. 9, September 1954, p. 72.
[62] Newsweek, In the Red Uranium Mines: Nov. 8, 1954, pp. 45, 46.

Germany, West.—Chancellor Adenauer informed allied military authorities that the West German Government wanted to initiate a nuclear research program, including construction of a 10,000-kilowatt reactor.[63]

Hungary.—The head of the Experimental Physics Institute at Debrecen declared in 1954 that extensive deposits of low-grade uranium ore existed in the coal-mining districts of Hungary. Efforts were made to determine an economical process for extracting uranium from the material.[64]

Italy.—The National Committee for Nuclear Research described a nuclear reactor estimated to cost $8 million in United States currency which it intended to have built at Milan. The heterogeneous reactor would require 5 to 6 tons of natural uranium metal as a fuel and 10 to 12 tons of heavy water as a moderator and pressurized coolant. The core would be in an aluminum tank surrounded by a graphite reflector. The power level of the proposed reactor may be 10,000 kilowatts.[65]

Pilot plants were built for production of heavy water and for separating metallic uranium from ore. Low-grade uranium deposits were reported to have been found on the island of Monte Cristo, and reconnaissance for uranium in Mondovi and Cuneo, in Piedmont, was encouraging.[66]

Netherlands.—The Lower Chamber of the Netherland Parliament approved a $2.2 million (United States currency) Government contribution to the construction of a $7.4 million experimental reactor. The reactor, a combined project of the Netherlands and Norway, was planned as a pressurized heavy-water type that would produce 10,000 kilowatts and be prototype for a merchant-ship propulsion unit.[67]

Also being considered was establishment of an experimental nuclear power station by F. O. M., the Netherland institution for fundamental materials research, of Utrecht, and K. E. M. A., the electricity research section, of Arnheim. The reactor would generate 100,000 kilowatts of power.[68]

Norway.—The Netherland-Norwegian Joint Establishment for Nuclear Energy Research (JENER) at Kjeller was said to have produced radioactive gold in its research reactor. The domestic production would supplant material formerly imported from the United Kingdom.[69]

The Kjeller conference on heavy-water reactors, the world's first public reactor conference, held at Oslo in August 1953, was described during 1954.[70]

Portugal.—A Junta de Energia Nuclear was formed by the Portuguese Government. The organization, whose headquarters was

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63 Nucleonics, vol. 12, No. 12, December 1954, p. 72.
64 Scientists Journal, vol. 4, No. 2, November 1954, p. 111.
Chimie et Industrie (Paris), vol. 72, No. 4, October 1954, pp. 776.
Metal Bulletin, No. 3916, Aug. 10, 1954, p. 24.
Chemical Engineering and Mining Review (Melbourne), vol. 47, No. 2, Nov. 10, 1954, p. 67.
65 Nucleonics, vol. 12, No. 8, August 1954, p. 62.
Atomic Scientists Journal, vol. 3, No. 6, July 1954, p. 348.
66 Engineering and Mining Journal, vol. 155, No. 6, June 1954, pp. 164, 165.
67 Nucleonics, vol. 12, No. 7, July 1954, pp. 5 and 77; vol. 12, No. 8, August 1954, p. 6.
Chemical Age (London), vol. 70, No. 1806, Feb. 20, 1954, p. 481.
Bulletin of the Atomic Scientists, vol. 10, No. 2, p. 62.
68 Atomic Scientists Journal, vol. 3, No. 3, January 1954, p. 155.
Nucleonics, vol. 12, No. 1, January 1954, p. 73.
69 Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 3, September 1954, p. 39.
70 Egelstaff, P. A., The Kjeller Conference on Heavy-Water Reactors: Atomics and Atomic Technol., vol. 5, No. 9, September 1954, pp. 260–261, 266.

Lisbon, was designed to promote prospecting for and mining and processing of uranium in Portugal and in Portuguese colonies. It would also control the sales and export of radioactive materials.

The atomic energy group was expected to propose new legislation governing the prospecting for and mining of uranium and other radioactive materials. Since 1949 it has been unlawful to prospect without a permit for radioactive materials in Portugal or its possessions.[71]

Sweden.—The Swedish atomic energy commission, A. B. Atomenergi, announced completion of the country's first experimental nuclear reactor in July 1954. The reactor, a natural-uranium-fueled, 100-kilowatt, heavy-water-moderated type, was on the outskirts of Stockholm near the Stockholm Institute of Technology in an underground chamber. France had supplied Sweden with the natural uranium metal required, and in return Sweden sent France uranium concentrate recovered from the shale deposits near Orebro, west of Stockholm.[72]

Full-scale operations for recovering low-grade uranium from shale were begun at Kvarntorp, central Sweden. Large shale deposits in the Kvarntorp area contained about 0.02 percent uranium. The Government indicated that it would construct facilities for producing uranium metal from the concentrates recovered.[73]

Under Proclamation 703, effective January 1, 1954, uranium and uranium compounds could be processed in Sweden at universities, colleges, and research and scientific institutions. Minerals with a uranium content not exceeding 0.005 percent could be exported from the country beginning January 1, 1954.[74]

Switzerland.—On September 18, 1954, an agreement was reached between Switzerland and Belgium allowing for delivery of 10 tons of natural uranium metal from the Belgian firm Union Miniére du Haut Katanga to the Swiss Government. The ore produced at the Shinkelobwe mine was to be shipped to England for refining before delivery.[75] [76]

A decree by the Swiss Government in November 1954 authorized the Government to subsidize a company to build and operate an experimental reactor.[77] The 10,000-kilowatt reactor will require about 10 tons of natural uranium metal as a fuel and about 12 tons of heavy water as a moderator.[78]

U. S. S. R.—According to the Soviet Council of Ministers, operation was begun of an atomic power plant with an electrical capacity of 5,000 kilowatts. It was believed that the plant would be utilized for experimental purposes.[79]

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[71] Mining World, vol. 16, No. 8, July 1954, p. 75.
[72] Atomic Scientists Journal, vol. 3, No. 6, July 1954, p. 348.
Engineering and Mining Journal, vol. 155, No. 7, July 1954, p. 164.
Nucleonics, vol. 12, No. 8, August 1954, p. 6.
Atomics and Atomic Technology, vol. 5, No. 11, November 1954, p. 320.
Scientists Journal (London), vol. 4, No. 2, November 1954, p. 115.
[73] Atomics and Atomic Technology, vol. 5, No. 2, February 1954, p. 60.
[74] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 2, February 1954, pp. 27, 28.
[75] Metal Bulletin (London), No. 3940, Nov. 2, 1954, p. 24.
[76] Mining World, vol. 16, No. 12, November 1954, p. 57.
[77] Nucleonics, vol. 12, No. 12, December 1954, p. 72.
[78] Nucleonics, vol. 12, No. 6, June 1954, p. 69.
[79] Chemical and Engineering News, vol. 32, No. 30, July 26, 1954, p. 2979.
Atomics and Atomic Technology, vol. 5, No. 8, August 1954, p. 217.
Atomic Energy Newsletter, vol. 11, No. 11, July 13, 1954, p. 3.
Nucleonics, vol. 12, No. 8, August 1954, p. 60.

It was estimated that the number of reactors in the U. S. S. R. was at least 10 and may be as high as 20. Russian scientists have published over 1,000 papers on radioisotopes.[80]

United Kingdom.—In 1954 the Government appointed eight members to the newly formed Atomic Energy Authority. They were: Sir Edwin Plowden, chairman; Sir John Cockcroft, in charge of scientific research; Sir Christopher Hinton, in charge of engineering and production; Sir William Penney, in charge of weapons research and development; and Sir Donald Perrott, in charge of finance and administration, plus the part-time services of Lord Cherwell, Sir Luke Fawcett, and U. A. R. Stedeford.[81] The British Ministry of Supply was to continue being responsible for producing complete atomic weapons, for placing contracts with the Authority for the production of components, and for research. The Authority was expected to be run on industrial lines to work for the swiftest and most economical development of atomic energy. Enterprises transferred to the organization were: (1) Harwell—fundamental research in nuclear physics and atomic energy; (2) the Radio-Chemical Centre at Amersham, producing radium, radon, and isotopes; (3) Risley near Warrington—producing fissionable material; (4) Springfields near Preston—producing pure uranium; (5) Windscale in Cumberland—producing plutonium; (6) Capenhurst in Cheshire—gaseous diffusion separation of uranium-235 from uranium-238; (7) the experimental atomic power station at Calder Hall; and (8) Aldesmaston, Berks., for atomic weapon research.[82]

In May 1954 a tripartite conference consisting of scientists and engineers from the United States, Canada, and England met at the Atomic Energy Research Establishment, Harwell, England, to discuss instrumentation problems associated with atomic energy projects.[83]

At Calder Hall, Cumberland, England, a commercial atomic power plant was being constructed. The electrical generating station will include two nuclear reactors of a graphite-moderated, gas-cooled type, using natural uranium metal as fuel. This conventional-design reactor was decided upon because it provided inherent safety and stability and the core offered a thermal uniformity. The coolant gas and heat-transfer medium will be carbon dioxide gas under pressure. The gas, after being circulated around the core by motor-driven blowers, is to be forced through heat-exchange boilers, where superheated steam will be generated. The steam will then be consumed in the operation of turbines for the production of electricity in a fashion similar to that of conventional power plants. The 50,000 kilowatts of electricity produced in the Calder Hall power plant will be fed into the gridlines of the British Electrical Authority. The capital cost of the plant was estimated to be probably twice that of a regular power station. In addition to electrical generation, the installation was to recover plutonium for use in military weapons from the fission products.[84] The plant was expected to be completed by mid-1956.[85]

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[80] Atomic Scientists Journal, vol. 3, No. 6, July 1954, p. 347.
[81] Atomic Energy Newsletter, vol. 11, No. 11, July 13, 1954, p. 1.
[82] Canadian Mining Journal, vol. 75, No. 1, January 1954, p. 64.
Chemical and Engineering News, Britain Looks to Civil Use of Atom: Vol. 32, No. 3, Jan. 18, 1954, p. 241.
[83] Atomic Energy Newsletter, vol. 11, No. 9, June 15, 1954, p. 4.
[84] Walter, Leo, Development of Atomic Power Plants in Great Britain: South African Min. and Eng. Jour., vol. 65, No. 3217, Oct. 9, 1954, pp. 189, 191, 193.
Atomics and Atomic Technology, Calder Hall, Britain's First Commercial-Scale Power Reactor: Vol. 5, No. 10, October 1954, pp. 275-278.
[85] Chemical Age (London), vol. 70, No. 1824, June 26, 1954, p. 1473.

A large, fast breeder reactor was planned for construction at Dounreay, Caithness, Scotland. It was expected that the nuclear power plant capacity would be greater than that of the Calder Hall reactor.[86]

The British Electricity Authority hoped to plan within a few years a large atomic power station employing standard 60,000-kilowatt generating units.[87]

"Zephyr," a fast reactor of zero energy utilizing plutonium as a fuel, began operating early in 1954. The reactor at Harwell was the first experimental unit designed for studying the process of breeding with plutonium and natural uranium.[88]

Also put into operation at Harwell in 1954 was Britain's first heavy-water reactor. The unit, called Dimple after its full title "Deuterium Moderated Pile, Low Energy," was a low-power, thermal neutron research reactor. The fissionable fuel material was submerged in a tank of heavy water that acted as a moderator. The tank was surrounded by a graphite neutron reflector. A thick concrete radiation shield was constructed around the complete reactor. The type of fuel and its arrangement in the heavy water moderator could be changed without undue difficulty, making the "Dimple" reactor a versatile tool in designing future power reactors and for measuring constants in reactor physics. Experimental work was to be conducted with "Dimple" relative to the E. 443 reactor, a new and a more powerful heavy-water type being constructed at Harwell.[89]

Sir John Cockcroft, in charge of British atomic energy scientific research, indicated that the economic development of nuclear power for industrial purposes depended on three major factors: (1) The reactor must be able to burn up enough of its uranium to achieve low fuel costs; (2) the fuel must be produced cheaply; and (3) the reactor must be of good engineering design for reliable and safe operation and low capital costs.[90]

The British Experimental Pile (BEPO) at Harwell was described. This reactor, the first of any size to be built in England, was completed in 1948. It required natural uranium as fuel and graphite as a moderator; it was air-cooled. Shielding and control features were normal. Also explained in some detail were the construction and operation of the Windscale piles built for producing plutonium. The Windscale reactors were similar in principle to the BEPO reactor. There followed a discussion of various types of reactors and the future prospects for nuclear power.[91]

The first public inspection of the Windscale plutonium production works was made on May 6, 1954, when representatives of the press were given a conducted tour of the installation by Government officials. The newsmen were shown reactors in operation, the primary separation plant, the uranium-purification plant, solvent-recovery

[86] Atomic Energy Newsletter, vol. 11, No. 2, Mar. 9, 1954, p. 1.
Nucleonics, vol. 12, No. 4, April 1954, p. 82.
Atomic Scientists Journal, vol. 3, No. 5, May 1954, p. 273.
[87] Iron and Coal Trades Review (London), vol. 169, No. 4506, Aug. 20, 1954, p. 476.
[88] Atomic Energy Newsletter, vol. 10, No. 13, Feb. 9, 1954, p. 1.
Iron and Coal Trades Review (London), vol. 168, No. 4479, Feb. 12, 1954, p. 376.
[89] Atomics and Atomic Technology, vol. 5, No. 9, September 1954, p. 244.
Atomic Energy Newsletter, vol. 11, No. 11, July 13, 1954, p. 2.
Nucleonics, vol. 12, No. 9, September 1954, p. 82.
[90] Iron and Coal Trades Review (London), vol. 169, No. 4509, Sept. 10, 1954, p. 617.
[91] Hinton, Christopher, Nuclear Reactors and Power Production: Atomics and Atomic Technol.: Part I, vol. 5, No. 4, April 1954, pp. 115–123; part II, vol. 5, No. 5, May 1954, pp. 147–151; part III, vol. 5, No. 6, June 1954, pp. 174–180.

equipment, and service groups, such as analytical and research laboratories and departments of health, physics, and safety. The natural uranium slugs irradiated in the Windscale piles were removed from the piles under water and transferred to the primary separation plant. Here the slugs were dissolved in nitric acid, several tons of acid being required for each ton of slugs. The uranium-bearing acid was then sent to the top of a series of solvent extraction towers, packed columns 1 foot in diameter and 20 feet in height. Solvent was injected into the middle and bottom of the tower. The two solutions mixed and the solvent phase containing uranium and plutonium was discharged from the top of the towers while the aqueous phase containing radioactive fission products was discharged from the bottom. The system was a gravity-type operation. Maintenance problems were held to a minimum owing to elimination of pumps and valves. From the extraction towers the uranium-plutonium-bearing solvent was sent to the plutonium-uranium purification unit. The entire plant was operated in an atmosphere of inert gas to minimize the fire hazard. Shielding was much less than in previous stages. The uranium solution, depleted of uranium–235, was processed in an adjacent building and the purified product sent to Springfields to be converted to uranium hexafluoride. The solvent was recovered and recycled through the extraction towers, and radioactive waste materials were transported by pipeline and discharged 2 miles out at sea. The Windscale plutonium production plant near Sellafield occupied some 300 acres and employed a staff of 3,000 persons.[92] The public was also given an opportunity to become acquainted with operations at Springfields, where uranium ore was crushed, ground, dissolved, and converted into natural uranium metal for the Windscale plutonium plant or uranium hexafluoride for the U–235 gaseous diffusion plant at Capenhurst. The British process for the recovery of uranium from ore was stated to consist of the following steps: (1) Ground uranium ore was dissolved in a warm acid mixture in stainless steel containers; (2) barium carbonate was added to precipitate out radium and other metals; (3) hydrogen peroxide was added to the filtrate to precipitate black uranium oxide; (4) the crude oxide was dissolved in nitric acid, from which pure uranyl nitrate was recovered by solvent extraction with ether; (5) the uranyl nitrate was returned to the aqueous phase by washing; (6) ammonium diuranate was precipitated from the purified uranyl nitrate; (7) the bright yellow ammonium diuranate filtrate was converted to uranium tetrafluoride by passing hydrogen fluoride gas over it in an electric furnace; and (8) the tetrafluoride was placed in a billet mold and reduced to uranium metal with metallic calcium. In subsequent steps the uranium billet was removed from the furnace, and descaled, and samples were taken. Analyses were made of the samples to ascertain purity. Next, the billet was remelted and vacuum-cast in rod form. The rod was rolled, machine-finished, cut into short lengths, and placed in aluminum cans, after which it was ready for the plutonium reactor at Windscale. The uranium hexafluoride for Capenhurst gaseous diffusion was prepared from the uranium tetrafluoride by adding extra fluorine and gasification.[93]

[92] Chemical and Engineering News, vol. 32, No. 23, June 7, 1954, pp. 2288, 2290, 2292.
South African Mining and Engineering Journal, vol. 65, Part 2, No. 3224, Nov. 27, 1954, p. 513.
[93] Chemical Engineering, Inside Three Atomic Factories: Vol. 61, No. 4, April 1954, pp. 130, 132, 134, 136.
Metal Bulletin (London), The Era of the Atom, part II: No. 3908, July 9, 1954, pp. 12, 13.

In January 1954 the British Ministry of Supply published a 100-page illustrated booklet, entitled "Britain's Atomic Factories." The publication described the growth of Great Britain's atomic energy industry.[94]

The latest annual report of the Geological Survey of Great Britain, issued in mid-1954, indicated that enough uranium ore had not been located in Britain to warrant construction of a recovery plant. About 5,000 feet of exploratory diamond drilling was conducted at the site of the old, abandoned South Terras uranium mine. No extension of the ore body was found, and existence of a new ore body was not revealed. Investigations were made of uranium mineralization in an old copper mine at Wheal Edward, near St. Just, and at other mines in the vicinity. A new occurrence of uranium mineralization was announced by the Survey at Wheal Bray on Bodmin Moor. The Government organization made radiometric surveys of mine dumps in the Devon and Cornwall districts to insure that good uranium ore would not be disposed of as waste for road-metal purposes. It was also mentioned that uraniferous coal had been found in the Warwickshire coal field.[95]

A paper was published that described the uranium mineralization in Cornwall and Devon and summarized all the published information relative to the occurrences in that area.[96]

An article on geochemical prospecting described a qualitative field method for the determination of uranium in natural waters,[97] and an article was published on the occurrence of uranium in coals in Britain and elsewhere.[98]

Yugoslavia.—Preliminary studies were made for construction of a heavy-water reactor at the Institute of Nuclear Studies at Belgrade.[99]

ASIA

India.—The country's first plant for the production of uranium and other radioactive materials was at Trombay and was expected to be completed in 1955.[1] The Trombay refinery would treat uranium-thorium-bearing residual cake from the Alwaye monazite treatment plant which recovered the rare-earth and phosphate content of the Travancore monazites.[2]

Erection of a pilot plant was sanctioned to study methods of extracting uranium from the tailings of the Indian Copper Corp. mines and from ores to be mined from Government prospects. Construction of the facility was expected to begin in the near future.[3]

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[94] Nucleonics, vol. 12, No. 2, February 1954, p. 72.
Mining Journal (London), vol. 242, No. 6179, Jan. 22, 1954, p. 94.
Time, British Smyth Report: Vol. 63, No. 6, Feb. 8, 1954, p. 69.
South African Mining and Engineering Journal, vol. 64, part II, No. 3185, Feb. 27, 1954, p. 921.

[95] Mining Journal (London), vol. 242, No. 6188, Mar. 26, 1954, p. 358; vol. 243, No. 6203, July 9, 1954, p. 37.
Iron and Coal Trades Review (London), vol. 169, No. 4501, July 16, 1954, p. 141.
Scientists Journal, vol. 4, No. 2, November 1954, p. 111.

[96] Rumbold, Richard, Radioactive Minerals in Cornwall and Devon: Min. Mag. (London), vol. 91, No. 1, July 1954, pp. 16–27.

[97] Ostle, D., Geochemical Prospecting for Uranium: Min. Mag. (London), vol. 91, No. 4, October 1954, pp. 201–208.

[98] Davidson, C. F., and Ponsford, D. R. A., On the Occurrence of Uranium in Coals: Min. Mag. (London), vol. 91, No. 5, November 1954, pp. 265–273.

[99] Atomic Scientists Journal, vol. 3, No. 6, July 1954, p. 348.

[1] Metal Industry (London), vol. 85, No. 24, Dec. 10, 1954, p. 497.

[2] Mining Journal (London), vol. 242, No. 6190, Apr. 9, 1954, p. 415.

[3] Mining Journal (London), vol. 242, No. 6192, Apr. 23, 1954, p. 469.

Discoveries of uranium mineralization were said to have been made near Chota-Udepur about 65 miles from Baroda [4] and near Harash and Siladipura villages in the Sikar district of Rajasthan. Drilling operations were expected to begin in the area.[5] The Indian Bureau of Mines prospected for uranium in the Singhbhum district of Bihar, where the Indian Atomic Energy Commission applied for a mining lease.[6]

The Government announced continuation of its program, established in 1952, of giving rewards of 1,000 rupees for discovery of uranium deposits containing at least 50 tons of ore, assaying not less than 0.4 percent U_3O_8. It also made public a new incentive for prospecting—the grant of 100 to 1,000 rupees for discovering lower-grade deposits of uranium. The amount of financial remuneration would depend upon the grade and extent of the occurrence among other factors.

A 2-day conference on development of atomic energy in India was held November 26–27, 1954, at the National Physical Laboratory, New Delhi. Senior officials of the Indian Atomic Energy Commission and 50 Indian experts in science, engineering, and industry attended. Dr. Homi J. Bhabha, chairman of the AEC, explained the overall plan of atomic energy development in that country. The introductory speech of Dr. Bhabha was followed by talks on the prospecting for and geology of uranium and other radioactive substances, the extraction and purification of uranium and thorium, the roles of chemistry and metallurgy in atomic energy, and the biological and medical aspects of radioactivity.

Published reports in Indian newspapers and journals during 1954 indicated that the Indian Atomic Energy Commission made good progress on the 4-Year Plan for the development of atomic energy in India drawn up by the commission and approved by the Government in 1953.

The 4-Year Plan called for (1) a survey of India for radioactive minerals, (2) construction of a plant for recovering uranium and thorium from residues produced at the Alwaye monazite treatment facility, (3) installation of a pilot plant for the extraction of uranium from Indian copper-tailings and low-grade uranium ores, (4) setting-up of a plant to process uranium to a "state of atomic purity," (5) construction of a nuclear reactor, (6) establishment of a medical and health division of the atomic energy group to look after the health of persons engaged in nuclear energy work, and (7) establishment of a biological division of fundamental studies utilizing techniques developed in the nuclear energy field.

Israel.—Exploration for uranium was conducted near Millenia, south of the Sea of Galilee, and in the Jordan Valley by scientists from the Werzmann Institute and an unnamed Haifa institution.[7]

The chairman of the Israeli Atomic Energy Commission announced that it had found an economical way of extracting uranium from uranium-bearing phosphate deposits in Israel, as well as a new method of making heavy water.[8]

[4] Metal Industry (London), vol. 85, No. 6, Aug. 6, 1954, p. 113.
[5] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 2, August 1954, p. 39.
[6] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 3, March 1954, p. 28.
[7] Chemical Age (London), vol. 56, No. 1710, Apr. 19, 1952, p. 590.
[8] Metal Bulletin (London), No. 3948, Nov. 30, 1954, p. 28.

Japan.—The Japanese Government's Board of Industrial Technology planned to send scientists to the United States and Europe in 1955 to study the progress in nuclear research. The Government was said to have decided to begin construction of an experimental power reactor within 5 years.[9]

A scientist at the Kyoto University was reported to have developed a process for extracting 85 percent of the uranium contained in poor host minerals, such as monazite and apatite.[10]

Philippines.—It was reported in 1954 that personnel from the United States AEC and the Philippine Bureau of Mines made a preliminary search for uranium in the Philippine Islands during 1953. The survey party mentioned having found "interesting mineral occurrences, possibly containing uraniferous materials." Areas examined of most interest as possible sources of uranium were: (1) Deposits of the Baguio mineral district; (2) Paracale-Mambulao stock, Masbate gold district; (3) Jetafe copper district; (4) Eastern Cordillera, Mindanao; (5) Pan Philippine mine at Lobo, Batangas; and (6) areas of acidic igneous intrusives. Areas examined of moderate interest included: (1) Deposits of the Looc lead-silver mine in Batangas; (2) Mineral Resources Mining Co. in Marinduque, (3) the Pauli prospect in Marinduque, and (4) areas of sedimentary rocks, particularly of marine origin. Areas examined of least interest included: (1) High-temperature replacement deposits, and (2) areas of ultrabasic rocks.[11]

In November 1954 press reports described a uranium discovery at the property of the Philippine Iron Mines, Inc., on Luzon, 110 miles southeast of Manila. Samples of the material were shipped to the United States for analyses. Tests indicated the samples contained a significant amount of uranium.[12]

Tibet.—It was reported that the Chinese Government, in cooperation with Russia, planned to develop occurrences of radioactive materials said to have been found in the Himalaya Mountains of Tibet. A nuclear research study center was believed to have been established at Gartok, western Tibet.[13]

Turkey.—Prospecting was said to have uncovered a high-grade uranium deposit in the Province of Siva, central Turkey.[14]

AFRICA

Belgian Congo.—Belgian Congo continued to be a major source of uranium ore. It was reported that in 1952 and 1953 the operations at the Union Minière du Haut Katanga's Shinkolobwe mine were maintained around the clock and employed 100 Europeans and 100 native personnel.[15]

With reference to the utilization of the Congo's uranium resources, the Belgian banking house, Société Génèrale de Belgique mentioned in its annual report issued early in 1954 that:

[9] Nucleonics, vol. 12, No. 12, December 1954, p. 72.
[10] Engineering and Mining Journal, vol. 155, No. 9, September 1954, p. 220.
[11] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 4, October 1954, p. 43.
[12] Metal Bulletin (London), No. 3948, Nov. 30, 1953, p. 28. Evening Star, Washington, D. C., No. 326, Nov. 22, 1954, p. A-20.
[13] Chemical and Engineering News, vol. 32, No. 41, Oct. 11, 1954, p. 4090.
[14] Engineering and Mining Journal, vol. 155, No. 11, November 1954, p. 186.
[15] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 2, February 1954, pp. 36-37.

The industrial use of atomic energy is actively pursued in Belgium and in the Congo. These areas owe it to themselves to make the most of the beneficial use of their fissionable materials and the competence of their technicians.[16]

The story of the first shipment of Congo uranium ore to the United States during World War II was published. More than 1,000 tons of rich pitchblende ore from the Shinkolobwe mine was exported to the United States with much secrecy in 1940. It was indicated that probably all of this material was refined for use in our early model atomic bombs.[17]

Madagascar.—Deposits of uranium-bearing thorianite were discovered and worked at Behara-Esire near Andranondambo, 80 kilometers northeast of Fort Dauphin. Assays indicated that the thorianite contained 13.8 percent uranium and 66.4 percent thorium.[18] The mineralization was said to cover an area 50 miles long by 12 miles wide. It was reported that the French Atomic Energy Commission, which controls all uranium production in Madagascar, paid $1.25 a pound for such ore at the Fort Dauphin purchasing depot. Other uranium deposits were exploited near Antsirabe.[19]

Mozambique.—Claims were granted two individuals for mining of radioactive minerals in the Tete district at Benga. The concessions granted were permanent and subject only to the provisions of the mining laws of Mozambique.[20]

With the financial assistance of the Entreposto Commercail de Mocambique, a gravity concentrating mill was being constructed at Tete for treating davidite ores. High-grade alluvial material had been mined previously. The radioactivity of the underlying dolomitic rock was less than 0.1 percent uranium. The economics of a gravity concentrator in treating the ore had to be proved.[21]

A preliminary geological survey of some uranium occurrences in Mozambique was completed by the Swedish firm, Bolidens Gruv AB.[22]

On February 13, 1954, the Government agreed to continue the 10-percent surtax levied on all exports of radioactive minerals. The tax had been extended annually at the same rate since 1951.[23]

Northern Rhodesia.—At the annual meeting of Rhokana Corp., Ltd., in Kitwe, December 15, 1954, it was announced that a satisfactory process was evolved for recovering uranium from a small ore body in the Mindola section of the Rhokana copper mine at Nkana. The Atomic Energy Authority of the United Kingdom agreed to buy the uranium concentrates at a price based on cost plus a reasonable profit.[24]

Rhokana Corp., Ltd., erected a pilot plant at Nkana to investigate the possibility of recovering uranium from the Mindola section. The unit was operated by an associated company, Rhoanglo Mine Services.[25]

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16 Mining Journal (London), The Belgian Congo: Vol. 242, No. 6184, Feb. 26, 1954, p. 232.
17 Gunther, John, Mystery Man of the A-Bomb: Readers Digest, December 1953, pp. 18–20.
18 Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 2, February 1954, p. 27.
19 Engineering and Mining Journal, vol. 155, No. 8, August 1954, pp. 166, 168; vol. 155, No. 9, September 1954, p. 203.
Nucleonics, vol. 12, No. 9, September 1954, p. 87; vol. 12, No. 12, December 1954, p. 73.
20 Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 1, January 1954, p. 25.
21 Mining Journal (London), vol. 242, No. 6179, Jan. 22, 1954, p. 101.
22 Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 3, March 1954, p. 21.
23 Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 3, March 1954, p. 21.
24 American Embassy, Salisbury, Southern Rhodesia, State Department Dispatch 103, Dec. 22, 1954.
Mining Journal (London), vol. 243, No. 6226, Dec. 17, 1954, p. 716.
25 Mining World, vol. 16, No. 3, March 1954, p. 73.
Chemical Age (London), vol. 70, No. 1799, Jan. 2, 1954. p. 26.

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New uranium occurrences were noted in the copper belt by airborne radiometric surveys.[26]

Southern Rhodesia.—Uranium mineralization, assaying 0.5 percent U_3O_8, was reported to have been found near the Southern Rhodesia-Transvaal border.[27]

The Southern Rhodesian Minister of Mines stated that all district mining officers were issued Geiger counters and encouraged to search for radioactive materials when on missions in their districts. He mentioned, however, that no significant discovery of uranium had been made as yet in that country.[28]

Uganda.—The Tororo Exploration Co., an enterprise said to be controlled by Monsanto Chemicals, Ltd., Frobisher, Ltd., and the Uganda Development Corp., announced the discovery in Lorona, Uganda, of about 200 million tons of material containing significant amounts of apatite and pyrochlore. Company officials said the deposit might result in a mining operation for recovering columbite, fertilizer bases, and possibly uranium.[29]

Union of South Africa.—A report was published in 1954 describing geological age determinations of uraninite in the Witwatersrand system, using the lead-isotope method. It was estimated that the source from which the uranium minerals of the Rand were derived was between 1,800 and 2,000 million years old.[30] It was deduced from the age determinations that the uranium minerals were much older than the Witwatersrand system, and that the uranium and gold could have been eroded from mountain ranges, which have since vanished, and washed into the sediments that eventually hardened, forming Witwatersrand beds.[31]

The potentialities of utilizing nuclear energy to produce power for the fabrication of high-purity materials at remote mine sites in Africa was reported.[32]

Another theory regarding the genesis of the Witwatersrand gold-uranium mineralization was published in 1954. The article suggested that a rich vegetation of uranium-concentrating organisms developed under anaerobic conditions in the marine-gravel deposits of a steep coastline, from which thucholite and pyrite were subsequently derived. The gold was believed to have been reduced from percolating thermal waters by the organic matter at a later date and deposited in the sediments.[33]

According to the American Embassy at Pretoria, Union of South Africa, 6 uranium plants were in operation, and 4 new plants were scheduled for completion by the end of 1954. The new plants were being constructed at President Steyn Gold Mines, Welkom Gold Mines, Luipaardsvlei Gold Mines, and Vogelstruisbult Gold Mines. Four additional plants were to be constructed in the future. Twenty-three mines in the Johannesburg area were authorized to supply

[26] Mining World, vol. 16, No. 11, October 1954, p. 78.
[27] Engineering and Mining Journal, vol. 155, No. 2, p. 194.
[28] Chemical Age (London), vol. 70, No. 1819, May 22, 1954, p. 1161.
[29] Engineering and Mining Journal, vol. 155, No. 2, February 1954, p. 194.
[30] Louw, J. D., Geological Age Determinations on Witwatersrand Uraninites Using the Lead-Isotope Method: South African Min. and Eng. Jour., part I, vol. 65, No. 3226, Dec. 11, 1954, pp. 621, 623, 625; part II, vol. 65, No. 3227, Dec. 17, 1954, pp. 677–680.
[31] Engineering and Mining Journal, vol. 155, No. 9, September 1954, p. 204.
[32] Bronowski, J., Nuclear Power—a Great Opportunity for Southern Africa: Opitma, vol. 4, No. 4, December 1954, pp. 9–18.
[33] Miholic, Stanko, Genesis of the Witwatersrand Gold-Uranium Deposits: Econ. Geol., vol. 49, No. 5, August 1954, pp. 537–540.

uranium to the extraction plants, and some 40 mining companies were granted permission to search for radioactive materials in the Union of South Africa.

The uranium-production industry of South Africa may earn more than $70 million annually when it begins operation at full capacity.[34] During the first 9 months of 1954 some $25.6 million worth of radioactive material including uranium concentrates was exported from South Africa.[35]

The process for recovering uranium from Witwatersrand sediments was described as being basically similar to that employed for recovering gold from the sediments. After the gold was extracted from the ground ore, the filter-cake residues were fed into the uranium plant. The material was repulped, leached with dilute sulfuric acid, and agitated several hours. The mixture was then filtered through rotary-drum filters, to which a filter aid of animal glue was added to improve the rate of filtration. The filtrate was clarified in sand filters and passed to the purification and precipitation section of the plant. The solid residues from the filter system were mixed with water and run off into slime ponds. The final product from the classified precipitation section, a uranium precipitate, was dried, calcined, sampled, and packaged for export.[36]

Official Government reports mentioned the occurrence of radioactive minerals in copper-bearing formations, but no indication was given of their economic potentialities.[37]

OCEANIA

Australia.—A 10,000-kilowatt nuclear reactor was to be constructed near Sydney for atomic power studies. The project was the result of a cooperative agreement between the Governments of Australia and United Kingdom. Australia would spend over $12 million on the project. It was stated that in Australia power from nuclear sources would probably be economic within the next 10 years, because some important economic centers were at a distance from fuel sources.[38] The use of atomic energy to produce power in Australia was discussed during a 2-day symposium at the New South Wales University of Technology at Sydney.[39]

The Australian Atomic Energy Commission selected Sydney as the site for special nuclear research laboratories authorized by the Government.[40]

The first annual report of the Australian Atomic Energy Commission was released in 1954; it described the establishment of the Commission, uranium production and nuclear research and surveyed future plans. The report reviewed the operations of the group from April 17, 1953 to June 30, 1953.

Prospecting for uranium in Australia became an increasingly popular pastime as well as business venture in 1954. The more

[34] Mining Record, vol. 65, No. 40, Oct. 7, 1954, p. 5.
[35] Chemical and Engineering News, vol. 32, No. 51, Dec. 20, 1954, p. 5053.
[36] McLean, C. S., The Uranium Industry of South Africa: Min. and Ind. Mag. Southern Africa, vol. 44, No. 6, June 1954, pp. 203, 205, 207–211, 213.
[37] Chemical Age, vol. 70, No. 1807, Feb. 27, 1954, p. 517.
[38] Engineering and Mining Journal, vol. 155, No. 12, December 1954, p. 160.
Nucleonics, vol. 12, No. 12, December 1954, p. 72.
[39] Mining Journal (London), vol. 243, No. 6218, Oct. 22, 1954, pp. 448, 449.
[40] Chemical Engineering and Mining Review (Melbourne), vol. 47, No. 2, Nov. 10, 1954, p. 56.
Nucleonics, vol. 12, No. 8, August 1954, p. 58.

important regions of uranium mineralization apparently occurred in Queensland and the Northern Territory, where private enterprise was encouraged by local governments. South Australia offered little incentive to the prospector, because of strict regulations; and few promising discoveries were made in Western Australia and New South Wales.[41]

Australian laws allowed that profits from uranium-mining operations were exempt from taxation, providing that at least 75 percent of the company voting power was held by Australian residents. Foreign uranium exploration and mining companies therefore found it necessary to register local groups to compete with Australian firms. Rio Tinto Co., Ltd., a British company, was the first foreign organization to initiate a uranium exploration program in Australia. Two or more United States firms also expressed an interest in prospecting in Australia.[42]

The Australian Minister for Supply announced in July 1954 that companies and individuals engaged in uranium mining could now publish information about ore reserves, grades of ore, and rates of output relative to their own operations. It was indicated that restrictions might have to be applied in special instances.[43]

The Bureau of Mineral Resources of Australia planned airborne scintillometer surveys for uranium in the Northern Territory and all States except South Australia.[44]

The development of uranium mining in Australia was summarized during 1954.[45]

In the Northern Territory on September 17, 1954, the Rum Jungle uranium-ore-treatment plant was formally opened. The agreement of January 1953 for developing the Rum Jungle uranium deposits resulted from negotiations between the Government of the Australian Commonwealth and the Combined Development Agency, a joint group representing the Governments of the United States and the United Kingdom. Under the agreement the Agency pledged to advance capital and provide technical assistance, and Australia agreed to sell to the Agency uranium produced at the Rum Jungle mines. Consolidated Zinc Pty., Ltd., created a wholly owned subsidiary, Territory Enterprises Pty., Ltd., to assist the Government in developing the Rum Jungle deposits. The company began operations in January 1953, and the first truckload of ore entered the extraction plant in September 1954. Territory Enterprises did not receive any financial remuneration other than a management fee. Three deposits were worked for uranium at Rum Jungle: (1) White's mine, (2) Dyson's mine, and (3) the Mount Fitch prospect. White's mine was an underground operation, the main shaft was down 500 feet. The soft, wet nature of the ground made underground mining dangerous and expensive, however, and it was planned to change to surface mining. Dyson's mine was developed by open-cut methods initially. The ore was soft, and bulldozers carved out the material and pushed it into waiting trucks. Ore was stockpiled at the mines

[41] Mining Journal (London), Increased Uranium Prospecting Activities in Australia: Vol. 243, No. 6214, Sept. 24, 1954, p. 344.
[42] Mining World, vol. 16, No. 10, September 1954, p. 87.
[43] Chemical Engineering and Mining Review (Melbourne), vol. 46, No. 11, Aug. 10, 1954, p. 436.
[44] Chemical Engineering and Mining Review (Melbourne), vol. 47, No. 2, Nov. 10, 1954, p. 60.
[45] Swan, P., The Development of Uranium Mining in Australia: Atomic Sci. Jour., vol. 3, No. 6, July 1954, pp. 341–345.

while the extraction plant was being constructed. Uranium ore was also purchased from other mines in the Northern Territory for treatment at the Rum Jungle uranium-recovery unit. The plant was designed to require few operators and only 35 men were employed in its continuous operation. Ore was crushed in primary crushers, from which it was transported by conveyor belt over a screen. Undersize ore was transported by conveyor belt to five ore bins and oversize ore to the Simonds cone crusher for further sizing. The fine ore was wet-ground in ball mills, and the slimes from the operation were transferred to the Dorr thickener, from which they were passed to the Pachuca tanks. In these large, rubber-lined tanks the uranium in the ore was dissolved with sulfuric acid. Oliver filters separated the uranium-bearing solution from the pulp,[46] and uranium was recovered from the solution by ion exchange.[47]

The main group of Rum Jungle deposits graded from copper-rich uranium-poor to uranium-rich copper-poor. White's deposit contained torbernite associated with azurite, malachite, cerussite, iron oxides, pseudo-malachite, and dehydrite. At depth uraninite, chalcopyrite, bornite, and pyrite were found in carbonaceous slates. At Dyson's prospect mineralization consisted of limonite-stained autunite and uranium ochers occurring in pyritized carbonaceous slates interbedded with quartzites.[48]

At Brock's Creek, Northern Territory, Brock's Creek Uranium N. L. was the first private organization to ship uranium ore to the Rum Jungle plant. The company sank a vertical shaft 90 feet. The mineralization was torbernite.[49]

It was announced in January 1954 that low-grade mechanical concentrates were recovered in a pilot plant at Radium Hill, South Australia. This was the first production of uranium concentrates in Australia.[50]

The Radium Hill uranium mine and full-scale metallurgical treatment plant were officially opened November 10, 1954. The deposits were explored originally by diamond drilling and later by a series of inclined prospecting shafts, from which horizontal and inclined openings were made to determine the lateral and downward extensions of the ore body. The main shaft of the mine was sunk 750 feet, and a system of levels and stopes was developed similar to procedures followed in conventional hard-rock mining. Hoisting equipment was provided for an ultimate shaft depth of 2,000 feet, the deepest known ore at the time being at 1,500 feet. Ore was composed of a coarse aggregate of heavy, black minerals, including davidite, ilmenite, rutile, magnetite, hematite, pyrite, and chalcopyrite intergrown in quartz and biotite. The uranium is present in the mineral davidite, an unusual iron-titanium-rich mineral, containing up to 9 percent

[46] Chemical Engineering and Mining Review, Rum Jungle Uranium Project Opened: Vol. 47, No. 1, Oct. 11, 1954, pp. 3-6.
Mining Journal, The Rum Jungle Uranium Project, Australia: Vol. 243, No. 6219, Oct. 29, 1954, pp. 488-490.
[47] Mining World, vol. 16, No. 12, November 1954, p. 58.
[48] Ward, H. J., The Search for Australia's Uranium: Min. Eng., vol. 6, No. 12, December 1954, pp. 1160-1173.
Fisher, N. H., and Sullivan, C. J., Uranium Exploration by the Bureau of Mineral Resources, Geology, and Geophysics, in the Rum Jungle Province, Northern Territory, Australia: Vol. 49, No. 8, December 1954, pp. 826-836.
[49] Mining World, vol. 16, No. 10, September 1954, p. 92.
[50] South African Mining and Engineering Journal, vol. 65, part I, No. 3188, Mar. 20, 1954, p. 111.
Engineering and Mining Journal, vol. 155, No. 1, January 1954, p. 114.
Chemical Age (London), vol. 70, No. 1803, Jan. 30, 1954, p. 314.

uranium oxide, approximately 50 percent titanium oxide, 30 percent iron oxide, up to 8 percent rare earths, and minor chromium and vanadium. The ore mined was to be concentrated nearby. Chemical extraction of the uranium oxides from the concentrate would take place in a separate installation, which was being constructed at Port Pirie, some 200 miles away. The concentration process involved heavy-medium separation and flotation principles, eliminating a high percentage of waste and allowing relatively small bulk for shipment to the Port Pirie chemical treatment plant. Techniques employed in the ore-dressing operation were similar to those used in base-metal concentration plants except that units were arranged and special reagents utilized to suit the unusual characteristics of the ore.[51]

The geology of the Radium Hill mining field was discussed in a paper published in 1954,[52] and the results of an airborne radiometric survey of the region were released.[53]

In the Coronation Hill, Lewin Springs, Ferguson River, A. B. C., Arnhem Land, and Edith River areas south of Rum Jungle, Northern Territory, ground and aerial surveys indicated the presence of radioactive anomalies. Some of the companies that explored claims in the region during 1954 included: Northern Mines Development N. L.; Consolidated Zinc Pty., Ltd.; Uranium Development & Prospecting N. L.; Northern Uranium Development N. L.; North Australian Uranium Corp. N. L.; Uranium Corporation of Australia Pty., Ltd.; Uranium Oxide N. L.[54]

On April 1, 1954, the Australian Government lifted its control over and opened for prospecting areas at Katherine and Coronation Hill, known to contain favorable uranium mineralization.[55] The Commonwealth's Bureau of Mineral Resources stated that about 900 possible deposits of uranium awaited investigation by prospectors in a 1,400-square-mile area of Northern Territory. Airborne scintillometer surveys had detected considerable radioactivity in these areas.[56]

The Mount Isa-Cloncurry area of Queensland was the scene of much intensive exploration for uranium. The first discovery of radioactivity was made in March 1954. Since that date, exploration has indicated that the mineralization extends over an area approximately 100 by 140 miles between Mount Isa and Cloncurry. The localities where uranium occurrences had been found were listed as (1) Paroo Creek, north of Mount Isa; (2) Spear Creek, northwest of Mount Isa; (3) Gorge Creek, 15 miles northeast of Mount Isa; (4) Carlton Hills, 40 to 50 miles north of Mount Isa; (5) Argylla area; (6) Monafoff; (7) Ballara, including the significant Mary Kathleen lease; (8) Mount Cobalt; and (9) Kuridala. Primary ore (pitchblende) occurred near the surface, and some davidite was found. Secondary uranium minerals were identified as uranophane and gummite. Little copper was associated with the uranium, which was considered unusual, inasmuch as economic copper deposits occurred between Mount

[51] South Australian Department of Mines, Radium Hill, South Australia; Official Opening, Souvenir: Nov. 10, 1954, 18 pp.
Mining Journal (London), vol. 243, No. 6227, Dec. 24, 1954, p. 735.
[52] Parkin, L. W., Gleason, K. R., The Geology of the Radium Hill Uranium Mine, South Australia: Econ. Geol., vol. 49, No. 8, December 1954, pp. 815–825.
[53] Gross, W. H., Airborne Scintillometer Survey of Radium Hill Area, South Australia: Canadian Min. and Met. Bull., vol. 47, No. 505, May 1954, pp. 348–350.
[54] Mining World, vol. 16, No. 13, December 1954, p. 39.
Australian Financial Review, Search Intensified in Wider Field for Uranium Ores: May 27, 1954, pp. 1, 4.
[55] Chemical Age (London), vol. 70, No. 1814, Apr. 17, 1954, p. 897.
[56] Engineering and Mining Journal, vol. 155, No. 1, January 1954, p. 162.

Isa and Cloncurry.[57] Two of the most important uranium occurrences discovered in 1954 were the Anderson's lode (Gorge Creek area) and the Mary Kathleen deposit (Ballara area), both of which were held by Australiasian Oil Exploration, Ltd. The Anderson lode was 130 by 80 feet in area and at least 180 feet deep. The reported grade of ore was 0.75 percent uranium oxide. The Mary Kathleen deposit was 400 by 300 feet in area. The depth of the mineralization was not determined in 1954, but the occurrence was to be diamond-drilled. The material assayed 0.63 percent uranium oxide.[58]

It was reported that Mount Isa Mines, Ltd., made an offer to the Australian Atomic Energy Commission to construct and operate a uranium-recovery plant at Mount Isa. Private industry considered the uranium reserves of the district large enough to warrant construction of a second uranium concentrator near Cloncurry.[59]

Other companies that conducted uranium exploration programs in Queensland were: Mount Isa Mines, Ltd., Uranium Holdings, Australiasian Oil Exploration, Ltd., Uranium Corp. of Australia, United Uranium, Gold Mines of Australia, and Cloncurry Uranium.[60]

At the Myponga uranium discovery in South Australia the Government determined that pitchblende was present. The occurrence was explored by diamond drilling.[61] About 40 miles from Adelaide near Myponga massive resinous pitchblende assaying 70 percent U_3O_8 was found on the surface. The South Australian Government paid an initial reward to the discoverers and reserved the mineral rights over a large area.[62]

In Western Australia uranium mineralization was located at Lake Dundas about 150 miles south of Kalgoorlie. Another occurrence was reported near Norseman. Norseman Gold Mines N. L. and Uranium Mines N. L. were making a cooperative investigation of the claims.[63]

The first occurrence of uranium mineralization in Victoria was reported in 1954. The uranium was associated with a granite outcrop on Mount Kooyoona near Inglewood, about 35 miles northwest of Bendigo. The strike adjoined the old Rheola and Kingower goldfields. Other potential radioactive areas were in the Kingower and Moliagul districts, Victoria.[64]

Torrington Uranium Mines N. L. conducted exploration on its leases northeast of Torrington, New South Wales, and Hopetown Mines N. L. began prospecting on leases nearby.[65]

In August 1954 the Department of Mines, South Australia, made available to the public a guide on prospecting for uranium in South

57 Chemical Engineering and Mining Review, Uranium Discoveries in Cloncurry Field, Queensland: Vol. 47, No. 2, Nov. 10, 1954, pp. 57–59.
58 Mining Journal (London), vol. 243, No. 6219, Oct. 29, 1954, p. 484.
59 Mining Journal (London), vol. 243, No. 6221, Nov. 12, 1954, p. 545.
60 Work cited in footnote 55.
61 Chemical Engineering and Mining Review (Melbourne), vol. 47, No. 1, Oct. 11, 1954, p. 31.
62 Mining World, vol. 16, No. 3, March 1954, p. 76.
Chemical Engineering and Mining Review (Melbourne), vol. 46, No. 4, Jan. 11, 1954, p. 163.
63 Industrial and Mining Standard (Melbourne), vol. 109, No. 2757, Jan. 21, 1954, p. 19.
Mining Journal (London), vol. 242, No. 6178, Jan. 15, 1954, p. 67.
Mining World, vol. 16, No. 3, March 1954, p. 67.
Chemical Engineering and Mining Review (Melbourne), vol. 46, No. 4, Jan. 11, 1954, p. 163.
Nucleonics, vol. 12, No. 2, February 1954, p. 75.
Chemistry and Industry (London), No. 1, Jan. 2, 1954, p. 27.
64 Industrial and Mining Standard (Melbourne), vol. 109, No. 2764, May 6, 1954, p. 19.
Engineering and Mining Journal, vol. 155, No. 6, June 1954, p. 161.
65 Chemical Engineering and Mining Review (Melbourne), vol. 46, No. 12, Sept. 10, 1954, p. 509; vol. 47, No. 1, Oct. 11, 1954, p. 30.

Australia. The 51-page booklet provided information about mining legislation in relation to uranium prospecting, rewards for the discovery of uranium, radiation detection instruments, where to look for uranium minerals, types of uranium minerals known to occur in South Australia, the Government's testing of samples from prospectors, purchase of uranium ore, and other pertinent data. The booklet was entitled "Handbook on Uranium Prospecting in South Australia."

An article on the methods of recovering uranium from South Australian ores was published.[66]

New Zealand.—Because of the potentialities of heavy water as a coolant and moderator in certain types of nuclear reactors the United Kingdom and the New Zealand Governments agreed to proceed with a project for the production of heavy water and power from geothermal steam in the Wairakei division of New Zealand.[67]

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[66] Mining Magazine (London), vol. 91, No. 2, August 1954, pp. 123–125.
Carr, John S., Uranium Minerals and Their Treatment: Chemical Eng. and Min. Rev. (Melbourne), vol. 46, No. 8, May 10, 1954, pp. 309–313.
[67] Atomics and Atomic Technology, vol. 5, No. 9, September 1954, p. 242.

Vanadium

By Hubert W. Davis [1]

PRODUCTION of vanadium (in ore and concentrate) in the United States increased for the sixth consecutive year to establish a new high of 9,860,000 pounds in 1954, a 6-percent gain over 1953. As a result of greatly increased uranium-ore output on the Colorado Plateau, the production of byproduct vanadium has exceeded industry requirements; and much of the surplus, after conversion to vanadium oxide, has been placed in the National Strategic Stockpile. Consequently, a growing problem of the vanadium industry is the large surplus production and the need to expand uses of the metal. At present no major applications involve vanadium alloys where vanadium is the primary constituent. Production of low-cost, high-purity vanadium for industrial applications might result in a substantial new outlet for the metal. The present high price of vanadium limits its use when other alloying elements, such as chromium, molybdenum, and nickel, are available at lower cost.

Production of vanadium oxide in the United States was 26 percent greater than in 1953, but output of ferrovanadium was 47 percent less.

Imports of vanadium concentrate declined 45 percent from 1953 and were the smallest since 1936. For the first time since 1949 there were no imports of ferrovanadium. Exports of ferrovanadium and other vanadium alloying materials were 10 percent less than in 1953, but those of vanadium pentoxide, vanadic acid, vanadium oxide, and vanadates were 3½ times greater.

Consumption of vanadium in the manufacture of steel declined 47 percent from 1953.

Quotations on vanadium ore, vanadium oxide, and ferrovanadium were unchanged throughout 1954.

Publication of figures on production and consumption of vanadium ore in the United States, which was suspended for security reasons in 1948, was resumed in 1954.

TABLE 1.—Salient statistics of the vanadium industry in the United States, 1945–49 (average) and 1950–54, in pounds of contained vanadium

	1945–49 (average)	1950	1951	1952	1953	1954
Mine shipments of ore and concentrate [1]	2,267,322	4,596,134	6,175,371	7,200,013	9,285,898	9,860,028
Imports:						
Ore or concentrate	985,683	1,457,010	982,878	1,043,797	716,977	395,287
Vanadium-bearing flue dust	23,809	804	----------	939	1,010	----------
Exports of ore, concentrate, and vanadium oxide	30,790	963	2,817	120,367	[2] 12,319	[2] 42,935
Consumption (ore and concentrate)	[3] 3,033,714	6,760,657	7,036,317	6,557,691	8,300,988	10,148,118

[1] Measured by receipts at mills.
[2] Comprises vanadium pentoxide, vanadic oxide, vanadium oxide, and vanadates.
[3] 1947–49 average.

[1] Commodity-industry analyst.

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. In 1954, for the first time, small outputs were made in South Dakota and Wyoming. Vanadium production in these six States was a byproduct or coproduct of uranium. Vanadium was also recovered as a byproduct of phosphate rock mined in Idaho in 1954.

Production of vanadium ore and concentrate established a new high in 1954 and was 6 percent more than in 1953. Total output of vanadium in ore and concentrate in the United States from 1910—the year of first commercial production—through 1954 was 88,633,000 pounds.

Colorado maintained its position as the largest vanadium-ore-producing State. Production established a new high in 1954 and was 7 percent more than in 1953. Ore-processing mills were operated in 1954 by Climax Uranium Corp. at Grand Junction, United States Vanadium Co. at Rifle and Uravan, and Vanadium Corp. of America at Durango and Naturita. Additional milling capacity was installed at Durango and Naturita, with resulting increased production at each plant.

Production of vanadium in ore and concentrate in Utah was 2 percent more than in 1953. Ore-processing mills were operated in 1954 by the Galigher Co. at Monticello and Vitro Uranium Co. at Salt Lake City.

More detailed information on domestic production is contained in Minerals Yearbook, volume III.

Table 2 shows production of vanadium ore and concentrate by States and group of States for 1948–54 and table 3 by years for 1945–54.

TABLE 2.—Vanadium in ore and concentrate produced in the United States, 1948–54, by States, in pounds of contained vanadium

State	1948	1949	1950	1951	1952	1953	1954
Colorado	1,508,466	2,794,288	3,819,335	5,407,161	6,751,926	7,993,922	8,516,174
Utah	99,893	219,903	439,463	551,949	277,367	1,058,345	1,077,806
Arizona, Idaho, and other States [1]	180,192	179,845	337,336	216,261	170,720	233,631	266,048
	1,788,551	3,194,036	4,596,134	6,175,371	7,200,013	9,285,898	9,860,028

[1] Includes New Mexico, 1948 and 1950–54; and South Dakota and Wyoming, 1954.

TABLE 3.—Vanadium in ore and concentrate produced in the United States, 1945–54 [1]

Year	Vanadium, pounds	Year	Vanadium, pounds
1945	2,963,913	1950	4,596,134
1946	1,272,148	1951	6,175,371
1947	2,117,962	1952	7,200,013
1948	1,788,551	1953	9,285,898
1949	3,194,036	1954	9,860,028

[1] Measured by receipts at mills.

OXIDE

The first objective in processing domestic vanadium ore and concentrate to a marketable form is conversion of the vanadium to pentoxide, which contains 85 to 92 percent V_2O_5. Vanadium oxide is consumed largely as a raw material in manufacturing ferrovanadium, which contains 35 to 55 percent vanadium. Production of vanadium oxide in the United States established a new record in 1954 and was 26 percent greater than in 1953. Vanadium oxide was produced at 9 plants in 1954 and 10 in 1953. The figures in table 4 include the vanadium oxide produced from Peruvian concentrates and that recovered as a byproduct of domestic phosphate rock and as a byproduct of foreign chrome ores.

TABLE 4.—Production of vanadium oxide in the United States, 1946–54, 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			

TABLE 5.—Producers of vanadium oxide in the United States in 1954

Producer:	*Location of plant*
Anaconda Copper Mining Co	Anaconda, Mont.
Climax Uranium Corp	Grand Junction, Colo.
Columbia-Southern Chemical Corp	Jersey City, N. J.
Galigher Co	Monticello, Utah.
Imperial Paper & Color Corp	Glens Falls, N. Y.
United States Vanadium Co	Rifle and Uravan, Colo.
Vanadium Corp. of America	Durango and Naturita, Colo.

FERROVANADIUM

In 1953 and 1954 ferrovanadium was produced in the United States by two companies—United States Vanadium Co. and Vanadium Corp. of America. The Bureau of Mines is not at liberty to publish the output figures of these companies; however, production was 47 percent smaller in 1954 than in 1953.

CONSUMPTION

Consumption of vanadium ore and concentrate in making vanadium oxide established a new record in 1954; it was 10,148,000 pounds (vanadium content), a 22-percent increase over 1953.

Complete information on the consumption of vanadium products is not available. The American Iron and Steel Institute has published figures showing the consumption of vanadium as an alloying metal in manufacturing steel.

TABLE 6.—Vanadium consumed in the manufacture of steel, 1950–54

[American Iron and Steel Institute]

Year:	*Contained vanadium in pounds*[1]
1950	1, 825, 831
1951	3, 310, 898
1952	3, 050, 586
1953	3, 227, 900
1954	1, 702, 354

[1] Excludes vanadium contained in scrap.

TABLE 7.—Ferrovanadium consumed in the manufacture of steel, 1951–54

[American Iron and Steel Institute]

Year:	Gross weight (in short tons)
1951	2, 353
1952	1, 965
1953	2, 009
1954	1, 349

USES

About 90 percent of the vanadium used is consumed as ferrovanadium in manufacturing tool steels, engineering steels, high-strength structural steels, nonaging rimming steels, and special wear-resistant cast irons. Ferrovanadium is also used in welding-electrode coatings, as a deoxidizer, and in permanent-magnet alloys. Vanadium oxide is also employed for adding vanadium to steels under certain special conditions. Vanadium oxide and ammonium metavanadate are utilized as catalysts, in glass and ceramic glazes, for driers in paints and inks, and for laboratory research. The use of metallic vanadium is limited largely to alloying with gold in dental alloys, with copper and bronzes (such as for aircraft propeller bushings), and with aluminum for airframe construction.

Vanadium is mainly used in steel for its grain-refining and alloying effects, but a very small amount is required. In high-speed steels the vanadium content ranges from approximately 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. 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. The replacement of molybdenum by vanadium for high-tensile steels was discussed in two articles.[2] They report the work of the British Welding Research Association on 12 types of low-carbon steel tested for tensile properties. Substituting vanadium for molybdenum doubled proof stress and improved ductility. The use of vanadium in steel for high-temperature service was reviewed in a booklet.[3]

A high-temperature steel, which contains neither cobalt nor columbium but instead employs titanium and small, controlled quantities of vanadium, has been developed. Alloy addition of 0.10 to 0.15 percent vanadium increases the strength of cast iron 10 to 25 percent and adds a considerable degree of toughness.

[2] Metal Progress, Replacement of Mo by V for High-Tensile Steels: Vol. 66, No. 3, September 1954, pp. 200, 202.
South African Mining and Engineering Journal, Vanadium-Bearing, High-Tensile, Weldable Steels: Vol. 64, pt. 2, No. 3182, Feb. 6, 1954, pp. 821, 823, 825.

[3] Cosman, C. M., Chromium-Molybdenum-Vanadium Steel for High-Temperature Service: Vancoram Rev. (published by Vanadium Corp. of America), vol. 9, No. 2, pp. 7–11, 16, fall, 1954.

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—matters important to the refiners, inasmuch as impurities vitally affect recoveries. Throughout 1954 vanadium pentoxide (technical grade) was quoted at $1.28 to $1.33 per pound of V_2O_5 and ferrovanadium at $3 to $3.20 per pound of contained vanadium (depending upon the grade of the alloy).

FOREIGN TRADE[4]

Imports of vanadium concentrate (all from Peru) in 1954 were 45 percent less than in 1953 and the smallest since 1936. Imports of vanadic acid, anhydride, salts and compounds, and mixtures of vanadium (all from France) were 29 percent more than in 1953.

Vanadium ore and concentrate enter the United States duty free; however, the rate of duty on ferrovanadium is 12½ percent ad valorem and on vanadic oxide, anhydride, salts and compounds, and mixtures of vanadium 40 percent ad valorem.

TABLE 8.—Vanadium ore or concentrate, vanadium-bearing flue dust, and ferrovanadium imported for consumption in the United States, 1945–49 (average) and 1950–54 [1]

[U. S. Department of Commerce]

Year	Vanadium ore or concentrate			Vanadium-bearing flue dust			Ferrovanadium	
	Gross weight, in pounds	Vanadium content, in pounds	Value	Gross weight, in pounds	Vanadium content, in pounds	Value	Gross weight, in pounds	Value
1945–49 (average)	4,179,743	985,683	$474,003	74,934	23,809	$9,668		
1950	5,110,403	1,457,010	708,806	9,575	804	2,475	130,022	$91,193
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					

[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.

Exports of vanadium pentoxide, vanadic oxide, vanadium oxide, and vanadates were 3½ times greater than in 1953, but those of ferrovanadium and other vanadium alloying materials, and vanadium flue dust and other waste materials were smaller by 10 and 56 percent, respectively.

[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 9.—Exports of vanadium from the United States, 1945–49 (average) and 1950–54, by classes

[U. S. Department of Commerce]

Year	Ore and concentrate[1]		Ferrovanadium		Vanadium metal, alloys, and scrap		Vanadium flue dust and other waste materials	
	Vanadium content, in pounds	Value	Gross weight, in pounds	Value	Gross weight, in pounds	Value	Vanadium content, in pounds	Value
1945–49 (average)	30,790	$75,067	179,210	$283,035	6,165	$6,238	(2)	(2)
1950	963	2,615	82,449	183,307	4,106	2,688	(2)	(2)
1951	2,817	6,581	122,344	190,346	1,712	6,481	(2)	(2)
1952	120,367	280,216	293,162	529,360	103,036	12,862	(2)	(2)
1953	[3] 12,319	[3] 32,141	[4] 156,952	[4] 296,157	(5)	(5)	54,211	$31,285
1954	[3] 42,935	[3] 120,311	[4] 140,510	[4] 237,333	(5)	(5)	23,953	13,609

[1] Figures for 1945–52 probably also included fused vanadium oxide.
[2] Not separately classified prior to Jan. 1, 1953.
[3] Comprises vanadium pentoxide, vanadic oxide, vanadium oxide, and vanadates.
[4] Comprises ferrovanadium and other vanadium alloying materials containing over 6 percent vanadium.
[5] Beginning Jan. 1, 1953, not separately classified.

TABLE 10.—Exports of vanadium from the United States, 1953–54, by countries, in pounds

[U. S. Department of Commerce]

Country	Vanadium pentoxide, vanadic oxide, vanadium oxide, and vanadates (vanadium content)		Ferrovanadium and other vanadium alloying materials containing over 6 percent vanadium (gross weight)		Vanadium flue dust and other waste materials (vanadium content)	
	1953	1954	1953	1954	1953	1954
North America:						
Canada	(1)	1,120	65,333	116,335		
Canal Zone			50			
Mexico			1,000	17,000		
Total	(1)	1,120	66,383	133,335		
South America:						
Brazil	34	11,318		3,128		
Chile				742		
Colombia		2,660				
Total	34	13,978		3,870		
Europe:						
Belgium-Luxembourg		2,256	4,840			
France	945	4			451	9,036
Germany, West	333					14,917
Italy	10,934					
Netherlands	73	560			53,760	
Spain			26,605			
Total	12,285	2,820	31,445		54,211	23,953
Asia:						
Japan		25,017	59,124	3,305		
Grand total	12,319	42,935	156,952	140,510	54,211	23,953

[1] Less than 1 pound.

TECHNOLOGY

Under sponsorship of the United States Army Air Force, Armour Research Foundation continued research to explore the feasibility of vanadium as a base metal in alloys for aircraft and guided missiles. The research done by Armour during the past 2½ years has been reviewed by Steel.[5] The alloys were evaluated on the basis of room temperature, ductility and strength, forgeability, elevated-temperature characteristics, and creep resistance.

Two methods for reducing vanadium tetrachloride to pure vanadium were described.[6] Concerning these methods, News Science Abstracts [7] reports as follows:

> Two methods are given for the reduction of VCl_4. The chloride was obtained by the chlorination of ferrovanadium at 665 to 670° and purified by distillation at 170° in an argon atmosphere. The VCl_4 was then free from oxychloride, Fe, and V oxides. H_2 was used as the reducing agent and as the carrier gas. The reduction temperature was 620°. In the second method the reduction with H_2 was done in an argon atmosphere. By the first method V powder was obtained 99.0 to 99.1 percent pure, and by the second method, 99.95 percent pure.

Patents were issued for recovering vanadium from Mayari (Cuba) laterite ore [8] and a method of extracting vanadium oxide from aqueous solutions.[9]

WORLD REVIEW

World production of vanadium ore is limited almost entirely to Northern Rhodesia, Peru, South-West Africa, and the United States.

Vanadium has also been recovered commercially from phosphate rock, iron ore, chrome ore, magnetite beach sands, caustic soda solution employed in the Bayer process of refining bauxite, naphtha soot collected from the smokestacks of ships and industrial plants, and vanadiferous ashes derived from asphaltites.

Because complete information on the quantity of vanadium recovered as byproducts of iron ore and other raw materials is lacking, it is impossible to determine world production of vanadium from all sources. Consequently, table 11 reflects only the production of vanadium in ore and concentrate for the countries listed, plus the quantity recovered in the United States as a byproduct of phosphate rock.

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[5] Steel, The Place for Vanadium: Vol. 135, No. 2, July 12, 1954, pp. 128–130.

[6] Jantsch, G., and Zemek, F., On the Separation of Chemically Pure Vanadium from the Gas Phase: Monatsh. Chem., vol. 84, Dec. 15, 1953, pp. 1119–1126. (In German).

[7] News Science Abstracts, vol. 8, No. 15, Aug. 15, 1954, p. 540.

[8] Hixson, A. N., and Horst, R. J. (assigned to Bethlehem Steel Co.), Process for Treating Chromium- and Vanadium-Bearing Material: U. S. Patent 2,697,650, Dec. 21, 1954.

[9] Halpern, Jack, and Forward, F. A. (assigned to National Research Council, Ottawa, Canada), Precipitation of Vanadium Oxides: U. S. Patent 2,665,970, Jan. 12, 1954.

TABLE 11.—World production of vanadium in ore and concentrate, 1945–54, in short tons

(Compiled by Pearl J. Thompson)

Country	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
North America: United States (shipments)[1]	1,482	636	1,059	894	1,597	2,298	3,088	3,600	4,643	4,930
South America:										
Argentina	3	7	8	[2] 8	[2] 8	[2] 8	[2] 8	[2] 8	[2] 8	[2] 8
Peru	758	355	480	563	503	481	495	482	349	195
Total	761	362	488	571	511	489	503	490	357	203
Africa:										
Rhodesia and Nyasaland, Federation of:										
Northern Rhodesia	241	75	62	191	169	-------	96	47	-------	-------
South-West Africa	463	474	311	206	180	325	583	688	596	633
Total	704	549	373	397	349	325	679	735	596	633
World total (estimate)[3]	2,947	1,547	1,920	1,862	2,457	3,112	4,270	4,825	5,596	5,766

[1] Includes vanadium recovered as a byproduct of phosphate-rock mining.
[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; total also excludes quantities of vanadium recovered as byproducts from other ores and raw materials.

SOUTH AMERICA

Argentina.—Vanadium occurs in widely scattered small deposits in the Provinces of Córdoba, Mendoza, and San Luis. A small quantity of ore is mined to produce 3 to 8 short tons of vanadium pentoxide annually.

Peru.—The famous Mina Ragra mine of the Vanadium Corp. of America in the Andes near Ricran, Department of Junin, has been an important source of vanadium since 1907, when production began. Output was 195 short tons (vanadium content) in 1954, a 44-percent decrease from 1953 and the smallest since 1936. According to the company, operations in Peru were partly curtailed, with Government approval, without diminishing development of the ore reserves.

EUROPE

Finland.—The following information was extracted from reports furnished by the American Embassy in Finland.

The Otanmäki titaniferous iron-ore mine in central Finland, where commercial production began in 1953, reached full-scale operation in July 1954. The ore contains about 35 percent iron, 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 that contains about 0.6 percent V and an ilmenite concentrate that contains about 0.25 percent V. The State-owned Otanmäki Oy, which operates the mine, was allocated funds to build a plant for extracting vanadium from the magnetite concentrate. The company estimated that it can obtain about 500 tons of vanadium pentoxide containing about 93 percent V_2O_5 during the first stage of operation, and by 1958 production can be increased to about 1,500 tons annually.

Germany, West.—Vanadium was recovered in West Germany from slags and bauxite residue in 1954. At the plant of Gesellshaft für Elektrometallurgie at Furth, near Nürnberg, vanadium was recovered from blast-furnace and Thomas-furnace slags containing 3 to 5 percent vanadium. The slags were roasted with salt (NaCl) and sodium carbonate (Na_2CO_3) to produce a water-soluble vanadic acid, which was filtered and calcined. The calcined material was mixed with aluminum powder and fired with a starter of aluminum powder and sodium peroxide (Na_2O_2), which was ignited with burning paper. Each heat produced about 1,500 kilograms of ferrovanadium containing about 80 percent vanadium. Aluminum required for reduction was 0.8 to 0.9 kilogram per kilogram of ferroalloy. This company also produces ferrovanadium and other vanadium products from vanadium concentrates obtained from South-West Africa. Vanadium was also recovered from slag by Farbenfabriken Bayer A. G. at Leverkusen. Vanadium is recovered from bauxite residue at the Lünen plant of Vereinigte Aluminium-Werke in Bonn.

ASIA

India.—The following information was extracted from a report furnished by the American Embassy in New Delhi.

The only producer of vanadium ore in India is Dublabera Mining Co., Ltd., Dublabera, Bihar. The company acquired a mining lease in 1939. Before the outbreak of World War II small quantities of ore were exported, and about 2,000 tons was sold domestically. A method for treating the ore was developed by Christiania Spigerverk, Oslo, Norway. An analysis of a sample of the ore (dried at 100° C.) was as follows:

	Percent		*Percent*
SiO_2	9.23	MnO	0.32
Fe_2O_3	49.54	CaO	.10
FeO	17.92	MgO	1.89
Al_2O_3	1.27	P_2O_5	.01
TiO_2	14.20	S	.04
V_2O_5	2.36	H_2O	2.79

Thirty-one other samples showed vanadium content varying between 0.28 and 1.92 percent, with an average of 0.96 percent.

AFRICA

Northern Rhodesia.—At Broken Hill the zinc-vanadium deposit of Rhodesia Broken Hill Development Co., Ltd., has been a source of vanadium since 1931—when commercial production of vanadium oxide was begun—through 1952. During this period production of vanadium in oxide was 4,970 short tons. There was no output of vanadium oxide in 1953 and 1954, and all vanadium ore produced by the mine was stockpiled with the mixed fines tailings, pending final evolution of a process for recovering both 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 and zinc in the Abenab West mine. Output of vanadium in lead and zinc concentrates (in terms of recoverable V_2O_5) was 1,130 short tons in 1954 compared with 1,064 tons in 1953; exports were 969 short tons in 1954 compared with 1,166 tons in 1953. The 1954 exports comprised 234 tons to Belgium and 735 tons to West Germany. The concentrate shipped to Belgium is processed to fused vanadium oxide for the South West Africa Co., Ltd.

Vermiculite

By Oliver S. North [1] and Nan C. Jensen [2]

THE RECORD of industry activity presented in this chapter is more complete than was previously possible, because, for the first time, the Bureau of Mines has conducted a statistical survey of exfoliated-vermiculite production. In 1954 the output of screened and cleaned vermiculite was maintained at a high level—only 6 percent below the record established in 1951.

The start of full-scale operation of a new mill in Montana and the beginning of construction of another new plant in South Carolina, both designed to beneficiate low-grade ores, greatly improved the domestic vermiculite reserves situation.

DOMESTIC PRODUCTION

Crude Vermiculite.—Seven firms and individuals operating 8 vermiculite properties in 5 States reported output of crude vermiculite in 1954. Of these, 3 produced crude vermiculite only for sale, 3 only for use in their own experimental mills or exfoliating plants, and 1 both for its own furnaces and for sale to other exfoliators. The bulk of the crude vermiculite was produced by the Zonolite Co. from its properties near Libby, Mont., and Lanford, S. C. The second largest producer was American Vermiculite Co. from a mine near Woodruff, S. C. Other producers were Alabama Vermiculite Co. from a mine near Lanford, S. C.; Phillip S. Hoyt from a mine near Aguila, Ariz. (for milling research only); Variegate Vermiculite Mines from a mine near Green Mountain, N. C.; National Vermiculite Co., Inc., from a mine near Lanford, S. C.; and R. C. Quaintance from a mine near Iola, Colo.

Table 1 shows output of crude vermiculite in 1945–54.

TABLE 1.—Screened and cleaned vermiculite sold or used by producers in the United States, 1945–49 (average) and 1950–54

Year	Short tons	Value	Year	Short tons	Value
1945–49 (average)	118,007	$1,185,655	1952	208,906	$2,657,826
1950	208,096	2,122,427	1953	189,535	2,445,381
1951	209,008	2,679,148	1954	195,538	2,537,577

Exfoliated Vermiculite.—In 1954, for the first time, the Bureau of Mines canvassed the output of vermiculite exfoliating plants. Production was reported by 27 companies operating 50 plants in 32 States and Hawaii. Of these 50 plants, 3 each were in Florida,

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

Illinois, New Jersey, North Carolina, and Texas. According to reports from producers, 144,994 short tons of exfoliated vermiculite was produced in 1954, and 144,964 short tons, valued at $10,807,023, was sold or used.

In the light of the new canvass, it now appears that production estimates of exfoliated material made in previous years have been somewhat higher than was actually attained.

Mine and Plant Developments.—Zonolite Co. began constructing a new mill just south of Enoree, S. C. When completed the plant will concentrate and size vermiculite mined from open pits in the immediate vicinity. This mill, which is designed to treat low-grade vermiculite ores, will be near the company's present sources of raw ore in this area, and will supplement or replace the older mill at Travelers Rest, S. C. The company estimated that the new mill will cost $313,000.

Zonolite Co.'s new concentrating plant near Libby, Mont., went into operation. Technological changes have made it possible for this facility to utilize the large tonnage of low-grade ore available in the Libby deposit.

It was reported that sizable deposits of vermiculite in Carriso Gorge, near Jacumba, San Diego County, Calif., were leased by the Chemical Plant Food Corp. That company disclosed plans to mine and mill the material for sale to exfoliators in the Southwestern States.[3]

Mikolite Products, Inc., Rawlins, Wyo., was incorporated during the year for the purpose of mining vermiculite and other minerals.

Western Mining Corp., Boise, Idaho, purchased vermiculite claims near Bozeman, Mont., and announced plans to process and expand vermiculite from those properties and crude perlite from Owyhee County, Idaho, in a plant to be built at Nampa, Idaho.

Early in 1954 Zonolite Co. acquired an exfoliating plant at North Billerica, Mass., and replaced its Sharpsburg, Pa., exfoliating plant with new facilities at Ellwood City, Pa. In June the same firm took over operation of plants in St. Louis and Kansas City, Mo., and the Kenilworth, Md., plant of Vermiculite Products Corp. was acquired by Carolina Vermiculite Co., High Point, N. C., a subsidiary of Zonolite Co.

CONSUMPTION AND USES

Crude Vermiculite.—Nearly all of the crude vermiculite used in the United States was exfoliated by heat before it was utilized. Relatively small quantities were used in unexfoliated form for special fire-retardant structural purposes, as a filler in certain paints and plastics, and for metallurgical purposes. Other limited quantities were treated with acids to produce a pure silica or silica-alumina material that was used as a catalyst in preparing organic compounds, and in the chemical industry to absorb water vapor.

Exfoliated Vermiculite.—No official figures on the use pattern of exfoliated vermiculite were available. Zonolite Co. listed the uses of the mineral under three major headings as follows:

[3] Mining and Industrial News, Jacumba Vermiculite Mine to be Opened: Vol. 22, No. 6, June 1954, p. 6.

Construction industries: Fireproofing gypsum plaster; fireproofing portland cement; loose fill insulation; concrete insulation; sound conditioning; roof decks and floors; underground pipe insulation; cold storage insulation; preformed concrete roof tiles; refractory Lumnite cement; and insulating bricks.

Agricultural industries: Fertilizer conditioners; hatchery litter; carriers of insecticides, herbicides, fungicides, and fumigants; soil conditioners; cutting beds; and propagation of seed.

General: Packaging; transportation of hot ingots; insulation of liquid air storage vessels; insulation of household appliances; and high temperature insulating cements.

Other applications of exfoliated vermiculite frequently came to light. Additional information on such uses will be found in the Technology section of this chapter.

PRICES

The mill value of screened and cleaned crude vermiculite sold or used by producers averaged $12.98 per short ton in 1954, compared with $12.90 in 1953. The average value of the Montana-mined vermiculite in 1954 was $13.02 per short ton, while the average of the crude mined in South Carolina was $13.05 per short ton.

The average value of exfoliated vermiculite in bags at the plant was $74.55 per short ton in 1954. Comparable data for earlier years are not available.

FOREIGN TRADE

As in the previous several years, nearly all imports of crude vermiculite during 1954 came from the Palabora district, Transvaal, Union of South Africa, and were used by exfoliating plants on the eastern seaboard of the United States. According to reports published by the Union of South Africa Mines Department, exports of crude vermiculite, values f. o. b. port of shipment, from South Africa to the United States since 1950 are shown in table 2.

TABLE 2.—Crude vermiculite exported from South Africa to the United States, 1950–54

Year	Short tons	Value	
		Total	Average per ton
1950	16,531	US $256,152	US $15.50
1951	9,920	142,184	14.33
1952	7,998	113,084	14.14
1953	6,930	101,646	14.67
1954	7,553	117,426	15.55

Crude vermiculite is imported into the United States duty free under paragraph 1719 of the Tariff Act of 1930 as material not specifically provided for.

Vermiculite is not produced commercially in Canada, as that country's requirements are supplied by imports from the United States and the Union of South Africa. According to the Canadian Department of Mines and Technical Services, the value of crude-vermiculite imports since 1951, in Canadian dollars, was as follows:

Country of origin	1951	1952	1953	1954
Union of South Africa	Can $35,472	Can $45,700	Can $34,337	Can $73,117
United States	269,867	274,638	294,680	275,041
Total	305,339	320,338	329,017	348,158

Through 1951 the Canadian dollar was worth, on the average, 95 cents in American money. During 1952–54 the Canadian dollar was worth about $1.02 in American money.

From the above figures it was estimated that the Canadian production of exfoliated vermiculite in 1954 was approximately 25,000 short tons.

TECHNOLOGY

Patents.—The use of small percentages of exfoliated vermiculite to prevent caking of bulk and bagged fertilizers was patented. Numerous materials, most of which are objectionable in one way or another, have been used for this purpose. It was claimed that the addition of exfoliated vermiculite, a material free of fire hazard and relatively inexpensive to use, makes fertilizer free-flowing and improves its nutrient character by adding acid-soluble magnesium to the composition. Magnesium is an essential component of chlorophyll.[4]

A method for manufacturing heat-insulating molded panels from any of several lightweight minerals, including exfoliated vermiculite, was patented. The lightweight of the product is maintained principally by foaming the mixture; the dry, absorbent aggregates are added mainly to take up the excess moisture therein.[5]

Another patent described the conversion of several siliceous materials, including exfoliated vermiculite, to more chemically reactive forms having properties that make them suitable for manufacturing lightweight heat-insulating materials having good strength. This object is accomplished by reacting the silica-containing material with an alkaline-earth silicate-producing compound, such as lime, and acidifying the resulting composition.[6]

A method of using exfoliated vermiculite in a preplastered gypsum wallboard was set forth in a patent. Conventional plasterboard is coated at the factory with a regular base-coat gypsum-vermiculite plaster, which in turn is sprayed with a sodium silicate solution and sprinkled with a mixture of Keene's cement and hydrated finishing lime. The latter coating constitutes a water-setting, unset layer. After the board is in place on the job, the unset layer is wetted and worked with a brush or trowel like job-placed plaster, subsequently setting in the same way as standard gypsum wall plaster. The principal reason for using vermiculite is to make a thick, and consequently rather heavy, unit as light as possible for handling convenience. It was claimed that this plasterboard and method of application will be of particular value to amateur plasterers and builders.[7]

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4 Dresser, H. A. (assigned to Zonolite Co., Chicago, Ill.), Fertilizer Conditioner: U. S. Patent 2,669,510, Feb. 16, 1954.
5 Willson, C. D., Making Molded Panels: U. S. Patent 2,674,775, Apr. 13, 1954.
6 Shea, F. L., Jr., and Hsu, H. L. (assigned to Great Lakes Carbon Corp., Morton Grove, Ill.), Siliceous Composition and Method for Manufacturing the Same: U. S. Patent 2,698,256, Dec. 28, 1954.
7 Cleary, D. E., Plasterboard: U. S. Patent 2,687,359, Aug. 24, 1954.

A patent disclosed the use of various types of mica flakes, including unexfoliated vermiculite, to hasten the maturity and improve the yield and size uniformity of fruits or berries borne on trees, bushes, or leguminous plants. This object is accomplished by covering the ground surface throughout the orchard, berry patch, or garden with a layer of sunlight-reflecting mica particles.[8]

Geology and Occurrences.—The geology and geochemistry of the Day Book dunite deposit near Burnsville, Yancey County, N. C., were discussed in a technical article. This deposit is a well-exposed ultramafic body intruded by pegmatites. Veins of vermiculite formed by the weathering of phlogopite in a magnesium-rich environment occur irregularly along the pegmatite intrusion on the north side of the deposit and at the intersections of major fracture systems. The considerable amount of development work done for vermiculite on this property has indicated that reserves of the mineral are limited to the depth of the zone of weathering, below which the vermiculite grades into unaltered phlogopite.[9]

The origin of vermiculite deposits lying within a 1-mile-square area in the Gold Butte mining district, Nev., was investigated. It was concluded that all vermiculites present are varieties of hydrobiotite and resulted from vermiculitization of biotite by hydrothermal and meteoric solutions. The mineral is distributed widely in the ultramafic rocks in veins, stringers, and pockets and as scattered flakes.[10]

Investigations of Physical and Chemical Properties.—A study was made of cation exchange in such micaceous minerals as vermiculite, biotite, and montmorillonite in soils. It was concluded that the replaceability of interlayer ammonium and potassium is strongly affected by the magnitude of the interlayer crystal lattice charge, particle size, presence of difficulty replaceable hydrogen, nature of the replacing cation, and the nature of the potassium.[11]

The effect of heat on both natural and barium-exchanged vermiculites was examined. Results of the investigation were published in an article in the technical press.[12]

An investigation of the molecular structure of vermiculites indicated that the vermiculite minerals can be classed as montmorillonoids.[13]

An X-ray investigation of the structure of vermiculites was made in Sweden, and the results were published in bulletin form in English. Structure determinations made previously by Hendricks and Jefferson and reported in the American Mineralogist were in the main confirmed by this investigation. However, at some points modifications of lat-

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[8] Cohen, H. (one-half assigned to Imperial Talc Co., Inc., Hoboken, N. J.), Method of Improving Plant Yields: U. S. Patent 2,669,804, Feb. 23, 1954.

[9] Kulp, J. L., and Brobst, D. A., Notes on the Dunite and the Geochemistry of Vermiculite at the Day Book Dunite Deposit, Yancey County, N. C.: Economic Geol., vol. 49, No. 2, March–April 1954, pp. 211–220.

[10] Leighton, F. B., Origin of Vermiculite Deposits, Southern Virgin Mountains, Nevada (abs.): Econ. Geol., vol. 49, No. 7, November 1954, p. 809.

[11] Barshad, I., Cation Exchange in Micaceous Minerals. I. Replaceability of the Interlayer Cations of Vermiculite with Ammonium and Potassium Ions: Soil Science, vol. 77, No. 6, June 1954, pp. 463–472; II. Replaceability of Ammonium and Potassium from Vermiculite, Biotite, and Montmorillonite: Vol. 78, No. 1, July 1954, pp. 57–76.

[12] Gregg, S. J., and Packer, R. K., The Production of Active Solids by Thermal Decomposition. Part IV. Vermiculite: Jour. Chem. Soc. (London), November 1954, pp. 3887–3893.

[13] Chemical and Engineering News, Should Vermiculites Be Classed as Montmorillonoids?: Vol. 32, No. 49, Dec. 6, 1954, p. 4842.

tice symmetry and developments of structural details were introduced.[14]

The crystal structure of a magnesium-vermiculite from Kenya was investigated by single-crystal X-ray methods.[15] Magnesium-vermiculite is formed by hydrothermal alteration of biotite and phlogopite.

Utilization.—Articles published in agricultural periodicals described the results of using exfoliated vermiculite for rooting flower cuttings,[16] preparing seed beds for iris,[17] mulching vegetable seedrows,[18] and as a carrier for liquid fumigants [19] and potato-scab inoculation solutions.[20]

The many uses of exfoliated vermiculite in the construction industries were listed and its advantages for each type of application discussed in an article.[21] The list included its utilization in: Hardwall, fireproofing, and finish plasters; acoustical plastic; poured concrete and concrete units of many types; loose-fill insulation; and asphalt roof fill. Other articles described its use in exterior portland-cement plasters,[22] gypsum plasters,[23] and acoustical plastics.[24]

An article discussed methods of preparing a good lightweight plaster for gun application. A rich mix (one containing a maximum quantity of gypsum) was recommended, except when the plaster is to be applied against a high-suction background.[25]

A building material made with exfoliated vermiculite, slag, oil, and water has been developed for exterior residence walls and office and factory partitions. The material is formed into 8 by 16-foot panels in various thicknesses.[26]

A 2-inch-thick slab of vermiculite insulating concrete poured on 1-inch-thick rigid insulation board was used as part of the roof deck of a large factory. The deck weighed only 7.7 lb. per sq. ft., had a "U" value of 0.15, and was economical compared with other roofing systems.[27]

A concrete-block firm began manufacturing an 8-inch hollow-core modular unit of vermiculite insulating concrete. Using a mix of 1 part portland cement to 5 parts vermiculite stabilized concrete aggregate, by volume, the company obtained a 15-pound block with a "K" factor of 0.69 and a "U" factor of 0.13. This unit is especially

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[14] Grudemo, A., An X-Ray Examination of the Structure of Vermiculites: Swedish Cement and Concrete Research Inst., Royal Inst. Technol., Stockholm, Proc. NR 22, 1954, 56 pp. (in English).

[15] Mathieson, A. McL., and Walker, G. F., Crystal Structure of Magnesium-Vermiculite: Am. Mineral., vol. 39, Nos. 3–4, March–April 1954, pp. 231–255.

[16] Mullard, S. R., Rooting Cuttings in Vermiculite (Acid Grades): Jour. Royal Horticultural Soc. (London), vol. 79, pt. 8, August 1954, pp. 367–368.

[17] Douglas, G., New Tools for Old: Bull. Am. Iris Soc., No. 132, January 1954, pp. 58–60.

[18] Market Growers Journal, Field-Seeded Vegetables Respond to Vermiculite Mulch: Vol. 83, No. 9, September 1954, pp. 26, 31.

[19] Sasser, J. N., and Nusbaum, C. J., The Use of Vermiculite as a Carrier for Volatile, Liquid Fumigants to Control Nematodes: Plant Disease Reporter, vol. 38, No. 2, Feb. 15, 1954, pp. 65–67.

[20] Houghland, G. V. C., and Cash, L. C., The Use of Vermiculite in Providing Scab Inoculation for Potatoes: Plant Disease Reporter, vol. 38, No. 7, July 15, 1954, pp. 460–461.

[21] Construction Methods and Equipment, Expanded Vermiculite Has a Lot to Offer: Vol. 36, No. 10, October 1954, pp. 74, 76, 78, 82, 84, 88, 90.

[22] Plastering Industries, Must "Roll With the Punch" for Best Portland Cement (Stucco): Vol. 33, No. 1, February 1954, pp. 10–11.

[23] Plastering Industries, Lightweight Plaster Celebrates 21st Anniversary This Year: Vol. 34, No. 5, December 1954, pp. 43–44.

[24] Plastering Industries, Vermiculite Plastic Direct Gets 4-hour Fire Rating: Vol. 34, No. 2, September 1954, pp. 46–47.

[25] Hobson, L. H., You May Be Spending More to Give Weaker Plaster: Plastering Ind., vol. 34, No. 1. August 1954, pp. 13–14.

[26] Rock Products, Vermiculite Wall Panels: Vol. 57, No. 3, March 1954, p. 65.

[27] Civil Engineering, Roof of Vermiculite Concrete Poured on Insulation Board: Vol. 24, No. 6, June 1954, pp. 67–68.

suited for metal-faced spandrel wall construction in multiple-story buildings.[28]

Many uses for vermiculite in the chemicals field were discussed in an article.[29] These uses included: Carrier for chemicals, such as iron chelates, phenyl mercuric acetate, and chlordane; conditioner in fertilizer; resilient packing material; filler in plastics, liquid sulfur mortar, and etching powder; lubricants; and insulation of process equipment. When iron chelates are used as a spray (for example on citrus trees), the leaves and fruit may be burned. Vermiculite is used to absorb and hold the solution for gradual release of the metal to the trees.[30]

RESERVES

Montana's reserves of vermiculite are extensive, especially since recent mill improvements have made usable large quantities of low-grade ore. Near Enoree, S. C., Zonolite Co. has outlined ore bodies large enough to justify erection of a modern mill. Medium-size deposits, several of which have been mined commercially in the past, are known in Colorado, Georgia, North Carolina, Pennsylvania, Texas, and Wyoming, and the mineral has been identified in many other States. Exact data are not available on the overall tonnage of reserves, but they are considered adequate to take care of domestic and export requirements for many years.

WORLD REVIEW

NORTH AMERICA

Canada.—Siscoe Vermiculite Mines, subsidiary of Siscoe Gold Mines, began operating an exfoliating plant in Etobicoke Township west of Toronto. The firm also exfoliated vermiculite at a plant in Cornwall, Ontario. Crude ore from South Africa was used at both locations. The company reportedly was continuing exploration for a domestic source of crude vermiculite. At its property at Stanleyville, near Perth, Ontario, the vermiculite is of good quality but too disseminated in the host rock to be economic.[31]

SOUTH AMERICA

Brazil.—The Government of Brazil granted a license to prospect for vermiculite in the municipality of Uba, Minas Gerais. This action was interpreted to indicate a discovery of mineral in that area.

28 Pit and Quarry, Minnesota Firm Markets Vermiculite Units for Metal-Faced Spandrel Walls: Vol. 46, No. 8, February 1954, pp. 162–164.
29 Chemical Engineering, Chemical Processors Put Vermiculite to Work: Vol. 61, No. 11, November 1954, pp. 136, 138, 140.
30 Farm Chemicals, Vermiculite-Carried Chelates: Vol. 117, No. 7, July 1954, p. 36.
31 Northern Miner (Toronto), Toronto Plant for Siscoe: Vol. 61, No. 27, Sept. 23, 1954, pp. 17, 24.

TABLE 3.—World production of vermiculite, by countries,[1] 1945–49 (average) and 1950–54, in short tons

(Compiled by Helen L. Hunt)

Country [1]	1945–49 (average)	1950	1951	1952	1953	1954
Australia	148	134	62	69	32	(2)
Egypt	----------	----------	702	66	[3] 100	----------
India	----------	58	260	24	----------	(2)
Japan	----------	----------	----------	----------	----------	882
Kenya	3	4	3	----------	82	403
Rhodesia and Nyasaland, Federation of:						
Southern Rhodesia	[4] 539	784	553	----------	----------	----------
Tanganyika	[5] 14	----------	----------	----------	----------	----------
Union of South Africa	12,250	46,763	27,014	39,918	33,844	45,633
United States (sold or used by producers)	118,007	208,096	209,008	208,906	189,535	195,538
Total [1]	130,961	255,839	237,602	248,983	[3] 223,600	[3] 242,500

[1] In addition to countries listed, vermiculite is produced in Brazil and U. S. S. R., but data are not available, and no estimates are included in the total.
[2] Data not available; estimate by senior author of chapter included in total.
[3] Estimate.
[4] Average for 1948–49.
[5] Average for 1946–49.

EUROPE

Finland.—Potentially commercial deposits of vermiculite were reported to have been found near Posio, northern Finland. The vermiculite was said to be stratified with amblygonite and to occur in an area 1 or more miles long and 500 to 1,000 feet wide.[32]

United Kingdom.—A new trade association, called the Association of Vermiculite Exfoliators, was formed by several British companies. Most British exfoliators used crude ore from Union of South Africa.

ASIA

India.—Vermiculite occurs in bands up to 3 or 4 feet thick in a series of highly folded peridotites and schists intruded by quartz veins and pegmatites, in the Ajmer-Merwara area, Kishengarh State, India.[33] It also is found in a number of localities in Mysore State.

AFRICA

Egypt.—Vermiculite and anthophyllite occur in close association with serpentine lenses and feldspar dikes in Wadi Hafafit, in the Central Eastern Desert. The vermiculite is strictly confined to the walls of feldspar dikes within serpentine masses; vermiculite does not occur where the dikes extend into granitic gneiss. These deposits have been worked for some time on a small scale for feldspar and vermiculite.[34]

Southern Rhodesia.—Exports of vermiculite from Southern Rhodesia in 1953 totaled 163 short tons. Of that quantity, 159 tons went to Northern Rhodesia and 4 tons to Mozambique. Vermiculite occurs in the vicinity of apatite-mineralized carbonate "pipes" in

[32] Chemical Trade Journal and Chemical Engineer (London), Finnish Vermiculite Discovery: Vol. 134, No. 3476, Jan. 15, 1954, p. 165.
[33] Roy, B. C., Vermiculite Deposits in Ajmer-Merwara (India): Indian Minerals (Calcutta), vol. 7, No. 3, July 1953, (Pub. 1954), pp. 117-124 (in English).
[34] Amin, M. S., and Afia, M. S., Anthophyllite-Vermiculite Deposit of Hafafit, Eastern Desert, Egypt: Econ. Geol., vol. 49, No. 3, May 1954, pp. 317-327.

an area 70 miles southeast of Umtali, near the Mozambique border.[35]

Uganda.—Extensive deposits of vermiculite of varying quality were reported to occur in the low hills surrounding Bukusu Hill, a volcanic center in the Eastern Province, near the Kenya border, about 15 miles from Mbale and 7 miles from Magodes, a station on the Tororo-Soroti railway line. The mineral usually underlies a gravel or rubble containing magnetite and knopite (a gray calcium-cerium-titanium silicate). Pits dug to prospect for titanium mineralization showed that the magnetite-knopite cover grades into vermiculite at a depth of 8 to 20 feet, below which vermiculite predominates. A small quantity of vermiculite from one of these deposits has been used commercially. It was estimated that one of the hills in this area contains at least 9 million cubic yards of vermiculite-bearing material of workable quality.[36]

Union of South Africa.—Production of vermiculite totaled 45,600 short tons in 1954 compared with 33,800 short tons in 1953. Local sales totaled 3,100 short tons valued at $52,500 (ave., $17.02) f. o. r. in 1954, compared with 3,300 short tons valued at $51,300 (ave., $15.76) f. o. r. in 1953. Exports totaled 40,900 short tons valued at $704,800 f. o. b. in 1954, compared with 34,300 short tons valued at $561,700 f. o. b. in 1953. Details of the 1953–54 exports from Union of South Africa appear in table 4.

TABLE 4.—Exports of crude vermiculite from Union of South Africa, 1953–54 [1]

Country of destination	1953			1954		
	Short tons	Value [2]		Short tons	Value [2]	
		Total	Average		Total	Average
United Kingdom	9,901	$161,913	$16.35	8,363	$151,155	$18.07
United States	6,930	101,646	14.67	7,553	117,426	15.55
France	3,158	57,434	18.19	5,209	97,443	18.71
Canada	2,821	40,827	14.47	5,160	79,811	15.47
Italy	3,655	61,818	16.91	5,036	88,455	17.56
Germany	1,392	24,626	17.69	2,668	46,953	17.60
Denmark	2,453	40,967	16.70	2,491	45,021	18.07
Netherlands	1,499	27,628	18.43	1,163	19,659	16.90
Sweden	284	5,121	18.03	1,097	19,541	17.81
Australia	505	9,033	17.89	578	10,158	17.57
Belgium	274	4,880	17.81	391	6,812	17.42
Japan	293	5,127	17.50	186	3,186	17.13
New Zealand	54	801	14.83	170	3,217	18.92
Venezuela				130	2,248	17.29
Rhodesia	251	4,091	16.30	116	2,167	18.68
Switzerland				116	2,075	17.89
Morocco	160	3,290	20.56	114	2,355	20.66
Lebanon	60	966	16.10	101	1,823	18.05
Egypt				70	1,263	18.04
Malaya	29	557	19.21	56	1,092	19.50
French West Africa	91	1,952	21.45	54	1,204	22.30
Arabia	55	1,005	18.27	52	874	16.81
Chile				48	890	18.54
Norway	214	3,738	17.47			
Uruguay	120	2,044	17.03			
Ireland	100	1,770	17.70			
Persian Gulf	25	454	18.16			
Total	34,324	561,688	16.36	40,922	704,828	17.22

[1] Source: Union of South Africa Mines Department Quarterly Reports.
[2] Converted to U. S. currency at the rate of SA£ 1=US$2.80.

[35] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 2, August 1954, p. 64.
[36] Taylor, R., The Magnetite-Vermiculite Occurrences of Bukusu, Mbale District (Uganda): Geol. Survey Uganda Records (Entebbe), 1953 (pub. 1955), pp. 59–64.

The Transvaal Ore Co., operating in the Palabora district, produced virtually all of the South African vermiculite output. The company planned early renovation of machinery and reorganization of its mining methods.[37]

OCEANIA

Australia.—Vermiculitized biotite occurs in schists and gneisses 10 miles south of Home Hill, Queensland. Lenses and veins containing vermiculite, biotite, quartz, and feldspar are numerous and large, but the limited prospecting had not uncovered by early 1954 any section of clean vermiculite large enough to warrant commercial development. However, the examining engineer recommended further sampling, mapping, and testing in this area.[38]

[37] Mining Journal (London), Vermiculite Production: Vol. 242, No. 6195, May 14, 1954, p. 577.
[38] Carruthers, D. S., Vermiculite and Asbestos Occurrences, Home Hill District (Queensland, Australia): Queensland Govt. Min. Jour. (Brisbane), vol. 55, No. 627, Jan. 20, 1954, pp. 64–65.

Water

By Robert T. MacMillan[1]

THIS is the first chapter on water as a mineral commodity to appear in the Minerals Yearbook. In 1954 water requirements in the United States continued to grow. Serious shortages were reported, notably in the southern two-thirds of the country. On the other hand, supplies in the Northeast and Northwest were above normal. Whereas records indicate that average precipitation over a long-term period is relatively stable, there is increasing concern over the outlook for future supply owing to the rapid increase in requirements.

DOMESTIC SUPPLY

Water is precipitated in widely varying quantities over the United States. According to the United States Weather Bureau, the highest average annual precipitation within the continental United States is 150.73 inches, recorded at Wynoochee, Wash., while the lowest is 1.66 inches, recorded at Greenland Ranch. Calif. Between these 2 extremes the average annual precipitation for the country as a whole is approximately 30 inches. In many Southern and Eastern States the annual precipitation is considerably above the National average, while in most of the West and Southwest it is below the average. Although there are local variations from year to year, there is little evidence to indicate that the average annual precipitation falling on the land area of the United States is either increasing or decreasing.[2]

Based on 30 inches of average annual precipitation and the total land area of the country, the average precipitation for the United States is about 4,300 billion gallons per day. Nearly 75 percent of this precipitation is returned to the atmosphere by direct evaporation or through vegetation by the process known as transpiration.

From measurements of streamflow throughout the country the Federal Geological Survey estimated that an amount approximately equivalent to 8.7 inches of the 30 inches total average annual precipitation finds its way to the oceans as runoff through streams. This represents about 1,145 billion gallons per day of potential water supply, or nearly 5 times the estimated total withdrawal for all industrial, irrigational and municipal purposes in 1954.

[1] Commodity-industry analyst.
[2] U. S. Congress, House Committee on Interior and Insular Affairs, The Physical and Economic Foundations of Natural Resources IV, Subsurface Facilities of Water Management and Patterns of Supply, 1953, 206 pp.

Among the greatest water problems is the unequal distribution of natural precipitation in respect to time, quantity, and area. In general, the eastern half of the country and the Pacific Northwest receive more than the average annual precipitation, and the remainder receives less than the average. According to estimates of the Water Sewerage Industry and Utilities Division, Business and Defense Services Administration, United States Department of Commerce, as much as two-thirds of the average annual runoff passes into the oceans under flood conditions in comparatively short intervals, and less than one-third is available during the majority of the year. Some areas receive a large part of their total average annual rainfall in a few brief showers.

According to the Water Resources Review of the Federal Geological Survey, the water year ended September 30, 1954, was dry over the southern two-thirds of the United States, except in a few areas. The annual runoffs of the major river systems of this area were the second lowest on record.

The Mississippi was 54 percent of normal; the Missouri, 58 percent; the Ohio, 51 percent; and the Colorado, 46 percent. On the other hand, the St. Lawrence and Columbia Rivers flowed at above-normal rates.[3]

Most major power reservoirs in the Northeast were nearly full and far above average. On the other hand, the major power reservoirs in the Southeast were below average. In the western and west-central areas water in power reservoirs was approximately average for the region, although individual reservoirs varied greatly.

With few exceptions water stored for irrigation and municipal and industrial uses was below average.

Since 1947 the surface reservoir capacities for the Nation have increased at a rate of more than 16 million acre-feet per year. In 1954 there were 1,300 reservoirs in the United States that had usable capacities of more than 5,000 acre-feet. Their combined usable capacity was 278 million acre-feet.[4] [5] Many additional reservoirs of less than 5,000 acre-feet were used for irrigation.

Ground-water levels fluctuate, depending upon the amount of pumping and the rate of recharge, much the same as the water level in surface reservoirs. In several areas in Florida, New Jersey, California, Louisiana, and other States, ground-water levels have been lowered by excessive pumping until saline waters from the oceans or other sources have flowed into the aquifers, affecting the availability of fresh water from these sources. Texas, Arkansas, New Mexico, Arizona, Nevada, and Utah, as well as Florida, New Jersey, California, and Louisiana, were said to have areas of perennial overdraft of ground water.[6] Remedial measures to balance draft against replenishment have been taken in some areas, particularly in California. Such measures included spreading storm runoff in recharge areas and actual pumping of surface water into the aquifer through

[3] Geol. Survey (in collaboration with Canada—Dept. of Northern Affairs and National Resources), Water Resources Review, Annual Summary, Water Year 1954: Oct. 21, 1954, 11 pp.

[4] Paulsen, Carl G., Our Growing Demands for Water: Paper presented before the Am. Assoc. for Advancement of Science, Berkeley, Calif., December 1954; subsequently published in Public Health Reports, vol. 70, No. 8, August 1955, pp. 731-737.

[5] One acre-foot equals approximately 326,000 gallons.

[6] Thomas, H. E., The Conservation of Ground Water: McGraw Hill Book Co., Inc., New York, N. Y., 1951, 327 pp.

recharge wells.[7] About 60 million gallons per day was reported being recharged to the aquifers in western Long Island to maintain satisfactory water-table levels.[8]

Despite the large increase in the water withdrawn for use in recent years, relatively few major shortages have developed. Severe shortages have been local and temporary. However, with growth of population and per capita requirements, much concern was expressed over future water supply. Consequently, water-supply problems received increasing attention.

President Eisenhower appointed a committee of Cabinet members to study the water-supply situation.

The saline-water-conversion program of the United States Department of the Interior investigated numerous proposals for converting brackish and sea water into water satisfactory for municipal, industrial, and irrigational use.

CONSUMPTION AND USES

Water was used in a multitude of ways, and the quality requirements of water varied widely according to its use. Domestic, municipal, irrigation, waterpower, and industrial uses are classed as withdrawal uses. On the other hand, navigation, waste disposal, recreation, and conservation of wildlife are examples of nonwithdrawal uses of water.

Water that is evaporated or incorporated in a product is said to be used consumptively. Most uses of water are both consumptive and nonconsumptive; for example, it has been estimated that 20 to 60 percent of the water used for irrigation seeps into streams or percolates to aquifers as return flow. As much as 95 percent of municipal and industrial water reaches the streams as sewage effluent. Most nonwithdrawal uses are nonconsumptive, although evaporation losses from reservoirs are high in certain areas. For example, evaporation losses have been estimated at 170 m.g.d. in North Dakota.[9] This nearly equaled the average daily withdrawal use of water in the State.

The greatest use of water was for generating hydroelectric power. This use required 4 to 6 times the total quantity used for all other withdrawal purposes. However, as the water was not degraded and was returned immediately to the stream or lake, this use was nonconsumptive and often was ignored in tabulations.

Irrigation was the next largest user of water, with approximately 46 percent of the total estimated withdrawal in 1954. Industrial water use has increased greatly since 1950, nearly equaling the estimated quantity used for irrigation in 1954. Together, irrigation and industry used more than nine-tenths of the water withdrawn in 1954, excluding that used for the generation of waterpower.

About 75 percent of the water used by industry was for cooling purposes.

Studies by industrial firms have shown that much can be done to improve their water situation. For example, water may be reused

[7] Brashears, M. L., Jr., Artificial Recharge of Ground Water of Long Island, N. Y.: Econ. Geol., vol. 41, August 1946, p. 503.

[8] Paulsen, Carl G., Our National Water Resources: Address presented at the Water Policy Conference sponsored by the Conservation Federation of Missouri, Jefferson City, Mo., April 1955, 7 pp.

[9] MacKichan, K. A., Estimated Use of Water in the United States, 1950: Geol. Surv. Circ. 115, May 1951, 13 pp.

under properly controlled conditions. A recent survey of over 3,000 plants indicated that less than half recirculated any water and only a quarter recirculated as much as half the water withdrawn.[10]

The use of high-quality water has been found to be unnecessary for certain purposes. For example, brackish water has been found in many instances to be satisfactory for cooling. An estimated 15 billion gallons per day was withdrawn in 1950 for cooling.[11] Treated sewage effluent from the city of Baltimore has been found satisfactory as a water supply for nonsanitary purposes in the Bethlehem Steel plant. A program of conservation and reuse enabled a western steel manufacturing plant to limit its water requirement to 1,100 gallons per ton of steel produced, which compares with the industry average of 65,000 gallons for finished steel.

Water is used by the mining industry in many ways. In placer mining high-velocity streams of water are directed against the face of the ore body, breaking it up and releasing the desired minerals. More than half the Nation's salt is mined by sinking wells into the deposit, pumping in water, and removing highly concentrated brines which are evaporated. Sulfur is mined by injecting hot water into a well, melting the sulfur, which is removed in a molten form.

TABLE 1.—Estimated use of water in United States, million gallons per day [1]

Year	Irrigation [2]	Public municipal	Farm [3] and rural	Industrial [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
1954 [5]	115, 970	16, 500	5, 200	112, 720	250, 390

[1] SOURCE: Water and Sewerage Industry and Utilities Division, B. D. S. A. Department of Commerce.
[2] Total including 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.
[5] 1954 figures obtained by extrapolation.

Large quantities of water are used by the mineral industries in cleaning, screening, classification, flotation, and separating minerals. Purity requirements for water used in these operations are variable. In many instances inferior-grade water may be satisfactory, while in others (for example, in flotation separations) the tolerance for certain impurities is very low. The water intake of specified mineral industries in 1954 is shown in table 2.

The productivity of certain oilfields has been materially increased by water-flooding programs. Controlled injection of water into oil sands through new or abandoned wells was found to increase the flow of oil toward producing wells by building up pressure behind the oil. Brines were found to be more satisfactory than water, as they tended to cause less swelling of the clay content of the oil sands.

[10] Paley, W. S., Report of the President's Materials Policy Commission: Resources for Freedom, vol. 1, June 1952, 183 pp.
[11] Work cited in footnote 10, p. 51.

Many water-flooding programs provided for recirculation of the brine, which was removed from the producing well along with the oil. The brine was separated from the oil, treated to remove undesirable minerals, and returned to the oil field through injection wells.

Bureau of Mines engineers estimated that in 1954 approximately 92.4 billion gallons of water was injected into oil-bearing strata in the secondary recovery of 110 million barrels of oil. About 40 percent of the water used for this purpose was classed as salt water; the remainder was fresh or brackish water.

Injection of waste oilfield brines into oil strata in connection with a water-flooding program was found to be a satisfactory method of disposing of such brines without causing pollution of surface water resources.

TABLE 2.—Water intake for selected mineral industries in 1954,[1] in million gallons

Mineral industry	Water intake [2]	Mineral industry	Water intake [2]
Barite	6,047	Natural abrasives, pumice, and pumicite	98
Copper ores	54,417	Natural gasoline and condensate	67
Diatomite	143	Oil and gas field contract service	7
Feldspar	1,211	Phosphate rock	63
Fluorspar	1,081	Potash, soda, and borate minerals	11
Gold lode	4	Pyrites	985
Gold placer	46	Salt (rock)	2,968
Gypsum	131	Stone (crushed)	60,000
Iron ores	27	Stone (dimension)	3,131
Lead and zinc ores	22,000	Sulfur	16
Manganese ores	3	Talc, soapstone, and pyrophyllite	324
Mercury ores	12	Titanium ores	2,793
Mica	1,022	Tungsten ores	3,380
Miscellaneous chemical and fertilizer materials	13,182	Vermiculite and miscellaneous nonmetallics not elsewhere classified	520
Native asphalt, bitumens, and related products	38		

[1] Bureau of the Census, U. S. Department of Commerce, Preliminary Report, 1954 Census of Mineral Industries.
[2] Includes mine water used.

TABLE 3.—Estimated water requirement per unit of product in selected industries [1]

Product:	*Gallons per ton*
Steel	65,000
Wood pulp	40,000
Petroleum (refined)	5,320

[1] U. S. Congress House Committee on Interior and Insular Affairs, Physical and Economic Foundation of Natural Resources, IV, Subsurface Facilities of Water Management and Patterns of Supply: 1953, 206 pp.

PRICES

The cost of water has varied greatly over the United States. Irrigation-water prices have varied from $1.50 to $20 per acre-foot in California or $0.005 to $0.06 per 1,000 gallons.

Municipal water prices ranged from a few cents to more than 20 cents per 1,000 gallons. As 1,000 gallons of water weighs more than 4 tons, it was one of the least expensive materials.

Most water used by industry was self-supplied, and the water costs of an industry depended in part on the treatment necessary. Treatment costs varied with the source of supply and the quality required.

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For highly purified water for boilers and certain chemical uses, treatment costs ranged up to several dollars per thousand gallons.

Initial cost goals were established by the Saline Water Conversion Program for converting saline water for municipal and similar purposes and for irrigation. Without distinguishing as to whether the water to be converted was sea or brackish water, the goals were $125 and $40, respectively, per acre-foot ($0.38 and $0.12 per 1,000 gallons).[12]

TECHNOLOGY

Dissolved impurities strongly affect physical and chemical properties of water. Some cause corrosion; and others, such as calcium and magnesium, cause scaling and interfere with the cleansing action of water by precipitating soap.

Substances commonly found dissolved in water in significant quantities are: Ca, Mg, Na, K, Fe, Mn, SiO_2, HCO_3, SO_4, Cl, and NO_3. Over 40 different molecular and ionic species have been detected in sea water. In land waters the principal dissolved substances are calcium, magnesium, sodium, bicarbonate, and sulfate. Except for some lake brines and connate waters, land waters contain much less dissolved solids than sea water.

For drinking purposes, water containing less than 1,000 parts per million (p. p. m.) of dissolved solids is preferred. However, water containing up to 2,500 p. p. m. has been used. According to United States Public Health Service, the total solids preferably should not exceed 500 p. p. m. for water of good chemical quality. However, a total-solids content of 1,000 p. p. m. is permitted in drinking water on interstate carriers if water of better quality is not available.[13]

Most United States cities serve water having chemical quality well within the upper limits of the United States Public Health Service Drinking-Water Standards. Many cities have water of much higher chemical quality. For example, most of the water supply of New York contained less than 50 p. p. m. and most of the Los Angeles supply contained less than 200 p. p. m.

In respect to mineral content, the requirements for good irrigation water were approximately the same as for drinking water. Water containing dissolved solids above about 1,400 p. p. m. was of doubtful value for irrigation purposes.

To avoid building up the concentration of sodium ion in the soil, the proportion of this element in the total dissolved solids must be below certain limits. As boron concentrations of 3 or more p. p. m. in water are extremely toxic to plants, particular attention was paid to the degree of concentration of this element in irrigation waters.

The problems connected with converting sea water into water suitable for municipal, irrigation, and industrial uses are chiefly those of discovering processes that will operate at low enough cost. According to a study by the Research Foundation of the State University of New York for the United States Department of the Interior, the absolute minimum theoretical energy required to separate 1,000 gallons of fresh water from sea water by any method without appreciable rise in the concentration of salts in the reject brine was 2.8 kilowatt-

[12] Secretary of the Interior, Third Annual Report on Saline-Water Conversion: January 1955, 125 pp.
[13] Public Health Service, Drinking-Water Standards: Reprint 2697 from Public Health Repts. 1946, 13 pp.

hours. If the concentration of salts in the reject brine were permitted to double, the minimum energy requirement would be 3.9 kilowatt-hours.[14] Energy requirements are, of course, an important factor in the total cost of a process.

Processes investigated by the Saline Water Conversion Program of the United States Department of the Interior for the conversion of sea water included the following:

(1) Vapor-compression distillation, wherein sea water is heated in a boiler under reduced pressure, forming water vapor which is mechanically compressed, causing it to condense. The energy liberated by the condensation of the pure water supplies heat to the boiler. Tests of the newly developed Hickman vapor-compression still have shown higher heat-transfer coefficients and increased efficiency over conventional stills.

(2) Solar distillation, in which the heat of the sun is utilized for heating brine, forming water vapor, which is condensed on cooled surfaces.

(3) An electric membrane process in which, under the influence of an electric current, the salt ions in saline water are caused to migrate through ion-permeable membranes into separate compartments, leaving desalted water behind. The apparatus consists of a series of electrolytic cells, each of which is separated into 3 compartments by 2 membranes, 1 of which is permeable only to the positively charged ions (cations) and the other to the negatively charged ions (anions).

Saline water is introduced into the middle compartment, and an electric current is passed through the solution in the direction causing the various ions to pass through the membrane permeable to them. Thus the water in the middle compartment is desalted, while that in the end compartments becomes more saline. Ordinarily a number of cells are used in series.

(4) Critical-pressure devices, wherein saline water was heated under such extremely high temperatures and pressures that the distinction between liquid and vapor for pure water was lost and the energy ordinarily required for this transformation was greatly reduced.

(5) Purification by freezing, wherein brine was cooled below the freezing point of pure water but above the brine-water eutectic temperature −21° C. In this range ice crystals are formed and may be separated from the remaining brine.

Although the experimental work was not advanced sufficiently for complete evaluation of the relative merits of the processes under study, several points seemed evident. As conditions under which processes operate are never ideal, the actual or practical energy required for vapor-compression distillation and electric-membrane processes was reported to be about 12 kilowatts per 1,000 gallons, or roughly 4 times the theoretical minimum of 2.8 kilowatts.[15] At a power cost of $0.01 per kilowatt-hour the costs for power alone were $39.10 per acre-foot. This was considered high for irrigation water but within range of municipal and some industrial water costs.

Because of the widely varying qualities of water and the specific requirements of water for certain purposes, water treatment is necessary. Treatment of the water for municipal uses has been in effect

[14] Secretary of the Interior, Third Annual Report on Saline Water Conversion: January 1955, p. 13.
[15] Work cited in footnote 14.

for many years. Such treatment usually consists of settling and filtration to remove suspended matter and chlorination to kill microorganisms. In some States, water treatment included the addition of small quantities of fluorine-containing compounds. The presence of this element in drinking water has been associated with a 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 the soap and detergent requirements and cause scaling in boilers.

Most of the water used for irrigation was either diverted from streams or pumped from ground-water reservoir and was not treated.

The quality of water used by industry varied widely, depending upon its use. Certain industries require water of extreme purity, which is obtained by either ion exchange or distillation methods.

Water for use in steam-generating boilers has special purity requirements, not only to reduce scale deposits on the heat-transfer surfaces but also to control corrosion in boilers and associated piping.

A west coast steam-electric generating plant was believed to be the first in the Nation to use specifically designed evaporator sets to produce fresh water from sea water for a large industrial use. A large plant under construction at Morro Bay, Calif., was expected to produce 72,000 gallons of fresh water per day from two triple-effect evaporators.[16]

The boiler-feedwater service of the Federal Bureau of Mines furnished boiler-feedwater test methods and equipment to all Government agencies requesting such service. Approximately 12,700 boiler-feedwater samples were tested in 1954 and appropriate treatment recommended.

Bureau of Mines researches in boiler-water treatment have resulted in the development of methods for controlling corrosion in steam-condensate return lines by the use of such additives as octodecylamine and cyclohexylamine. These inhibit corrosion by neutralizing residual carbonic acid in the condensate and also by leaving a protective coating inside the lines.[17]

WORLD REVIEW

A study was made by M. I. L'vovich in 1945 [18] of the annual runoff from the various land areas of the world. Results of the study indicated that the water supplies of South and North America were potentially greater than in other continental areas.

Fresh water was distilled from sea water in certain water-short areas of the world and aboard ships at sea. One of the largest installations for distilling fresh water from sea water was established at Kuwait on the Persian Gulf. Six triple-effect evaporation units had a total daily output capacity of 720,000 gallons.[19] This capacity was being expanded to 800,000 gallons per day.[20]

[16] Chemical Week, Leaving the Salt Behind: Vol. 75, No. 9, Aug. 28, 1954, pp. 52–54.
[17] Carman, E. P., and Caldwell, D. L., Report of Research and Technological Work on Coal and Related Investigations, 1954: Bureau of Mines Info. Circ. 7756, August 1956, pp. 58–61.
[18] Langbein, W. L., and others, Annual Runoff in the United States: Geol. Survey Circ. 52, June 1949, 14 pp.
[19] Secretary of the Interior, Second Annual Report on Saline-Water Conversion: January 1954, 61 pp.
[20] Oil Forum, vol. 8, No. 1, January 1954, pp. 19–20.

Zinc

By O. M. Bishop[1] and Esther B. Miller[2]

HIGHLIGHTS of the domestic zinc industry in 1954 were the continued oversupply of zinc, decreased mine production and imports, reduced consumption, and the beginning of Government purchases for the new long-term strategic stockpile. With zinc remaining at nearly the same low prices as in 1953, domestic mine production of recoverable zinc decreased for the third successive year and was the lowest since 1934. Many mines that closed in 1953 or 1952 remained idle, and some additional mines shut down. Despite the lower mine production and an 18-percent decline in imports, the supply of zinc (including newly mined, secondary recovered in all forms, and imports) exceeded consumption, totaling 1,288,000 tons, while the total zinc consumed as slab, ore, and secondary metal plus exports was about 1,210,000 tons.

Although both total smelter production and the consumption of slab zinc declined 10 percent from 1953, both improved significantly toward the end of 1954. Smelter production in the last quarter was 10 percent and consumption 16 percent more than the average of the first three quarters. Stocks of slab zinc at primary and secondary smelters, which totaled 180,000 tons at the beginning of the year, increased to 210,000 tons as of June 1 but thereafter declined to 120,500 tons on December 31 owing mainly to the expanded program of Government purchases of zinc (and lead) for the long-term stockpile, which began in June and continued through December. The decline in smelter stocks and the sharp rise in slab-zinc consumption in the last quarter of the year brought about price rises that enabled smelters to step up production rates curtailed in late 1953 and early 1954.

The decline in mine production was attributed almost wholly to the depressed prices. Of the 19 producing States, only New York, Oklahoma, Kansas, Utah, and Virginia reported increased production. Noteworthy were the complete shutdown of zinc and zinc-lead mining operations in New Mexico, ordinarily a major zinc-producing State, and closing of the Franklin, N. J., mine owing to exhaustion of ore reserves. Additional mines shut down or curtailed production during the year. Idaho, with an output of 61,500 tons of recoverable zinc, was the chief producing State; Montana, the largest producer from 1951 through 1953, followed closely with 61,000 tons. Other leading producing States, ranked by output, were New York, Oklahoma, New Jersey, Colorado, Utah, Tennessee, Washington, and Arizona.

The quoted price of Prime Western slab zinc, East St. Louis, which was 10 cents a pound at the beginning of 1954 and declined to the year low of 9.25 cents on February 15, advanced to 10.25 cents in March. Further increases in May, June, and September raised the price to 11.50 cents, where it remained through December.

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Domestic zinc smelters produced 870,000 tons of slab zinc in 1954 compared with 969,000 tons in 1953. Of the total 1954 output, 44 percent was derived from domestic ores, 48 percent from foreign ores, and 8 percent from scrap. Imports of zinc (metal content) in ores and concentrates totaled 454,000 tons, and imports of slab zinc 156,900 tons compared with 514,000 and 235,000 tons, respectively, in 1953. Mexico, Canada, and Peru together supplied 93 percent of the ores and concentrates and Canada 67 percent of the slab and other forms of refined zinc. Exports of refined zinc totaled 29,000 tons. Domestic secondary zinc production totaled 272,000 tons compared with 295,000 tons in 1953.

Consumption of slab zinc in 1954 was 884,300 tons compared with the record high of 986,000 tons in 1953. Stocks at primary and secondary smelters declined from 180,000 tons to 120,000, while stocks at consumers' plants or in transit thereto increased from 91,000 tons to 111,000. A significant feature that affected the zinc industry was the alltime record production of galvanized sheets, despite a slump in output of most steel products. Consumption of slab zinc in galvanizing sheets and strip increased from 164,600 tons in 1953 to 181,600 tons in 1954, nearly offsetting the decreased quantity of zinc used for galvanizing tubes and pipe and other products.

In April 1954 the Tariff Commission submitted a report in five parts on its general investigation of the zinc and lead industries, begun in

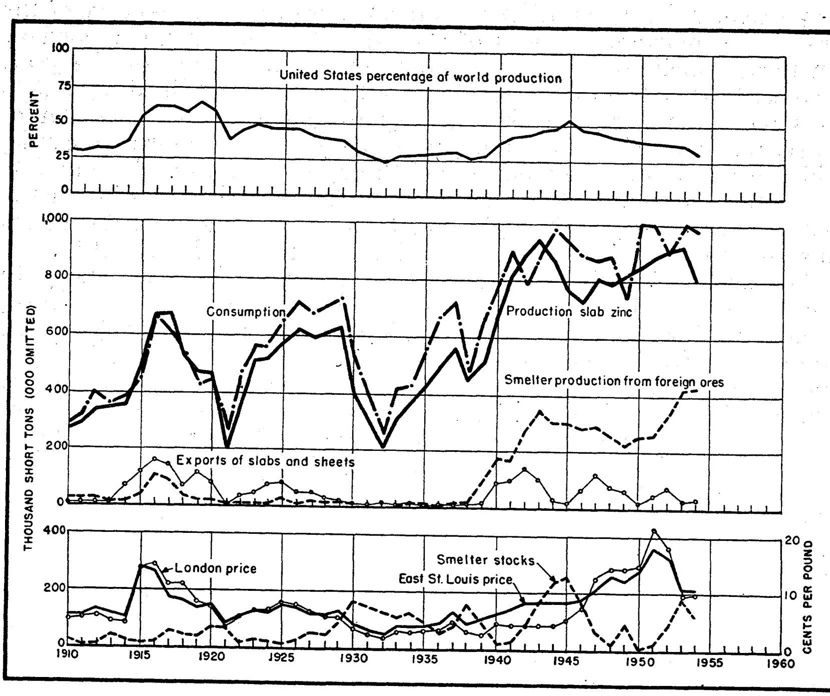

FIGURE 1.—Trends in the zinc industry in the United States, 1910–54. Consumption figures represent primary slab zinc plus zinc contained in pigments made directly from ore.

TABLE 1.—Salient statistics of the zinc industry in the United States, 1945–49 (average) and 1950–54

	1945–49 (average)	1950	1951	1952	1953	1954
Production of primary slab zinc:						
By sources:						
From domestic ores.........short tons..	513,154	588,291	621,826	575,828	495,436	380,312
From foreign ores.................do....	266,419	255,176	259,807	328,651	420,669	422,113
Total..........................do....	779,573	843,467	881,633	904,479	916,105	802,425
By methods:						
Electrolytic............percent of total..	38	41	38	39	40	39
Distilled..........................do...	62	59	62	61	60	61
Production of redistilled secondary slab zinc..........................short tons..	54,132	66,970	48,657	55,111	52,875	68,013
Stocks on hand at primary smelters Dec. 31 short tons..	121,428	7,948	21,343	81,344	[1] 176,725	118,902
Price:						
Prime Western at St. Louis:						
Average for period.....cents per pound..	10.64	13.88	17.99	16.21	10.86	10.69
Highest quotation.................do....	17.50	17.50	19.50	19.50	13.00	11.50
Lowest quotation..................do....	8.25	10.00	17.50	12.50	10.00	9.25
Yearly average at London............do....	10.86	14.89	21.46	18.53	9.47	9.78
Mine production of recoverable zinc: [2] short tons..	609,996	623,375	681,189	666,001	547,430	473,471
Tri-State district (Joplin) percent of total..	18	13	13	14	10	14
Western States.....................do....	54	59	58	58	56	50
Other..............................do....	28	28	29	28	34	36
World smelter production of zinc short tons..	1,720,000	2,170,000	[1] 2,310,000	[1] 2,420,000	2,560,000	2,650,000

[1] Revised figure.
[2] Includes Alaska.

1953 under instructions from congressional committees to determine the relevant facts of production, trade, consumption, and competitive position, including the effect of imports of lead and zinc on the livelihood of American workers. Certain data abstracted from this report were published in the 1953 chapter of this series (Minerals Yearbook, 1953, volume I). Another report of the Tariff Commission made in May on the "escape-clause" provisions of the Trade Agreements Extension Act of 1951 recommended that import duties on most lead and zinc materials be increased 50 percent above those in effect on January 1, 1945. The President did not accept the recommendations of the Tariff Commission but instead, in a statement dated August 23, 1954, outlined an expanded stockpiling program for strengthening the lead and zinc industry as an integral part of the Nation's defense mobilization base.

GOVERNMENT REGULATIONS

The last Government control over domestic use of zinc (that requiring periodic reports on the quantity of slab zinc stocked and consumed) was revoked in 1953, but export licenses continued to be required for exports to all countries except Canada.

GOVERNMENT PROGRAMS UNDER DEFENSE PRODUCTION ACT OF 1950

Provisions of the Defense Production Act of 1950 with respect to exploration continued to be carried out by the Defense Minerals Exploration Administration (DMEA) and those with respect to procurement by the General Services Administration.

DEFENSE MINERALS EXPLORATION ADMINISTRATION

The DMEA program to encourage exploration and increase domestic reserves of strategic and critical minerals and metals was continued throughout 1954, but inasmuch as lead and zinc were not on the list of metals eligible for the program from May 15, 1953, to March 23, 1954, the Government executed only four new exploration contracts for lead and zinc. These provided 50 percent of the approved cost of such programs for a maximum of $1,114,693. From the beginning of the program in 1951 through December 31, 1954, 197 lead and zinc exploration contracts were executed which authorized a maximum Government participation of $8,729,329.[3] Lead-zinc and lead-zinc-copper exploration contracts in 1954 accounted for 4 percent of all DMEA contracts executed and for 36 percent of all the funds obligated; and from the beginning through 1954 accounted for 28 percent of all contracts and 42 percent of the funds obligated.

TABLE 2.—Defense Minerals Exploration Administration contracts involving lead and zinc, by States, executed in 1954

State and contractor	Property	County	Date approved	Total amount [1]
IDAHO				
Hecla Mining Co	Silver Mountain	Shoshone	Oct. 21, 1954	$1,058,370
Sowers, E. H., and Johnson, S. G	Red Leaf group	Blaine	Oct. 19, 1954	10,662
Triumph Mining Co	Triumph	do	Aug. 9, 1954	143,354
TENNESSEE				
American Zinc Co. of Tennessee	West Newmarket group	Jefferson	July 7, 1954	1,017,000
Total				2,229,386

[1] Government participation was 50 percent in exploration projects for lead and zinc in 1954.

GENERAL SERVICES ADMINISTRATION

The General Services Administration (GSA) was responsible for developing expansion programs for metals, minerals, and certain other materials designed to meet objectives established by the Office of Defense Mobilization under the Defense Production Act of 1950, as amended, and for negotiating and executing all contracts under such programs. The scope of the stockpiling program was expanded in March 1954, when President Eisenhower authorized establishment of new long-term metal and mineral stockpile objectives. Pursuant to this new program, long-term objectives for lead and zinc were established and GSA, acting on directives from ODM, purchased lead and zinc each month from June through December 1954.

Direct financial assistance by the United States Government in developing zinc resources in foreign countries was negligible in 1954. The Foreign Operations Administration supplied technical advisors to some countries in connection with development of mineral resources.

[3] Includes sums provided through amendments to contracts and also funds for participation in exploration contracts which were subsequently canceled or terminated upon completion.

DOMESTIC PRODUCTION[4]

Statistics on zinc production are compiled both on a mine and on a smelter basis. The mine-output data, based upon the zinc content of ores shipped and concentrates produced (adjusted to account for average smelting losses), form an accurate measure of domestic zinc output from year to year. Smelter production of slab zinc from domestic ores represents a more accurate figure of zinc-metal recovery but differs from the mine-recovery figure because of a time lag between mine or mill shipments and smelter production and because considerable zinc concentrate is not smelted but rather utilized directly in making zinc pigments and chemicals.

The report of the United States Tariff Commission, based on its general investigation (begun in 1953) of the domestic lead and zinc industries, and the competitive position of the industry with reference to foreign producers under existing tariff structures was published in April 1954.[5] The study was based in part on a canvass of domestic lead- and zinc-mining, milling, smelting, and refining companies and covered employment, wage rates, principal expenses, profit-and-loss experience, and grades and value of ores mined in 1952 and some part for 1953. Where possible, comparisons were made with figures established by the Mineral Census for 1939. Certain data abstracted from this report were published in the report of this series for 1953 (chapter on Zinc, Minerals Yearbook, 1953, volume I).

MINE PRODUCTION

Domestic mine production of recoverable zinc (including 68,800 tons recovered as zinc pigments and salts directly from ores) decreased to 473,500 tons in 1954—14 percent less than the 547,400 tons produced in 1953 and 29 percent under the 666,000-ton output in 1952. The production in 1954 was the smallest since 1934. Although during 1954 the price of zinc rose from a low of 9.25 cents a pound on February 15 to a high of 11.50 cents on September 7, the rise was not enough to stimulate general renewed activity at the mines that closed because of low prices in 1952 and 1953, and some additional mines shut down or curtailed production during the early part of 1954.

Producing mines were widely dispersed in some 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 1954 output, Idaho, Montana, Colorado, Utah, Washington, Arizona, California, Nevada, and New Mexico). A brief review of domestic mine production by areas and major producing States and mines follows. Information in greater detail may be found in the State chapters, Minerals Yearbook, 1954, volume III.

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[4] Production data for 1954 were collected jointly with the Bureau of the Census (U. S. Department of Commerce). Production totals will be compared with the Census totals when they are available and differences adjusted or explained.

[5] U. S. Tariff Commission, Lead and Zinc—Report on Investigation Conducted Under Section 332 of the Tariff Act of 1930 Pursuant to a Resolution by the Committee on Finance of the United States Senate, dated July 27, 1953, and a Resolution by the Committee on Ways and Means House of Representatives, dated July 29, 1953: April 1954, parts I, II, III, IV, and V.

The Western States produced 50 percent of the United States total mine output of zinc in 1954 compared with 56 percent in 1953. Production was 22 percent less than in 1953 and the lowest since 1939. Idaho and Montana, ranking first and second in zinc production in the United States, together contributed over half of the Western States total zinc output. Production in Montana declined 24 percent from 1953 and was the smallest since 1949, owing chiefly to the shutdown of the Anaconda Copper Mining Co. Badger State and Travona mines at Butte and to a 53-day strike beginning August 23 that closed Anaconda's Butte mines. The Butte area in Silver Bow County yielded 88 percent of the State total zinc. The output in other counties came mainly from the Jack Waite mine in Sanders County, Algonquin and Scratch Awl mines in Granite County, and the lead-smelter slag treated at the East Helena fuming plant in Lewis and Clark County.

In Idaho output dropped 15 percent to the lowest point in 15 years owing to decreased output from virtually all mines in the Coeur d'Alene mining region, Shoshone County. This county supplied about 95 percent of the State total zinc production. The Star mine was the principal producer by a wide margin; other mines producing large tonnages of zinc were the Page, Bunker Hill, Frisco, and Sidney. The Triumph mine in Blaine County was the major producer in other areas. Idaho led other States in number of lead-zinc exploration projects and the amount of capital invested in such projects under DMEA contracts executed in 1953 and 1954.

In Washington decreased production by 3 of the 4 largest mines reduced the State output 32 percent from the record high reached in 1953. The Deep Creek mine was idle until May because of low lead and zinc prices; the Grandview mine was closed 5 months by a labor dispute; and the Pend Oreille mine, although in operation throughout 1954, produced a much smaller tonnage of zinc than in the previous year. On the other hand, output from the Van Stone open pit mine, the State's largest zinc producer, increased.

In Colorado, Utah, Arizona, Nevada, California, and New Mexico virtually all new capital available for mining was directed to the exploration and development of mines yielding uranium, tungsten, manganese, or other metals, in which prices were at incentive levels. No zinc or zinc-lead ore was mined in New Mexico in 1954 for the first time since the State became an important producer of zinc in 1903; before the drop in the zinc price in 1952 six large zinc mines and many small producers were in operation.

In Nevada and California zinc production decreased 82 and 74 percent, respectively, following closure early in 1954 of the principal producing mines in these States—the Combined Metals Reduction Co. mine group at Pioche, Nev., and the Darwin mine in Inyo County, Calif.

TABLE 3.—Mine production of recoverable zinc in the United States, 1945–49 (average) and 1950–54, by States, in short tons

State	1945–49 (average)	1950	1951	1952	1953	1954
Western States and Alaska:						
Alaska	10	6	1			
Arizona	52,734	60,480	52,999	47,143	27,530	21,461
California	6,950	7,551	9,602	9,419	5,358	1,415
Colorado	40,707	45,776	55,714	53,203	37,809	35,150
Idaho	80,172	87,890	78,121	74,317	72,153	61,528
Montana	38,628	67,678	85,551	82,185	80,271	60,952
Nevada	20,361	21,606	17,443	15,357	5,812	1,035
New Mexico	38,270	29,263	45,419	50,975	13,373	6
Oregon	2	21	3	1		
South Dakota	10					
Texas	13		24	3		
Utah	37,551	31,678	34,317	32,947	29,184	34,031
Washington	12,040	14,807	18,189	20,102	32,786	22,304
Total	327,448	366,756	397,383	385,652	304,276	237,882
West Central States:						
Arkansas	88	8	50	26		
Kansas	40,521	27,176	28,904	25,482	15,515	19,110
Missouri	14,771	8,189	11,476	13,986	9,981	5,210
Oklahoma	55,553	46,739	53,450	54,916	33,413	43,171
Total	110,933	82,112	93,880	94,410	58,909	67,491
States east of the Mississippi River:						
Illinois	11,664	26,982	21,776	18,816	14,556	14,427
Kentucky	516	731	3,457	3,280	489	458
New Jersey	70,006	55,029	62,917	59,190	45,700	37,416
New York	32,830	38,321	40,051	32,636	51,529	53,199
Tennessee	29,792	35,326	38,639	38,020	38,465	30,326
Virginia	15,763	12,396	7,332	13,409	16,676	16,738
Wisconsin	11,044	5,722	15,754	20,588	16,830	15,534
Total	171,615	174,507	189,926	185,939	184,245	168,098
Grand total	609,996	623,375	681,189	666,001	547,430	473,471

Colorado's output of zinc decreased 7 percent from 1953 following a 29-percent decline in 1953 from 1952. The principal producing mines in 1954 were the Eagle, Treasury Tunnel-Black Bear, Resurrection, and Rico Argentine. Arizona's output, which dropped for the fifth consecutive year, was 22 percent less than in 1953; the Athletic, Coronado, Flux, Iron King, and Manhattan mines were the State's only steady zinc producers in 1954. In Utah zinc production increased 17 percent owing to resumption of mining lead-zinc ore in September at the Park Utah mine, idle since June 26, 1952, and increased output from the Chief No. 1 mine. The United States and Lark mine continued to be much the largest zinc producer in the State, and the West Calumet was among the important producers.

The West Central group of States showed an overall increase of 8,600 tons or 15 percent in mine output of zinc in 1954 over 1953, but the 1953 production (58,900 tons) was unusually low owing to the strike that closed the Tri-State mines and the Central mill of the Eagle-Picher Co., largest zinc producer in the West Central States, for more than 6 months. Although Eagle-Picher Co. operations were resumed January 4, 1954, the West Central States output in 1954 was still 29 percent less than that in 1952. Eagle-Picher Co.

operated a number of mines in the Oklahoma and Kansas parts of the Tri-State district and the Central and Bird Dog mills in the Oklahoma part. The Ballard mine and mill of the National Lead Co. in Kansas resumed operations in May, while the Quick Seven mine and mill of the American Zinc, Lead & Smelting Co. in Missouri was closed permanently in June because of depleted ore reserves. Other important producers in the Tri-State district included the American Zinc, Lead & Smelting Co. (Oklahoma mines), Buffalo Mining Co. (Oklahoma), and John Henderson (Oklahoma-Kansas). The only mine output of zinc in the West Central States outside the Tri-State district in 1954 was 3,000 tons recovered as a byproduct of the lead mines in southeastern Missouri. Production from this source increased 58 percent over 1953 owing chiefly to the zinc-concentrate output from the new Indian Creek mine-mill operation of the St. Joseph Lead Co. There was no mine production of zinc in Arkansas in 1953 or 1954.

Mine production of recoverable zinc in States east of the Mississippi River declined 9 percent to 168,100 tons in 1954 and was the lowest since 1949. Output decreased in 5 of the 7 producing States. New York, the principal producer, gained 3 percent over 1953 and established a new record high of 53,200 tons for the State. The production came from St. Lawrence County, where the Balmat and Edwards mines of the St. Joseph Lead Co. operated continuously. In Virginia production increased slightly over 1953; the Austinville mine and 2,400-ton mill of the New Jersey Zinc Co. in Wythe County operated throughout the year, and development work continued at the company Ivanhoe mine 2½ miles southwest of Austinville.

Output in New Jersey, which ranked second among the Eastern States in zinc production, decreased 18 percent from 1953. The Franklin mine of the New Jersey Zinc Co. in Sussex County was closed on October 1, 1954, after more than 100 years of continuous operation. The nearby Sterling Hill mine continued operations throughout the year.

Zinc production in Tennessee declined owing to the sustained low price of zinc. The leading producers were the Mascot No. 2, Grasselli, and North Friends Station of the American Zinc Co. of Tennessee and the Davis-Bible mine of the Tennessee Coal & Iron Division of the United States Steel Corp.

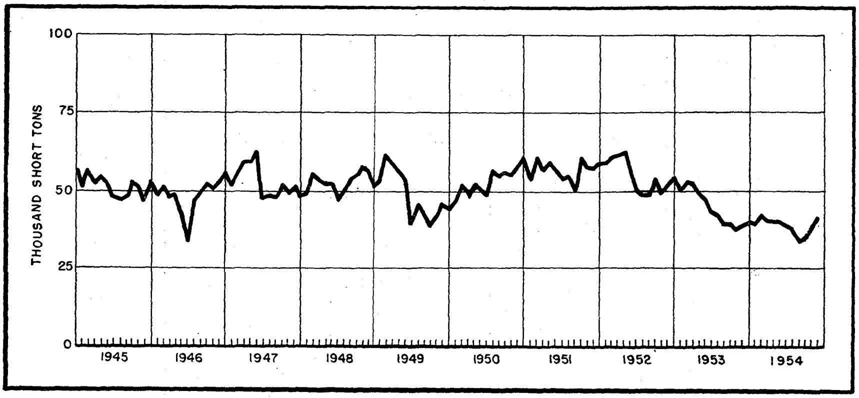

FIGURE 2.—Mine production of recoverable zinc in the United States, 1945–54, by months, in short tons.

TABLE 4.—Mine production of recoverable zinc in the United States,[1] 1953–54, by months, in short tons

Month	1953	1954	Month	1953	1954
January	54,034	40,148	August	41,677	38,808
February	50,356	39,508	September	39,893	34,833
March	52,726	42,706	October	39,635	35,957
April	52,119	40,357	November	37,699	39,375
May	48,840	40,510	December	39,919	41,305
June	47,310	40,936			
July	43,222	39,028	Total	547,430	473,471

[1] Includes Alaska.

In Illinois the mine of the Tri-State Zinc, Inc., at Galena continued to be the leading zinc producer. The Eagle-Picher Co. Graham Central mill at Galena, which was destroyed by fire in March 1953, resumed operations in June 1954. In Wisconsin many of the small operators that usually produced zinc were kept idle by continuance of the low zinc price. Only the Vinegar Hill Zinc Co. and the Calumet & Hecla, Inc., mines were in production the entire year. The Eagle-Picher Co. bought all Calumet & Hecla, Inc., holdings in Wisconsin in August and began operations as of August 15.

The 25 leading zinc-producing mines in the United States in 1954, listed in table 5, yielded 72 percent of the total domestic zinc output; the 3 leading mines 28 percent; and the 6 leading mines 40 percent.

TABLE 5.—Twenty-five leading zinc-producing mines in the United States in 1954, in order of output

Rank	Mine	District	State	Operator	Type of ore
1	Butte Mines	Summit Valley (Butte)	Montana	Anaconda Copper Mining Co	Lead-zinc.
2	Balmat	St. Lawrence County	New York	St. Joseph Lead Co	Do.
3	Franklin and Sterling Hill	New Jersey	New Jersey	New Jersey Zinc Co	Zinc.
4	United States and Lark	West Mountain (Bingham)	Utah	U. S. Smelting, Refining & Mining Co	Lead-zinc.
5	Eagle Group	Red Cliff (Battle Mountain)	Colorado	Empire Zinc Division, New Jersey Zinc Co	Do.
6	Star	Hunter	Idaho	Sullivan Mining Co	Do.
7	Austinville	Austinville	Virginia	New Jersey Zinc Co	Do.
8	Mascot No. 2	Eastern Tennessee	Tennessee	American Zinc Co. of Tennessee	Zinc.
9	Van Stone	Northport	Washington	American Smelting & Refining Co	Lead-zinc.
10	Old slag dump	Yreka	Idaho	Bunker Hill & Sullivan Mining & Concentrating Co	Zinc slag.
11	Edwards	St. Lawrence County	New York	St. Joseph Lead Co	Zinc.
12	Iron King	Big Bug	Arizona	Shattuck Denn Mining Corp	Lead-zinc.
13	Page	Yreka	Idaho	American Smelting & Refining Co	Do.
14	Davis-Bible Group	Eastern Tennessee	Tennessee	United States Steel Corp., Tennessee Coal & Iron Division	Zinc.
15	Treasury Tunnel	Upper San Miguel	Colorado	Idarado Mining Co	Copper-lead-zinc.
16	Bautsch and Luning	Northern Illinois	Illinois	Tri-State Zinc Co., Inc	Lead-zinc.
17	Pend Oreille	Metaline	Washington	Pend Oreille Mines & Metals Co	Do.
18	Bunker Hill and Sullivan	Yreka	Idaho	Bunker Hill & Sullivan Mining & Concentrating Co	Do.
19	Old slag dump	Summit	Montana	Anaconda Copper Mining Co	Zinc slag.
20	Calumet and Hecla	Wisconsin	Wisconsin	Eagle-Picher Co	Zinc.
21	Ballard Group	Tri-State	Kansas	National Lead Co., St. Louis Smelting & Refining Division	Do.
22	Barbara J	Tri-State	Oklahoma	American Zinc Lead Smelting Co	Do.
23	Mayflower-Galena	Park City Region	Utah	New Park Mining Co	Lead-zinc.
24	Blackstone, Hancock, and Mulcahy.	Wisconsin	Wisconsin	Vinegar Hill Zinc Co	Zinc.
25	Chief No. 1	Tintic	Utah	Chief Consolidated Mining Co	Lead-zinc.

TABLE 6.—Mine production of zinc in the principal districts [1] of the United States, 1945–49 (average) and 1950–54, in terms of recoverable zinc, in short tons

District	State	1945–49 (average)	1950	1951	1952	1953	1954
Tri-State (Joplin region)	Kansas, Southwestern Missouri, Oklahoma	110,223	80,558	91,553	90,512	55,729	64,322
Coeur d'Alene	Idaho	76,576	86,103	74,989	70,316	68,650	58,736
Summit Valley (Butte)	Montana	31,358	63,511	80,500	75,968	75,170	53,527
St. Lawrence County	New York	32,830	38,321	40,051	32,636	51,529	53,199
New Jersey	New Jersey	70,007	55,029	62,917	59,190	45,700	37,416
Eastern Tennessee [2]	Tennessee	29,792	35,326	38,639	38,020	38,465	30,326
Upper Mississippi Valley	Northern Illinois, Iowa,[3] Wisconsin.	17,329	26,793	31,403	34,716	26,286	25,441
West Mountain (Bingham)	Utah	17,419	16,120	18,286	20,395	19,669	20,489
Red Cliff	Colorado	16,684	19,956	29,200	26,000	16,850	18,604
Austinville	Virginia	15,748	12,396	7,332	13,409	16,676	16,738
Big Bug	Arizona	5,955	10,416	9,688	10,862	10,476	10,453
Upper San Miguel	Colorado	2,996	8,881	9,228	9,811	10,414	7,899
Park City region	Utah	9,189	7,425	10,209	7,746	4,848	6,650
Smelter (Lewis and Clark County).	Montana	2,572	2,358	2,428	2,807	2,924	5,301
Kentucky-Southern Illinois	Kentucky, Southern Illinois.	5,894	6,642	9,584	7,968	5,589	4,978
Tintic	Utah	4,074	5,985	3,410	2,951	2,433	4,335
Harshaw	Arizona	2,124	4,193	4,076	3,924	4,186	4,193
Cochise	do	2,391	1,025	3,243	4,266	3,893	3,566
Pioneer (Rico)	Colorado	3,064	1,365	2,527	2,734	2,634	2,896
Warm Springs	Idaho	2,186	1,236	1,860	2,142	3,026	2,584
California (Leadville)	Colorado	6,081	7,392	8,144	8,487	3,945	2,437
Rush Valley and Smelter (Tooele County).	Utah	5,093	1,219	1,608	916	1,528	1,738
Yavapai	Arizona	477	921	1,404	1,315	1,732	1,366
Flint Creek	Montana	41	120	392	1,084	(4)	1,290
Breckenridge	Colorado	729	427	366	620	1,200	1,186
Eureka (Bagdad)	Arizona	1,126	1,478	2,504	3,520	2,594	1,126
Creede	Colorado	155	873	892	1,024	858	1,111
Sneffels	do	612	810	1,094	931	(5)	712
Patagonia (Duquesne)	Arizona	547	368	601	1,049	257	54
Animas	Colorado	1,094	961	1,183	986	541	15
Old Hat (Oracle)	Arizona	4,281	4,603	3,583	3,368	-------	1
Chelan Lake [5]	Washington	2,232	2,430	1,879	(4)	(4)	(4)
Coso [5]	California	2,202	5,237	4,720	5,479	(4)	(4)
Heddleston [5]	Montana	1,668	892	1,395	1,066	-------	(4)
Metaline [5]	Washington	7,543	11,032	12,753	(4)	(4)	(4)
Northport [5]	do	2,134	1,304	3,496	(4)	(4)	(4)
Pioche [5]	Nevada	16,793	19,655	14,350	12,493	(4)	(4)
Silver Bell [5]	Arizona	46	11	-------	364	1,324	(4)
Central	New Mexico	33,639	26,897	41,884	48,043	12,743	-------
Cow Creek (Ingot)	California	(4)	(4)	(4)	(4)	-------	-------
Magdalena	New Mexico	3,730	1,677	2,276	2,122	512	-------
Pima (Sierritas, Papago, Twin Buttes).	Arizona	5,061	5,802	5,414	3,472	11	-------
Pioneer (Superior)	do	459	2,595	6,240	4,175	-------	-------
Ten Mile	Colorado	5,855	2,925	16	12	-------	-------
Tomichi	do	1,199	963	1,011	874	-------	-------
Verde (Jerome)	Arizona	962	7,800	10,155	4,360	959	-------
Warren (Bisbee)	do	27,212	20,707	4,511	4,791	1,182	-------
Yellow Pine (Goodsprings)	Nevada	655	643	1,332	1,464	-------	-------

1 Districts producing 1,000 short tons or more in any year of the period, 1950–54.
2 Includes zinc recovered from copper-zinc-pyrite ore in Polk County.
3 No production in Iowa since 1917.
4 Quantity withheld to avoid disclosure of individual company operations.
5 This district not listed in order of 1954 output.

SMELTER PRODUCTION

Seventeen primary zinc-reduction plants produced slab zinc in the United States in 1954 compared with 18 in 1953. Eight of the reduction plants operated with horizontal retorts exclusively, 4 with vertical retorts exclusively (1 wholly electrothermic and 1 partly so), and 5 with electrolytic methods. The retort furnaces at the Fairmont City plant of the American Zinc Co. of Illinois at East St. Louis, closed November 1, 1953, were idle throughout 1954, but the roasting and sintering units and the sulfuric acid plant operated.

Horizontal-Retort Plants.—The total number of retorts reported at active horizontal-retort primary plants in 1954 was 54,496 compared with 55,900 in 1953. Of the total retorts reported, 34,488 (63 percent) were in use at the end of 1954 compared with 38,800 (69 percent) at the close of 1953. No additional retorts were being constructed at the end of 1954.

Two Dorrco Fluosolids reactors were installed at the Bartlesville, Okla., plant of the National Zinc Co. early in 1954, replacing two roasters of an older type. The reactors deliver an 11 percent SO_2 gas to a contact acid plant and a calcine of controlled sulfur content for sintering before retort zinc production.

Vertical-Retort Plants.—Four vertical-retort, continuous distilling plants operated during 1954, the same number as in 1953. Three of these used the New Jersey Zinc Co. externally gas-fired vertical retorts, and the fourth used the St. Joseph Lead Co. electrothermically heated vertical retort in which the charge forms the resistor. The New Jersey Zinc Co. also continued to use its Sterling arc-type electric furnace, which was first put in operation experimentally in 1951.

The new zinc-slag furnace at the Herculaneum lead smelter of the St. Joseph Lead Co. was nearing completion at the end of 1954 and was expected to be put in operation in March 1955. The total number of vertical retorts of all types at the end of 1954, as at the beginning of the year, was 91. Of this number, 75 were in operation at the end of the year.

Electrolytic Plants.—Five electrolytic zinc-reduction plants, with a total of 3,720 electrolytic cells, were operated in 1954; 3,317 cells were in use at the end of the year. In 1953 there were 3,692 cells, of which 3,464 were operating at the end of the year.

Smelting Capacity.—Owing to changes in metallurgical practice in the various plants, statistics on domestic smelting capacity may vary from year to year, irrespective of additions or subtractions of smelter recovery units. According to reports to the Bureau of Mines, the active zinc-reduction plants in the United States, as of the end of 1954, had an annual capacity of 1,150,600 short tons of slab zinc. This figure indicates that smelter output was 76 percent of capacity. In 1953 smelter production was 84 percent of the reported capacity of 1,147,000 tons. Horizontal- and vertical-retort primary plants operated at 78 percent of the 668,700 tons reported capacity (83 percent of a 677,000-ton reported capacity in 1953), electrolytic plants at 73 percent of a 425,500-ton reported capacity (90 percent of a 412,500-ton capacity in 1953), and secondary smelters at 64 percent of a 56,400-ton reported capacity (61 percent of 58,000-ton capacity in 1953).

Waelz Kilns.—Waelz kilns operated in 1954 or available for operation during the year were as follows:

Arkansas: Fort Smith—The Residue Co.
Illinois:
- Danville—The Hegeler Zinc Co.[6]
- Fairmont City—American Zinc Co. of Illinois.[7]
- La Salle—Matthiessen & Hegeler Zinc Co.

Kansas: Cherryvale—National Zinc Co., Inc.[8]

[6] Plant sold and dismantled in August 1954.
[7] Plant idle entire year.
[8] Plant closed in August 1954.

Oklahoma: Henryetta—Eagle-Picher Co.
Pennsylvania:
Donora—American Steel & Wire Division, United States Steel Corp.
Palmerton—New Jersey Zinc Co.

Slag-Fuming Plants.—The following companies operated slag-fuming plants in 1954 to produce impure zinc oxide, which was treated further to recover the zinc as slab zinc:

California: Selby—American Smelting & Refining Co.
Idaho: Kellogg—Bunker Hill & Sullivan Mining & Concentrating Co
Montana: East Helena—Anaconda Copper Mining Co.
Texas: El Paso—American Smelting & Refining Co.
Utah: Tooele—International Smelting & Refining Co.

During 1954 these 5 plants treated 728,200 tons of hot and cold slag, which yielded 116,800 tons of oxide fume containing 80,600 tons of recoverable zinc. Corresponding figures for 1953 were 656,600, 113,800, and 79,200 tons, respectively.

Active Zinc-Reduction Plants.—Monthly production rates at zinc-reduction plants as a whole showed wider variation in 1954 than in 1953. Total smelter stocks of slab zinc at the beginning of the year, already the largest in 9 years, increased to 200,000 tons in February, and the price of zinc sank to the year low of 9.25 cents in the same month. A number of the smelters curtailed production in February and March in an effort to reduce stocks. Some smelters that had cut back production late in 1953 made further reductions in early 1954. Increases in the price of zinc in April and May, the beginning of Government purchases for the National Stockpile in June, and improvement in the commercial demand for zinc led to a pronounced reduction in stocks and a return to higher production rates toward the end of the year. A strike interrupted operations at the Anaconda Copper Mining Co. Montana smelters (as well as the mines and mills) from August 23 to October 15. The Fairmont City smelter of the American Zinc Co. of Illinois at East St. Louis, Ill., did not produce slab zinc in 1954, but the roasting, sintering, cadmium, and germanium units and the sulfuric acid plant continued to operate.

The new zinc-slag furnace at the St. Joseph Lead Co. Herculaneum smelter was nearing completion in 1954 and was expected to be put in operation in March 1955. At the Palmerton, Pa., zinc smelter of the New Jersey Zinc Co. the second enlarged and improved mechanical zinc oxide furnace was put in operation.

A list of zinc-reduction plants operating in the United States in 1954 follows:

Primary Zinc Distillers

Horizontal-retort plants

Arkansas: Fort Smith—Athletic Mining & Smelting Co.
Illinois: Fairmont City—American Zinc Co. of Illinois.[9]
La Salle—Matthiessen & Hegeler Zinc Co.
Oklahoma:
Bartlesville—National Zinc Co., Inc.
Blackwell—Blackwell Zinc Co.
Henryetta—Eagle-Picher Co.
Pennsylvania: Donora—American Steel & Wire Div., United States Steel Corp.

[9] Roasting and sintering, cadmium, and germanium units operated; furnaces idle entire year and therefore no slab zinc was produced.

Texas:
- Amarillo—American Smelting & Refining Co.
- Dumas—American Zinc Co. of Illinois.

Vertical-retort plants

Illinois: Depue—The New Jersey Zinc Co.
Pennsylvania:
- Josephtown—St. Joseph Lead Co.
- Palmerton—The New Jersey Zinc Co. of Pennsylvania.

West Virginia: Meadowbrook—Matthiessen & Hegeler Zinc Co.

Electrolytic plants

Idaho: Kellogg—Sullivan Mining Co.
Illinois: Monsanto—American Zinc Co. of Illinois.
Montana:
- Anaconda—Anaconda Copper Mining Co.
- Great Falls—Anaconda Copper Mining Co.

Texas: Corpus Christi—American Smelting & Refining Co.

Secondary Zinc Smelters.—Zinc-base scrap, a term that includes skimmings and drosses, die-cast alloys, old zinc, engravers' plates, new clippings, and chemical residues, was chiefly smelted at 12 secondary smelters, although about one-third is usually reduced at primary smelters, and much of the sal ammoniac skimmings is processed at chemical plants. Secondary smelters depend mostly on the galvanizers and dealers for their supply of the various types of scrap materials.

The primary and secondary smelting operations based on zinc-base scrap produced 68,000 tons of redistilled zinc, 4,500 tons of remelt zinc, and 26,700 tons of zinc dust in 1954.

In addition to secondary zinc and zinc products recovered from zinc-base scrap at primary and secondary smelters and other plants, 132,100 tons of zinc were recovered from copper-base scrap, chiefly in the form of brass and bronze. Additional details of the secondary zinc phase of the industry may be obtained from 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.

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.
- Philadelphia—General Smelting Co.

West Virginia: Wheeling—Wheeling Steel Corp.

SLAB ZINC

Production of primary slab zinc in 1954 was 802,000 tons, a decrease of 114,000 tons or 12 percent from 1953 and the lowest since

1948. Slab zinc from domestic ores declined 23 percent compared with 1953, but that from foreign ores increased slightly.

The output of redistilled slab zinc increased 29 percent to 68,000 tons; most of the increase was in the quantity redistilled at primary smelters, which composed 47 percent of the total in 1954 compared with 33 percent in 1953. In addition to primary distilled zinc and redistilled secondary zinc, 4,500 tons of remelted secondary slab zinc was recovered by remelting purchased scrap (2,900 tons in 1953). Zinc rolling mills and other large consumers of slab zinc recovered large quantities of slab zinc from "runaround" scrap generated in their own plants, but metal so recovered is not measured statistically by the Federal Bureau of Mines.

TABLE 7.—Primary and redistilled secondary slab zinc produced in the United States, 1945–49 (average) and 1950–54, in short tons

Year	Primary			Redistilled secondary	Total (excludes zinc recovered by remelting)
	From domestic ores	From foreign ores	Total		
1945–49 (average)	513,154	266,419	779,573	54,132	833,705
1950	588,291	255,176	843,467	66,970	910,437
1951	621,826	259,807	881,633	48,657	930,290
1952	575,828	[1] 328,651	904,479	55,111	959,590
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

[1] Includes a small tonnage of slab zinc further refined into high-grade metal.

TABLE 8.—Distilled and electrolytic zinc, primary and secondary, produced in the United States, 1945–49 (average) and 1950–54, in short tons

CLASSIFIED ACCORDING TO METHOD OF REDUCTION

Year	Electrolytic primary	Distilled	Redistilled secondary [1]		Total
			At primary smelters	At secondary smelters	
1945–49 (average)	297,074	482,499	22,512	31,620	833,705
1950	342,085	501,382	28,411	38,559	910,437
1951	336,087	545,546	16,251	32,406	930,290
1952	351,106	553,373	18,861	36,250	959,590
1953	370,870	545,235	17,645	35,230	968,980
1954	311,237	491,188	31,658	36,355	870,438

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		
1945–49 (average)	234,925	193,113	35,723	62,897	10,239	296,808	833,705
1950	271,678	192,075	21,571	46,730	4,021	374,362	910,437
1951	281,571	175,499	20,734	60,511	13,494	378,481	930,290
1952	295,801	182,125	17,903	48,817	13,608	401,336	959,590
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

[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, 1945–49 (average) and 1950–54, in short tons

Year	Arkansas	Idaho	Illinois	Montana	Oklahoma	Pennsylvania	Texas and West Virginia[1]	Total	
								Short tons	Value
1945–49 (average)	19,594	38,732	104,430	197,532	126,827	180,248	112,210	779,573	$169,056,347
1950	20,688	53,922	108,301	216,104	145,117	162,539	136,796	843,467	240,050,708
1951	21,776	54,468	108,544	208,482	161,247	189,177	137,939	881,633	321,619,718
1952	21,644	54,340	115,331	214,980	161,242	193,811	143,131	904,479	300,829,715
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

[1] Includes Missouri, 1944 and 1947–53.

Of the primary slab zinc produced in 1954, 61 percent was distilled and 39 percent produced electrolytically. The output of all grades except Intermediate decreased from 1953, ranging from 2 percent for Prime Western to 36 percent for Select. Prime Western constituted nearly 46 percent of the total in 1954 (42 percent in 1953), Special High Grade 31 percent (32 percent in 1953), High Grade 15 percent (19), Brass Special 6 percent in both years, Intermediate 2 percent (1), and Select less than 0.5 percent in both years.

Pennsylvania ranked first among the States in production of primary slab zinc in 1954, regaining the leading position held from 1934 through 1942 and in 1945. Montana, which ranked first in 1943, 1944, and 1946–53, ranked second in 1954, as operations at the electrolytic plants at Anaconda and Great Falls were interrupted 53 days by a strike. Oklahoma ranked third, as in other recent years. 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 all other States was distilled.

BYPRODUCT SULFURIC ACID

Sulfuric acid is made from sulfur dioxide gases produced in roasting zinc blende (sphalerite) concentrate at all zinc smelters where there is enough demand for sulfuric acid to warrant the plant investment and

TABLE 10.—Sulfuric acid (basis, 100 percent) made at zinc-blende roasting plants in the United States, 1945–49 (average) and 1950–54

Year	Made from zinc-blende[1]		Made from native sulfur		Total[1]		
						Value[2]	
	Short tons	Value[2]	Short tons	Value[2]	Short tons	Total	Average per ton
1945–49 (average)	552,116	$7,508,595	205,255	$2,785,253	757,371	$10,293,848	$10.61
1950	609,571	8,829,236	243,743	3,530,464	853,314	12,359,700	11.25
1951	635,948	10,218,400	261,106	4,195,451	897,054	14,413,851	12.48
1952	664,714	11,031,494	224,671	3,728,613	889,385	14,760,107	12.89
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

[1] Includes acid from foreign blende.
[2] At average of sales of 60° B. acid.

operation. At several such plants large quantities of elemental sulfur are also burned to increase acidmaking capacity. The production of sulfuric acid at such plants from 1950 through 1954 is shown in table 10.

ZINC DUST

Production of zinc dust in 1954 was 26,700 tons compared with 25,300 tons in 1953. 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 1954 ranged from 95.1 percent to 99.8 and averaged 97.9 percent. Shipments of zinc dust were 26,200 tons, of which 300 tons was for foreign consignees. Producers' stocks of zinc dust rose from 1,900 tons at the beginning of the year to 2,100 tons at the end of 1954.

The average price of all zinc dust shipped in 1954 was 13.6 cents a pound compared with 13.3 cents in 1953. Most of the production is from zinc scrap (principally galvanizers' dross), but some is 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, 1945–49 (average) and 1950–54

Year	Short tons	Value		Year	Short tons	Value	
		Total	Average per pound			Total	Average per pound
1945–49 (average)	28,009	$7,024,183	$0.125	1952	25,113	$9,794,070	$0.195
1950	28,922	9,602,104	.166	1953	25,297	[2] 6,729,002	.133
1951	31,695	13,438,680	.212	1954	26,714	7,266,208	.136

[1] All produced by distillation.
[2] Revised figure.

ZINC PIGMENTS AND SALTS

The principal zinc pigments are zinc oxide and lithopone and the principal salts the chloride and sulfate. These products are manufactured from various zinc-bearing materials, including ore, metal, scrap, and residues. In all, 153,000 tons of zinc was consumed in these products in 1954, of which 99,000 tons was derived from ore (foreign 30,000 tons), 19,000 tons from slab zinc, and 35,000 tons from secondary materials. Details of the production of zinc pigments and salts are given n the Lead and Zinc Pigments and Zinc Salts chapter of this volume.

CONSUMPTION AND USES

According to reports from approximately 750 plants, 884,300 tons of slab zinc was consumed in 1954 compared with 986,000 tons in 1953, a record year. Consumption during the first 9 months of 1954 averaged 70,000 tons per month but rose to 80,000 tons in October and 82,000 tons in both November and December.

As usual, galvanizing was the largest field of zinc use, with 403,500 tons or 46 percent of the total slab zinc consumed in 1954; in 1953 galvanizing composed 41 percent of the total. A significant feature that affected the industry in 1954 was the alltime record production of galvanized sheets, despite a slump in the output of most steel products. Consumption of slab zinc in galvanizing sheets and strips increased 10 percent from 164,600 tons in 1953 to 181,600 tons in 1954. This gain nearly offset a decrease in the quantity of zinc used for galvanizing tube and pipe and other items. The manufacture of zinc-base alloys (chiefly die castings) required 290,800 tons of zinc, or 5 percent less than in 1953. The expanding use of zinc in die castings, particularly castings for functional and decorative trim parts on home appliances and automobiles, contributed materially to the general improvement in the zinc market in the latter part of the year. Slab zinc consumed in making brass decreased 39 percent to 108,300 tons, the lowest since 1949. In addition to the slab zinc consumed in brassmaking in 1954, 132,100 tons of secondary zinc in the form of copper-base scrap was consumed in making brass and bronze ingots at secondary smelters.

Slab zinc consumed in rolled-zinc products in 1954 decreased 13 percent to 47,500 tons. In addition to slab zinc, the rolling mills remelt and reroll the metallic scrap (home scrap) produced from

TABLE 12.—Consumption of slab zinc in the United States, 1945–49 (average) and 1950–54, by industries, in short tons [1]

Industry and product	1945–49 (average)	1950	1951	1952	1953	1954
Galvanizing: [2]						
Sheet and strip	126,326	188,406	144,329	145,875	164,601	181,558
Wire and wire rope	45,722	47,317	51,792	48,645	44,100	44,882
Tubes and pipe	72,553	91,877	79,221	82,043	88,428	76,891
Fittings	11,320	15,948	21,186	10,366	10,330	10,513
Other	92,102	98,138	103,751	90,759	99,529	89,619
Total galvanizing	348,023	441,686	400,279	377,688	406,988	403,463
Brass products:						
Sheet, strip, and plate	71,536	68,737	67,815	71,706	94,826	52,284
Rod and wire	42,213	43,413	46,056	49,831	47,312	30,899
Tube	16,975	17,385	15,927	17,057	18,136	12,097
Castings and billets	5,544	4,170	7,098	7,262	8,145	5,499
Copper-base ingots	5,564	4,081	5,743	8,223	7,659	6,594
Other copper-base products	1,268	1,587	653	1,529	2,104	895
Total brass products	143,100	139,373	143,292	155,608	178,182	108,268
Zinc-base alloy:						
Die castings	193,816	285,022	282,812	225,877	297,280	279,676
Alloy dies and rod	4,519	2,929	11,135	9,235	7,140	8,857
Slush and sand castings	530	1,576	2,487	1,577	3,025	2,313
Total zinc-base alloy	198,865	289,527	296,434	236,689	307,445	290,846
Rolled zinc	78,508	68,444	64,085	51,318	54,649	47,486
Zinc oxide	16,322	18,187	18,223	17,205	20,675	18,701
Other uses:						
Wet batteries	1,523	1,527	1,749	1,396	1,417	1,264
Desilverizing lead	2,333	2,947	2,186	2,370	2,425	2,740
Light-metal alloys	961	1,356	3,132	3,266	5,939	3,526
Other [3]	4,263	4,087	4,591	7,243	8,207	8,005
Total other uses	9,080	9,917	11,658	14,275	17,988	15,535
Total consumption [4]	793,898	967,134	933,971	852,783	985,927	884,299

[1] Excludes some small consumers.
[2] Includes zinc used in electrogalvanizing and electroplating, but excludes sherardizing.
[3] Includes zinc used in making zinc dust, bronze powder, alloys, chemicals, castings, and miscellaneous uses not elsewhere mentioned.
[4] Includes 3,035 tons of remelt zinc in 1950, 4,505 tons in 1951, 4,144 tons in 1952, 3,710 tons in 1953, and 3,589 tons in 1954.

associated fabricating operations. The scrap so treated totaled 12,300 tons compared with 13,100 tons in 1953. Purchased zinc scrap in the form of zinc clippings, old zinc scrap, and engravers' plates, totaling 3,400 tons, was melted and rolled in 1954 (3,600 tons in 1953). Production of rolled zinc from both slab zinc and purchased scrap was 49,000 tons or 13 percent less than the 1953 total of 56,400 tons. Stocks of rolled zinc were 1,500 tons at the end of 1954. In addition to shipments of 33,200 tons of rolled zinc in 1954, the rolling mills processed 28,300 tons of rolled zinc in manufacturing 16,900 tons of semifabricated and finished products.

TABLE 13.—Rolled zinc produced and quantity available for consumption in the United States, 1953–54

	1953			1954		
	Short tons	Value		Short tons	Value	
		Total	Average per pound		Total	Average per pound
Production:						
Sheet zinc not over 0.1 inch thick	13,411	$7,416,190	$0.276	12,786	$6,985,291	$0.273
Boiler plate and sheets over 0.1 inch thick	1,014	473,375	.233	1,117	477,697	.214
Strip and ribbon zinc [1]	40,603	14,433,514	.178	33,492	12,040,429	.180
Foil, rod, and wire	1,359	679,475	.250	1,640	839,564	.256
Total rolled zinc	56,387	23,002,554	.204	49,035	20,342,981	.207
Imports	196	76,507	.195	259	88,010	.170
Exports	3,239	1,696,142	.262	2,960	1,443,995	.244
Available for consumption	[2] 53,635			46,404		
Value of slab zinc (all grades)			.115			.108
Value added by rolling			.089			.099

[1] Figures represent net production. In addition 13,113 tons of strip and ribbon zinc in 1953 and 12,280 tons in 1954 were rerolled from scrap originating in fabricating plants operated in connection with zinc rolling mills.
[2] Revised figure.

Consumption of the six commercial grades of refined slab zinc and purchased remelt zinc by the various industries in 1954 is shown in table 14. Of the 884,300 tons of domestic and foreign slab zinc consumed, 40 percent was Prime Western, 39 percent Special High Grade, 10 percent High Grade, 7 percent Brass Special, 3 percent Intermediate, and 1 percent combined Select and Remelt. All

TABLE 14.—Consumption of slab zinc in the United States in 1954, by grades and industries, in short tons

Industry	Special High Grade	High Grade	Intermediate	Brass Special	Select	Prime Western	Remelt	Total
Galvanizers	14,954	19,269	9,080	30,644	110	327,526	1,880	403,463
Brass mills [1]	28,512	54,924	1,524	5,605	1,579	15,248	876	108,268
Die casters [2]	290,003	18	32			627	166	290,846
Zinc rolling mills	8,054	15,473	11,001	12,240	82	636		47,486
Oxide plants	468	58		12,648		5,527		18,701
Other	5,320	1,327	512	371		7,338	667	15,535
Total	347,311	91,069	22,149	61,508	1,771	356,902	3,589	884,299

[1] Includes brass mills, brass ingot makers, and brass foundries.
[2] Includes producers of zinc-base die castings, zinc-alloy dies, and zinc-alloy rods.

grades were used in galvanizing; Prime Western grade was used mainly in hot-dip galvanizing and the higher grades for electrogalvanizing. Of the 108,300 tons of slab zinc used in brass products, 77 percent was Special High Grade and High Grade, as rigid specifications in brass manufacture dictate the use of high-grade metal.

CONSUMPTION OF SLAB ZINC BY GEOGRAPHIC AREAS

Data on slab-zinc consumption, broken down by States and groups of States, have been published by the Bureau of Mines [10] for 1940 through the current year to give information by which patterns of consumption on an industry and geographic basis may be compared. The distribution of slab-zinc consumption by geographic divisions and by major use categories for recent years is shown in tables 15–20.

Consumption of Slab Zinc for All Uses.—The region comprising Illinois, Indiana, Michigan, Ohio, and Wisconsin has used approximately half of the slab zinc consumed in the United States in each of the 15 years for which figures on a geographic basis are available. The region of least consumption is the Mountain States group, made up of Arizona, Colorado, Idaho, Montana, Nevada, and Utah, which consumed only 0.4 percent of the total. Illinois, with 146,500 tons in 1954, has ranked first in zinc consumption each year since 1940 except 1952 and 1953, when Ohio, second largest consumer from 1945 through 1951, ranked first. Pennsylvania has held either second or third place since 1940. Connecticut, which ranked seventh in 1954, was the second largest consuming State during World War II, when zinc for brassmaking was in greatly expanded demand. Michigan ranked fourth in 1954, Indiana fifth, and New York sixth.

Consumption of Slab Zinc for Galvanizing.—The iron and steel industry is the largest consumer of slab zinc, using it to galvanize or 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 use quantities of zinc in zinc-coating many products. Zinc consumed in coating sheet and strip increased 10 percent over 1953 to 181,600 tons, only 4 percent under the record high of 188,400 tons in 1950. Additional continuous galvanizing lines were put in operation, raising the total number in production from 18 at the end of 1953 to 22 at the end of 1954. Five more lines were under construction. It was estimated that 75 percent of the galvanized output was coming from continuous lines. Shipments of galvanized-steel sheets reported by the American Iron and Steel Institute in 1954 were at a new high, totaling 2,362,600 short tons, compared with 2,291,000 tons in 1953 and 1,961,000 tons in 1952. The principal iron- and steel-producing States are also the principal consumers of zinc for galvanizing. From 1940 to 1943 Pennsylvania ranked first among the 34 States consuming zinc for galvanizing, but in 1944 Ohio displaced Pennsylvania and through 1954 has held first place. Ohio, Pennsylvania, Illinois, and Indiana used 57 percent of the slab zinc consumed for galvanizing in 1954 and 58 percent in 1953.

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[10] For 1940–45 see Bureau of Mines Inf. Circ. 7450, 1948, 30 pp. For more recent years see the Bureau of Mines Minerals Yearbooks, beginning with 1948.

TABLE 15.—Consumption of slab zinc in the United States, 1947–51 (average) and 1952–54, by geographic divisions and States [1]

Geographic division and State	1947–51 (average)		1952		1953		1954	
	Short tons	Rank	Short tons	Rank	Short tons	Rank	Short tons	Rank
I. New England:								
Connecticut	59,229	5	65,350	4	73,197	6	46,955	7
Maine	86	32	(2)	35	(2)	34	(2)	34
Massachusetts	9,679	15	9,872	15	9,395	15	8,355	16
New Hampshire	14	38	(2)	39	(2)	38	(2)	38
Rhode Island	337	29	(2)	28	610	30	590	31
Total	69,345	3	75,984	3	83,476	3	56,082	4
II. Middle Atlantic:								
New Jersey	21,544	12	22,975	12	27,565	10	24,890	11
New York	48,866	6	52,738	7	67,081	7	56,971	6
Pennsylvania	126,523	3	126,083	3	135,850	3	124,841	3
Total	196,933	2	201,796	2	230,496	2	206,702	2
III. South Atlantic:								
Delaware	56	33	(2)	32	(2)	28	(2)	26
District of Columbia	33	36	(2)	37	(2)	37	(2)	37
Florida	49	34	(2)	33	(2)	33	(2)	32
Georgia	2,209	20	1,479	24	1,556	24	1,498	24
Maryland	28,008	9	29,077	9	36,850	9	33,985	9
North Carolina	------	------	(2)	38	------	------	------	------
South Carolina	31	37	(2)	36	(2)	35	(2)	36
Virginia	262	30	373	31	702	29	441	33
West Virginia	25,293	11	23,655	10	21,340	12	20,501	12
Total	55,941	4	55,350	4	61,810	4	58,253	3
IV. East North Central:								
Illinois	155,082	1	142,516	2	157,765	2	146,453	1
Indiana	59,347	4	53,444	6	74,329	4	68,642	5
Michigan	46,481	7	53,491	5	73,241	5	68,888	4
Ohio	140,268	2	143,350	1	165,062	1	141,668	2
Wisconsin	12,300	14	12,057	14	13,859	14	10,370	15
Total	413,478	1	404,858	1	484,256	1	436,021	1
V. East South Central:								
Alabama	25,605	10	23,241	11	25,420	11	30,106	10
Kentucky	9,033	16	(2)	16	8,291	16	11,697	14
Tennessee	1,359	23	(2)	25	1,865	23	1,421	25
Total	35,997	5	32,600	6	35,576	6	43,224	5
VI. West North Central:								
Iowa	5,685	17	4,632	18	5,452	18	4,547	18
Kansas	89	31	(2)	30	(2)	32	593	30
Minnesota	3,723	18	(2)	19	3,005	19	2,413	20
Missouri	16,592	13	14,734	13	14,858	13	14,233	13
Nebraska	1,574	22	(2)	23	(2)	25	1,664	23
Total	27,663	7	24,208	7	25,363	7	23,450	7
VII. West South Central:								
Arkansas	1	40	(2)	41	(2)	40	(2)	40
Louisiana	422	28	(2)	26	(2)	26	818	27
Oklahoma	1,214	25	1,921	22	2,229	22	(2)	21
Texas	2,789	19	5,230	17	6,641	17	7,822	17
Total	4,426	8	8,075	8	9,936	8	10,576	8
VIII. Mountain:								
Arizona	36	35	(2)	34	(2)	36	(2)	35
Colorado	1,966	21	(2)	20	2,250	21	2,583	19
Idaho	437	27	(2)	29	(2)	31	(2)	29
Montana	------	------	(2)	42	------	------	(2)	41
Nevada	------	------	------	------	------	------	------	------
Utah	7	39	(2)	40	(2)	39	(2)	39
Total	2,446	9	2,880	9	2,844	9	3,284	9
IX. Pacific:								
California	32,046	8	39,955	8	45,104	8	40,375	8
Oregon	448	26	767	27	835	27	811	28
Washington	1,355	24	2,166	21	2,521	20	1,932	22
Total	33,849	6	42,888	5	48,460	5	43,118	6
Grand total [1]	840,078	------	848,639	------	982,217	------	880,710	------

[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, 1947–51 (average) and 1952–54, by States [1]

State	Geographic division	1947–51 (average)		1952		1953		1954	
		Short tons	Rank	Short tons	Rank	Short tons	Rank	Short tons	Rank
Alabama	V	25,216	6	22,495	8	24,524	7	29,425	6
California	IX	18,104	8	22,516	7	27,116	6	25,462	7
Colorado	VIII	1,878	20	([2])	19	([2])	20	([2])	17
Connecticut	I	3,049	16	2,936	17	3,001	16	3,169	16
Florida	III	49	31	([2])	27	([2])	27	([2])	27
Georgia	III	2,203	19	([2])	22	([2])	22	([2])	22
Illinois	IV	47,392	3	46,633	3	46,605	3	49,412	3
Indiana	IV	29,107	4	30,865	4	35,196	5	39,265	4
Iowa	VI	102	29	268	28	242	30	172	30
Kentucky	V	8,956	9	7,852	9	7,854	9	11,308	9
Louisiana	VII	421	24	([2])	23	([2])	24	818	24
Maine	I	85	30	([2])	31	([2])	29	([2])	31
Maryland	III	27,541	5	28,656	5	36,261	4	33,694	5
Massachusetts	I	5,602	11	4,923	13	4,703	14	5,035	13
Michigan	IV	4,217	14	([2])	12	6,810	10	([2])	11
Minnesota	VI	3,723	15	2,939	16	2,944	17	([2])	18
Missouri	VI	4,585	13	3,598	15	4,234	15	4,108	15
Nebraska	VI	291	26	([2])	26	528	26	566	26
New Hampshire	I	-----	-----	-----	-----	-----	-----	-----	-----
New Jersey	II	4,958	12	5,354	11	6,041	12	4,995	14
New York	II	6,067	10	6,292	10	6,356	11	5,854	10
Ohio	IV	82,348	1	77,967	1	83,772	1	74,283	1
Oklahoma	VII	1,212	21	([2])	20	([2])	19	([2])	20
Oregon	IX	280	27	238	30	197	31	246	28
Pennsylvania	II	72,990	2	65,747	2	67,829	2	67,774	2
Rhode Island	I	330	25	([2])	25	([2])	25	([2])	25
South Carolina	III	31	33	([2])	32	([2])	32	([2])	32
Tennessee	V	1,074	23	736	24	1,305	23	1,185	23
Texas	VII	2,586	18	4,413	14	5,170	13	5,440	12
Utah	VIII	48	32	-----	-----	-----	-----	-----	-----
Virginia	III	179	28	([2])	29	([2])	28	([2])	29
Washington	IX	1,142	22	1,689	21	1,908	21	1,499	21
West Virginia	III	24,332	7	23,260	6	21,069	8	([2])	8
Wisconsin	IV	2,596	17	([2])	18	2,897	18	([2])	19
Total [1]	-----	382,694	-----	[3] 375,129	-----	[3] 405,068	-----	[3] 401,583	-----

[1] Excludes remelt zinc. Includes zinc used in electrogalvanizing and electroplating, but excludes sherardizing.
[2] Quantity withheld to avoid disclosure of individual company operations.
[3] Includes States not individually shown (footnote 2).

Consumption of Slab Zinc for Brass Products.—Slab zinc used in brass products in 1954 decreased 39 percent to 107,400 tons, the lowest since 1949. The concentration of brassmaking facilities in the Connecticut Valley has placed Connecticut first among the States in consumation of slab zinc for that use, a position held long before the compilation of detailed statistics and one that it has continued to hold by a wide margin from 1940 through 1954. Illinois ranked second in 1954 and the preceding 6 years. Michigan ranked third, Ohio fourth, and Pennsylvania fifth in 1954.

Consumption of Slab Zinc for Zinc-Base Alloys.—Slab zinc used in making zinc-base alloys totaled 290,700 tons in 1954, a 5-percent decline from the record high of 307,200 tons in 1953. The decline was due mainly to the smaller output by the automobile industry, the largest consumer of zinc-base alloys. These alloys are used for zinc die-cast parts and assemblies, such as fuel pumps, carburetors, radiator grilles, windshield-wiper motors, and much of the interior and exterior hardware. Passenger-car and truck production in 1954 totaled 6,600,000 units compared with 7,300,000 units in 1953. There was also continued extensive use of zinc die castings in the manufacture of home appliances; office machines; builders' hardware; and scientific,

TABLE 17.—Consumption of slab zinc for brass products in the United States, 1947–51 (average) and 1952–54, by States [1]

State	Geographic division	1947–51 (average)		1952		1953		1954	
		Short tons	Rank	Short tons	Rank	Short tons	Rank	Short tons	Rank
Alabama	V	348	13	(2)	12	(2)	12	(2)	12
California	IX	1,053	11	3,509	11	3,067	11	1,840	11
Colorado	VIII	68	16	(2)	15	(2)	16	88	18
Connecticut	I	49,816	1	56,704	1	63,127	1	38,970	1
Delaware	III	56	17	(2)	14	(2)	14	(2)	16
District of Columbia	III	33	19	(2)	22	(2)	24	(2)	23
Florida	III	------	------	------	------	------	------	------	------
Georgia	III	6	26	(2)	25	(2)	25	(2)	25
Illinois	IV	13,935	2	19,173	2	23,944	2	14,130	2
Indiana	IV	2,738	9	7,232	7	13,347	4	4,844	9
Iowa	VI	1	29	------	------	------	------	------	------
Kansas	VI	12	23	(2)	18	(2)	20	(2)	17
Kentucky	V	41	18	(2)	16	(2)	19	(2)	15
Maine	I	1	30	(2)	30	(2)	29	(2)	29
Maryland	III	465	12	(2)	13	(2)	13	(2)	13
Massachusetts	V	2,678	10	3,724	10	3,504	10	1,926	10
Michigan	IV	12,142	3	17,869	3	19,259	3	11,263	3
Minnesota	VI	------	------	(2)	27	(2)	23	(2)	21
Missouri	VI	80	14	80	19	(2)	15	(2)	14
Nebraska	VI	2	28	------	------	(2)	30	(2)	28
New Hampshire	I	14	21	(2)	24	(2)	27	(2)	26
New Jersey	II	5,297	8	6,721	8	6,652	9	5,011	8
New York	II	8,196	5	11,100	4	12,655	6	6,614	6
Ohio	IV	8,504	4	10,339	5	13,013	5	8,694	4
Oregon	IX	7	24	(2)	23	(2)	22	(2)	22
Pennsylvania	II	5,312	7	(2)	6	(2)	7	6,884	5
Rhode Island	I	7	25	(2)	29	(2)	26	(2)	27
South Carolina	III	------	------	------	------	------	------	------	------
Tennessee	V	6	27	(2)	28	(2)	31	------	------
Texas	VII	20	20	(2)	20	(2)	21	(2)	19
Utah	VIII	------	------	(2)	31	(2)	32	(2)	30
Virginia	III	14	22	(2)	26	(2)	17	(2)	20
Washington	IX	------	------	(2)	21	(2)	28	(2)	31
West Virginia	III	70	15	(2)	17	(2)	18	(2)	24
Wisconsin	IV	6,421	6	6,519	9	7,305	8	5,043	7
Total [1]	------	117,343	------	[3] 155,090	------	[3] 177,308	------	[3] 107,392	------

[1] Excludes remelt zinc.
[2] Quantity withheld to avoid disclosure of individual company operations.
[3] Includes States not individually shown (footnote 2).

communications, and photographic equipment. Table 18 shows the quantities of zinc consumed in zinc-base alloys by States and the relative rank of each State. Six States where large quantities of automotive parts and home appliances are manufactured—Illinois, Ohio, Michigan, New York, Pennsylvania, and Indiana—consumed 84 percent of the slab zinc used in zinc-base alloys.

Consumption of Slab Zinc for Rolled Zinc.—Slab zinc consumed for rolled zinc has continued in the same geographic pattern from 1940 through 1954, but the quantity rolled has ranged from a low of 47,500 tons in 1954 to a high of 98,000 tons in 1945. During the war years 1940–45 the annual average consumption of slab zinc in its use was 70,000 tons; in the postwar years 1946–49 it averaged 74,000 tons; and in 1950–54, 57,200 tons. In 1954 zinc rolling mills reported consumption of 47,500 tons of slab zinc in making sheet, strip, ribbon, foil, rod, and wire. Illinois ranked first with 19,300 tons followed in order by Pennsylvania, Indiana, and New York.

Consumption of Slab Zinc for Zinc Oxide.—Because only a small number of companies consume slab zinc in manufacturing zinc oxide and because individual company figures by State may not be dis-

TABLE 18.—Consumption of slab zinc for zinc-base alloys in the United States, 1947–51 (average) and 1952–54, by States [1]

State	Geographic division	1947–51 (average)		1952		1953		1954	
		Short tons	Rank	Short tons	Rank	Short tons	Rank	Short tons	Rank
Alabama	V	11	19	----	----	----	----	----	----
California	IX	12,488	7	13,411	6	14,399	7	12,683	8
Colorado	VIII	19	16	(2)	16	----	----	----	----
Connecticut	I	5,026	10	4,400	10	5,737	10	3,549	10
Delaware	III	----	----	----	----	(2)	15	(2)	13
Florida	III	----	----	----	----	----	----	----	----
Illinois	IV	59,217	1	48,944	2	60,613	2	58,953	1
Indiana	IV	13,965	6	8,840	9	15,476	6	16,686	6
Iowa	VI	----	----	----	----	(2)	17	----	----
Kansas	VI	62	14	(2)	14	(2)	14	(2)	15
Kentucky	V	36	15	(2)	15	(2)	16	(2)	16
Maine	I	----	----	----	----	----	----	----	----
Maryland	III	----	----	----	----	----	----	----	----
Massachusetts	I	13	17	(2)	19	(2)	19	----	----
Michigan	IV	29,954	3	30,197	3	46,977	3	52,109	3
Missouri	VI	11,559	8	10,478	7	9,499	9	9,106	9
New Jersey	II	9,441	9	9,622	8	13,531	8	13,882	7
New York	II	29,169	4	29,990	4	41,620	4	38,548	4
North Carolina	III	----	----	(2)	18	----	----	----	----
Ohio	IV	49,121	2	54,623	1	67,094	1	57,844	2
Oklahoma	VII	----	----	----	----	----	----	----	----
Oregon	IX	161	13	(2)	13	(2)	13	(2)	14
Pennsylvania	II	23,507	5	20,838	5	25,615	5	19,542	5
Tennessee	V	----	----	----	----	----	----	(2)	17
Texas	VII	178	12	(2)	12	(2)	12	2,291	12
Virginia	III	12	18	(2)	17	(2)	18	----	----
Washington	IX	7	20	----	----	----	----	----	----
Wisconsin	IV	3,282	11	(2)	11	(2)	11	(2)	11
Total [1]	----	247,228	----	[3] 236,147	----	[3] 307,203	----	[3] 290,680	----

[1] Excludes remelt zinc.
[2] Quantities withheld to avoid disclosure of individual company operations.
[3] Includes States not individually shown (footnote 2).

TABLE 19.—Consumption of slab zinc for rolled zinc in the United States, 1947–51 (average) and 1952–54, by States

State	Geographic division	1947–51 (average)		1952		1953		1954	
		Short tons	Rank	Short tons	Rank	Short tons	Rank	Short tons	Rank
Connecticut	I	1,113	7	(1)	7	(1)	7	(1)	7
Illinois	IV	32,922	1	25,353	1	23,066	1	19,310	1
Indiana	IV	12,885	2	(1)	3	(1)	2	(1)	3
Iowa	VI	5,519	4	(1)	5	(1)	5	(1)	5
Massachusetts	I	1,368	6	(1)	6	(1)	6	(1)	6
New York	II	4,939	5	(1)	4	(1)	4	(1)	4
Pennsylvania	II	7,427	3	(1)	2	(1)	3	(1)	2
West Virginia	III	843	8	(1)	8	(1)	8	----	----
Total	----	67,016	----	51,318	----	54,649	----	47,486	----

[1] Quantity withheld to avoid disclosure of individual company operations.

closed, slab zinc so used is included with the section on consumption of slab zinc for other uses.

Consumption of Slab Zinc for Other Uses.—The distribution, by States, of the quantity of slab zinc consumed in slush castings, wet batteries, desilverizing lead, light-metal alloys, zinc dust, chemicals, bronze powders, zinc oxide, and part of the zinc used for cathodic protection is shown in table 20. The increase in yearly totals beginning with 1952 is due in large measure to inclusion of slab zinc consumed for zinc oxide.

TABLE 20.—Consumption of slab zinc for other uses in the United States, 1947–51 (average) and 1952–54, by States [1]

State	Geographic division	1947–51 (average)		1952[2]		1953[2]		1954[2]	
		Short tons	Rank	Short tons	Rank	Short tons	Rank	Short tons	Rank
Alabama	V	30	18	(3)	25	(3)	25	(3)	21
Arizona	VIII	36	17	(3)	16	(3)	19	(3)	16
Arkansas	VII	------	------	(3)	26	(3)	28	(3)	24
California	IX	402	6	519	7	522	12	390	11
Colorado	VIII	1	26	(3)	29	(3)	27	(3)	19
Connecticut	I	225	10	(3)	15	(3)	14	(3)	12
Idaho	VIII	437	5	(3)	10	(3)	11	(3)	8
Illinois	IV	189	12	2,413	2	3,537	2	4,648	2
Indiana	IV	108	14	(3)	14	(3)	13	(3)	13
Iowa	VI	63	15	(3)	8	(3)	8	(3)	9
Kansas	VI	14	20	(3)	27	(3)	22	(3)	28
Kentucky	V	------	------	------	------	------	------	------	------
Louisiana	VII	1	27	(3)	30	(3)	23	------	------
Maine	I	------	------	------	------	------	------	------	------
Maryland	III	3	24	(3)	20	(3)	18	(3)	18
Massachusetts	I	18	19	(3)	18	(3)	20	(3)	22
Michigan	IV	168	13	(3)	13	(3)	15	(3)	17
Minnesota	VI	1	28	(3)	28	(3)	29	------	------
Missouri	VI	368	7	578	6	(3)	7	745	6
Montana	VIII	------	------	(3)	31	------	------	(3)	26
Nebraska	VI	1,281	3	(3)	4	(3)	6	(3)	3
Nevada	VIII	------	------	------	------	------	------	------	------
New Hampshire	I	------	------	------	------	------	------	------	------
New Jersey	II	1,849	2	1,278	3	1,341	3	1,002	4
New York	II	494	4	(3)	5	(3)	4	(3)	7
Ohio	IV	295	8	421	11	1,183	5	847	5
Oklahoma	VII	2	25	(3)	24	(3)	30	(3)	27
Oregon	IX	------	------	(3)	21	(3)	24	(3)	20
Pennsylvania	II	3,126	1	20,770	1	24,863	1	21,658	1
Tennessee	V	279	9	(3)	9	(3)	10	(3)	14
Texas	VII	5	23	(3)	19	(3)	17	(3)	25
Utah	VIII	7	22	(3)	22	(3)	26	(3)	23
Virginia	III	9	21	(3)	17	(3)	16	(3)	15
Washington	IX	206	11	(3)	12	(3)	9	(3)	10
West Virginia	III	47	16	------	------	------	------	------	------
Wisconsin	IV	------	------	(3)	23	(3)	21	------	------
Total [1]	------	9,664	------	[4] 30,955	------	[4] 37,989	------	[4] 33,569	------

[1] Excludes remelt zinc.
[2] Includes slab zinc used for zinc oxide.
[3] Quantity withheld to avoid disclosure of individual company operations.
[4] Includes States not individually shown (footnote 3).

STOCKS

National Strategic Stockpile.—In March 1954 the President authorized the ODM to establish new long-term metal and mineral stockpile objectives to eliminate the possibility of a wartime metals or minerals bottleneck. Preference was to be given to newly mined metals and minerals of domestic origin. Purchases were to be spread over a considerable period and timed to reactivate productive capacity and alleviate distressed economic conditions in domestic minerals industries. In accordance with purchase directives from ODM, the General Services Administration purchased zinc (and lead) each month from June through December.

Producers' Stocks.—Slab-zinc stocks on hand at producers' plants at the end of 1954 totaled 120,500 tons compared with 180,000 tons at the end of 1953. Average year-end inventories for 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. An important factor in the 1954 decrease in stocks was the monthly Government purchases of zinc for the National Strategic Stockpile from June through December.

TABLE 21.—Stocks of zinc at zinc-reduction plants in the United States at end of year, 1950–54, in short tons

	1950	1951	1952	1953	1954
At primary reduction plants	7,948	21,343	81,344	[1] 176,725	118,902
At secondary distilling plants	936	637	3,677	3,268	1,549
Total	8,884	21,980	85,021	[1] 179,993	120,451

[1] Revised figure.

Consumers' Stocks.—Slab-zinc stocks held by consumers on December 31, 1954, totaled 101,900 tons, an increase of 19 percent over the 85,700 tons held at the beginning of the year. At the average consumption rate of 73,700 tons a month in 1954, stocks on hand at the end of the year plus 9,000 tons of metal in transit to consumers' plants represented about a 6-week supply.

TABLE 22.—Consumers' stocks of slab zinc at plants at the beginning and end of 1954, by industries, in short tons

Date	Galvanizers	Brass mills [1]	Die casters [2]	Zinc rolling mills	Oxide plants	Others	Total
Dec. 31, 1953	[3] 43,303	[3] 14,783	[3] 20,689	[3] 4,485	472	[3] 1,963	[3, 4] 85,695
Dec. 31, 1954	55,868	16,247	23,623	4,689	101	1,397	[4] 101,925

[1] Includes brass mills, brass ingot makers, and brass foundries.
[2] Includes producers of zinc-base die castings, zinc-alloy dies, and zinc-alloy rods.
[3] Revised figure.
[4] Stocks on Dec. 31, 1953 and 1954, exclude 467 tons (revised figure) and 541 tons, respectively, of remelt spelter.

PRICES

The market price of Prime Western grade slab zinc, f. o. b. East St. Louis, was 10.00 cents a pound at the beginning of 1954 and declined to 9.50 cents on January 18 and to 9.25 cents on February 15. This price was less than half the highest ceiling price (19.50 cents a pound) established by the Government during the Korean emergency and in effect from October 2, 1951, to June 2, 1952. In March 1954 President Eisenhower authorized establishment of new long-term metal and mineral stockpile objectives to eliminate the possibility of a wartime metals and minerals bottleneck. It was indicated that zinc (and lead also) would be among the metals to be purchased on a larger scale under the new program, and although actual purchases of zinc did not begin until June, the long downward trend (nearly 2 years) in the zinc price was reversed with the increase to 9.75 cents a pound on March 10 and to 10.25 cents on March 29. Further advances of ¼ cent on May 26, ½ cent on June 3, and ½ cent on September 7 brought the price to 11.50 cents, where it stayed the remainder of the year. The yearly average of the average monthly quotations was 10.69 cents, nearly the same as the 10.86-cent average in 1953.

TABLE 23.—Price of zinc concentrate and zinc, 1950–54

	1950	1951	1952	1953	1954
Joplin 60-percent zinc concentrate:[1] Price per short ton..dollars..	87.39	120.00	116.10	64.65	65.72
Average price common zinc at—					
St. Louis (spot)[1]..........cents per pound..	13.88	17.99	16.21	10.86	10.69
New York[1]..........do....	14.60	18.75	17.03	11.53	11.19
London[2]..........do....	14.89	21.46	18.53	9.47	9.78
Price indexes (1947–49 average=100):					
Zinc (New York)..........	115	148	135	91	88
Lead (New York)..........	83	109	102	84	88
Copper (New York)..........	103	117	117	138	142
Straits tin (New York)..........	104	138	130	103	100
Nonferrous metals[3]..........	104	124	124	125	124
All commodities[3]..........	103	115	112	110	110

[1] Metal Statistics, 1955.
[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.

On the London Metal Exchange the price of zinc fluctuated moderately during the year. The monthly mean of buyers' and sellers' quotations at the close of morning sessions was lowest at pound 72 4s. 6d. per long ton for February, which compared with pound 73 0s. 5.2d. for January; the trend was upward thereafter and the highest was pound 82 14s. 5.1d. for December.

The equivalent in United States money was 9.23 cents per pound for the January mean and 10.42 cents per pound for December.

TABLE 24.—Average monthly quoted prices of 60-percent zinc concentrate at Joplin, and of common zinc (prompt delivery or spot) St. Louis and London 1953–54[1]

Month	1953			1954		
	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	85.44	12.60	11.21	54.61	9.75	9.23
February	72.08	11.48	10.35	51.33	9.37	9.16
March	67.46	11.03	9.98	52.52	9.66	9.36
April	65.00	11.00	8.99	57.85	10.25	10.04
May	65.00	11.00	8.70	58.23	10.29	10.02
June	65.00	11.00	8.93	62.54	10.96	10.07
July	65.00	11.00	9.24	64.00	11.00	9.77
August	65.00	11.00	9.19	64.00	11.00	9.49
September	57.81	10.18	8.77	67.69	11.44	10.16
October	56.00	10.00	9.22	68.00	11.50	10.40
November	56.00	10.00	9.42	68.00	11.50	10.23
December	56.00	10.00	9.29	68.00	11.50	10.42
Average for year	64.65	10.86	9.47	65.72	10.69	9.78

[1] Joplin: Metal Statistics, 1955, p. 603. St. Louis: Metal Statistics, 1955, p. 595. 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, 1950–54, by grades, in cents per pound

Grade	1950	1951	1952	1953	1954
Grade A:					
Special High Grade	14.30	18.79	17.04	11.81	11.46
High Grade	14.16	18.48	16.42	11.40	11.05
Grade B: Intermediate	14.69	18.57	17.76	11.38	11.36
Grades C and D:					
Brass Special	14.47	18.20	17.07	11.72	10.93
Select	17.37	18.00	16.73	11.59	10.02
Grade E: Prime Western	14.11	17.92	16.33	11.21	10.39
All grades	14.23	18.24	16.63	11.47	10.83
Prime Western; spot quotation at St. Louis[1]	13.88	17.99	16.21	10.86	10.69

[1] Metal Statistics, 1955, p. 595.

FOREIGN TRADE[11]

Imports.—Total imports (general imports) of zinc in ores and concentrate in 1954 dropped to 454,000 short tons from 513,700 tons in 1953. Of the total in 1954, Mexico supplied 39 percent, Canada 34, and Peru 20. The remaining 6 percent came mostly from Bolivia, Yugoslavia, Union of South Africa (South-West Africa), Guatemala, Australia, and Chile.

Imports of slab zinc during the year declined to 156,900 tons from 234,600 tons in 1953. Of the tonnage imported, Canada supplied 67 percent, Africa (Belgian Congo) 9 percent, Mexico 6 percent, Belgium-Luxembourg 5 percent, and Peru 4 percent—a total of 91 percent for these 5 countries. The remainder, in order of tonnage, came from Italy, Germany, Australia (Oceania), Netherlands, Norway, Mozambique (Africa), and United Kingdom.

Exports.—Exports of zinc in zinc ore, concentrate, dross, and slab zinc, sheet, scrap, and dust totaled 46,200 tons valued at $9,751,000 compared with 27,100 tons (revised) valued at $8,367,000 (revised) in 1953. In addition to the export items listed in tables 28 and 29, considerable zinc was exported, as in other years, in brass, pigments, chemicals, and 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.

Exports of slab zinc totaling 25,000 tons were mostly to the United Kingdom (40 percent), Belgium-Luxembourg (13 percent), Brazil (12 percent), Germany (11 percent), Argentina (9 percent), and Switzerland (4 percent). The 4,000 tons of sheets, plates, strips, or other forms not otherwise specified were shipped to Canada (42 percent), Brazil (24 percent), and Mexico (16 percent) as well as to several minor purchasing countries listed with quantities in table 29.

Tariff.—The duty on slab zinc remained at 0.7 cent per pound, that on zinc contained in ore and concentrate at 0.6 cent per pound, and that on zinc scrap at 0.75 cent per pound. The duties on zinc in other forms, also unchanged during the year, follow: Zinc dust, 0.7

[11] 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; zinc sheets, 1 cent; zinc sheets coated or plated, 1.125 cents; zinc oxide and leaded zinc oxides containing not more than 25 percent lead—(1) in any form of dry powder, 0.6 cent and (2) ground in or mixed with oil or water, 1 cent; lithopone and other combinations or mixtures of zinc sulfide and barium sulfate, 0.875 cent.

A table showing changes in the rates of duty imposed under the Tariff Act of 1930 by trade agreements from 1936 through 1954 may be found in the 1953 report of this series (Zinc chapter, Minerals Yearbook 1953, volume I).

Efforts of a large segment of the domestic lead- and zinc-mining industry to bring about increased tariff rates under the "escape-clause" provisions of the Trade Agreements Extension Act of 1951 continued during the early part of 1954. The report of the Tariff Commission

TABLE 26.—Zinc imported into the United States, in ores, blocks, pigs, or slabs, by countries, 1945–49 (average) and 1950–54, in short tons [1]

[U. S. Department of Commerce]

Country	1945–49 (average)	1950	1951	1952	1953	1954
Ores (zinc content):						
North America:						
Canada-Newfoundland-Labrador	69,751	77,525	[2] 96,470	149,130	[2] 165,910	155,608
Guatemala	--------	473	6,539	9,744	6,477	3,755
Honduras	50	104	154	316	637	792
Mexico	149,215	155,283	143,769	200,647	[2] 169,124	175,514
Other North America	10	5	62	171	(3)	(3)
Total	219,026	233,390	246,994	360,008	342,148	335,669
South America:						
Argentina	1,674	8	5,546	603	--------	--------
Bolivia	11,886	3,810	7,849	14,603	[2] 22,528	11,440
Chile	6,888	40	1,088	33	3,247	1,797
Peru	34,315	16,946	29,136	44,337	84,365	93,216
Other South America	71	273	380	320	389	31
Total	54,834	21,077	43,999	59,896	110,529	106,484
Europe:						
Italy	4,580	--------	--------	--------	8,738	--------
Netherlands	--------	--------	--------	--------	3,009	--------
Spain	3,461	17,738	4,392	16,647	8,617	--------
Yugoslavia	--------	--------	1,756	2,512	10,820	4,871
Other Europe	(3)	--------	--------	--------	1	15
Total	8,041	17,738	6,148	19,159	31,185	4,886
Asia:						
Japan	1,004	--------	--------	1,389	--------	--------
Philippines	--------	42	86	1,664	2,104	444
Other Asia	444	165	70	7	778	--------
Total	1,448	207	156	3,060	2,882	444
Africa:						
Algeria	--------	--------	--------	--------	2,804	--------
Union of South Africa	1,721	3,794	2,655	4,917	13,356	4,183
Other Africa	--------	1	(3)	198	--------	--------
Total	1,721	3,795	2,655	5,115	16,160	4,183
Oceania: Australia	5,094	2,366	2,825	2,398	10,820	2,361
Grand total: Ores	290,164	278,573	[2] 302,777	449,636	[2] 513,724	454,027

See footnotes at end of table.

TABLE 26.—Zinc imported into the United States, in ores, blocks, pigs, or slabs, by countries, 1945–49 (average) and 1950–54, in short tons[1]—Continued

Country	1945–49 (average)	1950	1951	1952	1953	1954
Blocks, pigs or slabs:						
North America:						
Canada	74,832	108,937	85,066	69,775	107,925	105,154
Mexico	14,428	26,293	760	18,686	33,878	9,726
Total	89,260	135,230	85,826	88,461	141,803	114,880
South America: Peru		1,205	26	1,600	8,406	6,757
Europe:						
Belgium-Luxembourg	616	3,617	612	6,854	21,549	7,540
Germany		1,637		[4] 7,619	[4] 13,906	[4] 3,109
Italy	316	2,679		4,063	23,972	5,285
Netherlands		2,005	254	3,976	4,338	1,461
Norway	640	7,939	882	110	6,323	717
United Kingdom	(3)	555			6,317	22
Yugoslavia		485		2,788	1,900	
Other Europe	132	621	3	12	165	
Total	1,704	19,538	1,751	25,422	78,470	18,134
Asia:						
Japan	4,323			222		
Other Asia	25	1				
Total	4,348	1		222		
Africa:						
Belgian Congo					882	13,895
French Morocco			440			
Mozambique						112
Northern Rhodesia					1,064	
Total			440		1,946	14,007
Oceania: Australia	3,564				3,951	3,080
Grand total: Blocks, pigs, or slabs	98,876	155,974	88,043	115,705	234,576	156,858

[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.

TABLE 27.—Zinc imported for consumption in the United States, 1945–49 (average) and 1950–54, 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	
1945–49 (average)	187,318	$11,759,046	98,189	$19,545,982	31	$8,297	6,099	$590,001	99	$10,900	$31,914,226
1950	237,564	24,313,625	155,332	38,759,435	211	92,862	2,862	688,176	472	80,564	63,934,662
1951	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	[4] 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	479,816	[5] 52,481,606	160,138	[5] 33,722,309	259	88,010	1,087	103,486			[5] 86,395,411

[1] Excludes imports for manufacture in bond and export which are classified as "imports for consumption" by the U. S. Department of Commerce.
[2] Includes dross and skimmings as follows: 1945–49 (average)—4,558 tons, $394,938; 1950—1,229 tons, $186,748; 1951—6,457 tons, $242,998; 1952—3,019 tons, $389,361; 1953—2,925 tons, $250,544; 1954—316 tons, $33,181.
[3] In addition manufactures of zinc were imported as follows: 1945–49 (average)—$6,615; 1950—$142,369; 1951—$51,700; 1952—$11,719; 1953—$5,855; 1954—$41,454.[5]
[4] Revised figure.
[5] Due to changes in tabulating procedures by the U. S. Department of Commerce, data known not to be comparable to earlier years.

TABLE 28.—Slab and sheet zinc exported from the United States, by destinations, 1951–54, in short tons

[U. S. Department of Commerce]

Destination	Slabs, pigs, and blocks				Sheets, plates, strips, or other forms, n. e. s.			
	1951	1952	1953	1954	1951	1952	1953	1954
North America:								
Canada	1,702	171	7	9	2,668	1,686	2,322	1,704
Cuba	199	33	12		176	73	99	96
Mexico	211	351	457	517	859	532	545	637
Other North America	5	3	5		62	70	47	58
Total	2,117	558	481	526	3,765	2,361	3,013	2,495
South America:								
Argentina		661		2,205	100	305	2	
Brazil	3,967	4,089	1,687	2,900	310	621	697	952
Chile	466	365	141	230	70	66	31	9
Colombia		1	23		369	147	136	219
Other South America	7	73	32	14	249	97	84	119
Total	4,440	5,189	1,883	5,349	1,098	1,236	950	1,299
Europe:								
Austria	466	986						
Belgium-Luxembourg			840	3,136	3	(1)	1	10
Denmark	80							
France	933	6,689	56	56	367			
Germany	215	[2] 607		[2] 2,777	26	[2] 21		
Italy				224				
Switzerland	823	498		1,064	20	23	13	17
United Kingdom	20,024	40,423	13,859	10,052	25	41	9	34
Yugoslavia	1,244							
Other Europe	4	67	34	673	44	67	8	26
Total	23,789	49,270	14,789	17,982	[3] 485	152	31	87
Asia:								
India	4,728	2,036		112	807	304	352	49
Israel and Palestine	3	60	34		97	55	9	[4] 16
Japan	816			28	45	3	11	4
Korea		90	[3] 771	948			94	6
Pakistan	220	111			10	3	3	
Philippines	5	3		16	140	43	104	67
Other Asia	42	9	10	33	52	24	43	8
Total	5,814	2,309	[3] 815	1,137	[3] 1,151	432	616	150
Africa:								
Egypt		385						
Union of South Africa	1				69	45	18	14
Other Africa	4	3	1		1			
Total	5	388	1		70	45	18	14
Oceania	345				10	5	(1)	
Grand total	36,510	57,714	[3] 17,969	24,994	6,579	4,231	4,628	4,045

[1] Less than 1 ton.
[2] West Germany.
[3] Revised figure.
[4] Israel.

on its investigations begun in 1953 relating to these provisions was released in 1954.[12] The report recommended that import duties on most lead and zinc materials be increased 50 percent above the rates existing on January 1, 1945. The President decided to use an expanded stockpiling purchase program rather than duty increases to assist the mining industry. Under the new program purchases of

[12] U. S. Tariff Commission, Lead and Zinc: Report to President on Escape-Clause Investigation 27, Under the Provisions of Section 7 of the Trade Agreements Extension Act of 1951: May 1954, 34 pp. (with statistical appendix).

TABLE 29.—Zinc ore and manufactures of zinc exported from the United States, 1945–49 (average) and 1950–54

[U. S. Department of Commerce]

Year	Zinc ore, concentrate, 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
1945–49 (average)	[1] 1,593	[1] $226,132	57,184	$13,343,854	9,156	$3,447,430	(2)	(2)	785	$236,026
1950	[1] 1,140	[1] 264,907	12,917	3,967,055	4,810	2,322,150	6,212	$674,235	506	186,557
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	[5] 17,969	[5] 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

[1] Effective Jan. 1, 1949, "dross" included with "scrap."
[2] Classification established Jan. 1, 1949. Not included in 1945–49 averages, 1949—1,570 tons, $224,291.
[3] Effective Jan. 1, 1952, zinc and zinc-alloy semifabricated forms, n. e. s., were exported as follows: 1952—$191,746 (quantity not available); 1953—286 tons, $151,496; 1954—543 tons, $257,316.
[4] "Dust" included with "scrap."
[5] Revised figure.

domestic lead and zinc could total up to 200,000 and 300,000 tons, respectively.

TECHNOLOGY

Although working under the handicap of a low price for zinc and loss of some technical personnel to the booming uranium industry, the zinc industry made commendable progress in applying improved production methods and in providing economical high-quality end products that enabled zinc to maintain or advance its competitive position in commercial uses, particularly in alloys and protective coatings. At the mines and ore-reduction plants efforts continued to be directed largely toward reducing costs through mechanization and improved extraction techniques.

An article [13] described tools and methods utilized at the Star zinc-lead-silver mine, Burke, Idaho, in planning for complete ore extraction. The article stresses the use of geology and of cost data for each stope and illustrates the use of smelter return charts, 1 for zinc and 1 for lead, used in determining the net smelter return value of muck samples as well as daily stope-face samples.

The testing and adoption of airleg drills to replace column-mounted drills and to compare airleg drilling with jumbo drilling in the mines of the American Zinc Co. of Tennessee were described.[14] A comparison of column-mounted machine drilling in 1951 with airleg drilling in 1953–54 showed an increase of 69 percent in tons of ore broken per machine man-shift. For mining in general it was found that for large, thick, and relatively uniform ore bodies, jumbo drilling will give the lowest cost and that airleg drilling is more suited for irregular, thin ore bodies, and has a definite advantage in selective mining.

[13] Sorenson, Robert E., Geology and Ore Delineation and Extraction: Min. Cong. Jour., vol. 40, No. 5, May 1954, pp. 33–38.
[14] Millar, Harry L., Drilling Methods at Mascot: Min. Cong. Jour., vol. 40, No. 12, December 1954, pp. 34–37.
Mining World, Are Your Drilling Costs Too High?: Vol. 16, No. 3, March 1954, pp. 42–45.

A practice in the reduction of ores was the use of the Waelz process to treat zinc oxide and zinc carbonate run-of-mine ores by Zinc Nacional, S. A., at Monterrey, N. L., Mexico.

A nodulizing kiln for removing impurities that remain after zinc concentrate has been put through the roasting process, thus improving the quality of the zinc calcine, was used by the Eagle-Picher Co. at its large zinc-roasting and sulfuric acid plant at Galena, Kans., scheduled for completion in 1954.[15]

Development of a new metallurgical roasting device for roasting metallic sulfides was described.[16] The device consists of a refractory column into which air is injected at various levels, forming several superimposed fluidized beds with no supporting grates. When pelleted zinc sulfide concentrates are charged, the roasted product needs no further sintering before reduction to metal. Improvements at the Palmerton, Pa., zinc works of the New Jersey Zinc Co. were summarized as follows in the company annual report for 1954:

> The second enlarged and improved mechanical zinc oxide furnace was placed in operation—an additional step in the modernization of our American Process oxide plant. Increased production from these units has resulted in substantial operating economies, and we are now assured of adequate capacity to permit abandonment of the last of the only manually operated stationary grate furnaces. Concurrently we will complete the installation of improved mechanical residue handling facilities, with further operating economies.
>
> Two equipment installations were made to prepare certain grades of zinc oxide in pelleted form—a step designed to facilitate its use by the rubber industry.
>
> An effective method was developed for producing an intermediate product suitable for use on mechanical grate oxide furnaces directly from crude ore from our Sterling mine, thus eliminating the milling of this ore at the mine, with resultant substantial operating economies.
>
> At the year end work was in progress on mechanized handling of French Process zinc oxide and construction of facilities to produce cadmium metal from sinter plant fume.

Plans to use a new process for making high-grade oxide directly from sulfide concentrate without prior roasting were described in Chemical Engineering.[17] A plant to produce 5,000 tons of zinc oxide a year by this process is planned by the Northwest Refining & Chemical Co. According to the report, the process can start with either standard concentrates (50–55 percent zinc) or low-grade flotation concentrates (30–40 percent zinc) and make either leaded or lead-free oxides of pigment quality at 96 percent purity; at slight additional cost zinc oxides 99.8 percent pure could be produced. Concentrate is dried, passed through vibrating screens, and conveyed to multiple ignition chambers of a special reverberatory furnace. Flash oxidation of the ore in air at 2,600° F. and rapid segregation separate the raw materials into slag, metallic oxides, and combustion gases. Zinc oxide particles (maximum size, 2 microns) are carried by the gases through a baffle system that aids in slag precipitation, then through a flue system that cools the gases to about 300° F. From there the mixture goes to bagging, where about 98 percent of the zinc oxide is recovered. The proposed plant would cost $180,000—about 10 percent of the capitalization of the average plant. Total production

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[15] Mining Congress Journal, vol. 40, No. 4, April 1954, p. 106.

[16] Cyr, H. M., Siller, C. W., and Steele, T. F. (Research Department, New Jersey Zinc Co., Palmerton, Pa.), Roasting Metallic Sulfides in a Fluid Column: Jour. Metals, vol. 6, No. 8, August 1954, pp. 900–904; also Tech. Paper 3809D, pres. New York Meeting, AIME, Feb. 16, 1955.

[17] Chemical Engineering, vol. 61, No. 11, November 1954, pp. 100, 104.

costs are estimated at 7–8 cents a pound, including raw materials. Only two operators would be needed per shift.

A review [18] of zinc-production processes and uses was prepared by the staff of the British Zinc Development Association. It noted that the European sheet-galvanizing industry is developing a pattern similar to that of the industry in the United States, while the pressure-die-casting industry in Europe is making great strides in international cooperation. Other important developments concern the use of zinc oxide in rubber, "Zinc-rich" paints, improved zinc compositions for cathodic protection, and tin-zinc plated coatings.

Savings were reported [19] in manufacturing die-cast zinc products by converting the finishing process from chromium electroplating to bright-finishing with aluminum, using the vacuum-deposition technique.

Tin-zinc alloy, a new plating process,[20] was used in industry for plating such parts as radio chassis, steel components for aircraft, motorcar, motorcycle, and cycle parts, evaporator units for refrigerators, switch gear, nuts and bolts, and steel, copper, and brass parts for electrical installations.

In galvanizing, distinct progress was made in the use of the continuous hot-dip line. According to Iron Age,[21] at least 75 percent of the galvanized production in the United States at the end of 1954 was coming from continuous lines, including about 6 percent from electrolytic lines. There were 22 hot-dip galvanizing lines in operation and 5 more under construction. In Canada [22] two of the major steel producers announced plans for installing continuous strip-galvanizing facilities. In Europe, too, continuous galvanizing of sheet steel, while practiced already for a number of years, was gaining further ground. Six lines were in operation in the United Kingdom, and installation of another was planned. In Belgium plans were made for building a line at Flemalle-Haute.

According to an article [23] on protection of steel, the use of zinc chromate as a rust-inhibitive pigment has grown largely since proof of its excellent performance was confirmed by naval research during World War II. At present many Government specifications stipulate its use in primer coats.

Paint formulation and the conditions for applying paint to metal surfaces were described [24] in relation to the permanence of its attachment. Some pigments like red lead and aluminum powder can have a beneficial effect on adherence, either because their reaction products with the binder or metal substrate improve adhesion or because they inhibit the rate of deterioration of the flexibility of the film. Others like TiO_2 have no effect. Some pigments like zinc oxide can accelerate the cure of a film, and some may retard it.

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[18] Metallurgia, Zinc and Its Uses, 1952–54: February 1955, pp. 93–99. (Specially contributed by the Staff of the Zinc Development Association.)

[19] Materials and Methods, Vacuum Metallizing: Vol. 39, No. 2, February 1954, pp. 108–109.

[20] Metal Bulletin (London), No. 388, Apr. 27, 1954, p. 24.

[21] Iron Age, Galvanized: Continuous Lines Surge: Vol. 174, No. 26, Dec. 23, 1954, pp. 23–24.

[22] Metal Bulletin (London), Continuous Galvanizing Makes Big Strides: No. 3961, Jan. 18, 1955, pp. 16–17.

[23] Schleicher, Martin E., Protection of Steel, Part III, Zinc Chromate for Primer Coats: Paint Ind. Mag., vol. 69, No. 9, September 1954, pp. 17–18.

[24] Bobalek, E. G., Adherence of Paint Films; Metal Progress, vol. 66, No. 2, August 1954, pp. 113–119.

Refractory boron compounds were shown to resist corrosion by molten zinc.[25] Various materials, including stainless steel, duriron, molybdenum, titanium, zirconium, tantalum, tungsten, and others, were given zinc-corrosion tests.

The Municipal Steel Corp., Chemical Division, announced the availability of FeRoSeal, a liquid that chemically converts rust into iron phosphate coating.[26] The method is said to be the only cold phosphating treatment for rusted iron and steel. The process is said to eliminate need for sand or shot blasting or acid pickling and requires only wire brushing to eliminate loose scale and rust. Water rinsing is not needed after treatment. Paint life following treatment is claimed to be 3 to 5 times that untreated. The product is not an additive; it works in harmony with coal-tar products, vinyls, siliceous neoprene, zinc-base materials, and other coatings as well as paint. One gallon covers 1,000 to 1,500 square feet of surface.

A zinc protective coating that can be used over rusted surfaces and is said to prevent rust creep has been marketed.[27] The material, called Zinktron, can be applied by brush or spray. According to the report, the coating (applied with a paint brush) will cling to the coated material with a high degree of adhesion. Zinktron No. 2 is especially designed for use under abrasive conditions and is expected to find uses in farm machinery. The coatings are said to provide resistance to fresh water up to 212° F. and to dry heat from —40° to 350° F. They also provide good resistance to chemicals, gasoline, oils, and greases.

Cathodic protection of iron or steel against corrosion can be accomplished by coating it with vinyl resins heavily saturated with zinc powder, according to an article published during the year. The coating can be brushed, sprayed, or dipped.[28]

A new grade of British zinc dust, commercially produced in 1954,[29] was found to be very suitable for precipitation of gold from cyanide solution in the goldmining industry. Its use in anticorrosive paints is also expected to become increasingly important. The new product is being marketed under the name of "Zincoli Superfine Zinc Dust." Its chief characteristic is that its average particle size is 2 to 2.5 microns, against the average particle size of 5 to 6 microns of the normal standard-grade zinc dust, while retaining the high metallic zinc content (95 to 97 percent) associated with the standard grades now used in the United Kingdom.

Bureau of Mines Bulletin 542, entitled "Contributions to the Data on Theoretical Metallurgy. XII. Heats and Free Energies of Formation of Inorganic Oxides,"[30] contains tables of heat and free-energy-of-formation data for inorganic oxides. Such data are used in evaluating heat balances in metallurgical processes, in appraising possible improvements in existing metal extractive methods, and as guides in

[25] Hodge, Webster, Evans, R. M., and Haskins, A. F. (of Battelle Memorial Institute or St. Joseph Lead Co.), Tech. Paper 3996D, AIME, pres. at Chicago meeting, February 1955; repr. in Jour. Metals, vol. 7, No. 7, July 1955, pp. 824–832.

[26] American Metal Market, vol. 61, No. 167, Aug. 31, 1954, p. 3.

[27] Materials and Methods, vol. 40, No. 4, October 1954, p. 151.

[28] Grebinar, H. L., Zinc-Rich Compounds Give Cathodic Protection: Steel, vol. 134, No. 13, Mar. 29, 1954, pp. 113–114.

[29] American Metal Market, vol. 61, No. 250, Dec. 31, 1954, p. 7.

[30] Coughlin, James P., Contributions to the Data on Theoretical Metallurgy. XII. Heats and Free Energies of Formation of Inorganic Oxides: Bureau of Mines Bull. 542, 1954, 80 pp.

the search for better methods of producing metals of recent or possible future commercial interest.

Publications of the Federal Geological Survey relating to zinc and issued in 1954 are:

Bulletin 1000-B.—Geochemical Prospecting Investigations in the Nyeba Lead-Zinc District, Nigeria, by H. E. Hawkes, pp. 51–103.

Bulletin 1010.—Geologic Controls of Lead and Zinc Deposits in Goodsprings (Yellow Pine) District, Nev., by C. C. Albritton, Jr., Arthur Richards, A. L. Brokaw, and J. A. Reinemund, 111 pp.

WORLD REVIEW

World smelter production of zinc increased in 1954 for the ninth consecutive year and established a new alltime high, totaling 2,650,000 short tons compared with 2,560,000 tons in 1953. A 15-percent increase in smelter output in Europe overcame declines of 15 and 12 percent, respectively, in Canada and the United States, and there were important gains in Japan, Belgian Congo, Australia, and Peru.

World mine production, at 2,920,000 short tons, was about the same as in 1953. Increased output in Europe, Australia, South America, and Asia offset declines in North America and Africa (mainly in Belgian Congo). The largest tonnage decreases in mine production by countries were 74,000 tons (14 percent) in the United States, 44,600 tons (32 percent) in Belgian Congo, and 28,300 tons (7 percent) in Canada. The increase of 99,400 tons (12 percent) in Europe's output came mainly from the U. S. S. R., Poland, Sweden, and Italy; production in West Germany increased slightly, and that in Yugoslavia showed a small decline. There were increases of 17,500 tons (7 percent) in Australia, 14,000 tons (13 percent) in Japan, and 17,500 tons (11 percent) in Peru.

Tables 30 and 31 show the quantity of zinc mined and smelted throughout the world by individual countries. The United States, which consumed around 35 percent of the world's zinc in 1954, mined about 16 percent and smelted approximately 30 percent of the total.

TABLE 30.—World mine production of zinc (content of ore),[1] by countries,[2] 1945–49 (average) and 1950–54, in short tons [3]

(Compiled by Augusta W. Jann)

Country [2]	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Canada	284,571	313,227	341,112	371,802	401,761	373,448
Guatemala		366	7,165	9,039	6,724	4,409
Honduras [4]	[5] 125	104	154	316	636	791
Mexico	199,015	246,399	198,486	250,638	249,715	246,441
United States [6]	609,996	623,375	681,189	666,001	547,430	473,471
Total	1,093,887	1,183,471	1,228,106	1,297,796	1,206,266	1,098,560
South America:						
Argentina	14,815	13,998	17,058	16,971	17,735	[7] 22,000
Bolivia (exports)	20,628	21,572	33,659	39,263	26,427	22,403
Chile		66	675	3,650	3,500	[7] 1,650
Peru	67,090	96,960	111,664	140,925	153,334	170,881
Total	102,533	132,596	163,056	200,809	200,996	[7] 217,000

See footnotes at end of table.

TABLE 30.—World mine production of zinc (content of ore),[1] by countries,[2] 1945–49 (average) and 1950–54, in short tons [3]—Continued

Country [2]	1945–49 (average)	1950	1951	1952	1953	1954
Europe:						
Austria	2,057	3,274	3,698	5,496	4,826	5,140
Finland [7]	2,337	2,300	3,300	7,700	3,500	4,000
France	6,683	13,424	13,881	16,094	[7] 13,200	[7] 11,000
Germany, West	34,313	79,848	83,486	88,956	100,506	103,877
Greece	1,844	3,510	6,946	8,047	8,267	7,937
Ireland		446	1,387	1,892	1,819	([8])
Italy	54,045	95,930	111,039	124,466	111,929	118,792
Norway	5,447	6,285	6,029	6,160	5,661	5,842
Poland [9]	74,327	95,000	95,000	105,000	120,000	[7] 140,000
Spain [7]	45,636	71,000	82,000	95,000	92,000	97,000
Sweden	39,240	40,919	42,238	51,987	49,706	64,407
U. S. S. R.[7 9]	111,000	142,000	163,000	205,000	234,000	276,000
United Kingdom	798	40	214	1,707	3,188	3,905
Yugoslavia	31,809	41,989	43,453	52,678	66,106	63,052
Total [2 7]	409,500	611,100	672,700	794,500	845,100	944,500
Asia:						
Burma				827	4,300	6,393
India [7]		330	1,300	2,500	2,900	2,600
Indochina	84					
Iran [10]			13,227	5,512	6,173	[7] 5,500
Japan	34,620	57,482	71,011	96,418	106,507	120,504
Korea, Republic of	709		([8])	551	22	([8])
Philippines		55	165	1,764	827	
Thailand (Siam)	[5] 42	298	573	551	1,984	2,976
Turkey [7]	714	110	440	990	4,400	([8])
Total [2 7]	36,200	61,600	91,100	116,900	138,700	153,400
Africa:						
Algeria	5,656	7,900	10,886	12,337	21,120	29,762
Angola			386	44	110	[7] 110
Belgian Congo	45,018	82,458	97,780	109,071	138,661	94,015
Egypt	[11] 148	421	1,579	977	282	260
French Equatorial Africa	147	685	571	416		
French Morocco	1,991	12,580	21,445	31,253	38,895	37,908
Nigeria	97			57	71	
Rhodesia and Nyasaland, Federation of Northern Rhodesia	[9] 22,085	[6] 42,189	[6] 40,616	[6] 41,140	43,357	[6] 38,669
South-West Africa	6,324	12,456	16,314	[6] 17,196	[6] 17,416	[6] 22,046
Tunisia	2,369	3,232	3,911	3,902	4,023	5,776
Total	83,835	161,921	193,488	216,393	263,935	228,546
Australia	195,833	221,770	213,706	220,954	265,481	282,978
World total (estimate)[2]	1,920,000	2,370,000	2,560,000	2,850,000	2,920,000	2,920,000

[1] Data derived in part from the Yearbook of the American Bureau of Metal Statistics, the United Nations Statistical Yearbook, and the Statistical Summary of the Mineral Industry (Colonial Geological Surveys, London).
[2] In addition to countries listed, Bulgaria, Czechoslovakia, East Germany, North Korea, China, and Rumania also produce zinc, but production data are not available; estimates by senior author of chapter included in total.
[3] This table incorporates a number of revisions of data published in previous Zinc chapters.
[4] United States imports.
[5] Average or 1948–49.
[6] Recoverable.
[7] Estimated.
[8] Data not available; estimate by senior author of chapter included in total.
[9] Smelter production.
[10] Year ended Mar. 21 of year following that stated.
[11] Average for 1947–49.

NORTH AMERICA

Canada.—Mines of Canada produced 373,400 short tons of recoverable zinc in 1954, a decrease of 28,300 tons (7 percent) from 1953. Smelter output of slab zinc, all from 2 electrolytic plants, was 213,800 short tons, 15 percent less than in 1953. One electrolytic plant was operated by the Consolidated Mining & Smelting Co. of Canada,

TABLE 31.—World smelter production of zinc by countries, 1945–49 (average) and 1950–54, in short tons [1] [2]

(Compiled by Augusta W. Jann)

Country	1945–49 (average)	1950	1951	1952	1953	1954
North America:						
Canada	189,977	204,367	218,578	222,200	250,961	213,810
Mexico	55,013	58,965	64,761	[3] 55,542	[3] 58,481	[3] 60,477
United States	779,573	843,467	881,633	904,479	916,105	802,425
Total	1,024,563	1,106,799	1,164,972	1,182,211	1,225,547	1,076,712
South America:						
Argentina	2,134	[4] 8,300	11,716	11,023	12,787	[4] 12,000
Peru	1,379	1,391	959	5,750	9,819	16,935
Total	3,513	[4] 9,690	12,675	16,773	22,606	[4] 29,000
Europe:						
Belgium [5]	122,253	195,468	221,439	205,910	213,217	234,481
Czechoslovakia	2,770	[4] 2,200	[4] 2,200	(6)	(6)	(6)
France	43,405	78,850	82,185	88,255	89,219	122,249
Germany:						
East	[4] 440					
West	39,429	135,359	155,029	162,278	163,430	184,804
Italy	20,540	41,805	52,638	60,463	66,175	74,356
Netherlands	8,983	21,773	24,918	28,555	27,780	28,702
Norway	34,637	47,590	45,002	43,248	42,767	48,767
Poland	74,327	95,000	95,000	105,000	120,000	[4] 140,000
Rumania	[4] 2,800	3,300	[4] 3,900	(6)	(6)	(6)
Spain	21,044	23,440	23,529	23,543	25,490	25,106
Sweden	646					
U. S. S. R. [4]	111,000	142,000	163,000	205,000	234,000	275,000
United Kingdom	74,350	78,725	78,100	76,984	81,433	89,869
Yugoslavia	6,036	13,575	14,576	15,943	16,038	15,040
Total [4]	563,000	879,000	962,000	1,023,000	1,088,000	1,247,000
Asia:						
China [4]	256	200	200	200	400	500
Japan	23,192	54,022	62,104	77,197	85,001	111,748
Total	23,448	54,222	62,304	77,397	85,401	112,248
Africa:						
Belgian Congo					8,599	35,274
Northern Rhodesia	22,085	25,441	25,301	25,636	28,370	29,736
Total	22,085	25,441	25,301	25,636	36,969	65,010
Australia	87,758	93,691	86,251	97,930	100,999	117,066
World total (estimate)	1,720,000	2,170,000	2,310,000	2,420,000	2,560,000	2,650,000

[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.
[3] In addition, other zinc-bearing materials totaling 3,746 tons in 1952; 30,288 in 1953, and 18,545 in 1954.
[4] Estimate.
[5] Includes production from reclaimed scrap.
[6] Data not available; estimate by senior author of chapter included in total.

Ltd., at Trail, British Columbia, and the other by the Hudson Bay Mining & Smelting Co., Ltd., at Flin Flon, Manitoba.

A report [31] of the Canada Department of Mines and Technical Surveys reviewed the zinc industry of Canada in 1954. The report showed that domestic consumption of primary zinc was 46,700 short tons compared with 50,700 tons in 1953. Exports of refined metal totaled 205,000 tons and of zinc contained in concentrate 180,200 tons. The zinc-producing Provinces, in order of rank in mine output, were British Columbia, with 150,300 short tons of recoverable zinc;

[31] R. E. Neelands, Zinc in Canada, 1954 (Preliminary): Mines Branch, Dept. of Mines and Tech. Surveys, Ottawa, 9 pp.

Quebec, 105,900 tons; Saskatchewan and Manitoba, 66,800 tons; Newfoundland, 30,200 tons; Yukon, 11,500 tons; Nova Scotia, 8,500 tons; and Ontario, 600 tons.

According to the report, the Consolidated Mining & Smelting Co., Ltd., Sullivan mine at Kimberley, British Columbia, largest zinc and lead producer in Canada, yielded 2,681,600 tons of ore in 1954 compared with 2,643,300 tons in 1953. At the company Bluebell mine at Riondell on Kooteney Lake, output was reduced sharply by a strike lasting 3 months. Tulsequah Mines, Ltd., a Consolidated Mining & Smelting Co., Ltd., subsidiary in northwestern British Columbia, increased its production following expansion of its mill capacity in 1953 from 300 to 500 tons a day. Other British Columbia producers of zinc concentrate included Canadian Exploration, Ltd., near Salmo; Sheep Creek Gold Mines, Ltd., southwest of Athalmer; Sil-Van Consolidated Mining & Milling Co., Ltd. (discontinued operations in April); Giant Mascot Mines, Ltd., near Spillimacheen; Britannia Mining & Smelting Co., Ltd., Howe Sound; Sunshine Lardeau Mines, Ltd., near Camborne; Violamac Mines, Ltd., and Carnegie Mines, Ltd., near Sandon; Yale Lead & Zinc Mines, Ltd., at Ainsworth; and Silver Standard Mines, Ltd., near Hazelton.

In Quebec the largest producer of zinc concentrate, according to the report, was Barvue Mines, Ltd., which operated its open-pit mine in Abitibi County at a daily rate of about 5,000 tons. Additional data on the Barvue operations were published elsewhere.[32] Other Quebec producers of zinc concentrate included the Quemont Mining Corp., Ltd., Normetal Mining Corp., Ltd., and Waite Amulet Mines, Ltd. (all treating copper-zinc ore); Golden Manitou Mines, Ltd.; New Calumet Mines, Ltd.; West MacDonald Mines, Ltd.; Anacon Lead Mines, Ltd.; Ascot Metals Corp., Ltd.; Consolidated Candego Mines, Ltd. (ceased all operations in October 1954 when ore reserves were exhausted); United Montauban Mines, Ltd. (closed in February 1954); and Weedon Pyrite & Copper Corp., Ltd.

Regarding zinc production in Manitoba and Saskatchewan, the report stated that the Hudson Bay Mining & Smelting Co., Ltd., mined 1,524,400 tons of copper-zinc ore from its Flin Flon mine. The company electrolytic zinc plant treated 124,200 tons of concentrate and 43,300 tons of zinc oxide fume to produce 66,900 tons of slab zinc and 48,700 tons of residue; the residue was shipped to the company copper smelter for further treatment. The total zinc production and the quantity of Special High-Grade zinc made were higher than in any previous year. The company Schist Lake mine was brought into production in August. Cuprus Mines, Ltd. (a Hudson Bay subsidiary), discontinued operations in August at its copper-zinc property southeast of Flin Flon, as the ore body from which production began in 1948 was completely mined out. Hudson Bay was developing 4 new copper mines in the Flin Flon area for production, but only 1—the Coronation—is known to contain recoverable quantities of zinc.

Zinc-concentrate producers in other areas included the Buchans Mining Co., Ltd., in Newfoundland; United Keno Hill Mines, Ltd., in the Mayo district, Yukon; Mindamar Metals Corp., Ltd., on

[32] Mining Magazine, vol. 90, No. 1, March 1954.

southern Cape Breton Island, Nova Scotia, and Jardun Mines, Ltd., in Ontario.

The report contained information on a number of important new exploration and development projects. In New Brunswick the American Metal Co., Ltd., announced in November discovery of several extensive zinc-lead-copper-pyrite ore bodies on its Little River property 30 miles northwest of Newcastle. The Brunswick Mining & Smelting Corp. constructed a 150-ton-per-day pilot mill and carried on exploration and development work at its Austin Brook and Anacon zinc-lead-pyrite deposits in the Bathurst area. In the same area the New Larder "U" Island Mines, Ltd., began sinking a 1,500-foot shaft to confirm drilling indications on its zinc-lead property. Near Manitouwadge Lake, Ontario, Geco Mines, Ltd., continued exploration by drilling on a copper-zinc deposit discovered in 1953. A road to the property was completed northward from Hemlo on the Canadian Pacific Railway, and construction of a railway spur was begun southward from Hillsport on the Canadian National Railways. Consolidated Sudbury Basin Mines, Ltd. (formerly Ontario Pyrites Co., Ltd.), continued exploration of the large zinc-lead-copper deposits on its Vermillion Lake and Errington mine properties near Sudbury. In Yukon, Prospectors Airways Co., Ltd., carried out a drilling campaign on its Vangorda property 30 miles west of the Canol Road-Pelly River crossing which disclosed extensive, flat-lying, zinc-lead deposits. The American Smelting & Refining Co. completed a drilling program 38 miles north of Watson Lake, where over a million tons averaging 15 percent combined lead and zinc was indicated. In the Northwest Territories, Pine Point Mines, Ltd., controlled by Consolidated Mining & Smelting Co. of Canada, Ltd., with Ventures, Ltd., holding a minority interest, resumed exploration at its extensive zinc-lead property near Pine Point south of Great Slave Lake; two prospect shafts were sunk to investigate mining conditions and provide ore for bulk sampling tests.

Data on mining costs for Canadian base-metal mining published in 1954 [33] show that there has been a sharp decline from the war years in tons of ore milled per wage earner and a rise in the wage cost per ton milled. From 1946 to 1952 the tons milled per worker per year declined from 1,533 to 1,016, and the wage-cost rose from $1.39 to $3.47 per ton.

Greenland.—The Nordic Mining Co., Ltd., of which 27.5 percent of the capital stock was owned by the Danish Government, continued exploration and development at the Mestersvig lead-zinc deposit in East Greenland. According to the Danish press, commercial exploitation of the deposit was scheduled to commence in the early months of 1956. During the first part of the winter of 1954–55 only a few watchmen were in Mestersvig, but later a team of 45 additional workers were flown to the area to prepare for receipt of new machinery purchased in Denmark, Great Britain, Sweden, and the United States. It was planned to install the machinery in such a manner that work could proceed, regardless of weather conditions. The machinery would be shipped from Denmark to the Mestersvig area when and if ice conditions permitted navigation.

[33] Metal Bulletin (London), Rising Mining Costs: No. 3925, Sept. 10, 1954, p. 13. (Source of data credited to Northern Miner.)

Guatemala.—The zinc-lead-silver mine and mill of Compania Minera de Guatemala, S. A., near Coban in northern Guatemala continued to operate in 1954.

Mexico.—Mine output of zinc in Mexico in 1954 was 246,400 tons, 1 percent less than in 1953. Smelter production rose 3 percent to 60,500 tons. Production of zinc has been sustained at a fairly even rate during the period of lower zinc and lead prices, because costs of operations at the large Mexican mines tend to remain constant regardless of the output. To lower expenditures by closing mines or reducing the work force involves complicated legal and administrative problems, attended by heavy indemnity payments to the workers released. In consequence, production tends to be maintained, if company resources permit, without reference to market conditions. The Government aided small mines by allowing a sliding-scale rebate of their production and export taxes. This rebate of up to 75 percent of the production and export taxes paid was applicable (at the discretion of the Minister of Finance) to operators whose production and export taxes did not exceed 200,000 pesos a month. Nonqualifying lead and zinc mines continued to pay the two taxes which averaged well above 20 percent of their total export sales.

The American Smelting & Refining Co. operated its retort zinc smelter at Rosita, Coahuila, and its lead smelter at Chihuahua. The company zinc-fuming plant at the Chihuahua smelter produced de-leaded zinc fume, which was shipped to Rosita for reduction to metal. Operating mines in Mexico, owned or leased by American Smelting & Refining Co.[34] and producing lead-zinc ores, included the Charcas unit, San Luis Potosi; the Parral, Santa Barbara, Santa Eulalia, Montezuma Lead, and Plomosas units, Chihuahua; the Taxco unit, Guerrero; and the Aurora-Xichu unit, Guanajuato. Also, the company completed construction of a new 400-ton-per-day mill at the Nuestra Senora lead-zinc-silver property in the Cosalá district, Sinaloa, and began operations on a part-time basis in August. Exploration and development of the Rosario lead-zinc property at Rosario, Sinaloa, continued to yield favorable results. The San Pedro mine, a lead-zinc property 75 miles north of the Charcas unit, San Luis Potosi, was purchased. All operations at the Angangueo unit, Michoacan, ended in April 1954, and the properties were returned to the owner, Michoacan Railway & Mining Co., Ltd., on December 31, 1954.

The American Metal Co.,[35] through its Mexican subsidiary, Cia. Minera de Penóles, S. A., produced zinc concentrate at its Avalos unit, Avalos, Zacatecas; Calabaza unit, Etzatlan, Jalisco; and Topia unit, Topia, Durango. The company zinc concentrate was shipped to the Blackwell, Okla., smelter, of the Blackwell Zinc Co. (subsidiary of American Metal Co.), but the lead concentrate was smelted at the company smelter at Torreon, Coahuila in Mexico. Pilot-plant operations at the Torreon lead smelter for the recovery of zinc from lead blast-furnace slags were successfully carried out, but construction of a commercial plant was postponed to await a more favorable climate for investment in metallurgical enterprises in Mexico.

The San Francisco Mines of Mexico, Ltd. (operating mines near Parral, Chihuahua), in the fiscal year ended September 30, 1954,

[34] American Smelting and Refining Co., Fifty-Sixth Annual Report for the Year Ending Dec. 31, 1954.
[35] American Metal Co., Ltd., Annual Report for the 67th Year, 1954.

milled 738,800 metric tons of ore yielding 80,500 tons of zinc concentrate, 56,400 tons of lead concentrate, and 8,000 tons of copper concentrate. The zinc concentrate was smelted in the United States.

Other large zinc producers were the El Potosi Mining Co. (subsidiary of the Howe Sound Co.), which operated its 1,700-ton-per-day El Potosi mine, Chihuahua; and the Fresnillo Co., operating its Fresnillo mine and mill at Zacatecas and its Naica mine and mill, Chihuahua, producing zinc, lead, and copper concentrates at each mill.

Operation of the new Waelz plant of Zinc Nacional, S. A., at Monterrey, begun in 1953, was continued in 1954. The plant treats run-of-mine zinc carbonate and zinc oxide ores.

SOUTH AMERICA

Argentina.—The Aguilar mine and mill in northern Argentina, operated by Cia Minera Aguilar, S. A., a subsidiary of the St. Joseph Lead Co., produced 36,200 metric tons of zinc concentrate and 22,600 metric tons of lead concentrate in 1954 compared with 31,800 and 19,800 tons, respectively, in 1953.[36] Prospecting for additional mining properties has been greatly expanded, and Aguilar has ample peso resources to finance any prospect that appears favorable. Progress in reorganizing the Comodoro Rivadavia zinc smelter in southern Argentina was most gratifying. The improved operating procedure and sales of metal resulted in this 43-percent St. Joseph-Aguilar-owned unit earning a profit of approximately 10 million pesos in 1954.

The National Lead Co., S. A., subsidiary of National Lead Co., New York, announced [37] that a major expansion was planned at its copper-lead-zinc property, Mina Castona, in the Province of San Juan about 700 miles north of Buenos Aires. The project will include erection of a lead, zinc, and copper concentrator, powerplant, pipeline, and housing for personnel. The new plant is expected to begin operations in mid-1956 and will be capable of handling 200 metric tons per day. National Lead also has a smelter at Puerto Vilelas for the treatment of lead ores and a metals fabricating plant in Buenos Aires.

Bolivia.—The nationalized zinc and lead mines in Bolivia are operated by the Corporacion Minera de Bolivia. Virtually all the zinc concentrate produced is shipped to other countries for smelting. Exports in 1954 totaled 35,700 metric tons containing 20,300 metric tons of zinc.

Peru.—The mine output of zinc in Peru again increased, totaling 170,900 short tons compared with 153,300 tons in 1953. Exports in 1954 (mostly to the United States) totaled 124,000 short tons. Smelter production of zinc increased to 16,900 short tons from 9,800 tons in 1953. The Cerro de Pasco Corp., largest zinc producer in Peru, operated zinc-lead-copper-silver mines at Cerro de Pasco, Morococha, Casapalca, San Cristobal, and Yauricocha, with mills at the first three mines and at Mahr, and also operated smelting and refining works at La Oroya. The works at La Oroya include, besides the lead and copper smelters and refineries, a 35-ton-per-day electrolytic zinc plant producing Special High Grade and Diecasting Grade zinc and

[36] St. Joseph Lead Co., Ninety-First Annual Report to the Stockholders: 1954.
[37] Engineering and Mining Journal, vol. 155, No. 12, December 1954, p. 117.

a new Sterling process electrothermic zinc plant on which construction of two units was completed in 1954.

According to the company annual report for the year ended December 31, 1954, the production of refined zinc increased to a total of 16,870 tons. Over three-quarters was produced in the electrolytic plant, which operated at a volume exceeding its designed capacity. Zinc-concentrate production totaled 131,700 dry short tons. As in 1953, only a small fraction of the corporation's production of low-grade zinc concentrate produced from the Cerro de Pasco zinc-lead orebody could be sold for export at reasonable profit, and there was a further increase in the stockpile of low-grade concentrate. The higher grade concentrate continued to be exported. The Sterling process electrothermic zinc plant, producing Prime Western zinc, experienced operating problems of the mechanical nature often associated with the starting up of a new process on a commercial scale. Although the electric furnaces, which are the heart of the process, have not yet attained their full capacity, no serious problems have arisen in their operation.

Further progress was made on construction of the various facilities comprising the corporation zinc-development program, which is to provide an integrated plant having an annual productive capacity of 150 million pounds of slab zinc. Construction of the 72,000 kv.-a. hydroelectric power plant on the Paucartambo River, being built primarily to provide power for the treatment of zinc concentrate, made good progress. Owing to operational difficulties in the electrothermic zinc plant, there will be a delay in the completion of additional zinc-production capacity, as certain modifications are to be made in the existing plant. On January 15, 1955, the corporation copper-lead-zinc mine at San Cristobal, in the vicinity of La Oroya, was brought into production again after a lapse of 6 years, during which ore reserves were developed and extended.

The Chilete silver-lead-zinc mine and 350-ton mill of the Northern Peru Mining & Smelting Co. (American Smelting & Refining Co. subsidiary) near Pacasmayo continued operations. The Tangana lead-zinc mine in the Province of Castrovirreyna, Department of Juancavelica, was put into production at 50 tons of ore a day;[38] the ore produced was shipped to the Banco Minero concentrator at Huachocolpa. About 40 other mines in Peru shipped ore to one or more of the four operating custom mills of the Banco Minero del Peru. Two of the Banco Minero mills were not in operation.

EUROPE

Austria.—The lead-zinc mine at Bleiberg-Kreuth, Province of Carinthia, operated by the Bleiberger Bergwerks Union (a nationalized mining company) was the only zinc producer in Austria in 1954. The ore mined in 1954 averaged 4.6 percent lead and 4.3 percent zinc. The total ore production was 120,200 metric tons, 44,500 tons of which was reclaimed from dumps. The ore was treated by flotation and yielded 9,300 metric tons of zinc concentrate (with 4,700 metric tons of extractable metal content), and 6,800 metric tons of lead concentrate (4,900 metric tons of extractable metal content). The

[38] Mining World, vol. 16, No. 12, November 1954, p. 76.

zinc concentrate was shipped to smelters in West Germany and Belgium and the lead concentrate was smelted at Gailitz-Arnoldstein in Austria. Construction of an electrolytic zinc plant with an annual capacity of 10,000 metric tons of zinc metal was begun at Gailitz-Arnoldstein in 1953 and was scheduled for completion in mid-1955.

Belgium and France.—Production of slab zinc by Belgian and French smelters in 1954 increased 18 percent over 1953 to a record high of 357,700 short tons. The smelters operated chiefly on concentrate produced in Belgian Congo, French Africa, Sweden, Australia, Spain, Peru, Canada, and other countries. The largest producing company was the Société Anonyme des Mines et Fonderies de Zinc de la Vieille-Montagne, with 3 smelters in Belgium (including 1 electrolytic plant) and 2 in France (1 electrolytic); the total zinc output was 146,000 metric tons of slab zinc, 37,000 tons of rolled zinc, and 18,400 tons of zinc white. Other smelting companies included the Cie. des Métaux d'Overpelt-Lommel et de Corphalie (2 active smelters), Soc. Anon. Metallurgique de Prayon, and Soc. Anon. de Rothem in Belgium and the Soc. Miniere et Metallurgique de Penarroya and Cie. Royale Asturienne des Mines (2 smelters) in France. No zinc has been mined in Belgium since 1946, when the Vedrin mine closed.

Mines in France produced 19,200 metric tons of zinc ore and concentrate in 1954, a decrease of 3,900 tons from 1953. The zinc-blende concentrate contained 50 to 55 percent zinc and the calamine 45 percent zinc. The decrease in 1954 was due to closing of the unprofitable Sentein (Ariège) and L'Orb (Herault) mines. The three principal producers were the Peirrefitte mine (Hautes-Pyrénées Department), Las Malines (Gard), and La Croix de Pallières (Gard), which together produced 90 percent of the total mine output of zinc.

Finland.—The Outokumpu Oy. continued to operate its Metsämonttu zinc mine throughout 1954 and in November also began operating its new Vihanti mine in Central Ostrobothinia. The Vihanti, with estimated ore reserves of 7 million metric tons to a depth of 250 meters, was to be the second largest nonferrous mine in Finland when operations reach full scale. The scheduled annual production was expected to be 64,000 metric tons of zinc concentrate, 7,500 metric tons of copper concentrate, 1,800 metric tons of lead concentrate, and 50,000 metric tons of pyrite. In 1954 the Metsämonttu mine produced 83,300 metric tons of zinc ore and the Vihanti mine 12,800 metric tons; the yield of zinc concentrate from these ores and other ores from the Orijarvi and Outokumpu mines totaled 9,200 metric tons. During the year 8,400 metric tons of zinc concentrate was shipped to Belgium under a processing agreement, and metallic zinc and zinc semimanufactures were returned to Finland.

Germany, West.—West German mine production of zinc in 1954 increased, totaling 94,200 metric tons compared with 91,200 tons in 1953. The major zinc- (and lead-) producing areas were the Harz Mountains, the Rhineland, and, to a lesser degree, south Germany. In the Harz area the principal mines were the Erzbergwerk Rammelsberg and the Erzbergwerk Grund mines. Rhineland mines included the important Auguste Viktoria, Ramsbeck, Maubacher Bleiberg, and Leuderich mines. Zinc and lead concentrates were also produced at some mines in south Germany. Several marginal mines were closed because of the high cost of production and low metal prices. During 1954 West Germany imported 54,600 metric tons of zinc ore and concentrate and 57,100 tons of zinc as metal; exports were 6,000 tons of concentrate and 14,100 tons of metal.

Zinc smelters were operated in West Germany at Munsterbush, Nievenheim, Friedrich-August Hütte (Post Nordenham), Borbeck, Duisburg-Wanheim, and Harlingerode (Oker). All 6 are retort smelters; that at Harlingerode has 2 continuous furnaces of the New Jersey Zinc Co. type, with 16 retorts each. The estimated combined annual capacity of the smelters is 186,000 metric tons of zinc metal. Besides West German concentrate, some of the smelters treat substantial tonnages of imported concentrate. The total smelter production of zinc (primary and secondary) in 1954 was 184,800 short tons—21,400 tons more than in 1953.

Italy.—Mine production of zinc in Italy rose to 118,800 short tons and smelter production to 74,400 tons compared with 111,900 and 66,200 tons, respectively, in 1953. About 80 percent of the mine production came from Sardinia. The increased smelter production was due partly to expansion of output facilities by existing smelting plants and partly to opening of a new zinc electrolytic plant at Nossa.[39] Although Italian electrolytic zinc has been produced chiefly from sphalerite at the Porto Marghera plant (Venice) of the Montevecchio Co. and the Crotone plant (Calabria) of the Pertusola Co., unique electrolytic plants have been developed to extract zinc from calamine ores.[40] These were at Monteponi (Cagliari-Iglesias) and at Nossa (Bergamo). The annual capacities (slab zinc, metric tons) and minerals treated for the four active Italian electrolytic plants were as follows: Monteponi Co. (Cagliari, Sardinia), capacity 8,000 tons, processing low-grade iron bearing calamine ore; Pertusola Co. of Crotone (Calabria), 20,000 tons, processing chiefly sphalerite ore; Montevecchio Co. of Porto Marghera (Venice), 20,000 tons processing exclusively sphalerite ore; and Sapez Co. of Nossa (Bergamo), 15,000 tons, chiefly processing calamine and siliceous carbonate only. The Monteponi Co. also has a 12,000-ton retort smelter at Vado Ligure.

Spain.—Most of the zinc concentrate produced in Spain in 1954 was shipped to other European countries for smelting. Mine output of zinc was 97,000 short tons and smelter output (slab zinc) was 25,100 short tons compared with 92,000 and 25,500 short tons, respectively, in 1953. The bulk of the mine production continued to come from the Reocin mine at Torrelavega near the north coast. The Arnao zinc smelter of Real Compania Asturiana de Minas near Aviles operated throughout the year, but the Penarroya zinc smelter near Córdoba in southern Spain remained idle. The Penarroya lead smelter continued operations.

Sweden.—Production of zinc in Sweden, based on the metal content of concentrate, was 64,400 short tons in 1954, a 30-percent increase over 1953. Producing companies in 1954 were the Boliden Mining Co., the Government-owned AB Statsgruvor, Falu Kopparverk, and AB Zinkgrubor. Virtually all of Sweden's zinc concentrate was shipped to Belgian, German, and Norwegian reduction plants. In

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[39] Metal Bulletin (London), No. 3985, Apr. 15, 1955, p. 18.
[40] Engineering and Mining Journal, vol. 155, No. 5, May 1954, pp. 68-72.

return, these countries supplied almost all of the slab zinc imported into Sweden.

United Kingdom.—Production of zinc concentrate was 3,500 long tons in 1954 compared with 2,900 long tons in 1953. Several small and moderate-size lead-zinc mines were operated, and exploration was continued on the lead-zinc deposits discovered in 1953 at Riber Hillside, near Matlock, Derbyshire, by the Matlock Lead Mines. Smelter production, derived chiefly from imports of Australian ore, was 80,200 long tons. Imports of metal, mostly from Canada, United States, Belgium, and Australia, totaled 154,700 metric tons, while consumption was 324,500 long tons (including secondary). Exports of slab zinc were about 1,700 long tons. The principal uses of zinc were for brass (109,000 long tons), galvanizing (106,600 tons), and zinc-alloy die castings (35,300 tons). Stocks of zinc, exclusive of Government stocks, totaled 19,300 tons December 31, 1954, compared with 13,200 tons on the same date in 1953.

During 1954 the average monthly price of zinc on the London Metal Exchange rose from £73 0s. 5.2d per long ton in January (9.23 cents a pound) to £82 14s. 5.1d. (10.42 cents a pound) in December.

According to the Metal Bulletin,[41] the zinc supply situation in 1954 varied considerably. At the beginning of the year spot zinc was in tight supply but gradually became easier after the Government made arrangements under its long-term contracts with Canadian producers for increased shipments of electrolytic and high-purity zinc to England. Consuming demand, both in the United Kingdom and on the European Continent, generally was on a good scale. As of September 1 the London Metal Exchange zinc contract was revised to permit half monthly settlements. Toward the end of the year, after a period of fairly plentiful supplies, high-grade and high-purity zinc in the United Kingdom became very tight, and increased premiums were demanded. The dock strikes in October had rather less effect on the zinc market than on some of the other metals, as the United Kingdom stock position at that time was fairly satisfactory, but by the end of the year spot supplies were none too plentiful.

Yugoslavia.—Both mine and smelter outputs of zinc (63,100 and 15,000 short tons, respectively) showed small decreases from 1953. There were about 15 producing lead-zinc mines in Yugoslavia in 1954, but the Trepca mines in Serbia as a group was the major producer. There were still a number of unexplored districts in the country. The principal producing Trepca mine was the Stari Trg near Kosovska Mitrovica, which had ore reserves estimated at 10.5 million tons containing 660,000 tons of metal. The content of the ore mined in 1953 was 6.2 percent lead and 2.5 percent zinc. The ore was transported by aerial tramway 18 kilometers to the 850-ton (metric ton) mill at Zvecan for treatment. The lead concentrate was smelted at Zvecan, but the zinc concentrate had to be smelted elsewhere. Besides the mill at Zvecan, flotation mills were in operation at the Novo Brdo mine (80-ton mill), Ajvalija (50-ton), Zletovo-Kratovo (220-ton), Suplja Stena (80-ton), Rudnik (150-ton), Veliki Majdan (30-ton), and Mezica (370-ton).

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[41] Metal Bulletin (London), No. 3956, Dec. 31, 1954, p. 25.

At the Celje zinc retort smelter additional equipment was installed to increase its annual capacity from 16,000 tons to 18,000. The new 12,000-ton electrolytic zinc plant under construction at Sabac, when completed, will give Yugoslavia a total smelter capacity of 28,000 metric tons, an amount exceeding 1954 consumption of slab zinc by about 20,000 tons. Increased consumption is expected, however, when the zinc rolling mill at Sevojna and new steel plants are completed

ASIA

Burma.—The Burma Corp., Ltd., operator of the Bawdwin silver-lead-zinc mine in the Shan States of northern Burma, continued to produce ore at an expanding rate and to rehabilitate the mine and mill as well as the lead smelter at Namtu. Ore mined during the 12 months ended June 30, 1954, totaled 84,000 tons; the quantity mined in the last 6 months of the period was 21 percent more than in the first 6 months. The output of marketable products comprised 9,100 metric tons of refined lead, 100 metric tons of antimonial lead, 863,100 fine ounces of silver, 200 metric tons of copper matte, 200 metric tons of nickel speiss, and 9,600 metric tons of zinc concentrate averaging 57–58 percent zinc. The company planned to further increase its rate of ore production to about 300,000 metric tons a year, which is well below the 480,000 tons produced immediately before World War II. Reserves at the Bawdwin mine were estimated in 1951 to be 2,736,000 long tons containing 12.5 percent zinc, 20 percent lead, and 15.5 ounces of silver per ton.

To meet the urgent need for more skilled underground labor [42] the Burmese Government sanctioned the recruitment from India of a further 300 Gurkha miners. At Mansam Falls, hydroelectric generating station No. 4 generator (4,000-kw.) was successfully brought into commission, bringing the total rehabilitated capacity of the station to 8,000 kw. in preparation for the projected increased milling capacity now planned.

India.—Production of zinc concentrate in India in 1954 was nearly 4,000 long tons, averaging 55.05 percent zinc, according to the Geological Survey of India. The concentrate was shipped to Japan for smelting. Imports of zinc metal by India totaled 36,600 long tons. The Metal Corp. of India, Ltd., continued to operate the Zawar zinc-lead-silver mines 25 miles south of Udaipur, Rajasthan.

Japan.—The mine and smelter output of zinc in Japan increased to new record highs in 1954, reaching 109,300 metric tons (metal content) of mine production and 101,800 tons of slab zinc compared with 104,700 and 80,100 tons, respectively, in 1953, the former record year. The quantities produced approximate Japanese requirements. Imports of zinc in ore and concentrate were 3,900 metric tons (from India), and exports of slab zinc (mostly to India) were 2,000 tons. The principal Japanese mines were those of the Mitsui Metal Mining Co., Ltd., Nippon Mining Co., Dowa Mining Co., and Mitsubishi Metal Mining Co. The zinc ores contain some lead and were the source of most of Japan's mine output of lead. The smelter output of zinc came from 8 electrolytic plants and 1 retort plant.

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[42] Mining World, vol. 16, No. 11, October 1954, p. 68.

AFRICA

Mine production of zinc in Africa decreased from 263,900 short tons in 1953 to 228,500 in 1954, owing mainly to a 32-percent drop in Belgian Congo's output. Of the total African mine production in 1954 Belgian Congo contributed 94,000 short tons (41 percent), compared with 138,700 short tons (53 percent), in 1953. Other important producing areas were French Morocco, with 37,900 short tons; Algeria, 29,800 tons; Northern Rhodesia, 38,700 tons; Southwest Africa, 22,000 tons; and Tunisia, 5,800 tons.

Belgian Congo.—All Congo zinc production continued to come from the rich copper-zinc ores of the Prince Leopold mine of Union Minière du Haut Katanga at Kipushi. Ore milled at the Kipushi concentrator totaled 1,068,500 metric tons, yielding 150,300 tons of 54.80-percent zinc concentrate and 297,000 tons of copper concentrate with a combined average of 20.67-percent copper. About 100,600 tons of zinc concentrate was roasted at Jadotville to make sulfuric acid (85,300 tons produced in 1954) necessary for the company hydrometallurgical treatment of oxidized copper-cobalt ores. Some 63,000 tons of roasted zinc concentrate, or the equivalent of 74,200 tons of green concentrate, was shipped to the Métalkat electrolytic plant at Kolwezi, which produced 32,000 metric tons of zinc metal. Exports of zinc from Congo during the year comprised 102,000 metric tons of crude concentrate, 18,600 tons of roasted concentrate, 65 tons of ore, and 30,000 tons of electrolytic zinc.

French Africa.—Mines in French Africa produced 73,400 short tons of zinc (content of concentrate) in 1954 compared with 64,000 tons in 1953. Of the total in 1954, French Morocco contributed 37,900 tons, Algeria, 29,800 tons, and Tunisia, 5,800 tons.

Production of zinc concentrate in French Morocco in 1954 totaled 62,800 metric tons, of which 49,800 tons came from the Bou Beker mines, owned by the Société des Mines Zellidja and operated by its subsidiary Société Nord Africaine du Plomb, of which Newmont Mining Corp. and St. Joseph Lead Co. own 49 percent. The Bou Beker mines also produced 40,500 tons of lead concentrate during the year. The mines are 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 produced 6,400 tons of zinc concentrate and 25,700 tons of lead concentrate. Other output of zinc concentrate included 2,700 tons from the mines of the Société Minière des Gundafa, 1,900 tons from the Société des Mines de l'Assif el Mal, and 2,000 tons which represented the combined output of 4 other mines.

A decree of November 2, 1954, modified the decree of June 26, 1954, in which all shipments of zinc ore were exempted from the 5-percent ad valorem export tax. Under the new decree the first 4,000 tons of zinc ore shipped by a producer from October 1 to December 31, 1954, and the first 16,000 tons shipped in the calendar year 1955 are exempt from the 5-percent ad valorem tax. The 0.5-percent ad valorem statistical service tax remained in effect. Of the 71,400 metric tons of zinc concentrate exported from French Morocco in 1954, France received 67,400 tons, West Germany, 2,000 tons, and Netherlands, 2.000 tons.

Across the border in Algeria Société Nord Africaine du Plomb Zellidja mines produced ore which was concentrated in a 1,000-ton-capacity gravity concentrator at Bou Beker. Algerian ore milled in 1954 totaled 158,400 metric tons containing 13.70 percent zinc and 1.67 percent lead.[43] Further development of the property in Algeria was resumed from El Abed shaft, about 7,000 feet easterly from the center of present production. Encouraging mineralization was encountered about 800 feet northwest of the shaft.

The zinc concentrate from the Bou Beker, Touissit, and Zellidja's Algerian mines was shipped to the various smelters of Compaganie Royale Asturienne des Mines in Europe. Most of the Bou Beker Société Nord Africaine du Plomb Zellidja lead concentrate was smelted at the Qued-el-Heimer Moroccan smelter, a Zellidja subsidiary in which Société Minière et Métallurgique de Pennarroya owns a 49-percent interest.

In Tunisia zinc concentrate production in 1954 was 9,500 metric tons with a zinc metal content of 5,300 tons compared with 6,600 and 4,200 tons, respectively, in 1953. The zinc concentrate output in 1954 comprised 6,000 tons from the El-Akhouat mine, 2,200 tons from the Sakiet Sidi Youssef, and 1,300 tons from the Djebel Ressas. These and other mines also produced 41,600 tons of lead concentrate in 1954.

Nigeria.[44]—Ore reserves at the Ameri and Nyeba areas of Mines Development Syndicate (West Africa), Ltd., were estimated at between 900,000 and 1,000,000 tons containing 10 percent lead and 7.3 percent zinc. This has been indicated by diamond drilling. The management planned to mine and treat the ore on the basis of 250 tons daily.

Rhodesia and Nyasaland, Federation of.—Output of the Rhodesia Broken Hill Development Co., Ltd., in Northern Rhodesia, the only producer of zinc in the Federation, was 172,100 dry short tons of lead-zinc ore in 1954 compared with 188,400 tons in 1953. The output of lead and zinc concentrates was 21,900 and 42,300 tons, respectively. The company electrolytic zinc-reduction plant, with an output of 29,700 tons of slab zinc, reached a record high in production. The lead smelter produced 16,800 tons of lead, the highest since 1947. Exports of zinc metal amounted to 31,700 tons. Ore reserves of Rhodesia Broken Hill Development Co., Ltd., at the end of 1954 were reported to be 2,372,500 tons averaging 17.3 percent lead and 26.0 percent zinc.

South-West Africa.—The Tsumeb Corp., Ltd., controlled by Newmont Mining Corp. and the American Metal Co., Ltd., operated its Tsumeb lead-copper-zinc mine, producing a lead-copper concentrate and zinc concentrate. Output of metals in the fiscal year ended June 30, 1954,[45] was 15,800 short tons of zinc, 52,100 tons of lead, 12,400 tons of copper, 839,200 ounces of silver, and 420,800 pounds of cadmium. Also, toward the end of 1954 the American Metal Co., Ltd., began to market electronically pure germanium dioxide produced in Belgium from the Tsumeb ores. At the mine [46] between 45,000 and 50,000 tons a month of ore was being treated in the flotation plant. Copper-lead and zinc concentrates were railed to Walvis

[43] Mining World, vol. 17, No. 7, June 1955, pp. 73–74.
[44] Mining World, vol. 17, No. 3, March 1955, p. 73.
[45] American Metal Co., Ltd., Annual Report for the 67th Year, 1954.
[46] Mining World, vol. 17, No. 4, April 1955, p. 66.

Bay and loaded for shipment overseas. Development in the Tsumeb mine was making rapid progress on the deeper 26th, 27th, 28th, 29th and 30th levels.

At the Abenab West mine at Abenab the South-West Africa Co. produced lead, zinc, and vanadium in concentrate form.

OCEANIA

Australia.—Mine production of zinc in Australia increased 7 percent in 1954 over 1953 to 283,000 short tons, and smelter production increased 16 percent to 117,100 tons. A moderate rise in lead and zinc prices was the principal factor in the increase in production.

The States and producing districts were New South Wales (Broken Hill and Captain's Flat districts), Queensland (Mount Isa field of Cloncurry district), and Tasmania (Read-Rosebery district).

Four large lead-zinc-silver mines equipped with mills operated in the Broken Hill district. They comprised, in order of rank in output of zinc concentrate, the mines of New Broken Hill Consolidated, Ltd.; Zinc Corp., Ltd.; Broken Hill South, Ltd. (including Barrier Central); and North Broken Hill, Ltd. Details of concentrate production at each of the mines and information on ore reserves at some of them are given in the chapter on Lead in this volume.

At Captain's Flat ore milled by the Lake George Mines (Pty), Ltd., in the fiscal year ended June 30, 1954, totaled 175,300 long tons yielding 25,500 tons of zinc concentrate, 13,200 tons of lead concentrate, 4,300 tons of copper concentrate, 21,700 tons of pyrite, and 100 tons of gold concentrate. Operations were suspended from June 25, 1954 to the end of the year, due to unsettled labor conditions.

At Mount Isa, North Queensland, Mount Isa Mines, Ltd., produced zinc concentrate from lead-silver-zinc ore treated in the company 2,000-ton mill, which also treated copper ore from the company mines. The lead-silver and copper concentrates produced were smelted at company plants at Mount Isa, and the zinc concentrate, of which 22,000 tons was produced in 1954, were exported.

In Tasmania the Electrolytic Zinc Co. of Australasia, Ltd., operated its Rosebery and Hercules mines and concentration mill. According to the company annual report (No. 34), ore milled during the fiscal year ended June 30, 1954, totaled 189,400 tons assaying 17.65 percent zinc, 5.4 percent lead, 0.46 percent copper, and 6.36 ounces of silver, and 1.74 dwt. of gold to the ton. The mill products were 52,600 tons of zinc concentrate assaying 55.6 percent zinc; 8,800 tons of 58.3-percent lead concentrate containing also silver, gold, copper, and zinc; and 6,200 tons of copper concentrate averaging 7.9 percent copper, 40.5 percent lead, 14.7 percent zinc, and 111.05 ounces of silver and 26.75 dwt. of gold per ton. Ore reserves as of June 30, 1954, were 2 million tons.

The Risdon electrolytic zinc plant produced 99,200 long tons of refined zinc, the highest yet recorded. Part of the production was from company concentrates, with the remainder from Broken Hill. Erection of a third flash roaster and ancillary equipment associated with the increase in roasting capacity was well advanced and should be completed by the beginning of 1955 as scheduled. The initial plant for treating zinc plant residue for recovery of zinc was brought into operation.

Zirconium and Hafnium

By Horace T. Reno [1]

ZIRCONIUM metal, produced in the past almost entirely by the Government, was produced in appreciable quantity in 1954 by private enterprise. Carborundum Metals Co., Inc., using a slight modification of the Kroll process developed in the laboratories of the Bureau of Mines, achieved full output at its Akron, N. Y., plant and filled the company's commitments to the Atomic Energy Commission for zirconium, with excess metal available for sale on the commercial market. National Lead Co. formed a subsidiary, Zirconium Metals Corp. of America, to handle production and sale of zirconium; the new corporation used the Kroll process to make ductile zirconium but did not extract the hafnium content to make a product suitable for use in nuclear reactors. The Bureau of Mines, by virtue of operations at its Albany, Oreg., plant, continued as the principal supplier of zirconium in 1954.

The U. S. S. *Nautilus*, the atomic-powered submarine in which zirconium was an important material of powerplant construction, completed its trial runs in 1954. Successful performance of the powerplant intensified interest in zirconium and established it as one of the new metals of the atomic age. Low neutron-absorption factor was the property that led to development of improved methods for recovering zirconium; but the additional qualities of high strength, easy formability, and corrosion resistance were the properties that won it final acceptance in the construction of nuclear powerplants. These properties also increased interest in the metal for other uses.

Zirconium, when used for other than nuclear purposes, does not need to be free of hafnium because the presence of a small quantity does not significantly change its physical and chemical properties. Such impure zirconium can be produced for about a third less than hafnium-free zirconium and therefore competes in a broader market. It was used in corrosion-resistant equipment in 1954 and apparently will be an important material in this field. The Bureau of Mines laboratories at Albany, Oreg., used zirconium to make 24 items that required strength and corrosion resistance and found that when they were exposed to corrosive liquids, fumes, and mists the lower maintenance costs involved would more than offset the relatively high cost of the zirconium.

Zircon, the mineral source of most zirconium, was used principally in refractories, foundry sands and facings, and ceramics.

[1] Commodity-industry analyst.

DOMESTIC PRODUCTION

Mine Production.—Domestic mine production of zircon decreased from 23,900 short tons valued at $894,900 in 1953 to 16,300 short tons valued at $745,300 in 1954, a decrease of 32 percent in quantity and 17 percent in value. Mine shipments exceeded mine production by 10 percent and decreased mine stocks by 61 percent. All marketed zircon of domestic origin was produced in Florida as a coproduct in the placer mining of monazite and titanium minerals. Zircon produced in Idaho as a byproduct of monazite dredging was not marketed because of unfavorable freight rates and is not included in domestic production figures.

Refinery Production.—The Kroll-process zirconium-hafnium plant of Carborundum Metals Co., Inc., placed in operation late in 1953, achieved full production in 1954, and the company began to actively seek new markets for its zirconium products when production exceeded the quantity required to fill AEC contract commitments. The Bureau of Mines zirconium-hafnium production plant at Albany, Oreg., however, continued to be the major United States producer, with an output of more than 310,000 pounds of zirconium sponge and over 7,000 pounds of hafnium sponge for the AEC.

The zirconium oxide plant of Zirconium Corp. of America, Solon, Ohio, began production in 1954. At full capacity the plant will produce 8,000 pounds of pure zirconium oxide a day. Firth Sterling Corp., Trafford, Pa., installed consumable-electrode arc-melting equipment with a capacity to melt 10,000 pounds of zirconium metal sponge a month. Zirconium Metals Corp. of America, a subsidiary of National Lead Co., began production of wrought zirconium-metal products.

Other 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 and melting and rolling mills.
Bureau of Mines, Northwest Electrodevelopment Experiment Station, Albany, Oreg.	Hafnium-free zirconium sponge, zirconium-alloy ingots, and hafnium sponge.
Carborundum Metals Co., Inc., Akron, N. Y.	Hafnium-free zirconium sponge and zirconium compounds.
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.
Kawecki Chemical Co., New York 17, N. Y.	Zirconium fluorides.
Massillon Refractories Co., Massillon, Ohio	Refractories.

Producer and plant location	*Products*
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 & Hass Co., Philadelphia 5, Pa.	Zirconium sulfate solution (tanning agent).
Shieldalloy Corp., New York 17, N. Y.	Milled and granular zircon.
Stauffer Chemical Co., New York 17, N. Y.	Zirconium tetrachloride (custom chlorination).
Chas. Taylor & Sons (subsidiary of National Lead Co.) Cincinnati, Ohio.	Refractories.
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.
Zirconium Metals Corp. of America (subsidiary of National Lead Co.) New York 6, N. Y.	Ductile zirconium and zirconium compounds.

CONSUMPTION AND USES

Zircon consumption in the United States in 1954 was estimated at 42,000 tons, a decrease of 3,000 tons compared with consumption in 1953. By far the largest quantity was used in refractories, foundry sand and facings, and ceramics. According to information furnished by principal dealers and consumers, about 7 percent of the zircon consumed was used in metals and alloys and less than 2 percent in chemicals and salts.

Zircon sand is superior to silica sand for foundry purposes because it has uniform grain size, is a better heat conductor, and is not wetted by molten metals. It is replacing metal shot as a chilling medium in magnesium castings. Zircon and zirconium compounds were widely used in ceramics, ceramic enamels, and glazes. A zircon-cordienite ceramic body that has near zero porosity (preventing infiltration of molten metal or other liquids) and high resistance to heat shock was developed.[2] The protective-coatings industry used zirconium complex of a synthetic acid as a drier catalyst.[3] Hydrous zirconium dioxide, both alone and with carbonate, was used to cure dermatitis resulting from poison ivy and zirconium compounds, including hydrous zirconia and zirconium lactate, were used as personal deodorants. Combinations of zirconium acetate, zirconyl carbonate, and wax emulsion were used to render textiles water repellent.[4] Pure zirconium oxide was used as an opacifier in antimony and sheet-steel enamels.

[2] Dreher, G. M., U. S. Patent 2,684,912, July 27, 1954.
[3] Gregg, G. W., Zirconium Metal as a Drier Catalyst: Paint Ind. Mag., vol. 1, No. 4, April 1954, pp. 17–19.
[4] Chemical Engineering, Where You Can Use Zirconium Chemicals: Vol. 61, No. 3, March 1954, pp. 138–142.

Zirconium in the form of zirconium-ferrosilicon found wide application as a deoxidizer and scavenger of nitrogen and sulfur in the manufacture of steel. Zirconium tetrachloride and zirconium tetrafluoride with alkali chlorides were used to refine the grain and increase the strength of magnesium castings.[5]

Zirconium was employed more extensively in 1954 as a corrosion-resistant material. The Bureau of Mines published descriptions of some useful applications of zirconium, including a list of 24 specialized items ranging from a zirconium-lined tank to proportioning pump parts and laboratory apparatus.[6]

STOCKS

Industrial stocks of zircon concentrate (plus 65 percent ZrO_2) totaled about 9,600 tons at the close of 1954.

National stockpile data cannot be published.

PRICES

E&MJ Metal and Mineral Markets quoted zircon concentrate (65 percent ZrO_2), c. i. f. Atlantic ports, at $42–$43 per long ton to January 21, $45–$46 per long ton to May 13, $47–$48 per long ton to December 16, and $48–$49 to the end of the year.

Zirconium-metal powder was quoted in E&MJ Metal and Mineral Markets throughout 1954 at $7 per pound. Zirconium alloy, 12–15 percent Zr, 39–43 percent Si, bulk, carload lots, was quoted at 7¢ per pound to March 18 and 8¢ per pound to the end of the year; and 35–40 percent Zr, 47–52 percent Si, was quoted at 20.25¢ per pound throughout the year.

Commercial quotations were as follows:

Zirconium Metals Corp. of America (subsidiary of National Lead Co.), late 1954

Zirconium-metal sponge and briquets, per pound	$10.00
Zirconium hot-rolled plate and bars, per pound, base price	27.00
Zirconium cold-rolled strip, per pound, base price	35.00
Zirconium cold-drawn wire 0.060–0.375 inch in diameter, per pound	42.50–32.50

Foote Mineral Co., late 1954

Iodide-process ductile zirconium metal:	
Zirconium crystal bar, lots over 100 pound, per pound	$70.00
Zirconium wire annealed, 0.050–0.005 inch 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 1954, f. o. b. railroad freight cars at destination

Zirconium-ferrosilicon:	
12–15 percent Zr per pound, depending on quantity and quality	$0.08 –0.1075
35–40 percent Zr per pound, depending on quantity and quality	0.2525–0.3025

[5] Work cited in footnote 4.
[6] McClain, J. H., and Nelson, R. W., Some Useful Applications of Zirconium: Bureau of Mines Inf. Circ. 7686, 1954, 7 pp.

Electro Metallurgical Division of Union Carbide & Carbon Co., late 1954, f. o. b. railroad freight cars at destination—Continued

Zirconium briquets (11 percent Zr, 38 percent Si) per pound, depending on quantity	$0.075 –0.10
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 1954

Hafnium-metal powder (99.3 percent), per gram	$25.00
Hafnium oxide (99.5 percent), per gram	17.00
Hafnium tetrachloride (99 percent), per gram	16.00
Hafnyl sulfate, nitrate, and chloride (99 percent), per gram	15.00

FOREIGN TRADE[7]

Although domestic capacity to produce zirconium concentrate was reported to be adequate to supply United States requirements, a substantial quantity was imported from Australia and Brazil. Australian imports were in the form of zircon concentrate; Brazilian imports were predominately baddeleyite. The average declared value of zircon imported from Australia in 1954 was $20.32 per short ton. The average declared value of zirconium ore concentrate imported from Brazil was $96.70 per short ton.

Exports of zirconium ore and concentrate to Canada and Mexico in 1954 totaled 692 short tons valued at $42,725. Exports of zirconium metals and alloys in crude form and scrap to Canada and Austria totaled 39,678 pounds valued at $5,254. Two pounds of semifabricated zirconium forms valued at $593 was exported to Japan.

Reexports of ore and concentrate to Canada and Japan in 1954 totaled 1,347 short tons valued at $65,317.

TABLE 1.—Zirconium ore (concentrates) [1] imported for consumption in the United States, 1945–49 (average) and 1950–54, by countries, in short tons

[U. S. Department of Commerce]

Country	1945–49 (average)	1950	1951	1952	1953	1954
North America: Canada	1	141				
South America: Brazil	2,678	697	2,084	1,972	1,206	1,408
Asia: India	892					
Africa: French West Africa	1					
Oceania: Australia [2]	19,021	15,988	25,208	21,935	23,461	17,249
Total: Short tons	22,593	16,826	27,292	23,907	24,667	18,657
Value	$621,342	$431,107	$664,428	$630,559	$571,783	[3] $486,555

[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, 22,200 tons; and 1954, 16,300 tons.
[3] Owing to changes and tabulating procedures by the U. S. Department of Commerce data are not comparable to earlier years.

[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.

TECHNOLOGY

Until 1954 many of the properties reported for zirconium were actually properties of zirconium containing some hafnium. Hafnium is intimately associated with zirconium in ores, and owing to the chemical similarity of the two elements separation is difficult. Investigators recognized the need for specifying both the chemical analysis and purification methods used when reporting results of physical tests of zirconium. Consequently, in 1954 more or less agreement was achieved on the fundamental properties of zirconium.

The Kroll process and the iodide process for making ductile, malleable, hafnium-free zirconium have been refined during the past few years so that purer metals can now be produced on a large scale. Some of the mechanical properties of these purer metals were investigated.[8]

Zirconium has relatively poor mechanical properties at elevated temperatures. It was found that binary additions of tungsten, chromium, vanadium, columbium, tantalum, and molybdenum strengthen zirconium at 1,800° to 2,200° F. but that all except tantalum and vanadium markedly reduce the workability. Molybdenum, tungsten, and chromium proved most effective.[9] A study was made of tensile properties, hot hardness, and impact strength of arc-melted binary alloys of iodide-process zirconium containing up to 1 weight-percent chromium, iron, or nickel in the annealed condition.[10]

Because zirconium mineral concentrates have high melting points, a large part of the cost of producing the metal is in the expense of fusing its ores. Caustic fusion processes for treating zirconium minerals were investigated.[11]

The problem of separating hafnium from zirconium on a commercial scale was solved in 1953, but the details of the process were classified and remained classified through 1954. However, results were published on investigations of liquid-liquid extraction of zirconium and hafnium and on the behavior of the elements in cation-exchange resin.[12]

It was found that zirconia and zircon refractories may be more stable if they contain hafnium. Zirconium oxide for use in refractories must be stabilized to overcome crystal inversion because its monoclinic lattice is unstable at 1,100° C. The presence of hafnium probably would raise the inversion temperature because the lattice of hafnium

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[8] Nelson, R. G., Kato, H., and Carpenter, R. L., The Mechanical Properties of Consumable-Arc-Melted Kroll-Process Zirconium: Bureau of Mines Rept. of Investigations 5063, 1954, 13 pp.
Russel, R. B., Coefficients of Thermal Expansion for Zirconium: Jour. of Metals, vol. 6, No. 9, September 1954, pp. 1045–1052.
Wallace, W. P., and Wallace, R. H., Endurance Limit of Zirconium: Iron Age, vol. 173, No. 11, Mar. 18, 1954, pp. 146–147.
Luetzow, H. J., A Study of the Critical Strain of Zirconium: Final Rept., Argonne National Laboratory, Contract W-31-109-eng-38 (ANL-5164), Mar. 3, 1953, 53 pp.

[9] Saller, H. A., Stacy, J. T., and Porembka, S. W., The Strength of Wrought Zirconium-Base Binary Alloys at 1,800° to 2,200° F., Am. Soc. Metals, Preprint 37, 1954.

[10] Chubb, W., and Muehlenkamp, G. T., The Effects of Chromium, Iron, and Nickel on the Mechanical Properties of Zirconium: Battelle Memorial Inst., Rept. BMI 938, Aug. 11, 1954, 20 pp.

[11] Beyer, G. H., Spink, D. R., West, J. B., and Wilhelm, H. A., Caustic Treatment of Zircon Sand: Ames Laboratory Rept., Contract W-7405-eng-82 (ISC-437 (rev.)), Aug. 17, 1954, 15 pp.
Gilbert, H. L., Morrison, C. Q., Jones, A., and Henderson, A. W., Caustic Soda Fusion of Zirconium Ores: Bureau of Mines Rept. of Investigations 5091, 1954, 31 pp.

[12] Huffman, E. H., Iddings, G. M., Osborne, R. N., and Shalimoff, G. V., Extraction of Zirconium and Hafnium With Various Fluorinated Diketones: Radiation Laboratory, Univ. California, Rept. Contract W-7405-eng-48 (UCRL-2536), Apr. 5, 1954, 15 pp.
Benedict, J. T., Schumb, W. C., and Coryell, C. D., Distribution of Zirconium and Hafnium Between Cation-Exchange Resin and Acid Solutions. The Column Separation with Nitric Acid Mixture: Jour. Am. Chem. Soc., vol. 76, No. 8, Apr. 20, 1954, pp. 2036–2040.

oxide is stable at 1,700° C.[13] A system of zirconium chemistry was suggested.[14]

RESERVES

Domestic zirconium-ore reserves have been estimated to contain 5 to 15 million tons of zirconium minerals. A slight increase in the value of zircon would make marginal deposits economic, doubling the present reserve figures. Florida beach deposits are believed to be adequate to supply domestic zircon requirements at the present rate of consumption for more than 100 years.

Total free-world reserves of zirconium ore are unknown, but the known reserves, principally in Brazil, India, and Australia, are believed to be of the order of 10 million tons of contained zirconium minerals in deposits that are now being worked.

WORLD REVIEW

Australia.—Australia, the free world's principal commercial source of zircon, produced 44,143 short tons of zircon in 1954, the largest quantity since 1951, when 47,006 short tons was produced. Australian zircon concentrates have been preferred by the molding and casting trade because they have a slightly larger grain size (between 80- and 100-mesh) than concentrates mined in India and the United States. About 1,000 tons has been consumed annually in Australia; the remainder was exported. Principal buyers of Australian zircon were United States, United Kingdom, and Japan.

Brazil.—Brazilian zirconium-mineral production apparently declined from a 7-year average (1946 to 1952) of 4,000 short tons to about 1,500 tons in 1953 and 1954. Probably the decrease was caused by the Government withdrawing radioactive lands on the Pocos de Caldes plateau from production.

Egypt.—Zircon was recovered at the mouth of the Nile River in Egypt as a coproduct in the mining of ilmenite, garnet, magnetite, and monazite. Mining was on a small scale, only 109 short tons of zircon concentrates being produced in 1954.

TABLE 2.—World production of zirconium ores and concentrates, by countries, 1945–54, in short tons

(Compiled by Pauline Roberts)

Country	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
Australia [1]	17,002	13,891	24,165	25,017	23,486	24,120	47,006	32,893	31,655	44,143
Brazil [2]	[3] 836	[3] 4,909	[3] 4,385	[3] 4,011	2,977	3,325	3,854	4,378	[3] 1,406	[4] 1,408
Egypt	11	4	--------	104	141	105	4	133	263	109
French West Africa	--------	--------	43	211	270	243	32	--------	1,047	1,012
India	1,142	522	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
United States	2,681	7,946	(5)	(5)	(5)	(5)	(5)	(5)	23,904	16,322

[1] Estimated zircon contents of all zircon-bearing concentrates.
[2] Chiefly baddeleyite.
[3] Exports.
[4] Imports into the United States.
[5] Data not available for publication.

[13] Curtis, C. E., Doney, L. M., and Johnson, J. R., Some Properties of Hafnium Oxide, Hafnium Silicate, Calcium Hafnate, and Hafnium Carbide: Oak Ridge National Laboratory Rept. Contract W-7405-eng-26 (ORNL-1681), Mar. 15, 1954, 36 pp.

[14] Blumenthal, W. B., Toward a System of Zirconium Chemistry: Ind. Eng. Chem., vol. 46, No. 3, March 1954, pp. 528-539.

French West Africa.—French West Africa produced 1,012 short tons of zircon concentrate in 1954, which supposedly was exported to France.

India.—Zircon was produced in India as a coproduct in the mining of radioactive minerals. Production figures have not been published since 1946.

Minor Metals

By Frank D. Lamb[1] and John D. Sargent[1 2]

CESIUM AND RUBIDIUM[3]

CESIUM is the most compressible, most alkaline, and most electropositive of all the elements. The metal is highly reactive with air and moisture and is usually stored in oil.

Rubidium is similar to cesium in many of its chemical properties, uses, and occurrences.

Production.—Domestic demand for cesium and rubidium continued to call for small quantities during 1954. Cesium was produced from the mineral pollucite, most of which was imported from Brazil, South-West Africa, Union of South Africa, Sweden, and Southern Rhodesia. Domestic production of pollucite was limited to small quantities from South Dakota and Maine in 1954.

Rubidium was recovered from both domestic and imported lepidolite as a byproduct of lithium recovery. About one-half ton of lepidolite from Colorado with a rubidium content of approximately 1.5 percent was processed for rubidium and lithium recovery in 1954.

The Fairmount Chemical Co., Newark, N. J., produced rubidium salts and cesium salts. The DeRewal International Rare Metals Co., Philadelphia, Pa., produced a relatively large quantity of rubidium from Colorado lepidolite, and A. D. Mackay, Inc., New York, N. Y., also produced rubidium in 1954.

Other former producers reported no output but shipped cesium and rubidium metal and compounds from inventory. Several companies were prepared to produce and market cesium and rubidium in pound quantities at lower cost than the quoted gram prices.

Uses.—Cesium and rubidium metals and compounds were used in photoelectric cells, infrared photography and signaling devices, scintillation counters, polymerization catalysts, vapor rectifiers, spectrometry, radio tubes, hydrogenation catalysts, and microchemical reagents.

Prices.—Rubidium metal was quoted at $2.75 per gram and rubidium compounds at 30 to 90 cents per gram. Cesium metal was available at prices varying from $2 to $5 per gram, and cesium compounds were sold for 30 cents to $2 per gram.

GALLIUM[4]

Gallium is a gray metallic element that melts at less than body temperature. Fewer than 100 pounds of gallium have been sold each

[1] Commodity-industry analyst.
[2] 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.
[3] Prepared by John D. Sargent.
[4] Prepared by John D. Sargent.

year compared with a potential production of more than 20 tons a year.

Domestic Production.—The Aluminum Co. of America, Pittsburgh, Pa., was the only domestic producer of gallium in 1954. Other former producers sold gallium from inventory stocks during the year. Both production and shipments of gallium in 1954 exceeded production and shipments in 1953, but the quantities involved in each of the 2 years were less than 100 pounds.

Uses.—Small quantities of gallium were used as a trace alloying agent for producing "P"-type germanium for transistors. Gallium also was used in other alloys, mirror plating, rectifiers, phosphors, pharmaceuticals, and catalysts. The United States Atomic Energy Commission has studied the use of bismuth-lead-tin-gallium alloys as coolants for atomic piles.

Prices.—Gallium was quoted in E&MJ Metal and Mineral Markets at $3.25 per gram for lots of 1 to 999 grams and $3.00 per gram in 1,000-gram lots.

Technology.—Gallium with an impurity content of not more than 0.005 percent was produced by the zone-melting technique.[5]

A phase diagram for the gallium-antimony system was constructed.[6]

A comprehensive review of gallium was published in 1954.[7]

GERMANIUM [8]

The use of germanium in electronic applications continued to expand despite the development of several other electrical semiconductors. Improvements in germanium diodes and transistors enabled germanium to maintain its dominant position in the field of semiconductors.

Domestic Production.—Domestic producers reporting germanium production in 1954 were: American Zinc Co. of Ill., Fairmont City, Ill.; Sylvania Electric Products, Inc., Towanda, Pa.; American Smelting & Refining Co., Perth Amboy, N. J.; American Steel & Wire Co., Donora, Pa.; and St. Joseph Lead Co., Josephtown, Pa. The Eagle-Picher Co., Miami, Okla., was probably the major producer of germanium in 1954.

Consumption and Uses.—Approximately 10.7 million germanium diodes were produced in 1954 as compared with approximately 2.5 million diodes made from other semiconductor materials.

Sales of hearing aids containing germanium transistors increased from 100,000 in 1953 to 325,000 in 1954.[9]

Air-cooled, 25-kw., germanium rectifiers and water-cooled, 120-kw. rectifiers, with an overall efficiency of more than 94 percent, were in use during 1954 in a hydrogen-oxygen plant, an electric sintering furnace, an electrolytic tin-reclamation process, titanium-refining arc furnaces, adjustable-speed motor drives, aircraft-engine starters, and telephone-exchange battery chargers.[10]

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[5] Zimmerman, W., Gallium Purification by Single Crystal Growth: Science, vol. 119, March 1954, pp. 411-412.

[6] Greenfield, I. G., and Smith, R. L., The Gallium-Antimony Phase Diagram: Contract A. F. 18(600)-465, Aug. 13, 1954, 26 pp.

[7] Thompson, A. P., Gallium: Rare Metals Handbook, Reinhold Publishing Corp., New York, N. Y., 1954, pp. 147-159.

[8] Prepared by John D. Sargent.

[9] Wall Street Journal, Dec. 30, 1954, p. 3.

[10] Mcintyre, H. N., Germanium Rectifiers—Big Low-Cost Power: General Elec. Rev. vol. 57, No. 6, November 1954, pp. 11-14.

The electronics industry continued to consume virtually all of the germanium sold in 1954.

Stocks.—Stocks of refined germanium held by germanium producers in 1954 were estimated to represent approximately a 2-year supply.

Prices.—Germanium metal was quoted at $295 per pound and germanium dioxide at $142 per pound throughout 1954 by the E&MJ Metal and Mineral Markets.

Foreign Trade.—In 1954, 4 import firms imported 3,630 pounds of germanium dioxide valued at $315,300.[11] Data on exports of germanium were not available.

The American Metal Co. sold germanium in the United States in 1954 that was produced by the Tsumeb Corp. of South-West Africa.[12]

Technology.—Development of a stabilized 98-percent germanium and 2-percent silicon alloy that was treated in a bath of molten potassium cyanide resulted in the manufacture of transistors that are undamaged by moisture and temperatures as high as 350° F.[13]

The relationship between the two germanium minerals germanite and renierite, found at Tsumeb, South-West Africa, was described.[14]

A tiny germanium photocell was developed that can be used for regulating heating devices, guiding missiles to targets, production control, counting, sorting, measuring, and radiation detection.[15]

Development was announced of an experimental germanium rectifier 0.875 inch in diameter and only 0.015 inch thick, with a capacity of 200 amperes of direct current at 100 volts.[16]

High-frequency germanium transistors were prepared by electroetching germanium disks with an indium electrolytic bath to a thickness of 0.0005 inch.[17]

A comprehensive review of germanium was published in 1954.[18]

World Review.—A large zinc deposit containing 0.002 percent germanium was under development near Meat Cove, on the northern tip of Cape Breton Island, Nova Scotia, Canada, by the Mineral Exploration Co. Production of germanium from ore mined at the property was not expected before 1956.[19]

About 500 pounds of germanium a year was expected to be recovered from coal to be consumed at a thermal electric plant to be erected on the island of Hokkaido, Japan, by the Tempoku Coal Mining Co. with the financial assistance of Land-Air, Inc., an American company.[20]

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[11] U. S. Tariff Commission.
[12] Metal Bulletin (London), Minor Metals: No. 3952, Dec. 14, 1954, p. 23.
[13] American Metal Market, Sylvania Develops New "Stabilized" Germanium Transistor: Vol. 61, No. 47, Mar. 11, 1954, p. 1, 9.
Canadian Mining Journal, Germanium: Vol. 75, No. 7, July 1954, p. 62.
Science News Letter, Transistor Improvements Described to Military: Vol. 65, No. 12, Mar. 20, 1954, p. 185.
[14] Scalar, C. B., and Geier, B., Paragenetic Relationships of Germanite and Renierite from Tsumeb, South-West Africa: Econ. Geol., vol. 49, No. 7, November 1954, p. 808.
[15] Industrial and Engineering Chemistry, Germanium Photocell Has Many Possible Uses: Vol. 46, No. 1, January 1954, p. 121-A.
[16] Materials and Methods, Water-Cooled Germanium Rectifiers: Vol. 39, No. 1, January 1954, p. 108.
[17] Business Week, Transistors; Big Push Coming: No. 1274, Jan. 30, 1954, pp. 58-60.
Metal Industry, Germanium Semiconductors: Vol. 85, No. 14, October 1954, pp. 291–292.
[18] Harner, H. R., Germanium: Rare Metals Handbook, Reinhold Publishing Corp., New York, N. Y., 1954, pp. 161-172.
[19] Northern Miner, Tonnage Possibilities for Cape Breton Zinc: Vol. 41, No. 22, Aug. 19, 1954, pp. 17–18
[20] Bureau of Mines, Mineral Trade Notes, Germanium: Vol. 38, No. 3, March 1954, pp. 11–12.

In the United Kingdom the price of germanium metal dropped toward the close of 1954 from 56 cents to 47 cents per gram and germanium dioxide from 35 cents to 28 cents per gram.[21]

INDIUM [22]

Indium is a soft, lustrous, silver-white metal of increasing industrial importance, especially in electronics, lubricants, and alloys.

Domestic Production—Only the Anaconda Co., Great Falls, Mont., and the American Smelting & Refining Co., Perth Amboy, N. J., produced indium in the United States in 1954. The Anaconda Co. was the leading domestic indium producer in 1954 for the first time. Production and shipments in 1954 declined from the 1953 record. Greater production could have been attained if larger demand had developed.

Prices.—The domestic price of indium metal, electrolytic grade, 99.9 percent, remained constant at $2.25 per troy ounce in lots of 5 or more troy ounces. Indium of 99.9975 percent purity was available at $7.25 per troy ounce in lots of 1 or more troy ounces. Indium alloys were available at prices ranging from 25 cents to $2.50 per troy ounce and indium compounds from $2.00 to $6.00 per troy ounce.

World Review.—The Consolidated Mining & Smelting Co. of Canada announced that the Sullivan mine at Kimberly had an annual production capacity of 1 million ounces of indium and a reserve of 10 million ounces in byproduct stockpiles.[23]

A comprehensive review of indium was published in 1954.[24]

RARE-EARTH MINERALS AND METALS [25]

Developments in the rare-earth-metals industry were accompanied by increasing public interest in the properties, uses, and sources of these little-known metals. Interest was stimulated by announcements of intensive research programs being conducted in laboratories and industrial installations throughout the world and by the promising results being obtained in the early stages of these investigations.[26] Prospectors, attracted to mineralized areas by the radioactivity of uranium- and thorium-bearing minerals, were constantly reminded of the existence of the rare-earth metals when returns from assay offices so often indicated the presence of appreciable quantities of cerium, lanthanum, and other rare-earth elements.

The principal sources of rare-earth metals and compounds were the minerals monazite, a rare-earth phosphate containing thorium and yttrium, and bastnaesite, a fluocarbonate of the rare earths. Although production of rare earths from monazite continued to surpass that from bastnaesite, the supremacy depended more upon the AEC's need for thorium for research purposes than any special qualities of

[21] Metal Bulletin (London), Germanium: No. 3954, Dec. 21, 1954, p. 25.
[22] Prepared by John D. Sargent.
[23] Chemical and Engineering News, Indium From the Sullivan Mine: Vol. 32, No. 30, July 26, 1954, p. 2978.
Northern Miner, Indium Reserve in Canada: Vol. 40, No. 15, July 1, 1954, p. 17.
[24] Mills, J. R. Bell, R. C., and King, R. A., Indium: Rare Metals Handbook, Reinhold Publishing Corp., New York, N. Y., 1954, pp. 191–213.
[25] Prepared by Frank D. Lamb.
[26] Chemical Age (London), U. S. Research on Rare-Earth Problems: Vol. 71, No. 1826, July 10, 1954, pp. 71–74.

monazite as a rare-earth raw material.[27] Because of its occurrence in relatively rich deposits in California and New Mexico, bastnaesite appeared to be the most economical raw material for producing the cerium group of rare earths. Except for the fact that the bastnaesite contained little or no thorium, which paid a large part of the cost of processing monazite in 1954, it would probably have been the major source of the cerium group or lighter rare earths. Interest in sources of the yttrium group or heavier rare earths, such as are found in fergusonite, euxenite, and pyrochlore, was high during the year; and a placer deposit in Bear Valley, Idaho, under preparation for dredging in 1955, was expected to yield substantial quantities of euxenite as well as monazite.

Domestic Production.—Output of monazite in the United States was confined in 1954 to 2 major and 3 smaller operations in Idaho and to 2 minor producers in Florida. Monazite production statistics continued to be classified by AEC because of the thorium content of the mineral, and their publication was prohibited.

The larger domestic producers were Baumhoff-Marshall, Inc., and Idaho-Canadian Dredging Co., both of Boise, Idaho, and Humphreys Gold Corp., of Jacksonville, Fla. Minor production was reported by Kenneth Steck, Weiser, Idaho; Grimes Creek Dredging, Inc., Centerville, Idaho; Twin Rivers Co., Riggins, Idaho; and Florida Ore Processing Co., Melbourne, Fla. The Molybdenum Corp. of America continued to produce bastnaesite concentrate from its mine in the Mountain Pass district of San Bernardino Co., Calif., and a small quantity was produced on an experimental basis by the New Mexico Copper Corp. from a deposit near Carrizozo, Lincoln County, N. Mex.

Concerns actively engaged in processing monazite and bastnaesite for the extraction of salts and compounds of the rare-earth metals were 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.

Misch metal, a mixture of all the rare-earth elements in metallic form, was produced by Cerium Metals Corp., New York, 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 major uses in 1954 for rare-earth salts continued to be in the manufacture of carbon-arc electrodes for intense lighting applications and in the glass industry for a variety of applications, including the coloring and decolorizing of glass, polishing of optical lenses, mirrors, and other glass specialties. Misch metal and ferrocerium were used to make lighter flints and as addition agents in various metallurgical applications, notably in the production of stainless steels and magnesium alloys. Other applications for rare-earth materials included the use of salts for fluorescent lighting; paint driers; textile waterproofing; catalysts; medicines; reagent chemicals; and condensers for radio, television, and radar applications.

Prices.—Quotations for monazite in the E&MJ Metal and Mineral Markets from January 1, 1954 through April 22, 1954 were as follows: Total rare-earth oxides, c. i. f. U. S. ports, 55 percent, 16½ cents per

[27] See chapter on Thorium.

pound; 66 percent, 19 cents per pound; and 69 percent, 22 cents per pound. From April 23 through June 30 quotations were nominal at 13 cents per pound, c. i. f. U. S. ports, for monazite assaying 55 percent total rare-earth oxides, including thorium oxide, and 16¼ cents per pound for monazite containing 65 to 68 percent total rare-earth and thorium oxides. E&MJ Metal and Mineral Markets quotations for monazite from July 1 through December 31, 1954, were as follows: 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.

No prices were quoted in trade journals for bastnaesite concentrate during the year, but a price of $1.50 per pound of rare-earth compound (essentially rare-earth oxides) made from bastnaesite was announced by the Molybdenum Corp. of America on January 1, 1954. This was a reduction from the previous price of $3.00 per pound and was reduced further to $1.00 per pound on November 10, 1954.

Prices for misch metal and ferrocerium remained unchanged at $4.50 and $8.00 per pound, respectively. High-purity cerium metal was quoted at $18 per pound. Rare-earth chlorides were sold at 40–45 cents per pound, rare-earth fluorides at $1 per pound, rare-earth oxides at $1 per pound, cerium oxide at $2 per pound, cerium hydrate at $1.75 per pound, and lanthanum oxide at $10 per pound. Prices of other compounds were nominal, depending on quantity and quality.

Foreign Trade.—Receipts of misch metal and ferrocerium in the United States in 1954 totaled 5,700 pounds valued at $21,500. West Germany was the principal source with Austria furnishing a minor quantity. Cerium ores and compounds valued at $1,900 and totaling 8,200 pounds, all of which originated in India, were imported during the year.

Exports totaled 29,500 pounds of cerium ores, metals, and alloys valued at $128,800 and 8,000 pounds of lighter flints valued at $55,600.

Technology.—Three processes developed in the Ames laboratory of AEC at Iowa State College, involving the use of ion-exchange resins for separating rare-earth elements in quantity, were described.[28] Some physical properties of each of the rare-earth metals produced at the Ames laboratory and the methods used to produce them were also described.[29]

Reports of studies of the effects of rare-earth additions to furnace melts in the production of stainless steels were presented in 1954 at the annual meeting of the American Institute of Mining and Metallurgical Engineers in New York, N. Y. These studies showed that improved hot workability of stainless steels is achieved by the use of rare-earth additives. The characteristic chemical affinity of the rare earths for oxygen, hydrogen, sulfur, and nitrogen is one of the reasons why these elements were being investigated so widely by metallurgists for applications in both ferrous and nonferrous fields. For most metallurgical purposes the cost of even the most available rare-earth metal, cerium, was prohibitive. As a result, most commercial investigations employed misch metal, or "Lan Cer Amp", a product of

[28] Spedding, F. H., and Powell, J. E., Methods for Separating Rare-Earth Elements in Quantity as Developed at Iowa State College: Jour. Metals, vol. 6, No. 10, October 1954, pp. 1131–1135.
[29] Spedding, F. H., and Daane, A. H., Production of Rare-Earth Metals in Quantity Allows Testing of Physical Properties: Jour. Metals, vol. 6, No. 5, May 1954, pp. 504–509.

American Metallurgical Products Co., Pittsburgh, Pa., consisting of a mixture of rare-earth metals with a higher lanthanum content than misch metal, or rare-earth oxides, such as "Raremet T Compound" (15 percent CaB_2, 2 percent KNO_3, balance rare-earth oxides obtained from bastnaesite) supplied by the Molybdenum Corp. of America, New York, N. Y. Additions of rare-earth metals were shown to reduce the sulfur content and improve the surface quality of low-carbon steel to which they had been added either in the ladle or the mold, while rare-earth oxides showed very little effect on sulfur either as ladle or mold additions.[30]

Studies of methods for extracting thorium and the rare earths from monazite conducted at Battelle Memorial Institute, Columbus, Ohio, for AEC resulted in development of a process that was reported to offer several advantages over the conventional sulfuric acid extraction process used by the rare-earth industry in the United States. The process involved reaction of monazite concentrate with a hot concentrated aqueous solution of sodium hydroxide, thus converting the rare-earth and thorium phosphates to hydrous metal oxides and trisodium phosphate. The insoluble hydrous metal oxides were separated from the dissolved sodium phosphate and excess sodium hydroxide, washed, and then dissolved in hydrochloric acid. Partial neutralization of the acid solution with ammonium hydroxide resulted in precipitation of a thorium product, and further neutralization of the filtrate and washings with sodium hydroxide precipitated the rare earths quantitatively. The dried rare-earth hydroxide product, analyzing 73 percent rare earths, contained 97–98 percent of the rare earths present in the original monazite.[31]

In June 1954 the Lindsay Chemical Co. put into operation an addition to its facilities at West Chicago, Ill., to increase the company production of thorium salts from monazite for the AEC. A substantial increase of byproduct rare-earth output was expected to result.

World Review.—The restrictions placed on the export of monazite by India in 1946 and Brazil in 1951 were still in effect in 1954. Both countries continued to process monazite for recovering thorium and offered substantial quantities of rare-earth chlorides for exportation.

Production of monazite in Malaya was reported to have been increased greatly since the export duty was reduced from 10 percent ad valorem to 50 cents per picul in 1950, but no production data were available. The Malaya Government announced that the export duty on monazite would be restored to 10 percent ad valorem on January 1, 1955.[32]

Australian production of monazite for 1950, 1951, and 1952 was reported to be 133, 293, and 148 long tons, respectively.[33] No production data were available for 1953 and 1954.

Offers were invited by the Ceylon Government for the purchase of 30 long tons of monazite having a total rare-earth oxide content of

[30] Russell, J. V., Rare-Earth Additions Affect Surface Quality of Low-Carbon Steel: Jour. Metals, vol. 6, No. 4, April 1954, pp. 438–442.
[31] Bearse, A. E., Calkins, G. D., Clegg, J. W., and Filbert, R. B., Jr., Thorium and Rare Earths From Monazite: Chem. Eng. Progress, vol. 50, No. 5, May 1954, pp. 235–239.
[32] American Metal Market, vol. 61, No. 228, Dec. 1, 1954, p. 1.
[33] Bureau of Mines, Mineral Trade Notes: Vol. 38 No. 2. February 1954, pp. 26–27.

64 percent, including 8 to 9 percent thoria.[34] The Ceylon Government was reported to believe that Ceylon could produce annually about 1,500 long tons of this grade material.[35]

Production from the lode deposit of monazite near Van Rhynsdorp, Cape Province, Union of South Africa, by the Anglo-American Corp. of South Africa increased slightly in 1954. About 90 percent of the output was exported to United States processors. The Karonge bastnaesite mine near Somuki, Ruanda-Urundi, continued to produce a few hundred tons of bastnaesite annually, which has been shipped to West Germany for processing.

SELENIUM [36]

The worldwide shortage of selenium continued throughout 1954, and the search for new sources of selenium was intensified. A smaller quantity of selenium was produced as a byproduct of electrolytic copper refining in 1954 than in 1953. This decrease was partly offset by an increase in selenium imports.

Domestic Production.—Production of primary selenium in 1954 totaled 713,200 pounds compared with 924,000 pounds in 1953, a 23-percent decrease resulting from a voluntary cutback of copper production early in 1954 and labor troubles in the copper industry.

The American Smelting & Refining Co. produced high-purity selenium, ferroselenium, and commercial-grade selenium at its Baltimore, Md., refinery, principally from electrolytic copper slimes and material returned by manufacturers of selenium rectifiers.

The American Metal Co., Ltd., at Carteret, N. J., produced commercial-grade selenium, selenium compounds, and ferroselenium from electrolytic copper slimes.

At Garfield, Utah, the Kennecott Copper Corp. produced both high-purity selenium and commercial-grade selenium from electrolytic copper slimes.

International Smelting & Refining Co. recovered commercial-grade selenium from electrolytic copper slimes at Perth Amboy, N. J.

The Kawecki Chemical Co. produced high-purity selenium and ferroselenium principally from purchased commercial-grade selenium, material returned by manufacturers of selenium rectifiers, and "burned out" selenium rectifiers.

The reported production of secondary selenium from scrap and spent catalysts totaled 126,500 pounds in 1954 compared with 97,950 pounds in 1953.

Consumption and Uses.—Apparent domestic consumption[37] of selenium decreased from 1,127,800 pounds (revised figure) in 1953 to 1,021,300 in 1954, a 9-percent decrease. Consumption of high-purity selenium in 1954 remained at approximately the same level as in 1953, but consumption of commercial-grade selenium was considerably less in 1954 than in 1953.

Manufactures of selenium rectifiers were the principal consumers of selenium in 1954. Selenium was also used for the following purposes: In decolorizing glass; in orange, pink, red, and maroon pigments for glass,

[34] U. S. Department of Commerce, Foreign Commerce Weekly: Vol. 51, No. 13, Mar. 29, 1954, p. 14.
[35] Mining World, vol. 16, No. 1, January 1954, p. 67.
[36] Prepared by John D. Sargent.
[37] Producers' domestic shipments to consumers plus consumer imports, minus exports.

paint, soap, rubber, ceramics, paper, printing ink, plastics, dyes, and leather; in rubber accelerators and in rubber vulcanizing agents; as an agent to promote resistance to heat, oxidation, and abrasion in rubber; as a chemical reagent and catalyst; as an antioxidant in printing ink, paint, mineral oil, transformer oil, and vegetable oil; as an antioxidant and antigalling agent in lubricating oils; as a gelation retardant in tung oil, as a nondrying agent in linseed, oiticica, and tung oils; in insecticides, fungicides, parasiticides, and bactericides; in pharmaceuticals; in photographic photosensitizers and toning baths; as a solvent and remover of rubber, resin, glue, paint, and varnish; as an alloying agent in machineable stainless steels and copper alloys; and in blasting caps, mercury-vapor detectors, flotation reagents, fireproofing agents, insect repellants, phosphorescents, luminescents, and xerographic applications.

Stocks.—Stocks of refined selenium in the possession of producers increased slightly from 94,700 pounds at the beginning of the year to 96,400 pounds at its end. Producers' and consumers' combined stocks of refined selenium were at a low level, estimated to be 400,000 pounds lower than was considered satisfactory. No additions were made in 1954 to the National Strategic Stockpile holdings of selenium.

Prices.—The producers' price of commercial grade selenium increased from $4.25 per pound to $5.00 per pound in wholesale lots and the dealers' price of commercial grade selenium increased from $4.75 per pound to $6.00 per pound for 100 pound lots effective January 4, 1954 and remained unchanged throughout the remainder of the year. High-purity selenium metal sold for $3.00 to $5.00 per pound more than commercial grades during 1954. European market prices continued to be 2 or 3 times higher than domestic prices.

Foreign Trade.—United States imports of selenium and selenium compounds in 1954 totaled 209,600 pounds valued at $1,153,800, compared with 102,200 (revised figure) pounds valued at $456,700 in 1953. This total included 14,900 pounds of selenium contained in selenium concentrate from Mexico and valued at $14,900. The selenium in this concentrate was recovered in the United States and reported as United States production. An additional 25,100 pounds of selenium in concentrate from Mexico was placed in a bonded warehouse and not recorded as an import for consumption. Imports from other countries were as follows: Canada, 189,200 pounds valued at $1,075,400; Japan, 4,200 pounds, $57,600; Australia, 840 pounds, $3,600; New Zealand, 300 pounds, $1,400; and Peru, 170 pounds, $950.

The exportation of 24,000 pounds of selenium was authorized in 1954. Indications were that most of this authorized total was exported.

Technology.—Under a contract between the Bureau of Mines and the General Services Administration that became effective July 1, 1954, the Bureau undertook to investigate seleniferous tuffs and black shales in Wyoming, to determine the selenium content of some uranium ores, hydrometallurgical and pyrometallurgical research for the extraction of selenium from ores, to conduct research on other metallurgical techniques for the extraction of selenium from various selenium bearing materials, and to develop new selenium analytical techniques. Early Bureau of Mines work under this contract included analysis of 284 samples of volcanic tuff taken from shallow pits and trenches near Lysite, Wyo. Sixty-one of these samples contained

0.010 to 0.109 percent selenium; the remaining samples assayed less than 0.01 percent selenium.

A contract between the GSA and Battelle Memorial Institute, Columbus, Ohio, provided for the study of commercial extraction of selenium from seleniferous vegetation.

H. D. Thomas, the Wyoming State geologist, conducted experiments on seleniferous ores from Baggs, Lusk, and Lysite, Wyo.[38]

Atomic energy installations operated selenium rectifiers with current ratings up to 150,000 a.[39]

The United States Navy determined that selenium and germanium rectifiers were more suitable than motor-generator sets for a. c. to d. c. conversion aboard Navy vessels.[40]

The Joint House and Senate Committee on Defense Production branded the selenium shortage the most troublesome problem in the overall mobilization program.[41]

Both the United States Government and the British Government issued publications in 1954 that provided general information on selenium.[42]

A selenium rectifier for high-temperature operation was developed.[43]

Selenium-gold photoelectric cells were used in burglar alarms, industrial safety devices, automatic door opening mechanisms, and in automatic ventilation of mines and tunnels where dust or fumes were present.[44]

A simplified analytical technique for the determination of selenium was published in 1954.[45]

A review of selenium rectifiers and photocells was also published.[46]

A comprehensive review of selenium was published in 1954.[47]

World Review

Australia.—Australia produced 3,200 pounds of selenium in 1954, all of which was consumed in Australia; additional quantities were imported.

Belgium-Luxembourg.—Belgium-Luxembourg exported 65,000 pounds of selenium in 1954 to the following countries: United Kingdom, 29,300 pounds; France, 16,300 pounds; West Germany, 9,000 pounds; Netherlands, 6,800 pounds; and other, 3,500 pounds. Raw material was imported largely from Northern Rhodesia.

Canada.—Canadian selenium production increased from 262,300 pounds valued at C$1,101,900 in 1953 to 368,800 pounds valued at C$1,844,000 in 1954. Most of the 40 percent increase in Canadian selenium production in 1954 was attributable to greater output by the Canadian Copper Refiners, Ltd., at Montreal East, Quebec, from

38 Mining World, Wyoming: Vol. 16, No. 11, October 1954, p. 87.
39 Western Industry, Selenium Rectifier Power Supplies: Vol. 19, No. 9, September 1954, p. 79.
40 E&MJ Metal and Mineral Markets, Watch These Trends: Vol. 25, No. 16, April 22, 1954, p. 7.
41 Chemical and Engineering News, vol. 32, No. 48, Nov. 29, 1954, p. 4729.
42 Sargent, J. D., Selenium: Bureau of Mines Inf. Circ. 7690, 1954, 25 pp.
Ashton, R., Hill, E. G., and Neville-Jones, D., Selenium: Dept. Sci. and Ind. Research, London, Her Majesty's Stationery Office, 1954, 29 pp.
43 Jour. Metals, vol. 6, No. 12, December 1954, p. 1357.
44 Manufacturing Jeweler, vol. 113, No. 21, Nov. 4, 1954, p. 11.
45 Sill, C. W., and Peterson, H. E., Iodometric Determination of Selenium in Ores and Flue Dusts: Bureau of Mines Rept. of Investigations 5047, 1954, 9 pp.
46 Pietsch, E. H., Selenium, System No. 10, Part A, Section 3: Gmelin Institut, Weinheim, Germany, 1954, 184 pp. (158 graphs).
47 Stone, J. R., and Caron, P. E., Selenium: Rare Metals Handbook, Reinhold Publishing Corp., New York, N. Y., 1954, pp. 365-377.

ores mined by Noranda Mines, Ltd., and from blister copper produced by the Hudson Bay Mining & Smelting Co., Ltd.

The gross weight and value of selenium and selenium salts exported from Canada in 1954 was as follows: United States, 190,700 pounds valued at Can$1,047,600; United Kingdom, 146,900 pounds, Can$848,-300; India, 3,900 pounds, Can$25,100; Australia, 2,500 pounds, Can$20,000; France, 300 pounds, Can$2,400; and West Germany, 50 pounds, Can$400.

Finland.—Finland produced 5,600 pounds of selenium in 1954.

Germany, West.—West Germany produced about 25,000 pounds and imported about 85,000 pounds of selenium in 1954.

Italy.—The Mortecatini Co. produced 1,500 pounds of selenium at Porto Marghera in 1954 as a byproduct of the production of sulfuric acid and copper sulfate from pyrite and chalcopyrite.

Japan.—Production of 90,600 pounds of selenium was reported in Japan in 1954, but the Japanese Ministry of International Trade and Industry estimated that actual production was approximately 132,300 pounds. Exports of selenium from Japan in 1954 totaled 84,700 pounds valued at $1,080,800. Exports by country of destination were available only by value, as follows: United Kingdom, $262,600; Western Germany, $256,200; France, $125,400; Netherlands, $112,400; Hong Kong, $77,800; Brazil, $60,500; India, $35,700; Mexico, $23,800; United States, $17,300; and others, $109,200.

Mexico.—Selenium concentrate with a selenium content of 14,900 pounds was exported from Mexico to the United States in 1954. Since such concentrate was refined in the United States and reported as United States production, the total should not be included in United States imports of refined selenium.

Netherlands.—The Netherlands imported 13,400 pounds of selenium in 1954 from the following countries: Belgium, 6,700 pounds; Sweden, 4,500 pounds; United States, 880 pounds; West Germany, 730 pounds; United Kingdom, 400 pounds; and Japan 240 pounds.

New Zealand.—New Zealand exported 300 pounds of selenium to the United States in 1954.

Northern Rhodesia.—An estimated 50,000 pounds of recoverable selenium contained in copper anode slimes was shipped from Northern Rhodesia to Belgium in 1954 for selenium recovery.

Peru.—Peru exported 3,700 pounds of selenium in 1954.

Sweden.—Over 150,000 pounds of selenium was produced by the Boliden Mining Co., Sweden's only producer of selenium, as a by-product of gold, copper, and arsenic recovery.

Swedish exports of selenium were as follows: West Germany, 118,600 pounds valued at $1,572,800; France, 9,300 pounds, $134,300; Switzerland, 6,200 pounds, $91,100; United Kingdom, 5,300 pounds, $70,400; Netherlands, 4,400 pounds, $68,500; Italy, 4,100 pounds, $56,100; East Germany, 1,100 pounds, $15,900; Brazil, 930 pounds, $12,600; Chile, 770 pounds, $11,200; Denmark, 660 pounds, $9,900; Australia, 660 pounds, $9,900; Norway, 620 pounds, $7,000; Uruguay, 600 pounds, $7,900; Spain, 530 pounds, $6,800; Greece, 220 pounds, $3,100; Belgium-Luxembourg, 70 pounds, $770; and Ireland, 20 pounds, $390.

Yugoslavia.—The Bor copper mine, produced 440 pounds of selenium in 1954.

TELLURIUM [48]

Although tellurium shipments exceeded production in 1954 for the second consecutive year, more tellurium could have been produced, and stocks were more than adequate to meet any anticipated demand.

Domestic Production.—Domestic production of primary tellurium in 1954 was 97,100 pounds, compared with 70,400 pounds in 1953. Tellurium producers in 1954 were the American Smelting & Refining Co., Perth Amboy, N. J.; United States Smelting, Refining, & Mining Co., East Chicago, Ind.; and the American Metal Co., Ltd., Carteret, N. J.

Consumption and Uses.—Tellurium shipments declined from 141,200 pounds in 1953 to 100,800 pounds in 1954. The major uses for tellurium in 1954 were in rubber to impart resistance to heat, abrasion, and aging and in lead to impart hardness, toughness, and corrosion resistance. Tellurium was also used as an alloying agent in copper and tin. Core washes of 25 percent tellurium and 75 percent silica flour were used to prevent localized shrinkage in iron castings. Ferrotellurium was used as a degasifier and to give a free machining quality to stainless steel. Tellurium was also used in ceramics and glass, ultramarine pigments, photographic toning baths, and electronic semiconductors.

Stocks.—Stocks of refined tellurium decreased from 128,000 pounds in 1953 to 103,600 pounds in 1954. Raw-material stocks in 1954 increased approximately 20 percent over those held in 1953 and represented a 5- or 6-year supply at present rates of consumption.

Prices.—The price of tellurium remained at $1.75 per pound for the 15th consecutive year.[49] Ferrotellurium, 50–58 percent tellurium, sold for $2.00 per pound of contained tellurium in 1954.

Technology.—A comprehensive review of tellurium was published in 1954.[50]

World Review.—In Canada the International Nickel Co. of Canada, Ltd., at Copper Cliff, Ontario, recovered tellurium from copper-nickel operations in the Sudbury Basin. The Canadian Copper Refiners, Ltd., a subsidiary of Noranda Mines, Ltd., recovered tellurium from the blister copper produced by the Hudson Bay Mining & Smelting Co., Ltd., Flin Flon, Manitoba. Preliminary estimates placed Canadian tellurium production at 7,200 pounds valued at C$12,600 in 1954, compared with 4,700 pounds valued at C$8,200 in 1953.

THALLIUM [51]

Thallium is utilized principally in rodenticides and insecticides. Thallium metal has little resistance to atmospheric corrosion, but thallium-lead alloys resist atmospheric and anodic corrosion.

Domestic Production.—The Globe cadmium refinery of the American Smelting & Refining Co. at Denver, Colo., was the only domestic thallium producer in 1954. Production, shipments, and stocks of thallium metal and thallium compounds were greater in 1954 than in 1953.

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[48] Prepared by John D. Sargent.
[49] E&MJ Metal and Mineral Markets, vol. 25, Nos. 1–52, 1954.
[50] Stone, J. R., and Caron, P. E., Tellurium: Rare Metals Handbook, Reinhold Publishing Corp., New York, N. Y., 1954, pp. 405–415.
[51] Prepared by John D. Sargent.

Uses.—The principal commercial use for thallium was in the form of thallium sulfate, an extremely poisonous substance having neither odor nor taste. This compound proved very efficient for exterminating rodents, insects, and other pests. Other uses for thallium metal, alloys, and compounds included infrared radiation transmitters, spectrometer lenses, photoelectric cells, low-freezing-point alloys, high-density liquids, special glasses, rectifiers, bearing alloys, corrosion-resistant and fusible lead alloys, mold- and insect-proofing, phosphor activation, and radiation detection. The AEC has studied bismuth-lead-tin-thallium alloys for use as coolants in atomic piles.

Prices.—E&MJ Metal and Mineral Markets quoted thallium metal at $12.50 per pound throughout 1954.

Technology.—A comprehensive review of thallium was published in 1954.[52]

[52] Howe, H. E., Thallium: Rare Metals Handbook, Reinhold Publishing Corp., New York, N. Y., 1954, pp. 417–428.

Minor Nonmetals

By Lee M. Hunt[1] and Annie L. Marks[2]

GREENSAND

THE OUTPUT of processed greensand (glauconite) in the United States dropped to 2,800 short tons in 1954, compared with 6,800 short tons in 1953. The value, however, rose to $198,900 in 1954, compared with $193,400 in 1953. Companies reporting production were: The Permutit Co., Birmingham, N. J.; Zeolite Chemical Co., Medford, N. J.; Inversand Co., Sewell, N. J.; and Kalorite Corp., Dunkirk, Md. Production was from open-pit operations in Burlington and Gloucester Counties, N. J.; and Calvert County, Md. The bulk of the 1954 output was used for water softening and purification and agricultural purposes because of its potassium content. One company also advertised its product as a source of trace elements for plant nutrition.

Greensand prices in 1954 ranged from $19 to $139 per short ton, with an average value of about $70 per ton, all prices f. o. b. shipping point.

A patent was issued on a molding sand in which ground greensand was mixed with other sand. It was claimed that the greensand served as a bonding material.[3]

TABLE 1.—Greensand marl sold or used by producers in the United States, 1945–1949 (average) and 1950–54

Year	Short tons	Value	Year	Short tons	Value
1945–49 (average)	6,372	$401,064	1952	4,600	$177,847
1950	3,935	304,321	1953	6,821	193,404
1951	5,067	263,944	1954	2,838	198,909

MEERSCHAUM

Although small deposits of meerschaum (sepiolite) occur in New Mexico,[4] Utah,[5] Pennsylvania, New York, and Massachusetts,[6] no domestic production has been reported since about 1914.

[1] Commodity-industry analyst.
[2] Statistical clerk.
[3] Freudenberg, Hellmut, Molding Sand: U. S. Patent 2,694,241, Nov. 16, 1954.
[4] Sterrett, Douglas B., Meerschaum in New Mexico: U. S. Geol. Survey Bull. 340, 1908, p. 469.
[5] Bradley, W. H., The Occurrence and Origin of Analcite and Meerschaum Beds in the Green River Formation of Utah, Colorado, and Wyoming: U. S. Geol. Survey Prof. Paper 158a, 1930, pp. 1–7.
[6] Ladoo, R. B., and Myers, W. M., Nonmetallic Minerals: McGraw-Hill Book Co., New York, N. Y., 1951, pp. 311–313.

Turkey continued in 1954 to be the principal world source of meerschaum, with a production of 776 boxes (about 70 pounds per box) and shipment of 903 boxes valued at $83,221.[7] Tanganyika reported output of 4,480 pounds valued at $261.[8] The bulk of this production was consumed by the European and American market for manufacturing pipes and other articles for smokers.

In the past 5 years imports into the United States have ranged from more than 8,000 to 12,000 pounds annually. Details are shown in table 2.

TABLE 2.—Meerschaum imported for consumption in the United States, 1945–49 (average) and 1950–54 [1]

[U. S. Department of Commerce]

Year	Pounds	Value	Year	Pounds	Value
1945–49 (average)	12,472	$23,141	1952	10,479	$12,344
1950	9,621	18,549	1953	8,568	12,600
1951	11,289	13,384	1954	12,068	26,357

[1] 1945–49 (average), 1951, and 1954, 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

Mineral wool produced in the United States during 1954 from rock, slag, and glass had a total value of $160,383,000, according to the Bureau of the Census. Production in 1953 was valued at $149,092,000 and in 1952 at $138,305,000. Use statistics were not available for 1954, 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; equipment insulation, 23; industrial insulation, 17; and unspecified, 4.

The average number of people employed in the mineral-wool industry in 1954 was 10,244, compared with 10,506 in 1953. The number of production workers in 1954 totaled 7,555, compared with 8,661 in the previous year.

Exports of mineral-wool products from the United States during 1954 were valued at $2,669,000, compared with $2,029,000 in 1953 and $1,723,000 in 1952.

The new bulk-handling system installed by American Rock Wool Corp. of Plainfield, N. J., to charge its cupolas was described.[9] This charging operation, formerly performed by 3 men with wheelbarrows, subsequently was operated by 1 man, who charged 250 tons of slag and coke per shift with completely mechanized equipment.

Results of tests at the Mississippi Valley Experiment Station of the Bureau of Mines on samples from several States and Alaska to determine their suitability as raw material for the production of mineral wool were reported.[10]

[7] Madenlerimizin Faaliyetleri, 1953–54 (Turkey), 1955, p. 75.
[8] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 4, April 1955, p. 51.
[9] Setterbey, C. B., Bulk-Handling System Cuts Cupola-Charging Costs: Iron Age, vol. 174, July 22, 1954, pp. 118–119.
[10] Kenworthy, H., and Moreland, M. L., Experimental Results in Testing Mineral-Wool Raw Materials: Rock Products, vol. 57, November 1954, pp. 70–73.

The crimped-wire-and-rod method for mineral-wool application developed by Detroit Edison Co. and used in the insulation of Conners Creek generating station in Detroit, was described. In this method mineral wool blocks were laced individually to one-quarter-inch steel rods run through crimped wires which were fastened at intervals to stiffeners on air ducts and other parts of equipment. The method was reported to lend itself to insulation of air ducts, fan housings, air heaters, and hoppers of various sizes, shapes, and surface temperatures.[11]

A heat-loss graph used to simplify determination of mineral-wool block and board insulation thickness best suited for specific jobs was published.[12] The graph was described as weighing the cost of insulating materials and installation against the cost of heat loss to obtain the most economical insulation thickness.

A patent was issued on a mineral wool obtained from flame-melted kaolin or bauxite and said to have heat-insulating properties up to 2,300° F. It was stated that, because of the low alkali content, the fibers were not attacked by water vapor at high temperatures.[13]

A patent was also issued on mineral wool mixed with organic or inorganic fibers as a blotting paper. The product was said to have good absorptive capacity and could be made on normal paper machines.[14]

WOLLASTONITE

In 1954 Cabot Carbon Co. (previously of Godfrey L. Cabot, Inc.), continued to be the sole producer of commercial wollastonite. The firm began production at a deposit near Willsboro, N. Y., in 1952. Initial production was from a pilot plant erected on the property by the former operator, Willsboro Mining Co. The company reported that a proved reserve of 4 million tons had been drilled out with an estimated 15 million tons in the deposit.[15]

In September 1953 a new plant with a designed capacity of 60,000 tons per year was completed, and by 1954 7 grades were being offered to the market and several others under evaluation. Garnet and diopside, associated minerals, were extracted by magnetic separation, and the company reported that it planned to develop a market for these byproducts.[16]

The company reported that because of the brightness, acicular form, and uniformity of its product, wollastonite was finding application in the paint industry as an inert filler and in the ceramic industry for manufacturing wall tile, grinding-wheel bonds, glazes, terra cotta bodies, low-loss dielectric insulators, and glaze frits. Other potential

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[11] Industry and Power, Insulation at Conners Creek: Vol. 66, No. 2, February 1954, pp. 74–75.
[12] Heating and Ventilation, Heat-Loss Graph for Specifying Block-Insulation Thickness: Vol. 51, No. 8, August 1954, pp. 81–82.
[13] Harter, Isaac, Jr., and Norton, Charles L., Refractory Fiberous Materials: U. S. Patent 2,674,539, Apr. 6, 1954.
[14] Wohlleber, Wilhelm, [Blotting Paper]: Austrian Patent 177,315, Jan. 25, 1954.
[15] Paint, Oil and Commercial Review, Cabot Wollastonite, Product of Promise: Vol. 117, No. 18, Sept. 9, 1954, p. 17.
[16] Ladoo, Raymond B., Wollastonite, a New Mineral: Pit and Quarry, vol. 47, No. 6, December 1954, p. 56.

uses that have been investigated or suggested are as a filler in paper, asphalt tile, and insulating materials, as a diluent for asbestos, as a filter medium, as a welding-rod coating, and in producing a special fiber glass.

Oil, Paint and Drug Reporter began quoting prices on wollastonite in December of 1954 as follows: 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.

Index

By Mabel E. Winslow [1]

NOTE.—Because nearly all commodity chapters in Minerals Yearbook, volume I, follow a rather standardized outline (Introductory Summary, Domestic Production, Consumption and Uses, Prices, Foreign Trade, Technology, and World Review), references to such data have been omitted under the various commodity headings, although they were included in past Yearbook indexes. However, outstanding new developments under Technology have been indexed, as well as important information by States and countries. Moreover, to assemble references to material in certain economic categories in one place, such subjects as Tariffs and Stockpile, National, have been indexed in detail. Work of various Government agencies concerned with the mineral industries (such as the Defense Minerals Exploration Administration and the General Services Administration as well as the Bureau of Mines and the Geological Survey) has also been indexed.

[1] Head, Editorial Section, Office of Mineral Reports.

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