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MINERALS YEARBOOK

METALS AND MINERALS
(EXCEPT FUELS)

Volume I

1953

Prepared by the staff of the
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FOREWORD

Minerals Yearbook 1953 is published in three volumes to provide a more comprehensive review of mineral-industry activities than was possible when all data were bound in a single volume. The results of the decision to change from a 1-volume to a 3-volume publication with the Minerals Yearbook 1952 have been gratifying because presentation of additional data has been possible with a format that permitted improvements in printing and binding. The Minerals Yearbook will continue to record the year's progress and developments, with enough historical background to give full significance to current activities.

The three-volume Yearbook permits fuller coverage in all phases of the reports, but major expansion has been undertaken in the regional presentation (volume III) and in the review of technologic developments and problems in the commodity presentation (volumes I and II).

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

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

Volume III is 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 capter recapitulating its statistics in summary form on a regional basis and another presenting employment and injury data regionally.

The Bureau of Mines wishes to acknowledge again the cooperation of industry and of many Government groups in the preparation of the Yearbook. Among the latter, some of the State geological surveys and mining bureaus have been of much assistance, particularly with their help in gathering and preparing the material that appears principally in volume III.

Thos. H. Miller, *Acting Director*.

April 20, 1956

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

Alabama: Geological Survey of Alabama.
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Washington: State of Washington Division of Mines and Geology.
West Virginia: West Virginia Geological and Economic Survey.
Wisconsin: Wisconsin Geological and Natural History Survey.
Wyoming: Geological Survey of Wyoming.

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: C. H. Johnson, former chief, and his successor, M. E. Volin, chief, Branch of Base Metals; N. B. Melcher, chief, Branch of Ferrous Metals and Ferroalloys; F. J. Cservenyak, chief, Branch of Light Metals; H. D. Keiser, 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 F. 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, Jane Doughman, Hope R. Anderson, Helen L. Gealy, Ruby J. Phillips, Anita C. Going, Ruth Kidwell, and Anne Rogers.

The assembly and preparation of data for world production tables were directly supervised by Berenice B. Mitchell, Division of Foreign Activities.

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.

CHARLES W. MERRILL.

CONTENTS

Review of the Mineral Industries[1]

(Metals and Nonmetals Except Fuels)

By Gabriel F. Cazell[2] and Robert E. Herman[3 4]

FOR THE TOTAL range of nonfuel metals and minerals, 1953 was a year of modest progress; total available supply, consisting of domestic production and imports, exceeded consumption, with the difference, aside from accretions to the National Strategic Stockpile, remaining largely as stocks in the hands of producers rather than consumers. Prices of nonfuel metals and minerals rose somewhat—on the average—over 1952, but costs appeared to rise even higher. As a result, returns to ownership were lower in 1953, and this poorer earning position for the industry was reflected in a significant decrease in the price of securities of mining companies over the year. Expenditures on new plant and equipment lagged behind those in other segments of the economy. On the world scene, many regulatory devices affecting mineral activities, both domestic and foreign, were discontinued during 1953, the most important of which were price controls in the United States and the International Materials Conference, which influenced distribution of strategic minerals among the countries of the world.

DOMESTIC PRODUCTION

Value of Mineral Production.—The value of production, in the continental United States, of metallic and nonmetallic minerals (except fuels) rose 9 percent in 1953 over 1952. In 1953 both metals and nonmetals contributed to the sizable increase, whereas in 1952 a decrease in metallic production held the total at about the 1951 level. Table 1 summarizes the value of mineral producton for 1944–53; detailed data, by commodities and States, are presented in the Statistical Summary chapter of this volume.

Volume of Production.—The index of physical volume of metal, stone, and earth minerals brought out of the ground in 1953 rose 3.5 percent over 1952 as it reached 119 percent of the 1947–49 Federal Reserve base. This raised mineral production to a level just under the record year of 1951. Most of the increase came in the mining of metals, as the output of stone and earth minerals was less than 1 percent above 1952.

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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.
3 Analytical statistician.
4 Assisted by Gabrielle Sewall, general economist.

TABLE 1.—Value of mineral production in continental United States, 1944–48 (average) and 1949–53, by mineral groups

[Million dollars]

Mineral group	1944–48 (average)	1949	1950	1951	1952	1953	Change in 1953 from 1952 (percent)
Metals and nonmetals except fuels:							
Nonmetallic minerals except fuels	1,171	1,559	[1] 1,822	[1] 2,079	[1] 2,163	2,337	+8
Metals	941	1,101	1,351	[1] 1,671	[1] 1,614	1,796	+11
Total	2,112	2,660	[1] 3,173	[1] 3,750	[1] 3,777	4,133	+9
Mineral fuels	6,185	7,920	8,689	9,779	9,615	10,249	+7
Grand total	8,297	10,580	[1] 11,862	[1] 13,529	[1] 13,392	14,382	+7

[1] Revised figure.

The production of pig iron and steel reached 138 percent of the 1947–49 base, 20 percent above 1952, and 5 percent above the previous peak (reached in 1951). The production of nonferrous metals—primary and secondary—rose 12 percent above 1952 to reach 136 percent of the base period. This represents a 17-percent increase over the emergency-stimulated output of 1951. Stone and clay products (including cement) and fertilizer, fairly representative of manufacturing in the nonmetallic minerals, rose only 5 percent over 1952 to reach 138 percent of the base period, only 3 percent above 1951. A weighted aggregate of these indexes indicates that total activity in the mining and manufacture of minerals and metals rose about 12 percent above 1952 compared to an 8-percent increase for total industrial production and reached a new high for this area of the economy—4 percent above 1951.

TABLE 2.—Indexes of physical volume of metal and mineral mining, production of metals, production of nonmetallic products, and industrial production, 1947–53[1]

[1947–49=100]

Year	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
1947	98	101	104	95	100
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

[1] Source: Federal Reserve Bulletin, December 1953, p. 1302, and July 1954, pp. 761–763. Indexes for years before 1947 are not available on the 1947–49 base, and recent years are not available on the 1935–39 base.
[2] Weighted average, computed by authors of this chapter, employing Federal Reserve indexes and weights.

Within the year itself, seasonally adjusted metal mining declined, with an 8-percent drop between the first and fourth quarters. Lead and zinc contributed to this decline, as did the mining of iron ore (as measured by shipments) which fell short of its normal first to fourth quarter increase; in 1951 and 1952 these increases were 127 and 142 percent, respectively, compared with only 98 percent in 1953.

Copper mining, on the other hand, enjoyed another stable year. The stone and earth minerals rose very slightly during the latter part of the year to offset partly the decline in metal mining in the latter half. The combined mining category "metal, stone, and earth minerals" thus declined slightly during the 12-month period.

Production of pig iron and steel declined during the year, and monthly production averaged 10 percent less in the second half than in the first half of the year. Primary nonferrous metals rose slightly during the year, largely as a result of the steady increases in aluminum production, but this was offset by a decline in secondary metal production; the combined production was quite stable and distributed evenly throughout the year. Largely because of steel, the total metal production showed a monthly decline over the 12-month period.

Value of Shipments of Mineral Manufactures.—Another indicator of activity in minerals can be found in data of the Bureau of the Census Annual Survey of Manufactures shown in table 3. Although fragmentary as to categories, these data attempt to measure first the value of shipments of mineral manufactures by all manufacturing industries, on a product basis, and second, the value of shipments of all products by mineral manufacturing industries, on an industry basis. All product categories increased except two groups, sheet-mica products and reagent and high-purity grade chemicals. The effect of increased price on shipment values cannot be measured precisely, but is estimated to average 3 or 4 percent for the total listing. Only inorganic color pigments showed a price decrease; the range of the increases for other categories for which data were available was from 1 to 7 percent.

Census figures indicate a general decline in the value of shipments of equipment items used by the minerals industries in 1953; specialized mining machinery and equipment, however, rose slightly over 1952.

Mining Firms.[5]—During 1953 there was a slight net increase in the estimated number of mining and quarrying firms, including those mining fuels. Such firms totaled 38,100 at the beginning of the year, 38,400 on June 30, and 38,300 on December 31. During the year 3,800 new firms were established, compared with 4,200 [6] in 1952; 3,700 firms were discontinued, the same number as in 1952. Transfers of ownership, which had numbered 2,100 in 1952, totaled 1,900 in 1953.

Latest estimates (as of January 1, 1951) indicated that about one fourth of the mining and quarrying firms were incorporated as compared with one-eighth of all firms in operation and one-third in manufacturing. Similar data for 1947 indicate that proprietorships represent the largest category, followed by partnerships and corporations, in that order, and more recent data indicate that this distribution had not changed substantially.

Estimates, as of January 1, 1951, of the size distribution of mining and quarrying firms indicated that about 60 percent had less than 4 employees; about 88 percent had less than 20 employees. The corresponding percentages for all firms were 75 and 95 and for manu-

[5] U. S. Department of Commerce, Office of Business Economics, Survey of Current Business: Vol. 34, No. 5, May 1954, pp. 15–24 and No. 11, November 1954, pp. 14–23; vol. 35, No. 4, April 1955, pp. 14–20; and records. All data cover both fuels and nonfuels mining and quarrying firms. Discrepancies in figures are due to rounding.

[6] Revised. Of these 4,200 new businesses, 2,400 had less than 4 employees, 1,100 from 4–7 employees, 500 from 8–19 employees, and 200, 20 or more employees.

TABLE 3.—Value of shipments of selected mineral and related manufactures and manufacturing industries, 1947 and 1951–53, in million dollars [1]

[U. S. Department of Commerce]

Industry and product classification [2]	Products [3] 1947	Products 1951	Products 1952	Products 1953	Products: Change in 1953 from 1952 (percent)	Industries [4] 1947	Industries 1951	Industries 1952	Industries 1953	Industries: Change in 1953 from 1952 (percent)
PRIMARY METAL PRODUCTS										
Blast-furnace products	1,622	2,958	2,683	3,362	+25	1,714	3,047	2,797	(5)	(5)
Pig iron	1,551	2,814	[6] 2,578	3,230	+25					
Other blast-furnace products [7]	71	144	[6] 105	132	+26					
Electrometallurgical products [7]	226	406	413	482	+17	151	307	312	401	+29
Primary zinc	169	(5)	(5)	(5)	(5)	191	346	336	268	−20
Primary aluminum	116	(5)	(5)	(5)	(5)	161	302	340	477	+40
STONE, GLASS, AND CLAY PRODUCTS										
Abrasive products [8]	241	376	346	391	+13	223	360	326	405	+24
Nonmetallic abrasives	190	325	304	345	+13					
Asbestos products	194	342	340	345	+1	205	315	316	360	+14
Cement, hydraulic [9]	375	685	712	778	+9	409	692	719	749	+4
Gypsum products	126	235	223	242	+9	128	234	224	253	+13
Lime [9]	65	94	93	103	+11	73	105	105	118	+12
Mineral wool	79	134	138	149	+8	73	130	135	149	+10
Minerals, ground or treated [10]	93	161	165	178	+8	90	(5)	(5)	159	(5)
Nonclay refractories	93	156	[6] 139	165	+19	90	176	155	186	+20
Sheet-mica products, except radio parts	30	49	45	42	−7					
CHEMICALS AND ALLIED PRODUCTS										
Synthetic ammonia, nitric acid, and ammonium compounds	97	182	219	247	+13					
Fertilizers [8]	467	765	852	919	+8	505	774	865	(11)	[11] +2
Mixed fertilizers, complete and incomplete	378	648	734	793	+8					
Superphosphate	86	109	111	118	+6					
Inorganic color pigments	280	397	337	362	+7	270	417	350	333	−5
Reagent and high-purity grades of inorganic and organic chemicals refined from purchased technical grades	5	17	15	13	−13					
Sodium carbonate (soda ash)	68	109	99	119	+20					
Sulfuric acid	89	137	136	156	+15					

onstruction and mining machinery [8]	932	1, 413	1, 592	1, 420	−11	927	1, 344	1, 560	1, 541	−1
Power cranes, draglines, and shovels	191	(5)	(5)	253	(5)					
Specialized mining machinery and equipment	(12)	140	140	144	+3					
Crushing, pulverizing, and screening machinery	(12)	108	118	115	−3					
Other construction, mining, and similar machinery	(12)	198	160	152	−5					
Industrial furnaces and ovens	85	127	149	139	−7	75	120	146	168	+15

[1] U. S. Department of Commerce, Bureau of the Census, Annual Survey of Manufactures: 1952 volume, pp. 40–42; Ser. MAS-53-1 (Final), May 25, 1955, pp. 10-14, 17, and 19; and Ser. MAS-53-5, Feb. 14, 1955, pp. 25–27. Except for 1947, data are estimates, subject to standard errors as indicated in source publications.

[2] Designates both industry and all products classified as primary to such industry, except that where leaders appear in all columns under "Industries" the item is only one of two or more classes of products primary to a particular industry. Further, where such item is not indented, the industry has not been specified. No data are shown for certain mineral and related manufactures and industries for which 1953 data are available on neither a product basis nor an industry basis, for example, primary copper, primary lead, other primary nonferrous metals, cut-stone and stone products, and explosives. Industries listed below the parallel rule were selected from among those supplying equipment to the mineral industries.

[3] Value of shipments, by all manufacturing industries, of products designated.

[4] Value of all shipments by establishments classified in the specified industry, including their shipments of products primary to other industries.

[5] Data not available.

[6] Revised figure.

[7] Ferroalloys and other additives made in blast furnaces are included in electrometallurgical products.

[8] Includes product classes not shown separately below.

[9] Product figures exclude, industry figures include, cost of shipping containers.

[10] Includes natural graphite, ground, refined, or blended.

[11] Value not available for establishments primarily engaged in mixing fertilizers from purchased fertilizer materials. Percentage change shown is based on value for establishments primarily engaged in manufacturing mixed fertilizers from one or more fertilizer materials produced in the same establishment—1952, $533,000; 1953, $543,000.

[12] Comparable data not available.

TABLE 4.—Net new supply of principal minerals in the United States, 1952–53

Commodity	Total (thousand short tons unless otherwise stated)			Major components as a percent of total					
				Domestic production [1]				Net imports [2]	
	1952	1953	Change from 1952 (percent)	1952	1953			1952	1953
					Primary shipments	Secondary production	Total		
Ferrous ores and metals:									
Iron and steel (equivalent) [3]	100,081	113,939	+14	96	62	[4] 32	94	4	6
Manganese (content)	1,442	1,924	+33	11	11		11	[5] 89	[5] 89
Chromite (Cr_2O_3 content)	725	966	+33	1	3		3	99	97
Cobalt (content) ... thousand pounds	17,235	20,553	+19	13	9	[6] 7	16	87	84
Molybdenum (content) ... do	35,769	46,376	+30	119	116		116	−19	−16
Nickel (content)	114	125	+10	4	1	4	5	96	95
Tungsten ore and concentrate (W content) ... short tons	12,319	18,587	+51	29	25		25	71	75
Other metallic ores and metals:									
Copper (content)	1,797	1,910	+6	75	49	22	71	25	29
Lead (content)	1,415	1,315	−7	57	26	33	59	[5] 43	[5] 41
Zinc (recoverable content)	1,178	1,260	+7	63	44	5	49	[5] 37	[5] 51
Aluminum (equivalent) [7]	1,371	1,733	+26	33	[8] 20	5	25	[9] 67	[9] 75
Tin (content) ... thousand long tons	127	130	+2	16	([10])	15	15	84	85
Antimony (recoverable content) ... short tons	36,373	32,967	−9	65	6	58	64	[11] 35	[11] 36
Cadmium (content) [12] ... thousand pounds	9,825	11,326	+15	36	34	1	35	64	65
Magnesium (content)	112	99	−12	101	[13] 95	6	101	−1	−1
Mercury ... 76-pound flasks	84,002	97,184	+16	15	[13] 15		15	85	85
Platinum-group metals ... thousand troy ounces	522	701	+34	18	4	[14] 9	13	82	87
Titanium concentrate: Ilmenite and slag (TiO_2 content)	378	441	+17	70	59		59	30	41
Nonmetallic minerals:									
Asbestos	753	744	−1	7	7		7	[15] 93	[15] 93
Barite, crude	1,050	1,279	+22	90	74		74	10	26
Boron minerals and compounds ... gross weight	481	576	+20	121	124		124	−21	−24
Bromine and bromine in compounds ... thousand pounds	153,414	160,730	+5	102	102		102	−2	−2
Clays	41,507	42,283	+2	100	100		100	([10])	([10])
Fluorspar, finished	683	678	−1	48	47		47	52	53
Gypsum, crude	11,503	11,477	([10])	73	[16] 72		72	27	28
Mica (except scrap) ... thousand pounds	12,508	14,469	+16	6	6		6	94	94
Phosphate rock (P_2O_5 content) ... thousand long tons	3,213	3,319	+3	113	120		120	−13	−20
Potash (K_2O equivalent)	1,731	1,813	+5	92	96		96	8	4
Salt, common	19,202	20,677	+8	102	101		101	−2	−1
Sulfur (content) ... thousand long tons	4,832	5,049	+4	125	[17] 123		123	−25	−23
Talc and allied minerals	590	598	+1	100	100		100	([10])	([10])

[1] *Primary shipments* are mine shipments or mine sales (including consumption by producers) plus byproduct production. Shipments are used rather than production because shipments represent the actual quantities marketed by the domestic mining industry under competitive conditions existing during the respective years and as such are more comparable to imports, which in general, are or represent actual quantities from foreign mines marketed or processed in the United States. Further, use of shipment data permits uniformity of treatment between more commodities, because such data are more generally available than are production data. *Secondary production* is that from old scrap only. Footnotes that indicate individual exceptions to the foregoing apply to both 1952 and 1953.

[2] In general, imports for consumption minus exports of domestic merchandise. Minus sign denotes net exports. Both imports and exports insofar as possible exclude scrap (reflected in secondary production) but include all other sources of minerals through the refined or roughly comparable stage, except where the commodity description indicates an earlier stage.

[3] Iron ore reduced to an estimated pig-iron equivalent; reported weight is included for all other items of supply.

[4] Receipts of purchased scrap.

[5] General imports minus exports of both domestic and foreign merchandise (that is, reexports).

[6] Consumption of purchased scrap.

[7] Includes, for bauxite, 82 percent only of production (rather than shipments) and imports and for alumina, 91 percent of imports, both converted to estimated aluminum equivalent; percentages used are estimated proportions of respective 1953 consumption used in production of metal. Further, to avoid, insofar as possible, a duplicate adjustment for nonmetallic use, exports of bauxite to Canada—mostly for nonmetallic use—were excluded from exports.

[8] Mine production of bauxite. See also footnote 7.

[9] Includes ingot equivalent (weight times 0.9) of net imports of scrap, imports of 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 7.

[10] Less than 0.5 percent.

[11] Includes antimony recovered in antimonial lead from foreign silver and lead ores.

[12] Primary shipments estimated as 40 percent of total primary production of metal and compounds not made from metal, while imports are represented by the sum of the remaining 60 percent of such production plus imports of metal. Secondary production includes that from both old and new scrap.

[13] Primary production of metal.

[14] Recovery from both old and new scrap.

[15] Exports of foreign merchandise (that is, reexports) have also been deducted.

[16] Estimated by adjusting production, excluding byproduct, for changes in producers' stocks.

[17] Includes, for pyrites, sulfur content of production.

facturing 43 and 76. However, the bulk of the employment in the industries was accounted for by firms having 20 or more employees. For example, 5 percent of the mining and quarrying firms had about 76 percent of total employment in that industry, and the top 1 percent accounted for 52 percent. The corresponding percentages for all firms were 77 and 60 percent and for manufacturing 74 and 56 percent. It was estimated that the smallest firm in the 5-percent group of mining and quarrying firms had about 60 employees; for all industries, 20 employees; and for manufacturing firms, 200 employees. For the 1-percent group of firms, the smallest firm in mining and quarrying employed about 450 employees, in all industries 100 employees, and in manufacturing 650 employees.

The entry rate of new mining and quarrying firms (ratio of new firms to those in operation, expressed as a percentage of the ratio for all firms) was estimated to have been 129 in 1951 compared with 108 for all manufacturing firms. However, entry rates for the mineral-manufacturing industries, stone, clay, and glass products, and primary metal industries were much lower (67 and 80, respectively). For most industries the entry rate decreased as the size of the firm increased. However, for mining and quarrying (as well as several other industries) the entry rate for firms with 4 to 7 employees was greater than that for firms with less than 4 employees (231 and 124, respectively).

An estimated geographical distribution of mining and quarrying firms, as of January 1, 1951, indicated that Texas had the largest number of firms (6,100), followed by Pennsylvania (5,600), West Virginia (3,000), and Oklahoma (2,600). In all of these States, the value of production of mineral fuels greatly exceeded that of nonfuel minerals.

NET NEW SUPPLY

The net new supply [7] of most of the principal minerals increased between 1952 and 1953. The largest gains were made in tungsten ore and concentrate, the platinum group, manganese, chromite, molybdenum, and aluminum. Magnesium, antimony, lead, asbestos, fluorspar, and gypsum showed declines in net new supply.

Sources of New Supply.—As indicated in table 4, net imports provided a greater percentage of net new supply in 1953 than in 1952. Of the minerals for which the United States was a net importer, for only five were net imports a smaller percentage of net new supply in 1953 than in 1952. The largest net-import ratio gains were in titanium concentrate, zinc, aluminum, and barite. Most other commodities changed only moderately in the 1952–53 period. For nine of the commodities shown, domestic production exceeded net new supply; that is, there were net exports. Production of iron and steel, potash, and barite was 90 percent or more of the net new supply in 1952, but the share of domestic production of barite fell to 74 percent of the total in 1953, mainly because of a tripling of imports.

Sources of Imports.—Imports of the principal minerals by areas of origin are shown in table 5. Increases and decreases are about evenly divided for the commodities coming from Canada and Mexico. For the East and South Pacific 7 out of 11 commodities (for which compar-

[7] See table 4 for components of net new supply.

TABLE 5.—Percentage distribution of imports of principal minerals consumed in the United States, 1952–53, 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	
	1952	1953	1952	1953	1952	1953	1952	1953	1952	1953	1952	1953
Ferrous ores and metals:												
Iron and steel (equivalent)[3]	7,785	9,002	21	20	17	27	33	26	29	27		
Manganese (content)[4]	1,285	1,709	7	5	2	2	15	14	76	79		
Chromite (Cr_2O_3 content)	716	943			4	5	5	3	91	92		
Cobalt (content) ... thousand pounds	15,030	17,240	2	5					98	95		
Molybdenum (content) ... do	50		100									
Nickel (content)	109	119	87	80	(5)	(5)	7	12	6	8		
Tungsten ore and concentrate (W content) ... short tons	8,703	14,030	7	10	22	17	11	12	60	61		
Other metallic ores and metals:												
Copper (content)	632	664	22	25	60	49	3	3	15	23		
Lead (content)[4]	616	547	52	43	30	36	1	1	17	20		
Zinc (recoverable content)[4]	498	671	77	64	11	17	2	1	10	18		
Aluminum (equivalent)[6]	928	1,309	13	18	(5)	(5)	85	75	2	7		
Tin (content) ... thousand long tons	107	111	(5)	(5)	12	17			88	83		
Antimony (recoverable content)[7] ... short tons	12,152	10,856	26	22	40	51		(5)	31	27	3	
Cadmium (content)[8] ... thousand pounds	3,470	3,419	58	69	(5)	5			42	26		
Magnesium (content)	(9)	2	(10)	(10)					(10)	(10)		
Mercury ... 76-pound flasks	71,860	83,390	11	16		(5)			89	84		
Platinum-group metals ... thousand troy ounces	453	636	51	35	(5)	(5)	5	6	44	54	(5)	5
Titanium concentrate: Ilmenite and slag (TiO_2 content)	113	184	24	53		(5)			76	47		
Nonmetallic minerals:												
Asbestos	709	692	94	94	(5)	(5)	(5)	(5)	6	6	(5)	(5)
Barite, crude	108	335	74	80			3	2	23	18		
Boron minerals and compounds ... gross weight	(9)	(9)							(10)	(10)		
Bromine and bromine in compounds ... thousand pounds	2	1	(10)		(10)	(10)			(10)	(10)		
Clays	143	149	7	3		(5)	(5)	(5)	93	97		
Fluorspar, finished	353	361	55	59					45	41	(5)	
Gypsum, crude	3,088	3,184	99	98			1	2				
Mica (except scrap) ... thousand pounds	12,400	13,670	2	2		(5)	22	17	76	81		
Phosphate rock (P_2O_5 content) ... thousand long tons	36	33	(10)	(10)			(10)	(10)	(10)	(10)		
Potash (K_2O equivalent)	188	130	(5)	(5)	4	1	(5)	(5)	67	76	29	23
Salt, common	7	137	(10)	2			(10)	98				
Sulfur (content) ... thousand long tons	147	92	100	100			(5)		(5)	(5)		
Talc and allied minerals	20	23	(10)	(10)				(10)	(10)	(10)		

[1] Unless otherwise indicated, data are for imports for consumption and represent those used in calculating net new supply shown in table 4. Data not comparable in all instances with those shown in corresponding table in the 1951 Review of the Mineral Industries chapter.
[2] West coast of South America (Salvador, Chile, Bolivia, Peru, and Ecuador), Australia, New Zealand, and New Caledonia.
[3] See footnote 3, table 4.
[4] General imports.
[5] Less than 0.5 percent.
[6] See footnotes 7 and 9, table 4.
[7] Excludes antimony recovered in antimonial lead from foreign silver and lead ores, for which geographical distribution is not available.
[8] Covers metallic cadmium and flue dust only. Distribution by origin of cadmium recovered from foreign lead and silver ores not available.
[9] Negligible.
[10] Source of supply. Percentage distribution not shown where figure in total column is less than 50.

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ison is possible) showed increased percentages. While not conclusive, "Other Western Hemisphere" showed more decreases than gains on a commodity basis; "Other Free World" gained slightly in the same period. Commodity import supply patterns that changed noticeably included iron and steel, copper, lead, zinc, aluminum, cadmium, the platinum group, and titanium concentrate. The iron and steel changes were attributable largely to substantial receipts of iron ore from Peru for the first time in a number of years, a large increase of iron-ore shipments from Chile, and a 16-fold increase in pig iron from Australia. Peru also figured in the zinc supply pattern, with a sizable increase in shipments of that metal. The large absolute increase in imports of aluminum (equivalent) from "Other Western Hemisphere" was attributable to a quadrupling of receipts of bauxite from Jamaica as this area became a major source. The largest proportional increases were from Canada and Mexico and from "Other Free World." Of outstanding significance in the cadmium import change was the greater than 50-percent decrease in Belgium-Luxembourg shipments to the United States, which contributed to the decrease in the "Other Free World" group. Large increases in imports of the platinum group were received from the United Kingdom and the Netherlands, largely explaining the "Other Free World" increase for this group. Imports of titanium concentrate (in slag) from Canada increased to 3½ times that in 1952, the largest change in the supply pattern of this category.

FOREIGN TRADE

Imports.[8]—The value of imports of metallic and nonmetallic minerals (except fuels) and metals rose again in 1953, but only 7 percent as compared with 44 percent in 1952. Of the 36 subgroups, 8 decreased, the most significant being lead ore, lead metal, zinc ore, and tin metal. These rather substantial decreases largely explain the small overall increase over 1952; the combined decreases of these 4 subgroups alone actually exceed the grand total increase. The percentage of increase in imports of fuels and related materials (not shown in table) was about the same as that for the nonfuels. Imports of nonfuel minerals and metals constituted 71 percent of the grand total (including fuels) in 1953, about the same as in 1952.

Exports.[8]—The export value of nonfuel minerals and metals decreased 15 percent from 1952, fuels (not shown in table) 21 percent. Both crude metallic minerals and crude nonmetallic minerals (except fuels) showed export gains, but these increases were more than offset by the decrease in exports of metals.

Tariffs.—During 1953 no new bilateral or multilateral trade agreements were entered into that involved numerous changes in minerals tariffs, as occurred in 1951 and 1952. Legislative and executive consideration of proposed changes in minerals tariffs was restricted to a few items that were either being imported into the United States in substantially increased quantities in competition with domestic production or were in short supply in the United States.

[8] Data in this section are not comparable with those given in the corresponding chapter and section of the Minerals Yearbook 1952, which were based on a table using published totals for Bureau of the Census import and export commodity subgroups. The present section is based on data compiled according to the Standard International Trade Classification, as explained in footnote 1, table 6.

Proposals for increasing the tariffs on lead and zinc were introduced in the Congress early in the year and received widespread attention, not only because of the distress of the domestic industry but also because they were part of the major bill to extend the trade-agreement legislation. The President had asked for a simple 1-year extension of the trade-agreement legislation in order that, during this period, there might be a thorough reexamination of American economic foreign policy. The Simpson bill proposed a number of changes in the legislation, as well as the increased duties on lead and zinc on a sliding scale dependent on the United States price, and served as a basis for congressional hearings on extension of the trade-agreement legislation. Public Law 215, passed by the Congress and approved by the President August 7, 1953, extended the trade-agreement provisions but did not include the provisions for increased duties on lead and zinc.

A number of other bills were introduced, independent of the trade-agreements legislation, to increase the barriers to imports of lead and

TABLE 6.—Value of minerals and metals imported and exported by the United States, 1951–53, 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]		
		1951	1952	1953	1951	1952	1953
	CRUDE METALLIC MINERALS [5]						
281-01	Iron ore and concentrates	59,555	82,903	96,866	30,997	37,404	32,410
282-01	Iron and steel scrap	15,024	5,401	5,850	9,094	12,500	11,219
	Ores of nonferrous metals and concentrates:						
283-07	Manganese	46,598	67,758	105,234	466	504	552
283-11	Tungsten	17,604	57,062	91,612	--------	46	31
283-06	Tin	82,462	65,287	82,713	--------	--------	--------
283-01	Copper	49,079	60,463	60,473	174	495	290
283-08	Chromium	25,506	38,595	55,882	144	73	56
283-05	Zinc	35,324	113,785	49,714	793	899	759
283-03	Bauxite (aluminum ore) and concentrates	17,794	23,194	29,588	2,217	845	886
283-04	Lead	8,636	33,253	15,391	171	288	269
(6)	Other	18,949	24,828	33,731	3,873	7,434	7,588
284-01	Nonferrous metal scrap	19,660	17,049	21,363	9,347	8,902	34,843
285-02	Platinum-group metals	13,626	11,275	11,827	118	--------	1
	Total crude metallic minerals	409,817	600,853	660,244	57,394	69,390	88,904
	METALS (UNWROUGHT)[5] [7]						
681-01	Pig iron and sponge iron	51,086	20,976	27,958	458	752	1,145
681-02	Ferroalloys:						
	Ferromanganese	20,046	14,759	27,181	207	475	389
	Ferrochromium	6,123	4,851	10,398	97	519	286
	Other	6,423	1,978	2,812	5,271	6,802	2,708
682-01	Copper	217,109	333,870	362,079	73,203	121,596	70,104
687-01	Tin	76,388	232,692	187,505	763	581	298
684-01	Aluminum	41,400	43,505	115,761	433	519	937
683-01	Nickel (including scrap)	81,672	89,450	102,771	5,160	6,527	9,674
685-01	Lead	65,201	167,505	97,387	1,233	733	490
686-01	Zinc	31,109	36,220	50,282	15,984	24,715	4,746
689-01	Cobalt metal	16,585	27,304	33,225	(8)	(8)	(8)
689-01	Mercury	6,587	12,547	13,569	58	86	106
689-01	Other nonferrous base metals	9,722	11,334	12,725	7,225	4,599	3,858
671-02	Platinum-group metals, including unworked and partly worked	22,682	14,259	27,620	2,842	1,689	1,531
	Total metals	652,133	1,011,250	1,071,273	112,934	169,593	96,272
	Total metals and metallic minerals	1,061,950	1,612,103	1,731,517	170,328	238,983	185,176

For footnotes, see end of table.

TABLE 6.—Value of minerals and metals imported and exported by the United States, 1951–53, by commodity groups and commodities, in thousand dollars [1]—Continued

[U. S. Department of Commerce]

SITC No.[2]	Group and commodity	Imports for consumption [3]			Exports of domestic merchandise [4]		
		1951	1952	1953	1951	1952	1953
	CRUDE NONMETALLIC MINERALS (EXCEPT FUELS)						
	Diamonds:						
*672-01	Gems, rough or uncut	48,257	52,193	57,011	29	165	415
*272-07	Industrial	46,799	51,910	48,957	77	21	14
	Total	95,056	104,103	105,968	106	186	429
272-12	Asbestos, crude, washed or ground	58,634	61,596	59,866	3,217	2,550	540
271-02	Sodium nitrate	27,025	27,631	23,268	2,084	528	1,126
272-13	Mica, unmanufactured (including scrap)	22,101	14,271	14,704	94	41	28
*272-14	Fluorspar	4,110	10,527	11,551	67	48	49
272-06	Sulfur	158	106	51	33,708	35,966	36,581
271-03	Phosphates, natural, ground or unground	1,438	2,332	2,545	14,735	12,404	18,368
(9)	Other nonmetallic minerals (except fuels)	22,550	23,454	28,036	[10] 20,596	24,622	27,115
	Total crude nonmetallic minerals (except fuels)	231,072	244,020	245,989	74,607	76,345	84,236
	Grand total, minerals and metals (except fuels)	1,293,022	1,856,123	1,977,506	244,935	315,328	269,412

[1] The grouping of the commodities is based upon Standard International Trade Classification (see United Nations, Commodity Indexes for the Standard International Trade Classification: Statistical Papers, Series M, No. 10, indexed edition, New York, April 1953, 489 pp.).
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 the Chief Economist to, insofar as possible, (1) include for the various classifications the latest revisions compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from the records of the U. S. Department of Commerce; (2) incorporate in all years shown changes in assignments of classifications to SITC categories made by the Bureau of the Census and (3) in some few cases, make other changes in assignments which it appeared would make the data more comparable and/or more in line with the SITC.
As could be expected, individual commodities and groupings shown or omitted will not in all cases be in accord with usual Bureau of Mines practice as followed in individual commodity chapters in this Minerals Yearbook. In a few cases, values will differ from those for the same commodity in the corresponding chapter because of reclassifications, exclusions, or other reasons usually explained by footnotes in the chapter.
[2] An asterisk indicates that only part of the SITC category indicated is covered, the remainder of the category being covered elsewhere in the major grouping.
[3] Includes items entered for immediate consumption, items withdrawn from bonded storage warehouse for consumption, and ores, etc., smelted and refined under bond—included at time smelted or refined product is withdrawn for consumption or for export.
[4] Includes both mineral products of domestic origin and foreign mineral products which have been smelted, refined, manufactured, or otherwise processed in the United States.
[5] Excludes gold and silver.
[6] Includes all of SITC Nos. 283-02 and 283-19.
[7] Includes alloys.
[8] Exports, if any, are negligible and included with "Nonferrous metal scrap" (284-01; see Crude metallic minerals).
[9] Includes all of SITC Nos. 271-04; 272-01, 272-02, 272-03, 272-04, 272-05, 272-08, 272-11, 272-15, 272-16, and 272-19; and those parts of Nos. 672-01, 272-07, and 272-14 not shown separately above.
[10] Excludes sand, gravel, and crushed stone.

zinc, but none were enacted. The Senate Committee on Finance and the House Committee on Ways and Means requested the Tariff Commission to institute an investigation of the domestic lead and zinc industries, and later these industries applied to the Commission for an escape-clause investigation. The Commission published a report, Statistics on Unmanufactured Lead and Zinc.

The Trade Agreements Extension Act of 1953 established a bipartisan Commission on Foreign Economic Policy to study the general problem of tariffs and related matters and to make recommendations soon after Congress convened in 1954. Earlier in 1953 the Public Advisory Board for Mutual Security (the Bell Commission), appointed under the previous administration to review American economic foreign policy, issued its report, in which it recommended that tariffs on metals and minerals be eliminated or reduced and that, if domestic production must be encouraged for defense purposes, the Government should assist through special purchases and contracts.

Late in the year a number of firms applied to the Tariff Commission for an escape-clause investigation of acid-grade fluorspar, but the request was withdrawn a month later, leaving lead and zinc as the only minerals with applications pending at the end of the year.

Bills were introduced in the Congress for eliminating or suspending duties on several minerals and metals, but approval was given only for a 1-year continuance of the suspensions on copper and on metal scrap (lead and zinc scrap excepted).

CONSUMPTION AND STOCKS

Reported Consumption.—For most major metals and minerals on which such data are collected, reported consumption was greater in 1953 than in 1952. Bauxite consumption increased one-third over 1952 and iron ore, manganese ore, and mercury about one-fifth. Tungsten concentrate showed a large drop—10 percent in terms of contained tungsten—and primary antimony was down 5 percent, following its postwar trend. Consumption of slab zinc, the platinum group, and magnesium increased around one-sixth over 1952 levels. The large increases in bauxite and iron ore can be explained by the correspondingly large increases in the value of shipments of primary aluminum and pig iron shown in table 3. Consumption of mica splittings remained about the same as 1952, and the value of shipments of sheet-mica products showed a small decrease in the same period.

TABLE 7.—Reported consumption of principal metals and minerals in the United States, 1952–53

[Thousand short tons, unless otherwise stated]

Commodity	1952	1953	Change from 1952 (percent)
Iron ore ... thousand long tons, gross weight	100,640	122,125	+21
Manganese ore ... gross weight	1,809	2,196	+21
Chromite ... do	1,185	1,336	+13
Cobalt ... thousand pounds	10,818	10,748	−1
Molybdenum, primary products (shipments to domestic destinations) thousand pounds, Mo content	30,211	29,595	−2
Nickel, exclusive of scrap ... short tons	101,397	105,681	+4
Tungsten concentrate ... thousand pounds, W content	8,634	7,734	−10
Copper, refined	1,480	1,494	+1
Lead	1,131	1,202	+6
Zinc, slab	853	986	+16
Bauxite ... thousand long tons, dried equivalent	4,228	5,628	+33
Tin ... long tons	78,418	85,640	+9
Magnesium, primary ... short tons	43,847	50,240	+15
Antimony, primary ... do	14,988	14,300	−5
Mercury ... 76-pound flasks	42,556	52,259	+23
Platinum-group metals (sales to consumers) ... thousand troy ounces	454	533	+17
Titanium concentrate ... short tons, estimated TiO_2 content	385,652	430,384	+12
Barite, crude	1,034	1,149	+11
Fluorspar, finished	520	587	+13
Mica splittings ... thousand pounds	10,221	10,346	+1

Value of shipments of other minerals manufactures cannot be isolated to coincide with reported consumption figures. Lagging consumption of certain metals—such as cobalt, copper, and nickel—was the result of relative shortages, contributed to by national stockpiling, not an absence of economic growth in industries consuming these metals. Part of the large increases in consumption of some metals was indirectly attributable to such relative shortages in other metals.

Apparent Consumption.—For minerals on which direct consumption data are not collected, apparent consumption can be used as an indicator of the level of actual consumption. For minerals shown in table 8, the boron minerals and compounds experienced the largest increase (20 percent). All other increases were under 10 percent, most of them 5 percent or under. The apparent consumption of asbestos remained about the same as in 1952, as did the value of shipments of asbestos products (table 3). The apparent consumption of crude gypsum was 2 percent above 1952, although the value of shipments of gypsum products was up 9 percent.

TABLE 8.—Apparent consumption of metals and minerals in the United States, 1952–53

[Thousand short tons, unless otherwise stated]

Commodity	1952	1953	Change from 1952 (percent)
Cadmium [1] ... thousand pounds, Cd content	9,130	9,687	+6
Asbestos, all grades [1]	753	744	−1
Boron minerals and compounds ... gross weight	481	576	+20
Bromine and bromine in compounds ... thousand pounds	153,400	160,700	+5
Clays	41,510	42,280	+2
Gypsum, crude	11,360	11,640	+2
Phosphate rock ... thousand long tons, P_2O_5 content	3,213	3,319	+3
Potash ... K_2O equivalent	1,731	1,813	+5
Salt	19,200	20,680	+8
Sulfur ... thousand long tons, S content	4,832	5,049	+4
Talc and allied minerals [1]	590	598	+1

[1] Adjustments are not made for National Strategic Stockpile acquisitions, if any.

Sales and Orders.[9]—By December 1953 monthly sales (seasonally adjusted) of primary metal manufacturing were 25 percent below December 1952, a very large drop compared with the 2-percent decrease in total manufacturing. New orders (seasonally adjusted) for primary metal manufacturing were down 28 percent from December 1952; unfilled orders (unadjusted) were lower by 32 percent. These compare with decreases of 12 and 23 percent, respectively, for all manufacturing. New orders in primary metals began to decline after June; unfilled orders declined steadily from January on.

Physical Stocks of Mineral Manufacturers, Consumers, and Dealers.—1953 was a year of heavy stock increases in minerals. Net increases were experienced by the majority of those physical stocks of minerals and mineral products held by mineral manufacturers, consumers, and dealers shown in table 9. The data in this table cover most but not all principal minerals for which any stock data are available. Data are not available for many types of stocks, and gaps vary from mineral to mineral. In addition, because of varied diffi-

[9] U. S. Department of Commerce, Office of Business Economics, Survey of Current Business: Vol. 34, 1954, various issues.

culties, some available data on stocks are not included; hence, this summary of nonmine stocks, while representative, is not entirely complete. As an aid in assessing the significance of stock changes, a column is included in table 9 showing the ratios of stocks to the best available consumption measures.

If the stocks shown (other than for secondary raw materials) are divided roughly into three groups—stocks of raw materials and materials in process, producers' stocks of metals and primary products, and consumers' stocks of metals and primary products, including dealers, importers, etc., with producers or consumers as indicated in table 9—it is found that virtually all producers' stocks of metals and primary products increased during 1953, the most significant increases being for cadmium (metallic and in compounds) and slab zinc. The single exception was the platinum-group metals. Among the stocks of raw materials, chromite, manganese ore, and tungsten concentrate had large increases, of about equal significance in terms of consumption. Fluorspar was the only raw material having a decrease of any consequence in consumers' stocks. Increases and decreases were about evenly divided among the consumers' stocks of metals (metallic and in primary products). Stocks of mercury in the hands of consumers and dealers decreased considerably, not only in relation to 1952 stocks but also in terms of 1953 consumption. On the other hand, consumers' stocks of pig iron and nickel increased substantially percentagewise over 1952, but neither increase was especially significant in terms of consumption during 1953. Except for fluorspar and the platinum group, the only ratios that decreased were in consumer stock categories. Looking at stocks generally, it can be seen that much of the year's high production in minerals—especially the metals—remained in the hands of producers in the form of finished product inventories. Consumers, by reducing purchases of minerals in the latter half of the year, did not share, in general in the inventory build-up.

Value of Mineral Manufacturing Stocks.—Total inventories of almost all mineral manufacturing industries, shown in table 10, increased over 1952. Inventories of electrometallurgical products increased 46 percent, exceeding even the large 36-percent inventory increase in aluminum. All decreases in total inventories occurred in the nonmetallics; gypsum products, lime, abrasive products, and salt showed declines ranging from 1 to 9 percent.

The finished-product component of inventories increased for 17 of the 19 industries, and the portion of inventory in finished product increased in each of these same industries. The finished product to total inventory ratio increases were noticeably large for blast furnaces, zinc, aluminum, and other primary nonferrous metal industries. The significant increase in the finished-product segment of inventories—both absolute and percentagewise—resulted from declining sales that began in the metals around midyear. If the work in process and material, supplies, and fuels are combined, the reaction of metal producers to the latter-half business decline can be observed. This segment of inventories declined in absolute terms for six of the industries, and where increases occurred, they were small. Its ratio to total inventories, of course, declined for all but two industries, gypsum and abrasives.

TABLE 9.—Selected physical stocks of mineral commodities of mineral manufacturers, consumers, and dealers in the United States, at end of year, 1944–48 (average) and 1949–53 [1]

Commodity and type of stock	1944–48 (average)	1949	1950	1951	1952	1953	Change in 1953 from 1952 (percent)	Ratio to 1953 consumption (percent)[2]: Stocks at end of 1953	Ratio to 1953 consumption (percent)[2]: Change in stocks during 1953
Aluminum (short tons):									
Primary, at reduction plants	19,870	29,100	16,640	8,130	7,270	39,300	+441	[3] 3	[3] +2
Purchased aluminum scrap, consumers (gross weight)	[4] 35,700	[4] 20,200	18,800	12,600	20,300	27,000	+33	7	+2
Bauxite, at consumers ... thousand long tons, dried equivalent [5]	484	861	759	1,046	1,921	1,915	−(6)	34	−(6)
Cadmium, metal and compounds, producers and distributors thousand pounds, Cd content	957	902	824	1,448	2,186	3,815	+75	[3] 40	[3] +17
Cement, at mills ... million barrels	13.9	14.9	13.3	18.2	16.0	19.4	+21	[3] 7	[3] +1
Chromite, at consumers' plants (thousand short tons):									
Metallurgical	174	326	249	305	364	608	+67	82	+33
Refractory	130	303	251	247	270	260	−4	59	−2
Chemical	78	128	106	85	120	148	+23	97	+18
Total	382	757	606	637	754	1,016	+35	76	+20
Copper (thousand short tons):									
At primary smelting and refining plants (Cu content):									
Refined	87	61	26	35	26	49	+88	3	+2
Blister and material in process	258	261	232	182	185	223	+21		
In fabricators' hands, refined, including in process and primary fabricated shapes (Cu content)	385	355	290	280	331	381	+15		
Purchased copper scrap, consumers (gross weight)	[4] 124	[4] 94	106	66	107	130	+21	9	+2
Ferrous scrap and pig iron, at consumers' plants (thousand short tons):									
Total scrap	4,530	5,640	5,420	4,370	6,900	7,150	+4	9	+(6)
Pig iron	1,250	1,660	1,800	1,750	1,970	2,800	+42	4	+1
Total	5,780	7,300	7,220	6,120	8,870	9,950	+12	7	+1
Fluorspar (thousand short tons):									
At consumers' plants	110.6	130.6	164.7	169.1	252.2	227.5	−10	39	−4
Importers		11.0	7.5	2.8	31.4	15.5	−51	3	−3
Iron ore (thousand long tons):									
At consumers' plants	34,350	37,020	34,920	40,950	43,130	45,240	+5	37	+2
On Lake Erie docks	4,600	6,090	5,400	6,400	6,120	7,670	+25	6	+1
Total	38,950	43,110	40,320	47,350	49,250	52,910	+7	43	+3
Lead (thousand short tons, Pb content):									
At smelters and refineries:									
Refined pig lead	27.3	61.3	28.9	18.5	31.4	65.0	+107	8	+4
Antimonial lead	7.0	9.1	6.7	6.8	12.2	16.1	+32	6	+1
In base bullion, including in process at and in transit to refineries	28.9	35.6	32.3	31.0	40.4	47.5	+18		

In ore, matte, and in process at smelters	87.1	95.5	69.8	67.8	65.8	67.7	+3		
Total	150.3	201.5	137.7	124.1	149.8	196.3	+31		
Consumers' stocks:									
Refined	(7)	64.5	87.3	56.7	80.9	75.8	−6	10	−1
Antimonial	(7)	16.8	27.7	28.2	20.3	14.9	−27	5	−2
In unmelted white metal scrap, percentage metals, copper-base scrap, and drosses, residues, etc	(7)	16.0	24.9	17.9	21.3	23.1	+8	19	+2
Total	(7)	97.3	139.9	102.8	122.5	113.8	−7	10	−1
Manganese ore and ferromanganese, at plants including bonded warehouses (thousand short tons, gross weight):									
Ore	679	928	827	546	1,249	1,692	+35	77	+20
Ferromanganese (excludes producers' stocks)	97	101	132	149	143	137	−4	15	−1
Mercury, in hands of consumers and dealers thousand 76-pound flasks	17.0	15.6	32.9	29.1	33.7	25.9	−23	50	−15
Molybdenum primary products, producers' stocks thousand pounds, Mo content	8,030	10,840	1,500	3,040	3,370	3,890	+15	[8] 13	[8] +2
Nickel, consumers' plants:									
Metal [9] thousand pounds, Ni content	[10] 15,020	12,720	9,850	8,570	10,460	13,210	+26	9	+2
In other forms, exclusive of scrap [9] do	[10] 7,210	5,620	2,450	3,260	6,000	7,500	+25	12	+2
Total [9] do	[10] 22,230	18,340	12,300	11,830	16,460	20,710	+26	10	+2
Purchased nickel scrap short tons, gross weight	(7)	(7)	1,550	1,150	1,360	1,190	−13	15	−2
Platinum-group metals, all forms, held by refiners, importers, and dealers (thousand troy ounces):									
Platinum	153.1	138.0	125.2	139.0	130.1	138.8	+7	[11] 50	[11] +3
Palladium	137.1	122.4	107.9	138.1	116.8	110.2	−6	[11] 48	[11] −3
Iridium, osmium, rhodium, and ruthenium	39.3	35.6	33.5	36.8	35.5	32.0	−10	[11] 127	[11] −14
Total	329.5	296.0	266.6	313.9	282.4	281.0	−(6)	[11] 53	−(6) (11)
Tin, consumers' plants (long tons):									
Pig tin, virgin (includes in transit in United States, at other warehouses and held by jobbers)	16,100	14,100	22,300	11,100	12,900	14,300	+11	26	+3
In process (tin content)	(7)	10,900	11,300	10,700	11,300	10,700	−5		
Purchased tin scrap (gross weight)	[4] 1,170	[4] 1,150	1,060	1,340	1,150	960	−17	21	−4
Titanium concentrate, consumers and distributors thousand short tons, estimated TiO_2 content	186	337	323	316	334	355	+6	83	+5
Tungsten concentrate, consumers and dealers thousand pounds, W content	3,520	4,230	5,120	4,040	2,820	4,340	+54	56	+20
Zinc (thousand short tons):									
Slab:									
At primary smelters and secondary distilling plants	151.1	94.2	8.9	22.0	85.0	179.9	+112	18	+10
At consumers' plants	81.2	81.8	64.2	50.6	92.3	86.0	−7	9	−1
Purchased zinc scrap, at consumers' plants gross weight	[4] 34.9	[4] 30.2	24.3	17.2	22.8	25.2	+11	13	+1

[1] Stocks in the National Strategic Stockpile are not included nor are Reconstruction Finance Corporation stocks of tin or Government-held nonstrategic stockpiles of bauxite. Regarding extent of all other stocks covered, see text.
[2] Consumption in 1953 (reported, unless otherwise indicated) of specific commodity or commodities. Leaders in these two columns indicate that no consumption data are available comparable with the stocks data given.
[3] Based on apparent consumption.
[4] Not strictly comparable with data for 1950–53.
[5] Estimated, using conversion factor of 0.85 for crude and 1.00 for processed.
[6] Less than 0.5 percent.
[7] Data not available.
[8] Consumption measured by shipments to domestic consumers.
[9] Includes amounts in transit to consumers' plants.
[10] Average for 1945–48.
[11] Consumption measured by sales to consuming industries.

TABLE 10.—Value of inventories of selected mineral manufacturing industries in he United States, at end of year, 1947 and 1952–53, in million dollars [1]

[U. S. Department of Commerce]

Industry	1947, total	1952 [2]				1953				Change in 1953 from 1952 (percent) [3]			
		Total	Finished products	Work in process	Materials, supplies, fuels, etc.	Total	Finished products	Work in process	Materials, supplies, fuels, etc.	Total	Finished products	Work in process	Materials, supplies, fuels, etc.
PRIMARY METAL INDUSTRIES													
Blast furnaces	223.0	408.1	23.4	21.0	363.7	450.5	41.0	21.2	388.3	+10	+75	+1	+7
Electrometallurgical products	31.8	86.3	19.3	16.3	50.7	125.7	31.1	20.1	74.5	+46	+61	+23	+47
Primary nonferrous metals:													
Copper	61.3	71.0	18.0	39.6	13.4	79.1	21.0	45.5	12.6	+11	+17	+15	−6
Lead	52.2	57.4	13.0	34.5	9.9	73.1	20.7	43.2	9.2	+27	+59	+25	−7
Zinc	38.5	55.3	16.6	8.6	30.1	62.2	25.4	9.8	27.0	+12	+53	+14	−10
Aluminum	19.8	43.4	3.2	10.7	29.5	59.1	14.8	12.2	32.1	+36	+358	+14	+9
Other primary nonferrous metals	5.2	25.0	5.7	5.6	13.7	30.1	10.7	6.1	13.3	+20	+86	+8	−3
Total	177.0	252.1	56.5	99.0	96.6	303.6	92.6	116.8	94.2	+20	+64	+18	−2
Secondary nonferrous metals	80.9	82.4	34.2	28.1	20.1	82.1	34.3	26.3	21.5	−(4)	+(4)	−6	+7
STONE, CLAY, AND GLASS PRODUCTS													
Abrasive products	53.5	70.9	28.7	18.1	24.1	69.8	27.9	16.9	25.0	−2	−3	−7	+4
Asbestos products	32.9	48.3	18.1	8.2	22.0	48.5	19.3	8.1	21.1	+(4)	+7	−1	−4
Cement, hydraulic	72.5	104.5	23.9	8.0	72.6	107.9	29.1	8.2	70.6	+3	+22	+3	−3
Gypsum products	11.9	17.1	5.3	1.8	10.0	15.6	4.3	1.5	9.8	−9	−18	−14	−2
Lime	8.6	12.1	(5)	(5)	(5)	11.0	(5)	(5)	(5)	−9	---	---	---
Mineral wool	8.4	12.4	4.0	.4	8.0	12.7	4.6	.5	7.6	+2	+15	+32	−5
Minerals, ground or treated	[6] 11.5	15.9	(5)	(5)	(5)	17.3	(5)	(5)	(5)	+9	---	---	---
Nonclay refractories	14.6	30.6	10.4	3.8	16.4	32.6	12.0	3.3	17.3	+7	+15	−12	+5
Cut-stone and stone products	[6] 7.9	17.9	6.0	3.8	8.1	18.6	6.4	3.9	8.3	+4	+6	+2	+2
CHEMICALS AND ALLIED PRODUCTS													
Fertilizers	51.8	88.4	31.5	10.6	46.3	96.9	36.8	12.7	47.4	+10	+17	+20	+2
Inorganic color pigments	47.6	68.9	27.4	6.4	35.1	72.3	32.1	6.6	33.6	+5	+17	+4	−4
Salt	6.9	8.9	1.2	(7)	7.7	8.7	1.2	(7)	7.5	−1	+7	+3	−3

[1] U. S. Department of Commerce, Bureau of the Census, 1953 Annual Survey of Manufactures: Ser. MAS-53-4, Feb. 2, 1955, 12 pp. Except for 1947, data are estimates, subject to standard errors as indicated in source publication.
[2] Revised.
[3] Where 1952 amount is less than $10.0 million, percentage is based on amounts in thousand dollars as given in source.
[4] Less than 0.5 percent.
[5] Estimate withheld by Bureau of the Census because it did not meet publication standards.
[6] Inventory data were not reported for minerals, ground and blended, and cut-stone and stone products establishments accounting for less than 0.5 percent and for 12 percent, respectively, of the total cost of materials, fuel, electricity, and contract work for their respective industries.
[7] Less than $50,000.

As reported by another source, seasonally adjusted inventories for all primary metal manufacturing (including several industries not considered part of mineral manufacturing) were 8 percent higher in December 1953 than in December 1952 compared with 6 percent for all manufacturing.[10]

Stocks at Mines.—Stocks at mines of most minerals for which such data were available were higher at the end of 1953 than at the beginning of that year. Exceptions were stocks of gypsum (down 9 percent) and Frasch sulfur (down 2 percent). Particularly noteworthy among the net increases during the year was a two-thirds increase in stocks of molybdenum concentrate, which brought the total of such stocks up from the equivalent of about one-fifth to the equivalent of one-third of the 1953 consumption of such concentrate. Also notable was the increase in producers' stocks of potassium salts, which at the end of the year were 1¾ times those at the beginning, equivalent to 15 percent of the 1953 apparent consumption as compared with 5 percent at the beginning of the year.

TRANSPORTATION

Rail and Water.—Rail and water transportation of metals and minerals except fuels increased in 1953 both in absolute terms and relative to such transportation of all products. Significant increases were recorded in both rail and water movements of iron ore and crushed limestone (see table 11).[11]

Rail Rates.—The index of average freight rates on carload traffic of products of mines (including mineral fuels) rose slightly in 1953 over 1952 (see table 12). Rates for mine products rose less, measured from either 1947 or 1950, than rates for any other commodity group. During the period 1947–53 a number of general rate increases had been authorized by the Interstate Commerce Commission, the latest in 1951 (April 4, 2.4 percent; August 28, 4.0 percent) and 1952 (May 2, 6.8 percent). On July 29, 1953, the Commission extended from February 28, 1954, to December 31, 1955, the expiration date of the 1952 increases.[12] However, the average rates did not rise the full accumulated percentage permitted by these authorizations, partly because some increases were not put into effect on the date authorized and because of numerous cases of individual reductions in rates.

Of the individual mine-products (nonfuel) classes for which indexes of rates are available (shown in table 12), clay and bentonite, and phosphate rock had the greatest increase in average rates in 1953, while industrial sand had the only decrease. Among the mineral-manufactures class of products, an increase of about 4 percent in average freight rates was indicated for fertilizers, while rates for lime, and scrap iron and scrap steel increased, on the average, approximately 3 percent.

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[10] U. S. Department of Commerce, Office of Business Economics, Survey of Current Business: Vol. 34, 1954, various issues.

[11] These transportation data do not agree exactly with those submitted to the Bureau of Mines by its respondents, as shown in a number of commodity chapters, because of different reporting concepts and item and respondent coverage.

[12] Monroe, J. Elmer, A Review of Railway Operations in 1953: Association of American Railroads, Bureau of Railway Economics, Special Series 88, Washington, April 1954, p. 27.

TABLE 11.—Rail and water transportation of mineral products in the United States, 1952–53, by product

[Thousand short tons]

Product	Rail[1] 1952	Rail[1] 1953	Rail[1] Change from 1952 (percent)	Water[2] 1952	Water[2] 1953	Water[2] Change from 1952 (percent)
Metals and minerals, except fuels:						
Iron ore	107,427	130,148	+21	77,326	100,203	+30
Iron and steel scrap	25,578	24,417	−5	1,599	1,728	+8
Metals and alloys	13,863	13,782	−1	}		
Other ores and concentrates	13,514	14,550	+8	} 2,270	3,033	+34
Other scrap	2,095	2,119	+1	}		
Slag	7,482	7,958	+6	(3)	(3)	(3)
Sand and gravel	72,421	70,512	−3	} 55,734	53,224	−5
Stone, crushed, except limestone	58,627	54,704	−7	}		
Limestone, crushed	17,647	21,514	+22	24,475	28,468	+16
Cement	30,559	29,943	−2	3,453	3,803	+10
Phosphate rock	21,732	22,092	+2	2,330	2,328	−(4)
Clays	9,403	10,069	+7	1,217	1,286	+6
Sulfur	4,418	4,558	+3	3,377	3,787	+12
Other	24,134	26,092	+8	3,611	3,913	+8
Total	408,900	432,458	+6	175,392	201,773	+15
Mineral fuels and related products:						
Coal:						
Anthracite[5]	50,386	38,663	−23	3,004	2,448	−19
Bituminous[5]	346,187	335,168	−3	106,033	122,458	+15
Coke[5]	21,991	21,870	−1	685	777	+13
Crude petroleum	3,477	3,883	+12	74,864	70,586	−6
Gasoline	12,457	11,502	−8	76,743	79,865	+4
Distillate fuel oil	} 12,691	12,169	−4	61,586	60,656	−2
Residual fuel oil	}			38,618	38,568	−(4)
Kerosine	} 20,739	20,294	−2	10,922	10,063	−8
Other	}			12,810	13,766	+7
Total	467,928	443,549	−5	385,265	399,187	+4
Total mineral products	876,828	876,007	−(4)	560,657	600,960	+7
Grand total all products	1,368,124	1,370,937	+(4)	660,396	706,151	+7
Mineral products as percent of grand total:						
Metals and minerals, except fuels	30	32		27	29	
Mineral fuels and related products	34	32		58	56	
Total mineral products	64	64		85	85	

[1] Revenue freight originated excluding forwarder and less-than-carload-lot 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, 1952 and 1953: Statements 53100 and 54100.

[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: 1952 data, part 2, Annual Report of the Chief of Engineers, 1953; 1953 data, 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."

Insofar as average rates for products of mines, including fuels, within the five major rate territories are concerned, the southwestern territory showed the largest change in average rates in 1953 and became the territory with the greatest relative increase since 1950. Southwestern thus overtook the western trunk line territory, whose average rates did not change in 1953, after having shown the most substantial increase among the territories in 1952. The 1953 indexes for the latter, the official, and the southern territories were identical, indicating the same relative change from 1950 for each. Mountain-Pacific territory, with no change in its index in 1953, had had since

1950 only about two-thirds of the net increases in average rates experienced within the other territories.

On the average, both interstate and intrastate rates for products of mines pushed upward by about the same proportion in 1953; interstate rates continued to show somewhat more change since 1950 than intrastate rates.

TABLE 12.—Indexes of average freight rates on railroad carload traffic in the United States, 1947–53 [1]

[1950=100]

Item	1947	1948	1949	1950	1951	1952	1953
ALL CARLOAD TRAFFIC							
Products of mines [2]	83	91	98	100	102	108	109
Iron ore	88	95	99	100	103	110	110
Clay and bentonite	84	95	98	100	103	112	115
Sand, industrial	77	91	98	100	105	114	113
Gravel and sand, n. o. s	90	98	102	100	103	108	110
Stone and rock, broken, ground and crushed	85	93	100	100	103	108	110
Fluxing stone and raw dolomite	75	88	98	100	104	110	111
Salt	86	93	98	100	102	108	109
Phosphate rock	81	95	100	100	102	109	112
Manufactures and miscellaneous	78	94	101	100	102	110	112
Fertilizers, n. o. s	78	93	98	100	102	110	114
Iron, pig	72	90	96	100	104	113	114
Cement: Natural and portland	79	92	98	100	103	110	112
Lime, n. o. s	75	90	97	100	102	110	113
Scrap iron and scrap steel	74	90	97	100	105	112	115
Furnace slag	86	96	104	100	102	107	107
Products of agriculture	80	93	98	100	102	108	110
Animals and products	77	93	99	100	102	110	113
Products of forests	79	93	98	100	102	110	113
Forwarder traffic	80	101	106	100	103	113	114
All commodities	80	93	99	100	102	109	111
PRODUCTS OF MINES ONLY [2]							
Intraterritorial movements:							
Official	81	90	98	100	102	108	109
Southern	84	94	100	100	101	107	109
Western trunk line	90	96	99	100	102	109	109
Southwestern	87	93	99	100	102	107	110
Mountain Pacific	88	96	99	100	101	106	106
All movements, by type of rate:							
Interstate rates	82	91	98	100	102	108	109
Intrastate rates	84	93	99	100	102	107	108

[1] U. S. Interstate Commerce Commission, Bureau of Transport Economics and Statistics, Indexes of Average Freight Rates on Railroad Carload Traffic, 1947–53: Statement 555, File 26–C–11, Washington, February 1955, 17 pp. Indexes are based on the Commission's 1-percent waybill sample.

[2] Includes fuels and related commodities, as well as other nonfuel minerals not shown separately below.

The indexes cited above do not give any indication as to interterritorial differences in rate levels. Some light can be shed on such differences by comparing mileage block data available from the Commission's 1-percent waybill sample data. For example, for iron ore the authors of this chapter compared for the several territories the mileage block progressions, in revenue per ton-mile, from intraterritory movements at interstate commodity rates (such movements evidently constitute the bulk of all movements of iron ore by rail). It was estimated that 3 territories handled virtually all of the carloads of iron ore so moved in 1953: Western trunk line, 66 percent; official, 32 percent; and mountain-Pacific, 1 percent. Among these 3 territories, for movements up to about 350 miles, rates evidently averaged lowest in the western trunk line territory, with those in the official territory next highest by a rather substantial margin. (Movements up to 350 miles were estimated to have been 99 and 85 percent, respectively, of all iron-ore carload movements at such rates within these 2 territories). For longer distances the rate positions of these two territories were generally (but not always) reversed, with, however, less interterritorial differential. Rates in the mountain-Pacific territory, with much less traffic and a smaller variety of mileage block movements, apparently averaged higher than in the 2 territories previously cited, especially for movements exceeding 200 miles. Both the number of carload movements and the variety of mileage block movements were too small in the southern and southwestern territories to warrant adequate comparisons with the other three territories. In general, the 1953 relative levels of rates represented no material change from 1952 for iron ore. Furthermore, although the interterritorial differences in levels for iron ore may not necessarily be representative of differences for other mineral products, it should be noted that, at least quantitywise, iron ore represents the main mineral product (nonfuel) carried by railroads as a whole (see table 11).

Truck Transportation.—Only fragmentary figures and rough estimates are available for commodities transported by truck. The Bureau of Mines collects data on this subject for a limited number of commodities, including cement, sand and gravel, crushed stone, and iron blast-furnace slag. These data generally give, for the individual commodities, some idea of the relative importance of truck transportation compared with other transportation methods. For example, for the four commodities specified above, the proportion of shipments (or sold or used) by truck in 1953 was about the same as in 1952 for crushed stone and slag (54 and 53 percent, respectively); declined slightly for sand and gravel (from 74 to 73 percent); but rose for cement (from 27 to 29 percent).

With the view in mind of testing a method of collecting essential information from an important segment of the trucking industry, the Bureau of the Census, in the first half of 1953, made a pilot survey of commodity movements by private and exempt trucks for hauls of 25 miles or more.[13] The survey report indicated that, roughly estimated, the ton-miles for such hauls constitute about 35 percent of the total ton-miles for all hauls by private and exempt trucks and further that this total, in turn, composes roughly 65 percent of the grand total ton-miles of truck service in urban, rural, and intercity operations. Thus private and exempt trucks, for hauls of 25 miles or more, hauled roughly about 20 percent of the grand total truck miles.

Findings in the survey[14] included an estimate that products of mines (including mineral fuels) accounted for 8.5 percent of the total tons carried 25 miles or more by private and exempt trucks during March–May 1953, but for only 3.7 percent of the total ton-miles. Petroleum products in the manufactures and micellaneous group ac-

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[13] U. S. Department of Commerce, Bureau of the Census, Transportation Division, Pilot Survey in Commodity Movements by Truck, March–May, 1953: December 1954, 67 pp. The sample represented essentially total property-carrying vehicles in the United States except those owned or leased by regulated interstate carriers or by Federal, State, or local Government agencies. The commodity classifications used were based on the ICC classifications used for railroad carload statistics.

[14] Several qualifications of the estimates should be noted. For one, the survey report indicates that the sampling errors associated with estimates relating to the hauling of products of mines tend to be substantially higher than for most other commodities. Also, it appeared to the authors of this chapter that, for such products, the proportion of ton-miles not covered because of the 25-mile cutoff was probably higher than for all other commodities, since mine products on the average have a relatively lower unit value making shipment by truck for great distances uneconomical. Further, since the survey data cover only a 3-month period, March–May, they probably reflect, more or less, a seasonal bias.

counted for 19.4 percent of the total tons carried and 14.3 percent of the total ton-miles for all groups, while for fertilizers, cement, brick, artificial stone, and scrap and waste materials together, the corresponding percentages were 7.6 and 4.4, respectively. Insofar as products of mines alone are concerned, sand and gravel accounted for about 55 percent of the tons carried but for only about 43 percent of the ton-miles, coal for 17 and 18 percent, respectively, stone and rock, 13 and 13 percent, and all other, 15 and 26 percent.

Concentration of truck hauls of products of mines (including mineral fuels) in the lower ranges of the mileage scale is indicated by survey estimates of tons carried, by mileage block, which show that the length of haul for 63 percent of the tonnage of mine products carried fell in the lowest mileage block (25–49 miles). This percentage was twice as large as for any other commodity group. Another 27 percent was carried between 50 and 74 miles. The estimated length of haul per ton for mine products was 52 miles, or about one-half that of the next lowest commodity group in this respect (products of forests, 100 miles). As to the geographic nature of truck movements, it was estimated that 82 percent of the tonnage of products of mines transported by truck involved points of loading and unloading within the same State; 18 percent were unloaded in an adjacent State, and only a negligible quantity was carried beyond an adjacent State. The percentage for tons loaded and unloaded in the same State was only slightly higher than for the next highest commodity group—animals and products. Products of agriculture, with the lowest percentage in this respect (64 percent) had 11 percent of its truck tonnage carried beyond an adjacent State, about twice as much as any other commodity group.

Private trucks (owner also owns commodities hauled or performs the trucking service as an incidental part of his business activities) carried 40 percent of the products of mines tonnage and exempt for-hire trucks 60 percent; a negligible proportion was hauled in leased trucks. The corresponding percentages for all commodities were 65, 28, and 7 percent. In terms of ton-miles, the percentage for products of mines for private trucks was 45 percent and for exempt for-hire trucks 55 percent. For products of mines as well as for other commodity groups, heavy vehicles carried the great bulk of the tons. However, as between the two categories into which heavy vehicles were subdivided, heavy trucks (over 16,000 pounds gross vehicle weight) carried 68 percent of the mine product tonnage, by far the greatest proportion for any commodity group; on the other hand, the proportion of mine products carried by combinations (power units hitched to 1 or more carrying units)—27 percent—was the lowest for any group, being about one-half that of the next highest group. For ton-miles, the rank of products of mines in the above respect was the same, although the proportion accounted for by heavy trucks fell to 58 percent and for combinations rose to 38 percent.

LABOR

Employment: 1939–53 Trends.—Employment in the metals and minerals except fuels industries increased 18 percent in 1939–53. However, because of a 5-percent decrease in employment in fuel mining, there was a slight overall decline in employment in all mining.

As indicated in the following table, all other large industrial groups experienced a net increase in employment from 1939 to 1953.[15]

	Change in employment (percent)		
	1943 over 1939	1953 over 1943	1953 over 1939
All industries	+38.8	+18.1	+64.0
Mining	+8.5	-8.0	-.1
Metals and minerals except fuels	+20.7	-2.3	+17.9
Metal mining	+22.5	-15.9	+3.0
Nonmetallic mining and quarrying	+18.2	+16.6	+37.9
Fuels	+5.3	-9.7	-5.0
Construction	+36.3	+68.7	+129.9
Manufacturing	+72.5	-.7	+71.3
Government	+51.7	+9.9	+66.7
Service	+18.0	+40.0	+65.2
Trade	+8.7	+46.5	+59.3
Finance	+1.4	+44.5	+46.5
Transportation and public utilities	+24.3	+16.7	+45.1

There was considerable variation among geographical regions of the United States in percentage changes from 1939 to 1953 in all mining employment (a fuels and nonfuels breakdown is not available). The regional mining data, as well as total nonagricultural employment, are summarized as follows: [16]

Regions:	*All mining*	*Total nonagricultural employment*
Increased all mining employment:		
West South Central	+65.0	+91.2
West North Central	+28.6	+59.2
Mountain	+12.4	+83.0
Decreased all mining employment:		
South Atlantic	-1.7	+70.6
Pacific	-11.0	+104.6
East North Central	-12.2	+66.7
East South Central	-18.6	+71.0
Middle Atlantic	-25.4	+44.0
New England	-79.2	+37.4

Employment: Annual and Monthly.—Employment in nonfuel mining averaged about 3½ percent higher in 1953 than in 1952, with metallic mining up 6 percent compared to 1 percent for nonmetallic mining and quarrying. The larger increase placed metallic mining ahead of nonmetallic mining and quarrying as an employer of labor for the first time since 1950. This was accomplished in spite of an 18-percent employment drop in lead and zinc mining. Among the mineral manufacturing groups, the largest employment gain occurred in blast furnaces, steelworks, and rolling mills. Except for lead and zinc and nonmetallic mining and quarrying, monthly employment in the mineral industries was relatively stable throughout the year.

[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.

[16] These data are not strictly comparable with those cited in the preceding paragraph, having been based on aggregates of State totals prepared by State agencies using varying methods. Source: U. S. Department of Labor, Bureau of Labor Statistics ,Monthly Labor Review: Vol. 77, No. 7, July 1954, pp. 740, 742.

TABLE 13.—Employment in the mineral industries (nonfuel) in continental United States, 1944–53, by industry [1]

[In thousands]

Year and month	Mining					
	Total	Nonmetallic mining and quarrying	Metal			
			Total [2]	Iron	Copper	Lead and zinc
1944–48 (average)	186.2	88.2	98.0	(3)	(3)	(3)
1949	192.7	95.0	97.7	33.7	25.9	20.2
1950	192.0	95.1	96.9	35.5	25.8	19.2
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:						
January	206.5	99.7	106.8	38.9	28.1	20.2
February	206.5	100.0	106.5	38.4	28.4	19.8
March	207.1	101.5	105.6	38.5	28.6	19.0
April	209.8	104.7	105.1	39.1	28.4	18.5
May	211.4	106.0	105.4	40.1	28.1	17.9
June	213.7	107.1	106.6	40.6	28.7	17.5
July	213.1	107.2	105.9	40.8	28.5	16.6
August	213.9	108.7	105.2	40.8	28.5	16.3
September	213.8	108.6	105.2	40.5	28.6	15.8
October	212.8	107.7	105.1	40.0	28.7	15.7
November	211.3	106.0	105.3	39.7	29.2	15.5
December	209.5	104.0	105.5	39.6	29.4	15.4
Year (average)	210.8	105.1	105.7	39.8	28.6	17.4

Year and month	Mineral manufacturing				
	Fertilizers	Cement, hydraulic	Blast furnaces, steel works, and rolling mills	Smelting and refining of nonferrous metals	
				Primary	Secondary
1944–48 (average)	(3)	32.1	567.3	48.7	(3)
1949	34.3	40.3	550.4	46.9	(3)
1950	34.5	39.8	611.0	48.3	(3)
1951	36.0	40.6	643.5	51.6	13.2
1952	36.9	40.0	570.7	55.7	12.7
1953:					
January	36.3	41.0	653.0	56.8	13.4
February	41.0	41.1	654.4	58.4	13.5
March	46.5	41.1	656.5	59.2	13.6
April	48.1	41.2	656.6	59.6	13.8
May	40.6	41.7	655.9	60.4	13.8
June	34.7	41.7	662.1	60.8	13.7
July	32.0	42.5	665.1	60.9	13.5
August	33.0	42.7	666.8	60.6	13.4
September	34.7	42.5	654.0	60.8	13.3
October	34.2	42.0	650.3	59.7	13.4
November	32.4	42.3	637.7	58.9	13.1
December	32.9	42.0	626.6	58.4	12.9
Year verage)	37.2	41.8	653.3	59.5	13.5

[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] Not available.

Total Labor Payments.[17]—Total expenditures by the nonfuels-mining-industry group for wages and salaries and supplements increased over 1952. The following tabulation shows the 1952–53 percentage increases for this group and for other selected industries.

[17] U. S. Department of Commerce, Office of Business Economics, National Income, 1954 Edition: Survey of Current Business Supplement, 1954, pp. 179, 181.

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	Wages and salaries	Supplements	Total compensation
All industries	+7	+7	+7
Mining	+2	+7	+3
Nonfuel mining	+10	+14	+10
Metal mining	+12	+12	+12
Nonmetallic mining and quarrying	+8	+20	+8
Fuels mining	0	+6	+1
Manufacturing	+11	+14	+11
Primary metal industries	+14	+16	+15

Expenditures for supplements in 1953 constituted 6 percent of the nonfuel-mining-industry group's total direct compensation to labor (metal mining, 7 percent; nonmetallic mining and quarrying, 4 percent). The corresponding figures for the fuels-mining-industry group and for the primary metals (manufacturing) industry were 10 and 9 percent, respectively.

Hours and Earnings.—The average number of hours worked in 1953 by production and related workers was lower than in 1952 by one-half hour per week in nonfuel mining. Average weekly earnings were up about $6.00 per week as a result of a 15-cent-an-hour increase in the period. In mining, average weekly hours in copper rose slightly; all other categories were below 1952. Lead and zinc was the only mining category in which earnings were lower in 1953 than in 1952. The largest gain in earnings was $10.40 in iron mining, achieved in spite of the 1.5-hour decrease in weekly hours, largest for all mining. In the mineral-manufacturing group, hours were up in some categories, down in others; weekly earnings, however, were higher than in 1952 in all categories.[18] According to the Bureau of Labor Statistics Index of Aggregate Weekly Man-Hours in Industrial and Construction Activity (1947–49=100), aggregate weekly man-hours for production and related workers in all mining (fuel and nonfuel) in 1953 averaged 4.7 percent below 1952 and 13.4 percent below the average for 1947–49. The yearly averages for mining have been below the 1947–49 average continuously, beginning with 1949. In 1947, the first year for which the index has been published, the mining component accounted for 5.6 percent of the aggregate weekly man-hours, in 1953 only 4.2 percent.[19]

The above index, as published, does not give separate series for the fuels and nonfuels components of the mining industry. On the basis of the aggregates and data on hours and employment, it is estimated that in 1953 nonfuel aggregate weekly man-hours increased around 2 percent, while fuels declined about 7 percent.

Data regarding increases in wages and fringe benefits agreed upon in company-union negotiations that went into effect in 1953 at operations of one of the large companies in the copper industry have been published. Some specific types of occupation in this industry are indicated, as well as types of fringe benefits involved.[20]

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18 U. S. Department of Labor, Bureau of Labor Statistics, Monthly Labor Review: Vol. 77, 1954, various issues.

19 Wolfbein, Seymour L., Man-Hour Trends in Industrial and Construction Activity: Monthly Labor Review, vol. 77, No. 8, August 1954, pp. 859–881.

20 U. S. Department of Labor, Monthly Labor Review, Wage Chronology No. 26: Anaconda Copper Mining Co., Supplement No. 1—1952–53: Vol. 77, No. 9, September 1954, pp. 1002–1003.

TABLE 14.—Average hours and gross earnings of production and related workers in the mineral industries (nonfuel) in continental United States, 1944–48 (average) and 1949–53, 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	
1944–48 (average)	$48.59	44.0	$1.11	$50.54	42.6	$1.19	$48.15	41.2	$1.17
1949	59.03	42.1	1.41	61.55	40.9	1.51	58.91	39.7	1.48
1950	62.78	43.1	1.46	65.58	42.2	1.55	61.96	40.9	1.52
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	82.29	44.0	1.87	88.54	43.4	2.04	90.74	42.4	2.14
	Metal (Continued)						Nonmetallic mining and quarrying		
	Copper			Lead and zinc					
1944–48 (average)	$53.49	44.5	$1.20	$51.91	42.6	$1.22	$46.34	45.6	$1.02
1949	63.96	42.3	1.51	64.79	41.4	1.57	56.38	43.3	1.30
1950	72.05	45.0	1.60	66.64	41.6	1.60	59.88	44.0	1.36
1951	78.37	46.1	1.70	76.11	43.0	1.77	67.05	45.0	1.49
1952	85.73	45.6	1.88	81.60	42.5	1.92	71.10	45.0	1.58
1953	91.60	45.8	2.00	80.06	41.7	1.92	75.99	44.7	1.70
	Mineral manufacturing								
	Fertilizers			Cement, hydraulic			Blast furnaces, steelworks, and rolling mills[4]		
1944–48 (average)	$37.51	43.7	$0.86	$46.72	43.5	$1.08	$54.79	41.6	$1.33
1949	44.72	41.6	1.08	57.49	41.6	1.38	63.04	38.3	1.65
1950	47.00	41.3	1.14	60.13	41.7	1.44	67.47	39.9	1.69
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
	Electrometallurgical products			*Other*			Primary smelting and refining of nonferrous metals[4]		
1944–48 (average)	(5)	(5)	(5)	(5)	(5)	(5)	$50.98	42.9	$1.19
1949	(5)	(5)	(5)	(5)	(5)	(5)	60.36	40.4	1.49
1950	(5)	(5)	(5)	(5)	(5)	(5)	63.71	41.0	1.55
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
	Primary smelting and refining of copper, lead, and zinc			*Primary refining of aluminum*			Secondary smelting and refining of nonferrous metals		
1944–48 (average)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
1949	$58.99	40.1	$1.47	$61.95	41.3	$1.50	(5)	(5)	(5)
1950	62.37	40.9	1.53	63.97	40.9	1.56	(5)	(5)	(5)
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

[1] See footnote 1, table 13, regarding basis of data.
[2] Weighted average of data for metal mining and nonmetallic mining and quarrying, computed by authors of chapter.
[3] Includes other metal mining not shown separately.
[4] Italicized titles that follow are components of this industry.
[5] Not available.

Average Annual Earnings.[21]—In 1953 there was a general upward movement in average annual earnings (that is, wages and salaries) per full-time equivalent employee, with the average for the nonfuel-mining industry rising somewhat more than that for all industries, as indicated in the following table of average annual earnings in selected industries. The metal-mining average of annual earnings was exceeded by the averages of only 6 of the 70-odd individual industries into which the economy was subdivided.

	1953 (average)	*Increase over 1952 (percent)*
All industries [1]	$3, 590	5
Mining	4, 364	7
Nonfuel mining	4, 447	7
Metal mining	4, 879	7
Nonmetallic mining and quarrying	4, 019	7
Fuel mining	4, 336	7
Manufacturing [1]	4, 051	6
Primary metal industries	4, 712	7

[1] Includes industries not shown separately below.

Health and Safety in Mineral Industries.—Injury experience for the various mining-industry groups improved in 1953 except at nonmetallic mines other than stone quarries, where both the fatal- and nonfatal-injury rates increased. (See chapter on Employment and Injuries in the Metal and Nonmetal Industries.)

This compares reasonably well with the improved injury experience in both manufacturing and nonmanufacturing industries covered by the Bureau of Labor Statistics annual survey of work injuries. Only three manufacturing-industry groups had increased total injury rates in 1953; one of these was the stone, glass, and clay-products group. This last group and the primary-metals group had the same severity rate in 1953 (an average of 1.8 days' disability resulting from work injuries per thousand hours worked), the third largest rate among the 21 manufacturing-industry groups; the lumber and wood-products group and the furniture and fixtures group had greater rates (4.1 and 1.9 days, respectively). Among the individual manufacturing industries with high severity rates were nonferrous secondary smelting and refining (4.2 days), cut-stone and stone products (4.0 days), and fertilizers (3.2 days).[22]

PRICES, COSTS, AND PRODUCTIVITY

Prices.—With the lifting of price controls in February and March, prices of minerals rose during 1953. Although the annual wholesale index for all commodities dropped 1½ points, price relatives for every mineral category shown in table 15 rose (with the exception of iron and steel scrap) in a range of 1 to 12 points. The annual averages for nonferrous metals were mixed: Copper was up 18 percent, lead and zinc down 17 and 32 percent; nickel, aluminum, and silver were up, tin, antimony, cadmium, and mercury were down. The nonmetallic categories shown—clay products, gypsum products, concrete ingredients, building items, and fertilizer materials—rose 2 to 5 points.

[21] Data on average annual earnings are from or based on data in U. S. Department of Commerce, Office of Business Economics, National Income, 1954 Edition: Survey of Current Business Suppl., 1954, pp. 181, 197, 201.

[22] U. S. Department of Labor, Monthly Labor Review, Work Injuries in the United States, 1953: Vol. 77, No. 11, November 1954, pp. 1224–1227.

TABLE 15.—**Price relatives for selected metals and mineral commodities, January and December 1953 and annual averages, 1952 and 1953** [1]

[1947-49=100]

Commodity	1953		Change from January (percent)	Annual average		Change from 1952 (percent)
	January	December		1952	1953	
Iron ore	144.3	157.7	+9	137.6	153.8	+12
Iron and steel scrap	111.0	85.0	−23	114.2	103.1	−10
Iron and steel products	127.1	132.8	+4	124.7	131.3	+5
Nonferrous metals	122.5	122.1	−(2)	123.5	125.1	+1
Clay products	124.0	132.1	+7	122.0	128.1	+5
Gypsum products	117.7	122.1	+4	117.7	121.0	+3
Concrete ingredients	113.7	119.6	+5	113.0	117.4	+4
Building lime, insulation materials, and asbestos-cement shingles	115.3	118.9	+3	112.3	116.8	+4
Fertilizer materials	112.9	113.9	+1	110.6	112.9	+2
All commodities (mineral and all other)	109.9	110.1	+(2)	111.6	110.1	−1

[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.

Costs and Productivity.—A list of input items whose costs are of major importance to the mining and metal-producing industry are presented in table 16. The price relatives of these inputs afford only general indications of what happened to metal and mining costs. It will be noted, however, that the price of each item was higher in 1953 than in 1952, with the single exception of lumber. The increases ranged from 2 to 6 percent; the largest increases occurred in the fuel items.

TABLE 16.—**Price relatives for selected cost items in nonfuel mineral production, January and December 1953 and annual averages, 1952 and 1953** [1]

[1947-49=100]

Commodity	1953		Change from January (percent)	Annual average		Change from 1952 (percent)
	January	December		1952	1953	
Coal	116.3	112.5	−3	108.7	112.8	+4
Coke	131.8	132.5	+1	124.7	132.0	+6
Gas	108.0	109.6	+1	103.7	107.8	+4
Petroleum products	107.9	114.9	+6	109.3	112.7	+3
Industrial chemicals	112.8	118.6	+5	115.2	117.6	+2
Lumber	120.1	116.4	−3	120.5	119.3	−1
Explosives	116.7	121.8	+4	116.5	119.7	+3
Construction machinery and equipment	126.2	131.1	+4	125.4	129.3	+3

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

Additional indicators of cost movements between 1952 and 1953 are shown in table 17. In iron ore, average hourly earnings were up 17 percent, while the price of the product was up 12 percent; this unfavorable cost-price difference was somewhat offset by a 3-percent increase in productivity, but unit labor cost as a percentage of price, estimated by the authors of this chapter, was up about 1 percent over 1952. Copper experienced a relative price increase 3 times as large as the increase in average hourly earnings, and although this relative advantage was partly offset by a 7-percent decrease in output per man-hour, unit labor cost as a percent of price was down 4 percent from

1952. Unit labor cost as a percentage of price was up for lead-zinc mining and primary nonferrous metal production. The increase in lead-zinc can be attributed to the large decrease in price, and in primary nonferrous metals to a large increase in average hourly earnings.

TABLE 17.—Relative labor cost in mineral industries in the United States, 1952–53
[Percentage change in annual averages]

Industry	Average hourly earnings [1]	Price [1]	Output per man-hour [1]	Unit labor cost as a percentage of price
Iron ore	+17	+12	+3	+1
Copper (recoverable) mining	+6	+18	−7	−4
Lead-zinc mining	0	[2]−25	[3]+7	+24
Primary nonferrous	+8	+1	+2	+4
Cement	+9	+5	+3	+([4])

[1] Based on data from U. S. Department of Labor, Bureau of Labor Statistics. Data on output per man-hour are unpublished estimates.
[2] Estimate based on individual decreases of 17 and 32 percent, respectively, for lead and zinc.
[3] Preliminary.
[4] Less than 0.5 percent.

INCOME

National Income Originated.—National income originated in total mining, including fuels, increased 4 percent over 1952, slightly less than the increase in total national income. Eleven percent more income originated in metal mining and 19 percent more in the primary metal industries in 1953 than in 1952. Total mining, except fuels, increased its ratio to all industry income; the addition of fuels, however, reduces the ratio slightly between the 2 years, as indicated in table 18. The only breakdown available on distributive shares for these two separate components is shown in table 19. The portion of income going to wages and salaries was smaller for total mining except fuels than for all industries and stabilized at 60 percent, the same as 1952.

TABLE 18.—National income originated in the mineral industries in the United States, 1944–48 (average) and 1949–53, by industries [1]

[Million dollars]

Industry	1944–48 (average)	1949	1950	1951	1952	1953	Change in 1953 from 1952 (percent)
All industries	192,455	216,193	239,956	277,041	290,959	305,002	+5
Metal mining	439	513	693	815	836	932	+11
Percent of all industries	0.23	0.24	0.29	0.29	0.29	0.31	----------
Nonmetallic mining and quarrying	318	453	511	589	610	649	+6
Percent of all industries	0.17	0.21	0.21	0.21	0.21	0.21	----------
Total mining except fuels	757	966	1,204	1,404	1,446	1,581	+9
Percent of all industries	0.39	0.45	0.50	0.51	0.50	0.52	----------
Total mining including fuels	3,603	4,355	4,998	5,551	5,320	5,507	+4
Percent of all industries	1.87	2.01	2.08	2.00	1.83	1.81	----------
Primary metal industries	([2])	5,387	7,112	8,995	7,900	9,404	+19
Percent of all industries	([2])	2.49	2.96	3.25	2.72	3.08	----------
Stone, clay, and glass products	1,565	2,076	2,631	3,004	2,827	3,037	+7
Percent of all industries	0.81	0.96	1.10	1.08	0.97	1.00	----------

[1] U. S. Department of Commerce, Office of Business Economics, National Income, 1954 Edition; Survey of Current Business Suppl., 1954, p. 177. In arriving at national income, depletion charges have not been deducted. This has an important bearing on the data for the mining industries.
[2] Data not available.

TABLE 19.—Components of national income originated in the mineral industries in the United States, 1951–53, by industries [1]

[Million dollars]

Industry	National income originated, total	Wages and salaries	Supplements to wages and salaries	Other [2]	Percent of total		
					Wages and salaries	Supplements to wages and salaries	Other
All industries:							
1951	277,041	170,881	9,539	96,621	62	3	35
1952	290,959	185,039	10,384	95,536	64	3	33
1953	305,002	197,980	11,081	95,941	65	4	31
Change in 1953 from 1952 (percent)	+5	+7	+7	+(3)			
Metal mining:							
1951	815	418	30	367	51	4	45
1952	836	468	34	334	56	4	40
1953	932	522	38	372	56	4	40
Change in 1953 from 1952 (percent)	+11	+12	+12	+11			
Nonmetallic mining and quarrying:							
1951	589	373	15	201	63	3	34
1952	610	403	15	192	66	2	32
1953	649	434	18	197	67	3	30
Change in 1953 from 1952 (percent)	+6	+8	+20	+3			
Total mining except fuels:							
1951	1,404	791	45	568	56	3	41
1952	1,446	871	49	526	60	3	37
1953	1,581	956	56	569	60	4	36
Change in 1953 from 1952 (percent)	+9	+10	+14	+8			
Total mining including fuels:							
1951	5,551	3,584	326	1,641	65	6	29
1952	5,320	3,642	324	1,354	69	6	25
1953	5,507	3,727	347	1,433	68	6	26
Change in 1953 from 1952 (percent)	+4	+2	+7	+6			
Primary metal industries:							
1951	8,995	5,486	514	2,995	61	6	33
1952	7,900	5,515	542	1,843	70	7	23
1953	9,404	6,309	628	2,467	67	7	26
Change in 1953 from 1952 (percent)	+19	+14	+16	+34			
Stone, clay, and glass products:							
1951	3,004	1,988	120	896	66	4	30
1952	2,827	1,977	120	730	70	4	26
1953	3,037	2,160	133	744	71	4	25
Change in 1953 from 1952 (percent)	+7	+9	+11	+2			

1 U. S. Department of Commerce, Office of Business Economics, National Income, 1954 Edition: Survey of Current Business Suppl., 1954, pp. 176–181.
2 Covers income of unincorporated enterprises, corporate profits before taxes, rental income of persons, inventory valuation adjustments, and net interest. In arriving at the corporate- and unincorporated-enterprises-profits components, depletion charges have not been deducted. This has an important bearing on the data for the mining industries.
3 Less than 0.5 percent.

Profits and Dividends.—Profits for 1953 were slightly higher than for 1952 in the primary nonferrous metals. They were much higher for primary iron and steel but largely because of the effect of the steel strike on profits in 1952. However, profits in the fourth quarter for both categories were lower than both the first quarter of 1953 and the fourth quarter of 1952. Annual dividends in 1953 were about the same as in 1952 for these two primary metal categories; dividends for all manufacturing, on the other hand, were up about 2 percent. Fourth-quarter assets in the primary metal categories were up 6 percent over the fourth quarter of 1952 compared with a 3-percent increase for all manufacturing.[23] For all mining (including fuel) publicly reported cash dividends were down 2.5 percent in 1953 from

23 Federal Trade Commission and Securities and Exchange Commission, United States Manufacturing Corporations: Quarterly Financial Report, 4th quarter, 1952, pp. 6, 13–14, and 4th quarter, 1953, pp. 6, 13–14.

1952 compared with a 1.6-percent increase for all manufacturing. The quarterly pattern was very similar in the 2 years.[24] Net corporate dividend payments in mining (including fuels), another measure available, decreased 2.4 percent. This measure for all manufacturing showed an increase of 1.1 percent.[25]

Business Failures.—Dun & Bradstreet data showed a decline in business failures in the mining industries (including fuels) in 1953, both in number and in current liabilities involved. This improvement for mining is contrary to the increase in failures for manufacturing and all industrial and commercial industries.

It is interesting to note that recorded business failures were only about 1 percent of total discontinuances of mining businesses compared to about 3 percent for all businesses. This difference continues persistently from early years and probably reflects the widespread practice of planned abandonment of small mining deposits after being worked out.

TABLE 20.—Industrial and commercial failures and liabilities, 1951–53[1]

	1951	1952	1953
Mining:[2]			
Number of failures	38	42	41
Current liabilities (thousand dollars)	6,820	3,794	3,034
Manufacturing:			
Number of failures	1,495	1,539	1,816
Current liabilities (thousand dollars)	84,150	101,160	155,820
All industrial and commercial industries:			
Number of failures	8,058	7,611	8,862
Current liabilities (thousand dollars)	259,547	283,314	394,153

[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 by mining concerns (fuels and nonfuels) in 1953 on new plant and equipment were estimated to have been $986 million, only $1 million more than in 1952. Expenditures by iron and steel firms and by nonferrous-metals firms both decreased 20 percent. In the same period manufacturing firms as a whole increased their expenditures for new plant and equipment 2 percent and all firms (except agricultural business) 7 percent.

Quarterly expenditures (adjusted for seasonal variation) by mining firms (fuels and nonfuels) at annual rates of $940, $910, $1,030, and $1,050 million, respectively, exhibited a pattern just the reverse of that in 1952, when the first quarter was the high for the year and the third the low ($1,050 and $920 million, respectively). For mining as well as for all firms combined, the unadjusted peak of expenditures in 1953 came in the fourth quarter; the peak for iron and steel and nonferrous metals came in the second quarter. For all firms the adjusted peak occurred in the third quarter.[26]

These estimates are based on a company classification of expenditures; that is, companies included in the sample on which the esti-

[24] U. S. Department of Commerce, Office of Business Economics, Survey of Current Business: Vol. 33, 1953, and vol. 34, 1954, various issues.

[25] U. S. Department of Commerce, Office of Business Economics, National Income, 1954 Edition: Survey of Current Business Suppl., 1954, p. 191.

[26] U. S. Department of Commerce, Office of Business Economics, Survey of Current Business: Vol. 35, No. 3, March 1955, p. 8.

TABLE 21.—Expenditures for new plant and new equipment for selected mineral manufacturing industries in the United States, 1947 and 1949–53, by industries [1]

[Million dollars]

Industry	1947	1949	1950	1951	1952	1953	Change in 1953 from 1952 (percent)
NEW STRUCTURES AND ADDITIONS TO PLANT							
Blast furnaces, electrometallurgical products, and steel mills	149.8	108.5	89.4	244.3	326.9	240.1	−27
Primary nonferrous metals	6.5	9.0	11.0	29.8	[2] 137.9	63.4	−54
Secondary nonferrous metals	2.6	2.7	1.4	2.9	3.2	5.8	[3] +79
Cement, hydraulic	9.2	8.8	10.3	20.9	12.0	12.8	+7
Fertilizers [4]	6.9	5.2	4.4	11.4	10.1	10.6	+5
NEW MACHINERY AND EQUIPMENT							
Blast furnaces, electrometallurgical products, and steel mills	218.6	244.4	249.2	477.4	737.3	488.9	−34
Primary nonferrous metals	10.8	18.5	25.9	72.2	[2] 129.2	76.4	−41
Secondary nonferrous metals	4.6	5.0	4.1	5.8	5.6	4.7	[3] −15
Cement, hydraulic	33.3	36.1	40.5	56.2	32.8	56.1	+71
Fertilizers [4]	10.2	11.2	9.5	18.0	12.4	13.4	+8
TOTAL							
Blast furnaces, electrometallurgical products, and steel mills	368.4	352.9	338.6	721.7	1,064.2	729.0	−31
Primary nonferrous metals	17.3	27.5	36.9	102.0	[2] 267.1	139.8	−48
Secondary nonferrous metals	7.2	7.7	5.5	8.7	8.8	10.5	[3] +19
Cement, hydraulic	42.5	44.9	50.8	77.1	44.8	68.9	+54
Fertilizers [4]	17.1	16.4	13.9	29.4	22.5	24.0	+7

[1] U. S. Department of Commerce, Bureau of the Census, Annual Survey of Manufactures: Annual volumes, 1951, pp. 122–23, and 1952, pp. 109–110; and Series MAS–53–2, Dec. 31, 1954. Except for 1947, data are estimates subject to standard errors as indicated in source publications.
[2] Revised figure.
[3] Percent based on amounts in thousands as given in source.
[4] Establishments primarily engaged in manufacturing mixed fertilizers from materials produced in the same establishment and/or from purchased materials.

mates are based are classified by broad industry groups 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 as manufacturing capital expenditures.

The above series of estimates as published do not give data separately for nonfuels-mining capital expenditures; however, estimates available from another source indicate that the amounts of capital spending for iron-ore mining (except taconite) and for nonferrous mining (except uranium) were $74 and $117 million, respectively, the same in 1953 as in 1952. Further, spending for nonmetallic mining (except coal and the petroleum industry) was down only slightly (from $44 to $43 million). It should be noted that, except for nonmetallic mining, these data also cover mining expenditures by concerns not classified as mining concerns.[27]

For mineral manufacturing also, a more precise measure of expenditures by industry is provided by data from the Bureau of the Census

[27] McGraw-Hill Publishing Co., Department of Economics, Business Plans for New Plants and Equipment, 1955–58: New York, 1955, p. 12.

Survey of Manufactures. The survey not only provides somewhat more industry detail, but the data are also on an establishment basis. Each establishment of a company included in the sample is classified in a particular industry, in general, on the basis of the principal products it makes.

Table 21 gives, for selected mineral-manufacturing industries, data from the Survey of Manufactures for expenditures for plant and equipment. It is interesting to note that among the mineral-manufacturing industries shown, the metallic group, in general, decreased its expenditures for plant and equipment considerably in 1953 over 1952 (a peak for recent years). On the other hand, for the two nonmetallic mineral-manufacturing industries shown, expenditures that had declined in 1952 increased in 1953.

Mining-Security Issues.—The mining industry (including fuels) accounted for 2.6 percent of all new corporate securities offered in 1953. Table 22 shows mining corporate financing to be more heavily in terms of common stocks than is the case for all corporations or all manufacturing corporations. Whereas 80 percent of the securities offered by all corporations consisted of bonds, mining corporations financed only 55 percent of their capital requirements in this way. Common stocks composed 43 percent of mining offerings, 7 percent in manufacturing, and 15 percent in all corporations.

Mining corporations planned to expend (as indicated by proposed uses) a smaller percentage of net proceeds from the sales of securities on plant and equipment than either all manufacturing corporations or all corporations. Only about half of the proceeds of new mining securities were planned for plant and equipment, whereas almost two-thirds was planned for this use by all corporations and three-fifths by all manufacturing corporations.[28]

TABLE 22.—Estimated gross proceeds of new corporate securities offered for cash in the United States in 1953 [1]

Type of security	Total corporate		Manufacturing		Mining [2]	
	Million dollars	Percent	Million dollars	Percent	Million dollars	Percent
Bonds	7,083	80	2,004	89	130	55
Preferred stock	489	5	81	4	5	2
Common stock	1,326	15	169	7	100	43
Total	8,898	100	2,254	100	235	100

[1] U. S. Securities and Exchange Commission, Statistical Bulletin: Vol. 13, No. 7, July 1954, p. 4.
[2] Including fuels.

Mining-Security Prices.—The 1953 index of common-stock prices for mining (including fuels) was 13 percent below 1952, while the composite index (see table 23) fell only 1 percent and the all-manufacturing index remained at about the 1952 level. Between 1947 and 1953, however, mining-security prices had more than doubled, whereas the composite index was up only 47 percent.

[28] U. S. Securities and Exchange Commission, Statistical Bulletin: Vol. 13, No. 7, July 1954, p. 5.

TABLE 23.—Indexes of common stock prices, 1944–53[1]

[1939=100]

Year	Composite[2]	Manufacturing	Mining[3]
1944	108.0	108.9	93.2
1945	131.2	129.0	114.3
1946	149.4	146.6	125.5
1947	130.9	132.4	117.2
1948	132.7	136.8	133.0
1949	127.7	132.1	129.4
1950	154.1	165.7	143.5
1951	184.9	206.8	204.9
1952	195.0	220.2	275.7
1953	193.3	220.1	240.5

[1] U. S. Securities and Exchange Commission. These indexes are yearly averages of the weekly closing price indexes of common stock published currently in the SEC Statistical Bulletin (monthly).
[2] Covers, in addition to mining and manufacturing, transportation, utility, and trade, finance, and service.
[3] Including fuels.

Foreign Investment.[29]—Direct private investment abroad in mining and smelting, which had grown more rapidly since 1949 than in the case of any other major industry, reached nearly $2 billion by the end of 1953. The amount added was lower in 1953 than in 1952—$292 million compared with $325 million—because some large projects in Canada, Venezuela, Chile, and Peru were nearing completion. Canada and the Latin American republics continued to receive the bulk of the net additions. The 1953 increment for Canada brought the total United States direct private investment in mining and smelting in that country up to an amount twice that at the end of 1950—$681 million as compared with $334 million.

Earnings of direct-investment mining enterprises were cut severely in 1953 because of price weaknesses for nonferrous metals and reduced output. This was particularly marked in Chile. Earnings were also retarded because of increased charges for exploration and depreciation expenses and allowances for accelerated depreciation.

American direct investments abroad constitute an important segment of the world economy. From the standpoint of foreign countries, gains from such investments could be measured partly from their contribution to overall output. The data required to compute such a measure on a careful and comprehensive basis have never been assembled; however, rough calculations made for Latin America indicate that as much as one-tenth of the goods and services produced in that area may be accounted for by United States-owned enterprises and that the proportion would be much higher for the mining industry.

During 1953 a report giving preliminary findings and recommendations regarding factors limiting American private foreign investments was issued. This report, which applied to mining as well as to other industries, discussed, among other things, the various impediments by area to American foreign investment and analyzed the basic factors that are the underlying causes of impediments.[30]

[29] Survey of Current Business, Foreign Investments and Income: Vol. 34, No. 11, November 1954, pp. 6–13.
[30] U. S. Department of Commerce, Office of International Trade, Study of Factors Limiting American Private Foreign Investment, Summary of Preliminary Findings and Recommendations: July 1953, 39 pp.

TABLE 24.—Direct private investments of the United States in foreign mining and smelting industries, 1953 [1]

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

Country	Mining and smelting				All industries			
	Book value, beginning of year	Net capital movements	Reinvested earnings of subsidiaries	Book value, Dec. 31	Book value, beginning of year	Net capital movements	Reinvested earnings of subsidiaries	Book value, Dec. 31
Canada	550	115	15	681	4,593	413	250	5,257
Latin American Republics:								
Chile	420	31	2	453	623	35	8	666
Mexico	131	7	4	142	490	3	17	509
Peru	143	16	3	161	230	30	−1	259
Total [2]	871	119	11	1,002	5,758	93	152	6,001
Western European countries	26	(3)	2	30	2,145	48	173	2,367
Western European dependencies	118	3	8	128	468	79	47	593
Union of South Africa	47	8	5	60	194	4	15	213
All other countries	29	1	3	33	1,660	85	128	1,872
Total, all areas	1,642	247	44	1,934	14,819	722	765	16,304

[1] Source: Survey of Current Business, Foreign Investments and Income: Vol. 34, No. 11, November 1954, pp. 6–13; and records of U. S. Department of Commerce, Office of Business Economics. Figures may not add exactly to totals owing to rounding.
[2] Includes countries not shown separately above.
[3] Less than $500,000.

DEFENSE MOBILIZATION

Defense Production Act.[31]—The Defense Production Act of 1950 was renewed by Public Laws 94 and 95, 83d Congress, on June 30, 1953. The same powers over expansion of mineral production as the act originally contained were continued in essentially unmodified form. The act as amended made no change in the authorization of designated agencies to incur obligations (borrowing authority) up to $2.1 billion. With slight modification, it continued through June 30, 1955, authority for allocations and priorities, V-loans, defense loans, long-term contracts, housekeeping provisions, and voluntary agreements. However, in reviewing the act, Congress carried out its policy of relaxing controls by allowing some of them to expire: Import controls (sec. 104, title I), authority to requisition and condemn (title II), control of real-estate construction credit (title VI), price and wage controls (title IV), and labor-dispute-settlement machinery (title V). The Small Defense Plants Administration was extended only to July 31, 1953; it was succeeded by the Small Business Administration.

Reorganization.—To strengthen central direction of the defense-mobilization program and simplify organization of the independent civilian agencies having national security responsibilities, the Defense Production Administration was terminated as a separate agency, and its functions were transferred to the Office of Defense Mobilization (Executive Order 10433, February 4, 1953), as were designated activities of the Munitions Board and National Security Resources Board (Reorganization Plan 3, June 12 and Executive Order 10461, June 17). Also, the Defense Materials Procurement Agency was

[31] Joint Committee on Defense Production Activities, 3d Ann. Rept., House Report 1097, 83d Cong., 2d sess., Jan. 7, 1954, pp. 8–14 and 263–277.

abolished, and certain of its functions were transferred to the General Services Administration including responsibilities for the purchase of metals, minerals, and other materials; subsidy payments on non-processed, domestically produced materials other than agricultural commodities; the installation of equipment in industrial plants; the certifying of essentiality of direct Government loans to aid in carrying out defense contracts; and the guaranteeing of certain loans made under the provisions of the Defense Production Act (Executive Order 10480, August 14).

The orders under which these actions took place gave the Office of Defense Mobilization a broad responsibility for supervising the defense-materials activities of the Government, including the determination of objectives and the development of procurement programs for the National Strategic Stockpile, and for balancing supplies and requirements of materials.

During the first 6 months of the year the Defense Materials Operating Committee continued to operate as an interagency forum, but in the latter part of the year this function ceased to exist.

Under the liquidation of the Reconstruction Finance Corporation, which was begun in 1953, the lending powers of that agency under the Defense Production Act of 1950, as amended, were transferred on September 28 to the Secretary of the Treasury.[32]

On July 31 the Small Defense Plants Administration went out of existence and was replaced by the Small Business Administration, a new agency with broader powers, created under the Small Business Act of 1953. The Small Business Administration was authorized to make loans up to $150,000 to small business concerns, subject to certain conditions, and to develop a program to promote the fuller use of private sources of credit and capital in encouraging small business enterprises.[33]

The Defense Solid Fuels Administration and the Petroleum Administration for Defense, delegate agencies in the United States Department of the Interior, continued to administer programs for expansion through 1953. By the end of the year shortages had eased substantially, and most control orders had been rescinded, as expansion goals were met or approached.[34]

On October 26 the President's Mineral Policy Committee, chaired by the Secretary of the Interior, was established to formulate a national mineral policy relating to the production and utilization of metals and minerals.[35]

Defense Materials Procurement Agency.—The Defense Materials Procurement Agency continued, through August 14, 1953, to function under the Defense Production Act as a delegate agency under the Office of Defense Mobilization for expanding the supply of critical metals and minerals. However, in February 1953, because of satisfactory progress toward meeting supply objectives, all programs were frozen by the ODM pending a review of their status relative to these objectives. Subsequently, some programs were reopened with

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32 Work cited in footnote 31, pp. 62–63, 248, 259–260.
33 Work cited in footnote 31, p. 225.
34 Work cited in footnote 31, pp. 159, 161.
35 Executive Office of the President, Office of Defense Mobilization, Stockpile Report to the Congress, July–December 1953, p. 9.

changes in the amount or type of assistance available; for other programs further expansion was stopped, as objectives had been met.

For those minerals whose projected supply had not reached prescribed goals the agency continued to develop and revise programs for expansion, to meet mobilization as well as current needs, recommending to ODM measures for augmenting supply and negotiating means for developing domestic and foreign projects through various types of assistance.

On August 14, 1953, the staff and certain functions of DMPA were transferred to the General Services Administration. An agreement was also entered into with the United States Department of the Interior, whereby the Bureau of Mines would continue to furnish technical advice and services necessary for conducting the materials expansion programs, and specialists of the Bureau of Mines and Geological Survey would make field inspections of mines and mineral-research projects.

At the end of 1953 the total proposed investment in minerals-expansion projects covered by certificates of necessity recommended by DMPA (and its successor, GSA) and approved by ODM was $1.5 billion, mostly on facilities for the expanded production of taconite and iron ore. Of this amount, about $150 million had been approved during 1953. These certificates are covered in table 25, which also covers certificates approved by ODM on a number of mineral industries not within the purview of DMPA. The totals in the table are cumulative from late 1950, when applications for rapid tax amortization in defense industries began to be certified, and show the total number of certificates of necessity granted by ODM for selected mineral-industry groups as well as the total for all groups and the progress of construction for these facilities.

A certificate of necessity entitles the holder to write off a specified portion of the installation cost in 5 years instead of the normal depreciation period. This has the effect of an interest-free loan to the holder during that period. Industry percentages were set by the degree of supply urgency of the commodity and the portion of the facility directed to national defense purposes.

Under the terms of purchase commitments with individual firms and through programs under which the Government purchased from all qualified suppliers large increases were effected in supplies of the following materials: Beryl, chrome ore, chrysotile asbestos, cobalt, copper, columbite-tantalite ores, acid-grade fluorspar, lead, manganese ore, mica, molybdenum, nickel, titanium, tungsten, and zinc.

As established by regulations issued by DMPA, most of these programs would have terminated by 1956, or sooner if goals had been met. However, the Domestic Minerals Program Extension Act of 1953 (Public Law 206, 83d Cong.), approved August 7, extended for an additional 2 years the regulations governing purchase programs designed to stimulate the domestic production of tungsten, manganese, chromite, mica, asbestos, beryl, and columbium-tantalum-bearing ores and concentrates. (See table 26.)[36]

[36] General Services Administration, Report on Activities under the Defense Production Act of 1950, As Amended: June–September 1953, pp. 1, 3–4 (unpublished).

TABLE 25.—Certificates of necessity approved and progress on facilities in selected mineral and related industries in the United States, as of Dec. 31, 1953, by industries [1]

Industry	All certificates [2]					Certificates covered by progress reports [4]			
	Number	Certified cost of facilities covered				Number	Reported cost of facilities (million dollars)		
		Total (million dollars)	Percents of individual costs eligible for rapid amortization [3]				Total	Value in place	
			Low	High	Weighted average			Amount	Percent of total [5]
Mining, extracting, and quarrying:									
Metallic:									
Iron ores (including taconite)	136	1,007	40	85	72	133	1,098	485	44
Copper ores	14	111	65	85	73	12	123	87	71
Lead and zinc ores	22	31	50	60	60	19	36	27	73
Bauxite and other aluminum ores	15	138	50	85	83	11	138	56	40
Tungsten ores	13	7	50	70	65	11	6	6	100
Uranium-vanadium-radium ores	9	5	65	90	83	9	7	6	82
Other metallic ores	18	51	50	90	78	12	46	37	80
Nonmetallic:									
Limestone	14	21	20	75	24	13	28	11	39
Barite	6	1	25	50	39	5	2	2	100
Fluorspar	7	4	60	80	64	5	3	3	92
Phosphate rock	5	9	45	50	49	5	14	6	43
Sulfur	12	27	70	85	74	8	25	21	82
Other chemical and fertilizer mineral mining	11	10	25	85	61	11	11	9	79
Industrial chemicals:									
Fertilizers	18	77	45	75	51	17	85	30	36
Explosives	17	6	40	90	68	12	3	3	82
Stone, clay, and glass products									
Cement	29	119	30	75	66	28	125	97	77
Gypsum, asbestos, and graphite products	6	1	50	75	61	4	1	(6)	61
Lime	28	19	20	85	73	28	18	18	100
Mineral wool	16	20	55	90	71	15	21	20	95
Abrasive products	65	32	45	85	64	64	35	31	90
Minerals and earths, ground or treated	15	14	30	75	52	15	14	8	57
Nonclay refractories	37	54	25	85	81	35	54	49	92
Other nonmetallic mineral products	4	4	30	65	56	4	2	2	100
Primary metal industries:									
Blast furnaces	106	902	30	85	80	106	1,040	459	44
Electrometallurgical products	37	193	55	85	68	[7] 39	238	218	92
Primary smelting and refining of:									
Copper	8	87	40	85	70	5	81	24	29
Lead and zinc	22	24	50	75	62	21	27	27	99
Aluminum	39	836	50	95	82	39	783	537	69
Other nonferrous metals	14	56	45	90	80	[8] 19	58	26	44
Secondary smelting and refining of nonferrous metals and alloys	11	4	55	85	71	[8] 13	4	4	97
All industries, total	18,632	29,025	5	95	60	17,757	29,011	21,500	74
Industries listed above, total	754	3,868	20	95	75	718	4,128	2,309	56
Percent of all industries	4	13	------	------	----------	4	14	11	--------

[1] Office of Defense Mobilization, Listing of Certificates of Necessity as of Dec. 30, 1953, by Standard Industrial Classification and Report of Progress Under Certificates of Necessity, as of Mar. 31, 1954 (unpublished). For definition of certificate of necessity, see text. Figures may not add exactly to totals owing to rounding.

[2] Data adjusted to exclude cancellations, expirations, and withdrawals.

[3] This percent has varied within the same industry from certificate to certificate, as indicated by the "low" and "high" given below.

[4] As of Mar. 31, 1954. Data are not available for Dec. 31, 1953, since progress reports are tabulated as of the end of odd quarters only. Data are not strictly comparable with those for all certificates, in part because some reports included cover certificates approved after Dec. 31, 1953, while reports were not received for all certificates in effect on that date. Furthermore, the total cost shown on the progress report represents the latest estimate of the company and may be different from the latest certified cost because of lag between revision in such estimates and official revision of the certified cost.

[5] Based on amounts in thousand dollars. [6] Less than $500,000.

[7] Includes progress reports on 2 certificates approved after Dec. 31, 1953.

[8] Discrepancy between the number of certifications and the number covered by reports may be due to differing interpretations of SIC classification in the 2 reports.

TABLE 26.—Commodities purchased under United States Government domestic purchase programs, as of December 31, 1953 [1]

Commodity	Quantity purchased	Authorized total purchases
Tungsten concentrates (thousand short-ton units)	600	3,000
Manganese ore (thousand long-ton units):		
Butte and Philipsburg depots	429	6,000
Deming depot	790	6,000
Wenden depot	2,089	6,000
Domestic small producers (carlot program)	557	19,000
Chrome ores and concentrates (long tons)[2]	46,640	200,000
Mica: Block, film, and hand-cobbed (short tons hand-cobbed equivalent)	2,593	25,000
Beryl (short tons)	145	1,500
Asbestos, chrysotile, nonferrous (short tons):		
Crude No. 1 and No. 2	176	1,500
Crude No. 3 [3]	150	------------
Columbium-tantalum ores and concentrates (thousand pounds combined contained pentoxides)[4]	3,486	15,000

1 General Services Administration. Published in Federal Register, Washington, vol. 19, No. 34, Feb. 18, 1954, p. 962. Except as indicated, represents quantities purchased under Defense Production Act of 1950 (as amended).
2 Purchased with stockpile funds for the National Strategic Stockpile.
3 Crude No. 3 accepted on tie-in basis with other 2 grades, not figured into the quantity authorized.
4 Mostly foreign. Figures not available for domestic only.

Other types of financial assistance made possible under the Defense Production Act of 1950, as amended, provided for the development of mining properties and for a long-range program of research and experimentation. Such assistance granted through December 31, 1953, was in the form of direct advances by DMPA–GSA amounting to $83 million under contracts with individual producers; 7 private loan guarantees by DMPA–GSA amounting to $85 million; and loans recommended by DMPA–GSA as follows: 5, aggregating $44 million in credits for foreign enterprises, made by the Export-Import Bank and 14, totaling $95 million for domestic enterprises, made by the Reconstruction Finance Corporation.

Through December 31, 1953, gross transactions totaling $6.5 billion had been consummated under the Defense Production Act. The probable net cost to the Government under transactions consummated was estimated at $690 million. Programs for nickel, titanium, manganese, copper, tungsten, and magnesium accounted for approximately 70 percent of the probable net cost.[37]

During 1953 DMPA revoked or suspended most of the mineral orders that had been issued in 1950–51 to control and conserve certain strategic metals and minerals. Mineral Order 1 (MO–1), which prohibited hoarding of various strategic materials, was revoked March 12 when it became apparent that lifting the ban would not appreciably affect distribution. In February Mineral Orders 6 and 8 were amended, virtually restoring free domestic trading in tungsten and molybdenum concentrates. Certain controls over the export of zinc were discontinued with revocation of Mineral Order 3, effective March 30. Mineral Order 2, covering the allocation of manganese ore, was suspended in May. Mineral Order 7, on serialization of mines, smelters, and mineral-processing plants, was revoked effective June 30.[38]

37 General Services Administration, Report on Activities Under the Defense Production Act: October-December 1953, pp. 1–3 (unpublished).
38 Joint Committee on Defense Production Activities, 3d Annual Rept., House Rept. 1097, 83d Cong., 2d sess., Jan. 7, 1954, p. 252.

Defense Minerals Exploration Administration.—Continued progress was made by the Defense Minerals Exploration Administration in its program of encouraging, through Government assistance, exploration of potential domestic sources of critical and strategic minerals. Through 1953, 89 certifications of discovery or development had been issued by the agency, of which 69 were issued during 1953. Certifications were made on the following commodities: Antimony, asbestos, beryl, copper, fluorspar, lead, manganese, mercury, mica, monazite, rutile, sulfur, talc, tungsten, uranium, and zinc. These projects were located in 20 States. In all 323 contract projects were in force December 31, 1953.[39]

Office of Price Stabilization.—Most metals and minerals were released from price control on February 12. Copper and aluminum were decontrolled February 25. The final action of March 17, removing the remaining controls, also terminated the voluntary agreements between the Office of Price Stabilization and steel producers. After decontrol, prices for lead and zinc, which had begun to decline in 1952, continued to drop, while prices for copper, magnesium, iron ore, copper and aluminum scrap promptly increased. Nickel and aluminum price increases had been authorized shortly before decontrol. Price-control authority was terminated April 30, and liquidation of the agency was virtually complete by June 30.[40]

National Strategic Stockpile.[41]—A review of stockpile policy begun in 1952 was completed in May 1953 and approved by members of the Munitions Board and the Secretary of the Interior in June. A most significant addition to policy was a provision for the release of materials during partial mobilization, developed from actual practice during the Korean War.

On June 12 the responsibility for the stockpiling program was transferred to the Office of Defense Mobilization. The services of special committees, such as the interdepartmental advisory committees and industry advisory committees, were used to make an evaluation of plans and policies governing stockpile activities to assure compatibility with overall ODM materials policies and to reflect changes that had taken place since the Korean truce. A continuing review of the program, material by material, was planned. With the transfer to ODM, the stockpile program was integrated with materials-expansion programs that had been launched during the Korean War period.

Deliveries to the stockpile in 1953 maintained the high rate of the previous year. The 25 items less than 80 percent complete at the end of the first 6 months were reduced to 24 by the end of the year. Purchases during the year amounted to 20 percent of cumulative expenditures. Cancellations of outstanding obligations in the period exceeded new obligations by $114 million, or 2 percent of total incurred obligations.

[39] Executive Office of the President, Office of Defense Mobilization, Stockpile Report to the Congress: July–December 1953, p. 16; U. S. Department of Defense, Office of the Secretary of Defense, Stockpile Report to the Congress: January–June 1953, p. 29.
[40] Work cited in footnote 38, pp. 76–82, 87.
[41] Work cited in footnote 39, January–June 1953, pp. 1, 3, 13; July–December 1953, pp. 1, 7.

Selenium was added to the stockpile list in May; however, none was purchased because of the limited supply available. Revisions of specifications were made in muscovite mica block and film to include nonruby mica, in mercury to acquire higher purity material, in amosite asbestos to make a change in grade, and in metallurgical manganese to permit purchase of domestic slag.

With only a few exceptions, supplies of materials being stockpiled had become available to meet consumer demand and to permit an orderly rate of stockpiling. The supply of some ferroalloys still posed a severe problem of acquisition and conservation. Efforts continued to stimulate research and development, as well as to encourage production planning for substitute materials. Most critical in this list were selenium and nickel, while supplies of molybdenum, tungsten, cobalt, chrome, and columbite-tantalite had improved substantially.

Commodity Credit Corporation.[42]—The barter program effecting the exchange of agricultural commodities owned by the Commodity Credit Corporation for strategic and critical materials produced abroad and needed for the stockpile resulted in the acquisition of materials amounting to $24 million during 1953, bringing the total acquisitions from this source as of December 31, 1953, to $74 million. Industrial diamonds, chromite, and mercury were the minerals received and transferred to the stockpile in exchange for tobacco, corn, and wheat.

International Materials Conference.[43]—By the end of February molybdenum and nickel were the only commodities remaining under international allocation by the International Materials Conference. As their respective materials reached a reasonable balance between supply and demand, the commodity committees of the International Materials Conference disbanded. By the end of September the elimination of nickel allocations brought to a close all international allocations of materials. (Domestic control of nickel was removed November 1, 1953, leaving only titanium subject to end-use limitation.)

Bureau of Foreign Commerce.[44]—The Bureau of Foreign Commerce, formerly the Office of International Trade, United States Department of Commerce, under its export-control authority was responsible for export-control policy with the advice of an interagency committee. At the close of 1953 only the following metals and minerals remained under quota export control: Chromium, cobalt, columbium-tantalum ores and concentrates, diamond bort and grinding wheels, nickel, and selenium.

Export-Import Bank.[45]—During 1953 the Export-Import Bank established credits abroad under its own act totaling $35 million for assistance to mining projects to produce iron ore, uranium, sulfur, and manganese. Another $28.4 million of credits was established under the Defense Production Act to assist production of cobalt, copper, molybdenum, and bismuth. Total disbursements under this program approximated $8 million as of December 31, 1953.

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[42] Work cited in footnote 39, January–June 1953, p. 5; July–December 1953, p. 3.

[43] Work cited in footnote 38, pp. 2, 64; work cited in footnote 39, January–June 1953, p. 9.

[44] Work cited in footnote 39, July–December, 1953, p. 5.

[45] Export-Import Bank of Washington, 16th Semiannual Report to the Congress, 1953, pp. 10–19; 17th Semiannual Report, pp. 12–19.

WORLD REVIEW

World Production.—World production of most major minerals in 1953 was greater than in any year since early in World War II. Striking annual increases were made by the metals for which uses have been developed in high temperature and high strength alloys: Columbite-tantalite concentrates, 60 percent; beryl, 30 percent; cobalt, 20 percent; and molybdenum, 30 percent. Among metals with historical peaks of mine production in 1953 were iron ore, chromite, manganese ore, copper, lead, zinc, cobalt, nickel, tungsten, titanium concentrate, and bauxite. In the nonmetallic minerals, cement, diamonds, potash, salt, and fluorspar reached new production records during the year.[46]

Data for the world, excluding the United States, the USSR, and the China mainland, also indicate a general growth in mineral production; the output of cement, pig iron, copper, zinc, lead, and aluminum increased 1 to 12 percent over 1952. Increased production of these basic commodities was a significant factor in the high 1953 gross national products enjoyed by many countries of the Free World.[47]

Indexes of production in metal mining and metal production for selected countries of Europe as prepared by the United Nations are presented in table 27. It can be seen that progress in these industries has varied greatly between countries; 8 showed increases and 7 showed decreases in 1953 from 1952. Largest gains were in Greece, the Netherlands, and Turkey; largest losses were in Belgium, Luxembourg, Finland, and France. Similar figures from the United Nations indicate decreased activity in mining and quarrying in China (Taiwan only), decreased activity in metal manufactures in India, and increased activity in mining and metal manufactures in Japan.[48]

TABLE 27.—Index numbers of production in metal-mining and metal-making industries in selected European countries, 1951–53 [1]

[1950=100]

Country	1951	1952	1953	Country	1951	1952	1953
Austria	120	135	148	Italy	128	142	141
Belgium	129	124	113	Netherlands	110	111	140
Luxembourg	128	130	115	Norway	108	118	127
Finland	136	142	130	Spain	113	122	129
France	115	122	111	Sweden	119	122	123
Germany, West	121	134	129	Turkey [2]	95	136	167
Berlin, West	152	192	210	United Kingdom	106	109	106
Greece	148	189	227				

[1] United Nations Economic Bulletin for Europe, vol. 6, No. 2, July 1954, p. 71. Indexes cover the production of metalliferous ores, primary metal, rolled products, castings, forgings, and other basic forms of ferrous and nonferrous metals.
[2] The index numbers cover metal mining only and exclude metalmaking, for which no data are available.

World Prices and Stocks.—Stocks of copper in the United States and Chile increased in 1953; stocks decreased in the United Kingdom and Canada. Chilean stocks were high because of the setting of a 36½-cent price (equivalent, delivered to United States plants), about 6½ cents higher than imports available from other sources. The price

[46] See table 10, Statistical Summary of Metals and Nonmetals chapter of this volume.
[47] Statistical Office of the United Nations, Monthly Bulletin of Statistics, vol. 8, No. 7, July 1954, pp. xiv-xvi; and No. 11, November 1954, p. viii.
[48] United Nations, Economic Commission for Asia and the Far East, Economic Bulletin for Asia and the Far East: Bangkok, vol. 5, No. 1, May 1954, p. 40.

increase following the lifting of price controls in the United States led to lower consumption in the United States in the latter part of the year, although the total year's consumption was somewhat higher than in 1952. A high price carried over from 1952 also contributed to a lower consumption in the United Kingdom. Lead stocks were higher in both the United States and the United Kingdom; zinc stocks were higher in the United States and lower in the United Kingdom.[49] World tin stocks (excluding the United States National Strategic Stockpile) were down about 2.5 percent from 1952.[50] Prices for copper rose during 1953 in Chile, Northern Rhodesia, and Canada, averaging 5 to 10 percent higher in these countries than in 1952; the lifting of price controls in the United States, however, resulted in a 19-percent rise between the 2 years. The spread in copper prices among these 5 countries had narrowed to about 1 cent by the end of the year. Lead prices fell most sharply—31 percent—in the United Kingdom; in December 1953 the United Kingdom price was 2.3 cents lower than in the United States and 2 cents lower than in Canada. Zinc prices also fell sharply throughout the world in 1953, almost 50 percent from 1952 in the United Kingdom.[51] Tin prices fell sharply after the first quarter of the year with the approaching end of United States stockpiling purchases. The year 1953 also marked resumption of free trading on the London Metal Exchange in zinc, aluminum, and copper.

International Cooperation.—International allocation of materials was discontinued in September 1953 as the International Materials Conference was dissolved (see section on Defense Mobilization).

In early 1953 the High Authority of the European Community for Coal and Steel—composed of France, West Germany, Italy, Belgium, the Netherlands, and Luxembourg—established common markets for coal, iron ore, iron and steel scrap, and steel.[52]

The European Payments Union, established under authority of the Organization for European Economic Cooperation, made progress in freeing trade from quantitative restrictions and permitted substantial expansion in 1953 in the volume of intra-European trade. The European Payments Union serves as a clearing house for member countries through which they agree to settle periodically the net surplus or deficit in their European accounts with the Union as a whole rather than separately. Another OEEC instrument affecting minerals was the European Productivity Agency, established to increase productivity in Western Europe.[53]

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49 United Nations, Review of International Commodity Problems, 1953: New York, 1954, pp. 19, 33, 55. British Bureau of Nonferrous Metal Statistics, Bulletin, Statistics for October 1954: Vol. 7, No. 10, Dec. 10, 1954.

50 International Tin Study Group, Statistical Yearbook: The Hague, Netherlands, 1954, p. 20.

51 International Monetary Fund, International Financial Statistics: Vol. 6, 1953, and vol. 7, 1954, various issues. Monthly prices in terms of U. S. dollars for copper, lead, zinc, tin, and nitrates in selected countries are available in this publication.

52 European Community for Coal and Steel, High Authority Information Service Bulletin (Luxembourg): No. 1, January 1954, p. 1.

53 United States Department of State Bulletin, vol. 26, No. 671, May 5, 1952; vol. 29, No. 752, Nov. 23, 1953; and No. 732, July 6, 1953.

Review of Metallurgical Technology

By Oliver C. Ralston [1]

THIS CHAPTER purposes to point out a few of the more important advances and trends in mineral technology that took place during 1953. This review is based on developments that have come to the attention of the Bureau of Mines through its own activities, a review of technical literature, and direct contact with technologists in the industry. Similar review articles appearing in the technical press have been drawn upon freely. No attempt is made to acknowledge all sources of information. Certain references are cited for the convenience of readers who may be interested in further study of some of these developments. This is the second successive review of this kind; it will be continued as a regular feature of the Minerals Yearbook.

MINERAL CONCENTRATION

The major developments in milling and concentration methods are associated largely with concentration of iron ores, particularly the low-grade ores known as taconites. There has been continued development in equipment for materials handling, which always assumes a major role in any plant for concentrating or beneficiating low-grade ores. Centrifugal methods of classification and concentration, as typified by hydraulic cyclones and spiral concentrators, are finding more diversified applications.[2]

It is predicted that within 10 years a total annual output of 10,000,000 tons of taconite concentrates will be produced from over twice that weight of ore from the Great Lakes area. The mills producing these concentrates will utilize many of the newer devices and techniques, such as wet cyclones, dense-medium processes, spiral concentrators, classifiers, magnetic separators, and flotation with specially adapted reagents.[3]

Magnetic separators have been widely used on the magnetic taconites. The Erie Mining Co. employs a permanent-magnet drum separator to clean rougher concentrates that are made with an electromagnet.[4]

The iron-smelting furnaces are not adapted to large volumes of finely divided material in their charge. Sintering or other methods of

[1] Chief metallurgist.

[2] Scott, Donald W., Developments in Minerals Beneficiation: Min. Eng., vol. 6, No. 2, February 1954, pp. 166–179.

Booth, Robert B., Flotation: Ind. Eng. Chem., vol. 46, January 1954, pp. 105–111.

[3] Bechaud, Leslie J., Jr., New Devices, New Flowsheets Liven Iron-Ore Processing: Eng. and Min. Jour., vol. 54, February 1953, pp. 124–127.

[4] Devaney, F. D., Iron-Ore Beneficiation: Eng. and Min. Jour., vol. 155, No. 2, February 1954, pp. 123–125.

agglomerating finely divided material—normal procedures in copper and lead smelters—are also being applied to taconite concentrates. Pelletizing of fines, one of the new methods of agglomeration originally developed by the Bureau of Mines, is one of the methods being considered. Round water-bound pellets are formed by rolling the partly dried material in a slightly inclined rotary cylinder. These pellets, on drying, have some green strength but on heating are greatly strengthened so that they withstand rough handling. Some colloidal material, such as colloidal iron oxides or hydroxides, cheap starchy residues, or bentonite clay, must be present in the charge to thicken the water. One plant that is employing pelletizing for agglomerating fine concentrates is that of Erie Mining Co. at Aurora, Minn. A magnetite concentrate is oxidized to ferric oxide on heating and gives off much of the heat needed for sintering. Magnetic taconites thus have peculiar advantages not originally accredited to them.

The hydraulic cyclone separator, known also as the Dutch cyclone or the Driessen cone, has received wide use as a classifier for coal, iron, and other ores. It has also undergone tests as a classifier in closed circuit with ball mills. The pumps and piping connected to cyclones have also been observed to cause considerable abrasion to soft minerals.[5] This effect could prove useful as a means of physically separating mixtures of minerals of wide difference of hardness. In other words, it might serve as a hydraulic analog to the Mardun disintegrator, which operates on dry ores.

Spiral concentrators compete with gravity-concentrating tables for treating of sand sizes of mineral mixtures. The spiral flow creates a mild centrifugal force at right angles to the direction of pulp flow and thereby produces effects somewhat similar to the cross water on concentrating tables. An attempt to use spirals for separating oversize from undersize in closed circuit with ball mills is reported to have been abandoned.

There is a continuing trend toward larger capacity for primary crushers, particularly of the gyratory type. The largest crusher ever built, a 60- by 109-inch gyratory with a rated capacity of 3,000 tons an hour, is being built for the Reserve Mining Co. taconite project. There is a trend toward increasing the number of crushing stages in large plants to permit each type of crusher to operate in its optimum size range, thereby improving crushing efficiency. Rod mills are being used more and more for primary grinding, particularly for a feed in the range from 8 mesh to 1 inch.

The release of experimental results by the Tennessee Copper Co. on the effect of a change of ball load has stimulated new interest in the effect of ball load in grinding efficiency when the ball load was changed from 55 tons of balls (45 percent of mill volume) to 35 tons (29 percent of mill volume). The same degree of grinding was attained, even though the output rose from 2,130 to 2,250 tons in 24 hours; at the same time, the power consumption dropped from 490 to 370 hp., and ball consumption dropped from 1.02 to 0.24 pound

[5] Erickson, S. E., Differential Grinding in Cyclone Shown by Screen Tests: Eng. and Min. Jour., vol. 155, No. 1, January 1954, pp. 95, 168.

per ton of ore ground. A better flotation extraction was effected and the consumption of flotation collector decreased.[6]

The feldspar concentrator at Kona in western North Carolina has been in operation for some years, and an adequate description long awaited has now been supplied.[7]

The new flotation setup adaptable to recovery of molybdenite from porphyry copper ore deserves attention.[8] The average molybdenite content of such ores is very low, and consequently rougher concentrate is of very low grade. The rougher concentrate is cleaned in 6 stages to raise the grade to 85 percent MoS_2, with less than 1.5 percent Cu. Thickening and repulping are used at two points in the cleaning circuits to discard excess flotation reagent, and regrinding is practiced before the fifth and sixth recleaning steps. Sodium ferrocyanide is introduced at each step of roughing and cleaning, and the sixth cleaning is done at pH 9–11 with sodium cyanide as modifier, which is converted to ferrocyanide. The previous cleanings were done with pH 7.5–9.0; and whereas roughing is done at 20 percent solids, each cleaning step is in successively higher dilution until the fourth and fifth steps are at only 2–3 percent solids content. Recovery of marketable-grade molybdenite is about 70 percent.

HYDROMETALLURGY

Hydrometallurgical processes are finding new applications in the treatment of low-grade ores. A hydrometallurgical process usually involves preparation of the raw materials for chemical dissolution of the desired metal; removal of impurities from solution, if necessary; and finally, precipitation of the metal or one of its compounds by chemical or electrochemical means. Hydrometallurgical processes were first applied extensively to the extraction of gold and silver. Using much of the equipment and many of the techniques developed in cyanide extraction of gold ores, other leaching processes were applied to oxidize copper and zinc, with subsequent electrolysis of the purified solution to produce the pure metal. Recently leaching processes are being applied in the large-scale treatment of low-grade ores of copper and nickel. Several new processes have been developed for acid leaching of sulfide ores at temperatures considerably above the boiling point.

During the past year Anaconda Copper Co. began to operate its new copper-leaching plant for treating low-grade ore from the Yerington, Nev., deposit.[9] Oxidized copper in a siliceous gangue is leached in open vats with sulfuric acid made from brimstone from the Leviathan mine, Alpine County, Calif. Copper is precipitated from the leach solution by detinned tinplate scrap from the Pacific coast, and the cement copper is sent to the smelter at Anaconda, Mont. About 450 tons of sulfuric acid is required per day to treat about 15,000 tons

[6] Engineering and Mining Journal, The Remarkable Case of the Copper Hill Ball Mill: Vol. 154, No. 5, June 1953, pp. 86-89. Copper Hill Story Stirs Thinking on Grinding: No. 9, September 1953, pp. 80-83, 202.

[7] Lutjen, Geo. P., Kona Plant Features Flexibility: Eng. and Min. Jour., vol. 154, No. 5, May 1953, pp. 92-95.

[8] Barker, L. M., and Young, O. E., Flotation Recovery of Molybdenite: U. S. Patent 2,664,199, Dec. 20, 1953.

[9] Engineering and Mining Journal, Yerington Mine Starts Production: Vol. 155, No. 1, January 1954, pp. 112, 166.

of ore. All operations are on a large scale, and heavy, durable equipment is used throughout. The grade of the ore is marginal, but a long-term sales contract for several years ahead with the General Services Administration assures a price that permits economic operation. This operation exceeds in size the copper-leaching plant at Inspiration, Ariz., previously the largest in the United States.

The Bagdad Copper Co., near Prescott, Ariz., which has been treating both oxidized and sulfide ore for many years, plans to increase the capacity of its 3,000-ton-per-day concentrator to 8,000 tons. A flotation concentrate of copper sulfide minerals will be roasted in two 220-foot-diameter Dorrco fluosolids reactors to form water-soluble copper sulfate, which is to be leached to extract 97 percent of the copper. The copper will be recovered from solution by electrolysis, although precipitation on sponge iron is also under consideration. The White Pine Copper operation in Michigan also experimented with sulfate roasting in fluosolids reactors but ultimately decided on smelting its chalcocite concentrate.

The Nicaro plant in Cuba owned by the United States Government and operated by Nickel Processing Corp. employs a hydrometallurgical process to treat 3,600 tons of nickel ore per day. The ore contains about 1.2 percent nickel and about 0.12 percent cobalt. The nickel and cobalt are present in an iron-containing laterite derived from the parent rock of decomposed serpentine. The ore is dried in rotary kilns and "roasted" in a battery of multiple-hearth circular roasters to reduce the nickel and cobalt to metal and the iron to magnetite, in an atmosphere of producer gas made from anthracite. The nickel is leached from the calcine in an ammoniacal ammonium carbonate solution of about 6-percent strength. The solution is aerated to reoxidize the nickel during dissolution. There are no provisions for separating cobalt from the nickel-bearing solution; conditions are chosen to keep most of the cobalt insoluble so that the nickel precipitate will be sufficiently free of cobalt. Nickel carbonate is precipitated by boiling the ammoniacal solution. It is planned to increase the capacity of the plant 75 percent now that exploration has developed adequate reserves.

Of particular interest are the two new processes employing acid leaching of sulfide ores under pressure, which have been proposed, respectively, by the Chemical Construction Co. (Chemico) and by Prof. F. A. Forward of the University of British Columbia. The details of these processes have been withheld for several years, but much detailed information was revealed during the past year through the technical press and a dozen or so patents covering the processes.[10]

[10] Forward, F. A., Ammonia Pressure-Leach Process for Recovering Nickel, Copper, and Cobalt From Sherritt Gordon Nickel Sulfide Concentrate: Trans. Canadian Inst. Min. and Met., vol. 56, 1953, pp. 677-684; Mining Eng. (AIME), vol. 5, 1953, pp. 576-581. Extracting of Nickel Values From Nickeliferous Sulfide Material: U. S. Patent 2,576,314, Nov. 27, 1951. Processes for Recovering Nickel and/or Cobalt Ammonium Sulfate From Solutions Containing Nickel and/or Cobalt Values: U. S. Patent 2,647,820, Aug. 4, 1953.

Roberts, E. S., Precipitation of Pure Metallic Copper From Copper-Bearing Solutions: U. S. Patent 2,647,825, Aug. 4, 1953. Gas Replacement of Metallic Sulfides: U. S. Patent 2,662,009, Dec. 8, 1953.

McGauley, P. J., Recovery of Cu and Ni From Flotation Concentrate: U. S. Patent 2,647,827, Aug. 4, 1953. Recovery of Ni From Ammonia Liquors: U. S. Patent 2,647,828, Aug. 4, 1953. Decomposition of Copper Scrap and Alloys With Copper Ammonium Carbonate Solutions: U. S. Patent 2,647,829, Aug. 4, 1953.

Allen, L. N., Preparation of Pure Copper Metal From Copper-Bearing Scrap: U. S. Patent 2,647,830, Aug. 4, 1953. Preparation of Pure Copper Metal From Nonferrous Metal-Bearing Scrap: U. S. Patent 2,647,831, Aug. 4, 1953. Preparation of Pure Copper Metal From Copper-Bearing Scrap: U. S. Patent 2,647,832, Aug. 4, 1953.

Unroasted sulfide-flotation concentrates are leached in an aqueous solution contained in a heated pressure autoclave equipped with an agitator to keep the solids in suspension and are blown with air to oxidize the sulfur to soluble sulfates. In the Forward process, ammonia is added to the solution, and it is blown with air only. In the Chemico process, the leach pulp is blown with air or air containing SO_2. Exit gases are chilled to condense moisture and wash out reagents, which are returned to the autoclave directly or indirectly. The steam pressure of the autoclave is maintained at a few hundred pounds to a thousand pounds per square inch, depending on the solvent and the minerals involved. At the corresponding temperatures, 150°–350° C., the sulfides are oxidized to sulfates and sulfuric acid. The sulfuric acid (and certain sulfur oxygen complexes lower in oxygen than sulfates) is neutralized with ammonia, and ammonium sulfate is produced as a byproduct. In the Chemico process, ammonia is added progressively to neutralize part of the sulfuric acid and control the pH. The iron and aluminum sulfates formed are hydrolyzed to hydroxides or basic sulfates, and the ultimate solution as filtered from the pulp contains mainly sulfates of nickel, cobalt, and copper.

Procedures after dissolution vary considerably. Soluble iron can be precipitated at a pH of 4. In the Chemico process, hydrogen gas is applied in a second autoclave at suitable pressures, temperatures, and pH values to precipitate each of the three metals individually as fine powders. In the Forward process, copper is precipitated with hydrogen sulfide, and nickel and cobalt are precipitated by reduction with hydrogen. The metal powders, when properly cleaned and prepared, are worth more than ingot metal. The solutions left after metal precipitation can be evaporated, and crystallized and marketed as ammonium sulfate.

There is little essentially new in these pressure processes. At higher temperatures most chemical reagents are more active. The analytical chemist fumes ore samples with sulfuric acid to subject them to acid decomposition at temperatures higher than the boiling point of water. Metal sulfides have low vapor pressures at room temperature, but a few hundred degrees higher brings appreciable vapor pressure and ease of reaction. When SO_2 is pumped under pressure into water at 200° C. it reacts to form sulfuric acid and elemental sulfur by the reaction: $3SO_2 + 2H_2O = 2H_2SO_4 + S$. If enough oxygen or air accompanies the SO_2, all of the sulfur is oxidized to sulfuric acid. The polythionates or other sulfur-oxygen complexes may also be converted to sulfate and sulfur. The principal problem in the pressure processes is to find suitable materials for construction, particularly for valves, heat exchangers, agitators, and similar gear, that can withstand the corrosive and abrasive effects of the leach pulp. The Howe Sound cobalt plant at Salt Lake City, which is employing the Chemico process, has met serious difficulties in this respect.

The problem of extracting uranium from very low-grade ores has stimulated development of many hydrometallurgical techniques not previously applied to leaching of ores.

In 1953, 5 plants came into operation on the Witwatersrand; operation eventually of 15 or 16 such plants, with 23 or 24 mines contributing material for treatment, is expected.

The new plant being operated by the Anaconda Copper Mining Co. at Blue Water, N. Mex., is the ninth extraction plant to go into operation in the Colorado Plateau district. It uses a sodium carbonate leach solution; uranium is extracted as a uranate of sodium.

Test results were published [11] on pressure precipitation of vanadium tetraoxide from sodium vanadate solutions by hydrogen gas under pressure in the presence of suspended nickel powder as a catalyst in an autoclave at 100°–200° C. and 200–400 p. s. i. pressure. There are other ways of precipitating the vanadium from uranium carbonate solutions that do not call for pressure equipment or hydrogen gas under pressure; this example serves merely to illustrate the wide possibilities for precipitating metals by hydrogen from solutions under pressure.

There has been increased interest in utilization in the pure state of many metals which heretofore have been important only as alloying constituents in the production of steels. From 1937 to 1945 the Bureau of Mines developed a process for producing pure manganese metal. In 1944 a small commercial plant built at Knoxville, Tenn., by Electromanganese Corp. was gradually increased to a capacity of 10 tons a day. Recently its capacity was doubled, and another plant was built at Marietta, Ohio, by Electrometallurgical Co. of Union Carbide & Carbon Co.

Chromium is another ferroalloy metal that is now assuming a place of its own. High-purity chromium metal has been shown to be malleable and ductile and is being seriously considered as a structural metal for high-temperature applications.[12] The Bureau of Mines developed a process for electrolytic production of chromium metal from ferrochrome, using a chromous sulfate electrolyte. This process is being employed as a basis for another plant to be operated by the Electrometallurgical Co. at Marietta, Ohio, for producing electrolytic chromium. Increased interest is also apparent in the properties and potential uses of molybdenum and vanadium as pure metals.

As a means of extracting manganese from low-grade ores in the form of a carbonate or high-grade oxide precipitate, a number of processes were developed during 1953, but details were sparse. The Nossen nitric acid process was offered to General Services Administration for pilot planting, largely on Aroostook, Maine, ores. Manganese nitrate hydrate is decomposed thermally into nitric acid and MnO_2. The dithionate process was further developed by the Bureau of Mines pilot plant in Boulder City, Nev. The Dean carbamate leaching process was adopted for a plant under construction in the Cuyuna range in Minnesota. It produces manganese carbonate and recovers ammonia and carbon dioxide used in the leach. At Minneapolis, the Bureau of Mines is studying sulfate roasting of low-grade ores with SO_2 gas. Chemical Construction Co. was working on wet-pressure sulfating with SO_2.

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[11] O'Brien, R. M., Forward, F. A., and Halpern, J., Precipitation of Vanadium From Aqueous Vanadate Solutions: Trans. Canadian Inst. Min. and Met., vol. 56, 1953, pp. 673–676.

[12] Gilbert, H. L., Johansen, H. A., and Nelson, R. G., Malleable Chromium and Its Alloys: Bureau of Mines Rept. of Investigations 4905, 1952, 22 pp. Forging of Arc-Melted Chromium: Trans. AIME, vol. 197, 1953, pp. 63–65.

Goodwin, H. B., Gilbert, R. A., Schwartz, C. M., and Greenidge, C. T., A Preliminary Study of the Ductility of Chromium: Jour. Electrochem. Soc., vol. 100, 1953, pp. 152–160.

PYROMETALLURGY

An interesting new development was reported at the Finnish copper smelter Outokumpo Oy at Harjavalta.[13] The smelting is done in a short shaft whose bottom opens into a reverberatory furnace through which the gases sweep to a waste-heat boiler and then through an air preheater to a Cottrell precipitator. By preheating the burner air to 500° C. the smelting becomes autogenous, and no fuel is needed. Downflow of the ore and hot air through the shaft to the reverberatory causes most of the solid material to stop there and separate into slag and matte layers. The boiler and air preheater are each provided in the bottom with dust-recovery bins. The shaft is 26 feet tall and 11.6 feet inside diameter, but 250 tons of flotation concentrate daily is burned and smelted, the volume of air being enough to produce a 15-percent sulfur calcine. The heat of combustion of sulfur and iron, in addition to the sensible heat in the air, suffices for the operation. The gases are very rich in SO_2, 13–15 percent, and are therefore suitable for making liquid sulfur dioxide needed in Finland's paper industry.

The so-called subhalide process for refining aluminum has been investigated on an experimental scale extensively in the United States and abroad. It is an interesting process, involving distillation at low pressure. The vapor of $AlCl_3$, which boils at 182° C., will react with impure aluminum at temperatures above red heat to form aluminum monochloride, AlCl, which is also volatile but less so than $AlCl_3$. On cooling, AlCl decomposes into metallic aluminum and $AlCl_3$, which is recirculated to form more monochloride. In this way it is possible to distill pure aluminum from a relatively impure metal.[14]

The revolutionary development in electronics growing out of the study of the remarkable properties of semiconductors is also having its effect on metallurgical techniques. One of the requirements for germanium used in transistors is that the critical impurities, such as phosphorus, antimony, and arsenic, be very carefully controlled with an accuracy of the order of less than 1 part in 10^6. Efforts in this direction have led to development of the so-called zone-melting technique for refining to ultrapure metal.[15] The method is simple; it is based on the well-known principle that addition of small quantities of one substance to another usually decreases the melting point. A long bar of the metal to be refined is placed in a snug boat and passed slowly through a quartz-tube furnace, around which are placed several induction coils at equal intervals. As the bar enters each induction zone, a short length melts and then resolidifies. With each melting process, more of the impurities concentrate in the liquid phase, leaving the solid metal purer. Most impurities are thereby concentrated in the last section to freeze, which may then be cut off. In certain instances the impurities raise rather than lower the melting point and concentrate in the solid phase. The same process will then be effective in reverse, but more passes are required for the same degree of refining.

[13] Benitez, Fernando, Flash Smelting Improves Harjavalta's Metallurgy: Eng. and Min. Jour., vol. 154, No. 10, October 1953, pp. 76–80.

[14] Scheyer, Ernst, Distillation of Aluminum From Aluminum Alloys: U. S. Patent 2,625,472, Jan. 13, 1953.

[15] Pfann, W. G., and Olsen, K. M., Purification and Prevention of Segregation in Single Crystals of Germanium: Phys. Rev., vol. 89, 1953, pp. 322–323.

Lord, N. W., Analysis of Molten-Zone Refining: Trans. AIME, vol. 197, 1953, pp. 1531–1533.

PHYSICAL METALLURGY

Research and development on alloys and methods of fabricative metals continued to expand. Titanium and zirconium received special attention in this respect, although research on alloy steels, high-temperature alloys, and aluminum is not lagging.

For the past several years, much of the research in alloys was directed toward finding suitable substitutes for critical metals that were restricted in use. By 1953 most of these restrictions had been lifted, so it was possible to give more attention to improving physical properties to meet the growing demand for metals with greater strength and lightness and alloys with special combinations of properties.

The requirements of the aircraft industry have stimulated development of steels of exceptionally high strength, of the order of 300,000 p. s. i. Cerium and the rare earths are being investigated for grain refining and improvement of impact strength. For example, addition of 3 to 5 pounds of misch metal to 1 ton of stainless steel was reported to increase the impact strength 33 to 67 percent.[16]

There is a demand for better materials for electrically conducting springs for such uses as electrical contacts in computing machines. Copper-beryllium alloys have been employed for this purpose. Another alloy with similar properties has been developed; it contains 10 percent Ni, 1.5 percent Si, and 4.0 percent Al. It is easily formed in a solution-treated condition and can be age-hardened to give a proportional limit of 85,000 p. s. i. and a modulus of elasticity of 19×10^6.

Research continues to be active in the development of construction materials for high temperatures in jet engines. Molybdenum has requisite strength at temperatures as high as 1,800° F., but its alloys are not ductile enough, and it has an appreciable vapor pressure at high temperatures. An attempt is being made to avoid vaporization by cladding with nickel. Much work is also being done on ceramic coating of alloy steels and nickel to protect the metal against oxidation at high temperatures.

The machining and fabrication of titanium alloys have been serious obstacles to greater use of metallic titanium, but these problems are gradually being worked out. Many of these difficulties have been lessened by adoption of a double-arc-melting procedure which produces more homogeneous ingots. The initial ingot is forged into a rod which is then employed as the electrode in a second melting operation. Tapping is found to require a rigid support and power-driven tools. A skip-tooth, three-flute tap is found to be most practicable. Milling should be done with heavy cuts, slow speed, and coarse feed. High-speed tools are superior to tungsten carbide. Climb cutting and face milling are recommended. Improvements in welding techniques permit making welds with a tensile strength of 150,000 p. s. i.[17]

[16] Post, C. P., and Beaver, H. O., Use of Rare-Earth Metals and Compounds in Stainless-Steel Making: Am. Iron and Steel Inst., Yearbook 1953, pp. 183–212.

[17] Van Thyne, R. J., Turner, D. H., and Kessler, H. D., Double Melting Produces Homogeneous Titanium Alloys: Iron Age, vol. 172, August 1953, pp. 146–148.

Coughlin, V. L., How to Tap, Mill, and Broach Titanium: Iron Age, vol. 171, Mar. 5, 1953, pp. 186–188.

Extrusion is being used more and more for fabricating tubing and various more complicated shapes. It not only simplifies many fabrication operations but also has some of the beneficial effects of forging on the metal structure. Many of the more refractory metals, such as titanium, zirconium, and high-temperature alloys, have been extruded. Much progress was made during the year in extrusion of steel; it is about to become an important fabrication method for steel shapes.

Continuous casting methods, which are already in use for brass, are now being applied to steel. It is expected to be slightly more expensive than previous methods but yields about 10 percent more usable steel. The combination of electric-furnace melting and continuous casting offers the possibility of more economical production of steel in small mills.

Batch heat-treating furnaces are finding increased use. They have certain advantages over long, continuous furnaces, such as greater flexibility and more rapid warmup. Salt baths are being used to a greater extent, and the new fast-quenching oils are being applied to many of the more difficult quenching problems. There is a trend toward testing of full-size parts rather than relying on the microscope alone in controlling heat-treating operations.

One who has observed the trend of research and developments in physical metallurgy during the past few years will note an increasing influence of theoretical physics in a science that has heretofore been largely empirical.[18] Physical metallurgists are becoming increasingly aware of the potential value of the recently formulated theories of quantum mechanics and solid-state physics in guiding the development of new alloys and improving the techniques of fabrication.

Although the development of the metallurgical microscope and X-ray analysis made it possible to observe many qualitative relationships between structure and property of metals, it was not until the more recent developments in quantum theory were applied to metals that a quantitative relationship between the two became possible. Even now the only properties that can actually be dealt with quantitatively are the elastic constants, but there is now an adequate theoretical basis that, in principle, should permit prediction of many of the mportant physical properties from a knowledge of composition and tructure.

[18] Chalmers, Bruce (ed.), Progress in Metal Physics: Vol. 4, Interscience Publications, Inc., 1953.

Review of Mining Technology

By E. D. Gardner[1]

ALL BRANCHES of the mining industry accelerated efforts to improve techniques and practices so that more tons could be produced per man-shift and other economies be effected. No outstanding innovations were introduced during the year, but improvements were made all along the line; the trend toward more complete mechanization continued.

The mineral production in 1953 was 7 percent higher than in 1952 and the greatest in history. Labor rates and the cost of supplies increased during the year, but there were few areas of labor shortages. The industry as a whole was prosperous; coal production, however, was off, and in the metals field the lead and zinc mines were in distress because of relatively low prices for these metals.

Mining in the United States is a huge earth-moving operation. The relative magnitude of the various branches of the mineral industry is indicated in the following tabulation. Most of the indicated tonnages pertaining to ores and stripping are estimated and not based on actual production figures.

TABLE 1.—Tonnages handled in the mineral industry in 1953

Commodity	Material mined (short tons)	Stripping removed (cubic yards)
Bituminous coal	453,000,000	1,177,000,000
Anthracite	31,000,000	100,000,000
Sand and gravel	436,000,000	40,000,000
Stone	299,000,000	30,000,000
Iron ore	175,000,000	170,000,000
Placer-gold gravels	104,000,000	10,000,000
Titanium gravels and ores	16,000,000	2,000,000
Placer-monazite gravels	5,000,000	----------
Copper ore	101,000,000	85,000,000
Cement materials	[1] 76,000,000	8,000,000
Clays and shales	42,000,000	4,000,000
Phosphate ore and rock	40,000,000	42,000,000
Lead and zinc ore	25,000,000	----------
Potash ore	9,000,000	----------
Gypsum	8,000,000	1,000,000
Molybdenum ore	7,000,000	----------
Salt (rock)	4,000,000	----------
Gold and silver ores (dry ores)	3,000,000	----------
Aluminum ore (bauxite)	2,000,000	6,000,000
Manganese ore	1,000,000	----------
Pyrites	1,000,000	----------
Tungsten ore	1,000,000	----------
Others	5,000,000	1,000,000
Total	1,844,000,000	1,676,000,000

[1] Exclusive of 8,000,000 tons of clays and shales and 2,000,000 tons of gypsum used for cement manufacture.

As indicated by the tabulation, well over 4 billion tons of solid materials was moved from place by the mineral industries in 1953. Large tonnages of waste rock from development work are also handled underground.

[1] Chief mining engineer, Bureau of Mines.

In addition to the solid materials, 350,000,000 tons of petroleum and 210,000,000 tons of natural gas were produced in the United States in 1953. Fifteen million tons of salt was produced from brine wells, and 5 million tons of liquid sulfur was pumped from wells during the year. An appreciable tonnage of metallic copper was recovered by leaching old mine workings and mine dumps.

The total value of the minerals produced was $14.4 billion, broken down as oil and gas, $7.6 billion; coal, $2.6 billion; nonmetallics, $2.4 billion; and metals, $1.8 billion.

PROSPECTING

Important discoveries of uranium-ore deposits that were exposed at the surface were made in the western United States during 1953. Exploratory drilling discovered other important deposits that did not outcrop. Before World War II, however, few if any of the new deposits would have had commercial value.

New surface discoveries of the industrial minerals that have become valuable during recent years can be expected, but the old-time prospectors overlooked relatively few outcrops of gold, silver, quicksilver, lead, zinc, or copper deposits. More modern prospectors also have searched the surface for tungsten, molybdenum, nickel, tin, and antimony. Since World War I prospectors have been on the lookout for manganese and chrome.

New ore continues to be found at depth by exploration work based on geological deductions, as in the Coeur d'Alenes; the extensive San Manuel copper deposit in Arizona is another example.

Prospectors have adopted Geiger counters and scintillation counters as their own in searching for uranium. They use fluorescent lights in prospecting for scheelite or other minerals that fluoresce and dip needles in searching for magnetic deposits.

Geophysical prospecting, which requires highly trained personnel, has proved its worth in the search for buried deposits that lie within a few hundred feet of the surface. Geophysical instruments, however, have not been adopted by metal-mining engineers or geologists as working tools to the extent that they have been used in the oil industry.

An exploration program based on anomalies discovered by geophysical surveys was successful in Arizona in 1953.[2] The work was done by a geophysical survey firm, and it was pointed out that the area selected for intensive investigation was one of several studied in which the combination of various economic factors and susceptibility to the preferred exploration methods, including geophysics, was most attractive.

The use of helicopters for reconnaissance increased. Preliminary to a comprehensive drilling program of nickel-bearing laterites by the Bureau of Mines on United States Government holdings in Oriente, Cuba, the area was viewed from the air and lateritic areas mapped. Considerable time and expense were saved, as most of the area was rough and covered by dense vegetation.[3]

More new deposits will be found in mining areas by means of geological deduction as the geologist learns more of ore habits. The

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[2] Thurmond, R. E., Heinrichs, W. E., Jr., and Spaulding, E. D., Geophysical Discovery and Development of the Pima Mine, Pima County, Ariz.: Min. Eng., vol. 6, No. 2, February 1954, pp. 197-202.

[3] Davis, H. W., and McMillan, W. D., Nickel-Cobalt Resources of Cuba: Bureau of Mines Rept. of Investigations (in press).

art and the science of geophysical prospecting are constantly being improved, and a relative increase in important discoveries can be expected in the future.

The mineral industry and government agencies began to consider the formulation of scientific techniques and procedures to discover and develop ore bodies that might occur in favorable formations buried by later rocks or alluvial material.

Although the scientific approach is mostly in the discussion stage, a definite start has been made. According to James Boyd,[4]

> Ore finding is a research job in every aspect of its application, and the approach to exploration should follow the tried methods of research. Planned research is just as logical in prospecting as it is in prospecting the heart of the atom. Just as a physicist must have a reservoir of fundamental knowledge upon which to base his research, so must the exploration geologist have a fund of fundamental ideas upon which to base an interpretation of the evidence he has before him.

EXPLORATION

The diamond drill remains the tool most widely used in probing for mineral deposits below the surface. A double core barrel is being developed by which cores may be pulled inside the drill rods and without pulling the rods. Relatively lightweight, truck-mounted, diamond drills have come into use for drilling rather shallow holes at the surface.

Field tests of random set and oriented diamond-drill bits show a saving of 37 percent in bit cost per foot of hole drilled in favor of oriented bits,[5] but all difficulties in setting the bits have not been solved. There is a need for trained bit setters. The cost of setting is higher, and the size of diamonds is limited to 20 to the carat. All shapes are not oriented readily, and a used diamond is difficult to reset.

A truck-mounted rotary drill developed for putting down 5-inch-diameter "shot" holes for seismic geophysical work by the oil industry is gaining in use in prospecting for and sampling mineral deposits. The drill cuttings in dry ground are ejected by compressed air and collected in two cyclones mounted on the drill rig. The average footage of such a drill, prospecting for uranium in New Mexico, was 300 feet per 8 hours.

Of late years bulldozers have been used extensively for stripping outcrops to trace the strike of mineral deposits at the surface and to make fresh exposures for sampling.

After an ore deposit has been shown, by surface sampling or core drilling, to be of sufficient indicated importance to be explored underground, it is developed by running drifts and sinking shafts. Such workings also are commonly used to explore known deposits or to seek new ones at producing mines.

DEVELOPMENT

Development is an important item of expense in mining. In opencut mining it usually comprises clearing the land, building roads, initial stripping, and establishment of benches. The kind of development required for underground mining depends upon the type and attitude of the deposits. In flat-bedded deposits, such as limestone,

[4] Boyd, James, Exploration: Eng. and Min. Jour., vol. 155, No. 2, February 1954. p. 118.
[5] Ross, A. E., Long, A. E., Oriented Diamond Bits Cut Drilling Costs: Min. Cong. Jour., vol. 38, No. 8, August 1953, pp. 71–73.

advance or development headings may be full-size working rooms in which the cost per ton of mining the stone is the same as in other headings or rooms.

At the other end of the scale, in undercut block caving, the cost of haulage adits, grizzly drifts, raises, and other preparatory work may be the principal expense in mining a segment of ore.

Shaft-sinking practices are being refined from year to year, but no noteworthy accomplishment was recorded in 1953. Mechanical muckers are generally used for sinking large shafts. Improvements were developed for placing forms and placing concrete at the Mather mine.[6] A grapple device promised to replace clamshells in Germany for removing broken material in shaft sinking. The practice of placing crushers at shaft stations is increasing in mines where the ore breaks in large fragments.

Before the advent of mechanical muckers, drilling and blasting in drifts and crosscuts had been fairly well standardized in United States metal mines. A drift round was desirable that could be drilled in a shift and break the correct quantity of rock that could be loaded out by hand on a subsequent full shift. Much experimentation was done in the 1920's and early 1930's to develop the best round patterns for different conditions. A V-cut round was largely used in hard and medium rock.

Soon after dependable mechanical loaders were introduced underground, improvements in percussion rock drills also were made that permitted more rapid drilling. The standard practice became to load out the previous round blasted during the first part of a shift and then to drill and blast a round during the remaining hours. The depth that a round could be pulled was the limiting factor of the daily advance. The cross section of a heading being advanced has important bearing on the depth that a round can be successfully blasted. The tendency was to increase the size of the heading to permit longer rounds to be pulled. A parallel advancement in haulage practices was in process at the same time by which larger cars and wider gage tracks were being installed. The larger headings complemented the new haulage requirements.

So-called "burnt-cut" rounds have been used to a limited extent for many years. They have an advantage over V-cuts in that longer rounds can be pulled in given-size headings; during late years they have been adopted widely for use in driving development headings in metal mines. More skill is required to drill them than V-cut rounds, and usually more holes are required. Generally, 1 to 2 feet more ground can be pulled with each burnt-cut round than with a V-cut in most development headings under comparable conditions. The center hole of the burnt cuts is reamed at some mines. At a few others a larger diameter center hole is drilled. One drill on the market, mounted on a rig of its own, is used for drilling a large-diameter center hole to which the other holes of the round break. At 1 mine the advance in an 8- by 24-foot heading was increased from 7 to 11 to 12 feet by this procedure. The drill can drill 8- to 25-inch holes to a depth of 12 feet.[7]

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[6] Swanson, H. C., Mather Mine Uses Pipeline Concrete in Underground Operations: Min. Eng., vol. 6, No. 4, April 1954, pp. 393-396.

[7] Hubbell, A. H., Survey of Mining Practice: Eng. and Min. Jour., vol. 155, No. 2, February 1954, pp. 113-117.

The invention in the 19th century of the compressed-air percussion drill was a boon to the mining industry. Subsequent replacement of old heavyweight piston machines by lighter weight and faster hammer machines also was a great step forward. Another far-reaching change appears now to be in the offing—a rotary drill for underground use in sedimentary rocks; its successful use has been demonstrated at a number of places. The advent of the carbide bit has made this development possible. There is not now much promise that the rotary drill could be used successfully in unaltered granite, greenstone, quartzite, or similar hard rocks.

In 1947 the Bureau of Mines built an experimental rotary drill at its Experimental Oil-Shale mine, Rifle, Colo. The drilling speed in 2-inch holes in the oil shale was 100 inches a minute, contrasted with 18 inches a minute with 4-inch percussion drills, with air at 100 pounds pressure per square inch.[8] A rotary drill, such as is used in coal mines, was first tried, but the steel bit would not cut the oil shale. The same drill, using a carbide bit brought from Germany, indicated considerable promise for rotary drilling in the oil shale, and the experimental model was built. The first commercial-type carbide bits that came on the domestic market failed within 5 feet. Further trials found a bit that would go 350 feet before failure. The cooperation of the bit manufacturers then was sought and obtained. A bit has been developed that will now drill up to 5,000 feet before being worn out, and failure of a bit in use is rare.

Rotary drills with carbide bits are being used exclusively in the potash mines; they also have been adopted in salt mines. Attention is being given to rotary drills for other types of rocks. Cleveland-Cliffs Iron Co., Ishpeming, Mich., is getting the following advantages with rotary drilling of long holes over percussion drilling: Twice the drilling speed, less setup time and maintenance, no water required, and rod breakage virtually nothing.[9]

Mounted drill carriages or "jumbos" are now commonly used for drilling stope rounds in flat deposits and in development headings. Improved models of jumbos came on the market in 1953. Use of portable air compressors is gaining in mines on flat deposits; pipelines and pipeline air-pressure losses are eliminated. Air compressors have been mounted on jumbos at a few mines. Jacklegs activated by compressed air were used more widely in the United States in 1953 for drilling in stopes. They are also employed for drilling some development headings, particularly in easily drilled ground. The jackleg is an outgrowth of the "Mexican setup," long used in the Southwest, in which a jackhammer was supported on various lengths of steel for drilling a round.

Forged bits on drill steel were used for many years. The introduction of steel detachable bits was gradual and had about displaced the old type at the end of World War II.

The primary difficulty encountered in introduction of detachable bits was breakage of the bit connections and of the threads on the steel, as well as of the steel itself at the boundary plane of the heat treated portions. The bit and thread construction, in the main, now gives satisfactory service, but steel breakage remains a problem.

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[8] Wright, F. D., and Brakel, L. H., Development of a Rotary Test Drill: Bureau of Mines Rept. of Investigations 4864, 1952, 8 pp.

[9] Work cited in footnote 7.

"One-pass" or "throwaway" bits began to make inroads upon standard detachable bits during recent years, and since World War II carbide-insert detachable bits have been rapidly developed and widely adopted. It was first introduced into the United States from Europe. In 1953 the race was between "one-pass" and tungsten carbide bits, with the latter gaining ground rapidly. "One-pass" bits, however, are holding their own in easily drilled ground. A new contender has entered the race—a carbide-insert chisel type bit forged as an integral part of the drill rod. This type of bit is widely used in Sweden; they have been introduced at a number of mines in Canada and at a few in the United States. A Canadian company is advertising a crossbit as an integral part of the drill steel,[10] and a Canadian firm [11] has put three-wing bits on the market.

Crossbits have been favored in the United States over the years and are used almost universally. Chisel-type bits have not been satisfactory in this country in broken ground. The principal advantage of detachable bits was elimination of hauling and handling the forged steel into the working places and out to be sharpened each working shift. This handling problem would not be eliminated by the use of steel with a carbide bit forged in it as an integral part, but would be less serious, as fewer pieces of steel would be required to drill a round, and each piece could be used several times.

The advent of carbide bits has brought about important improvements both in development work and in stoping. As they do not lose their gage readily, blast holes may be drilled with a single piece of steel, obviating the changing of steel and saving considerable time; the use of jumbos and jacklegs is also facilitated. Holes are bottomed the same diameter as started, permitting relatively more explosive to be loaded near the bottom, where it is more effective. Use of carbide bits has improved the performance of percussion drills for putting in long holes. Air drills have largely replaced diamond drills for this purpose, although the high cost of diamonds has been an important contributing factor. The problem of satisfactory couplings for the jointed rods has not been completely solved.

The use of longer drill rods and higher costs of steel have accentuated the problem of steel breakage. The quality of drill steel appears to be improving, but breakage of drill rods is the source of a relatively large part of the expense of drilling with percussion drills, especially where long rods are used. Most breaks continue to occur at the boundary of the heat-treated segments at the ends of the steel. Considerable research is being done to correct this condition. The Homestake Mining Co. reports that it has solved the heat-treating problem,[12] and breaks of steel are at random. A Denver, Colo., manufacturer reports that the full lengths of rods of sectional steel for long-hole drilling are heat-treated; as a result, breakage of rods has been greatly reduced.

Perfection of the process for heat-treating the ends of the drill rods would greatly prolong their life. An ideal combination would be an integral bit that would have the same life span as the rod itself. It is reported that this balance has been attained in Sweden. Flexible rectangular-section drill rods are used in light drills mounted on jacklegs for drilling long holes in restricted places.[13] A Canadian com-

[10] Work cited in footnote 7.
[11] Work cited in footnote 7.
[12] Kravig, C. N., Drilling Progress at Homestake: Min. Cong. Jour., vol. 39, No. 8, 1953, pp. 38–41, 60.
[13] Janelid, Ingvar, Drilling Practice in Swedish Mining: Min. Eng., vol. 6, No. 6, June 1954, pp. 613–619.

pany is testing this type of steel in 24-foot lengths.[14] Slower drilling speeds are reported than with conventional steel.

Alloy-steel drill rods are available in the United States, and many companies have tested them. So far the reported general results are inconclusive; most mining companies, however, desire a better drill steel than is now available. An improved new alloy steel to be used with detachable drill bits has been announced by a Canadian firm.[15] Its possibilities are considered promising.

The trend toward unusually small diameter blastholes seems to have been reversed. Blastholes are drilled in a face to get explosive into the rock to break it. A drill-hole pattern is adopted to get a maximum break with optimum fragmentation. Obviously, a minimum-diameter hole should be drilled that will give a satisfactory break by a round. Moreover, as the cost per foot of drilling small-diameter holes is less, more holes can be drilled in a face to get better fragmentation than could be obtained by blasting a round of fewer larger diameter holes, with the same quantity of explosive in some instances. There is an economical limit, however, in how much the diameter of the blastholes can be economically reduced. Although the cost of drilling drops with the diameter of the hole, the cost per cubic inch of hole made does not. Large-diameter cartridges have a smaller percentage by weight of paper shells, and in some explosives the rate of detonation is higher in large cartridges than in small ones. Moreover, a better density of loading generally can be obtained with the larger cartridges; and relatively more of a given charge can be loaded nearer the bottom of a hole of larger diameter, where, in most instances, it is most effective.

Additional companies adopted jacklegs with lightweight drills during the year, which necessitated drilling smaller diameter holes than formerly. The use of carbide bits with the smaller drills permits drilling the full length of a hole the same diameter, so that a larger percentage of the powder can be loaded nearer the bottom, where it would do the most good. A Canadian mining company uses a 2½-inch steel bit to ream the cut holes of drift rounds of smaller diameter holes, which makes it possible to pull 8- and 10-foot rounds.[16]

A company has developed 4-point tungsten carbide bits with the necessary connections for 1- and ⅞-inch drill rods to be used with airleg drills for reaming cut holes. The sizes of the bits are 2¼, 2½, and 3 inches.[17]

The density of loading influences the effectiveness of the explosive loaded into a blast hole. Loose loading also wastes space in the hole, which is generally costly to drill.

Tests in Sweden show that the density of loading with 25-mm. cartridges in a 36-mm. hole (each cartridge tamped with a stick) was 35 percent; the density of loading with 5-foot-long cartridges that fit the holes was 59 percent; and loading density with standard cartridges by a pneumatic device that compacted the charge was 82 percent.[18]

Experiments in 1947 and 1948 at the Bureau of Mines Experimental Oil-Shale mine, Rifle, Colo., demonstrated that a given weight of explosive in 1⅞-inch cartridges, loaded into 2-inch holes without

[14] Work cited in footnote 7.
[15] Work cited in footnote 7.
[16] Work cited in footnote 7.
[17] Work cited in footnote 7.
[18] Work cited in footnote 13.

tamping, was as effective in breaking a round as when 1¼-inch cartridges were used and each one was tamped individually by hand. The round comprised 76 holes 18 feet long in a 27- by 60-foot heading; the time of loading was reduced to 2 hours by 2 men as against a full shift with the same men.

MINING METHODS

Ore deposits occur underground under widely varying conditions; almost any deposit can be mined by established mining methods. Mining costs will vary with the mining method used, which, in turn, is governed by the size and attitude of the deposits and the physical characteristics of the ore and the enclosing rocks. Obviously, low-grade deposits cannot be mined profitably by a high-cost method.

During 1953 the trend continued of modifying mining methods to permit greater mechanization and also to substitute less expensive methods for older, more expensive procedures. More attention is being given to the physical characteristics of the ore and rock and to taking advantage of favorable conditions where they exist.

With the advent of larger, more efficient drilling, excavating, and haulage equipment, it has become economical to strip greater thicknesses of overburden from ore deposits. Ore deposits are now being mined from surface workings that would have been developed for underground exploitation 10 years ago. Some deposits, of course, are too low grade to permit mining by underground methods, and others near the surface may have too little value to justify much stripping.

The attitude and extent of the deposits being mined govern the stripping practice, which, in turn, also influences the ratio of stripping to material mined. Ratios of over 20 cubic yards to 1 ton of coal are common in coal mining; in 1953 the average ratio was about 11:1. In this type of mining, the overburden usually is stripped with huge machines that overcast into the pit back of which the coal has been mined.

Usually, the cost per ton of handling overburden and included waste bands in open-pit copper mines equals that of mining the ore as the spoil has to be transported to disposal dumps. The ratio of cubic yards of overburden to tons of ore in open-pit copper mines has averaged about ¾:1. The ratio in iron mines has been over 1:1. Part of the stripping in the Minnesota iron range is glacial material, which is less expensive to remove than the iron ore.

For many years blastholes for opencut mining were mostly put down with churn drills; percussion drills were less commonly used. During the past 30 years, with improved equipment, the diameter of the churn-drill holes has progressively been increased from 4 and 6 inches to 8 to 10 and finally to 12 inches. Rotary drills with Tri-cone bits came on the market in 1952; their application was greatly extended in 1953, and they have replaced churn drills at a number of opencut mines. Several times the footage per shift previously obtained by churn drills is reported. At Yerington, Nev., up to 261 feet of 8-inch hole is drilled per shift by a rotary drill with an average life of the drill bit of 3,900 feet.[19] Rotary drills also have another advantage, in that the drill cuttings are deposited in a neat pile near the hole and are handy for stemming.

[19] Mining World, vol. 16, No. 8, July 1954, pp. 50–52.

A new drill rig with a 5½-inch percussion hammer drill came on the market in 1953; it is rubber mounted, with a portable compressor, and has a mast with a 26-foot drill feed. The hole diameter is 4½ inches. Its principal application is for drilling hard rock.

The usual practice in open-pit mining in 1953 was to use rail haulage where the material was eventually to be loaded into railway cars, if satisfactory track grades could be maintained and relatively large tonnages were to be moved. Trucks contined to gain favor at new mines just being opened. The trend continued toward larger off-the-road haulage units. Two-engine, 35-ton trucks are replacing smaller units at some mines. Fifty-ton trucks that operate at high speed on smooth roads are in use. Engines up to 400 hp. are now available. A 75-ton truck was placed in operation in an Arizona copper mine. In some old iron mines the ore is hauled by trucks to a belt terminal in the pit and then conveyed to railroad cars at the top.

The use of millisecond-delay detonation of explosive charges in open-pit mining increased. Refinements in the order of blasting the individual holes have resulted in better fragmentation.

The lowest underground mining costs per ton are obtained by an open-stope method in thick, flat deposits with strong roofstones. Open-pit mining costs are approached in some instances where quarry equipment has been taken underground. Truck roads up inclines have replaced hoisting at a few mines where conditions were favorable. Costs are relatively high in room-and-pillar mining in relatively narrow, flat beds where roof support is required. Long-hole drilling in sublevel stoping of large ore bodies has made possible important cost reductions in recent years. Mining methods were modified to make more effective use of machines that dig the coal from the face and load it into shuttle cars or onto conveyors. Experimental long-wall installations were in operation at a number of mines.

In 1953, 79 percent of the iron ore was produced from surface workings and 21 percent from underground. The principal underground mines are in the Lake Superior region, in Alabama, and in the North-eastern States. Adaptations of block-caving and open-stope mining are the leading methods used in the Lake Superior area. The Alabama deposits are mined in open stopes with a room-and-pillar system.

Copper ores, next to iron ores in tonnage, also were mined mostly from opencut mines; 83 percent of the tonnage and 75 percent of the copper came from opencut mines, and 17 percent of the tonnage and 25 percent of the copper metal from underground. About 85 percent of the copper ores came from the so-called porphyries in Arizona, Utah, New Mexico, and Nevada. These ores were mined largely by opencuts and to a minor extent by undercut block caving. The copper ores of the Butte, Mont., district have been mined by square-set-and-fill and cut-and-fill methods from the early days of the district. The "Greater Butte" project, by which a large mass of low-grade ore will be mined by the undercut block-caving method, was brought into production in 1953. The tabular copper deposits of Michigan have been mined chiefly by room-and-pillar methods.

Two new large-scale copper properties were being developed in 1953. A great mass of disseminated ore at the San Manuel mine at Tiger, Ariz., was being prepared for mining by the undercut block-caving method. An extensive bedded deposit at White Pine, Mich., will be mined by a room-and-pillar method; it will be nearly 100 percent mechanized.

The lead- and zinc-ore deposits of the Tri-State field, the Eastern Missouri lead district, the Mascot, Tenn., district, and the Southern Wisconsin district are mined by open-stope methods. These are flat-lying deposits and usually so thick that relatively large capacity equipment can be used in the stopes, with resultant low mining costs. The overlying formation usually is competent and stands safely in relatively wide spans. Since World War II mining practices have been greatly improved. Mobile equipment has been adopted widely, and in the Tri-State field particularly trucks have replaced track haulage.

About 60 percent of the domestic lead and zinc is mined in the western mining districts, of which the Coeur d' Alene is the largest. The lead-zinc deposits of the West mostly occur as ore shoots in veins. In nearly all places the enclosing rocks require support as the ore is removed. Square-set-and-fill and cut-and-fill methods ordinarily are used. Western straight silver ores occur in similar deposits and usually are mined by the same methods.

An undercut block-caving method is employed at the Climax Molybdenum Co., the principal producer of molybdenum.

Modified shrinkage stoping is the principal mining method used by the largest producer of lode gold, the Homestake Mining Co. at Lead, S. Dak. An important percentage of the gold produced in 1953 was by dredging. Tremendous quantities of gravels are handled. An important tonnage of monazite also was produced this year by dredging. Although the unit cost of overcasting overburden by modern huge draglines and power shovels used in coal stripping rivals that of digging by large gold dredges, dredging remains the least costly of the mechanical methods of handling metal-bearing material. The value of the placer gravels dredged in 1953 was $0.207 per cubic yard.

Sand and gravel comprised the largest tonnage of mineral, next to coal, produced in the United States in 1953. Crushed stone followed. The sand and gravel were mined from pits at the surface. Crushed stone came mostly from quarries; cement rock also is ordinarily quarried, but an increasing percentage is being produced from underground workings. Slate and building stone are quarried; an exception is that a larger proportion of marble is being produced underground. As the depth of overburden increased at some quarries in relatively thick, flat-lying limestone beds, mining was carried forward underground from the face of the quarries. Except for drills, the same equipment was used underground; natural conditions favored wide rooms, and the roof was supported by pillars. The lowest underground-mining cost in the mineral industry is being obtained in limestone deposits of this type.

Gypsum is mined from both surface and underground workings. A room-and-pillar method is commonly used underground.

The phosphate rock produced in the Southeast is mined at the surface. Both underground and surface mining is employed in the Idaho-Montana-Utah phosphate field. The western phosphate beds have various dips. The phosphate is mined underground in open stopes with pillars; stulls are also used.

Room-and-pillar methods are employed for mining potash in the Carlsbad, N. Mex., field. Pillars are being partly extracted in two mines. Faces are undercut with coal-mining shortwall machines.[20] Loading machines place the potash in shuttle cars, which discharge on belts or deposit the material into haulage cars. A number of continuous miners have been installed. One mainline belt conveyor is in use. Belt-conveyor gathering systems were expanded during the year. A 40-ton diesel electric is planned for a 6-mile underground haul.

Bauxite is mined both from surface and underground workings. A room-and-pillar method is employed underground. A continuous miner was installed in an Arkansas mine in 1953. Draining of a zone of quicksand above a bauxite bed at one mine has greatly improved mining conditions.

Salt is mined underground from large chambers. The overlying beds stand well without support. Modern drilling, loading, and haulage equipment is used.

Rock bolting found new applications in metal mining during the year. An airshaft was rock-bolted and then gunited on chicken wire held in place by boltheads and plates.[21] Rock bolting to anchor-bearer sets was used at an Idaho mine. Refinements were made during the year in roof-bolting techniques. By the end of 1953 roof bolting had become a standard practice in coal mining, particularly in conjunction with mechanized mining. It was used also in an increasingly large number of metal mines.

A horizontal auger used for mining coal seams from the high walls of strip mines was used experimentally at a New Mexico uranium mine for running a drift from the surface in shale. Four 36-inch-diameter, parallel holes, 12 inches apart, in a 2-by-2 pattern, were drilled 70 feet deep in 2 days by 2 men. After squaring out, a 7- by 7-foot entry was provided.

At the International Minerals & Chemical Co. potash mine at Carlsbad, N. Mex., hoisting is done by remote control. The hoist operator has a station at the collar of the shaft instead of the usual place in the hoistroom.

The water level at the new Anaconda opencut copper mine at Yerington, Nev., was lowered below the pit level by wells. The water from the wells is used at the plant and townsite.[22]

Four hundred tons of silica sand is pumped from a mine in Illinois in 4 hours, with relatively little wear on the pipeline. The broken sand, as blasted, is hydraulicked to the pipe intake. A jumbo with a mounted compressor supplies the air for drilling. Rooms are 25 feet wide.[23]

The Bureau of Mines continued its studies pertaining to rock mechanics during the year. Quantitative data were obtained regarding the time factor in roof control and on the mechanics of blasting rock. A device for testing roofs was being developed. Fundamental studies of the mechanics of subsidence were begun.

[20] Bruhn, H. H., and Miller, E. H., Potash Mining Methods: Min. Eng., vol. 6, No. 6, June 1954, pp. 608–612.
[21] Bowie, Robert F., Special Roof-Bolt Applications: Min. Cong. Jour., vol. 40, No. 1, January 1954, pp. 42–43.
[22] Work cited in footnote 19.
[23] Bryant, A. D., Hydraulic Methods for Underground Mining of Silica Sand: Min. Eng., vol. 5, No. 3 March 1953, pp. 282–283.

Statistical Summary of Metal and Nonmetal Production

By Kathleen J. D'Amico [1]

DETAILED statistical data for metals and nonmetals (except fuels) are given in this chapter. A similar summary chapter for mineral-fuels statistics is included in volume II, and a detailed summary chapter for all minerals will be found in volume III of this series.

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

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

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

[1] Publications editor.

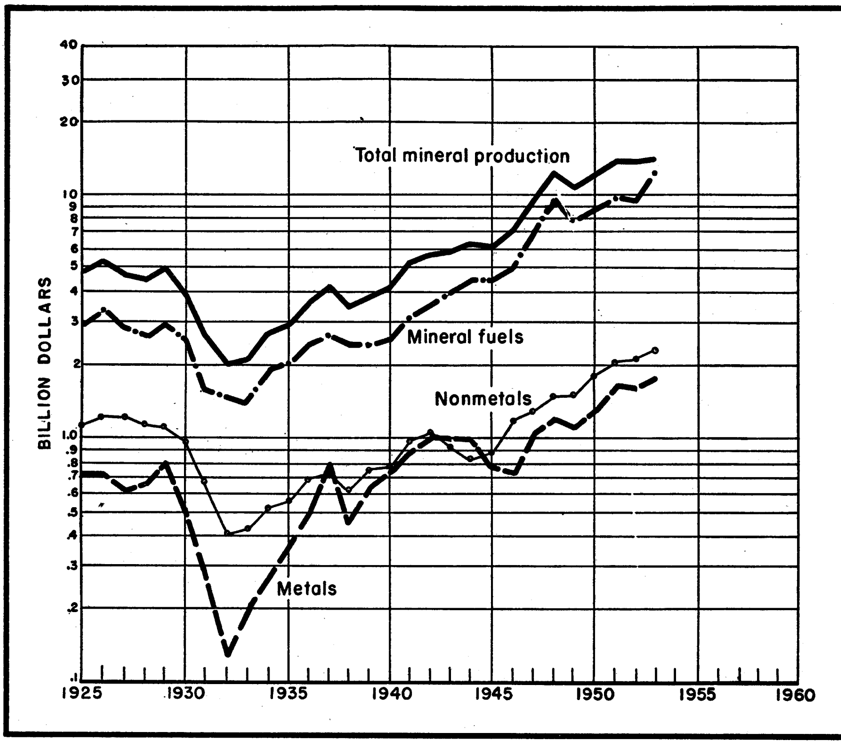

FIGURE 1.—Value of mineral production in continental United States, 1925–53

TABLE 1.—Value of mineral production in continental United States, 1925–53, 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	[2] 1,822	1,351	[2] 11,862
1936	2,405	685	516	3,606	1951	9,779	[2] 2,079	[2] 1,671	[2] 13,529
1937	2,798	711	756	4,265	1952	9,615	[2] 2,163	[2] 1,614	[2] 13,392
1938	2,436	622	460	3,518	1953	10,249	2,337	1,796	14,382
1939	2,423	754	631	3,808					

[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.

TABLE 2.—Mineral production in continental United States, 1950–53 [1]

Mineral	1950		1951		1952		1953	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
METALS								
Antimony ore and concentrate......gross weight..	6,888	$1,443,227	9,100	(2)	4,434	(2)	2,161	(2)
Bauxite......long tons, dried equivalent..	1,334,527	7,692,809	1,848,676	$12,477,516	1,667,047	$10,776,254	1,579,739	$13,439,141
Beryllium concentrate......gross weight..	559	170,550	484	161,361	515	233,757	751	[3] 354,681
Chromite......do....	404	(2)	7,056	510,741	21,304	1,776,981	58,817	3,432,872
Cobalt (content of ore)......pounds..	660,025	(2)	755,631	(2)	836,372	(2)	1,775,489	(2)
Columbium-tantalum concentrate...pounds, gross weight..	1,000	2,150	925	1,528	5,385	16,723	14,867	[3] 29,780
Copper (recoverable content of ores, etc.)......	909,337	378,284,192	928,329	449,311,235	[4] 925,359	[4] 447,873,756	926,448	531,781,152
Gold (recoverable content of ores, etc.)......troy ounces..	2,104,959	73,673,565	1,741,026	60,935,910	1,652,704	57,844,640	[3] 1,704,510	[3] 59,657,850
Iron ore, usable (excluding byproduct iron sinter) long tons, gross weight..	97,150,704	483,358,130	115,621,556	629,837,139	97,236,397	590,346,970	117,197,537	790,491,229
Lead (recoverable content of ores, etc.)......	430,678	116,283,060	388,143	134,297,478	390,161	125,631,842	342,635	89,770,370
Manganese ore (35 percent or more Mn)......gross weight..	134,451	6,229,985	105,007	6,045,452	115,379	8,251,774	157,536	12,479,759
Manganiferous ore (5 to 35 percent Mn)......do....	1,087,597	4,609,432	[4] 1,171,991	[4] 5,239,986	1,009,018	5,116,985	1,239,390	6,946,862
Manganiferous residuum......do....	183,842	(2)	267,751	(2)	215,255	(2)	293,758	(2)
Mercury......76-pound flasks..	4,535	368,514	7,293	1,532,478	12,519	2,492,533	14,297	2,759,750
Molybdenum (content of ore and concentrate)......pounds..	44,544,000	37,729,000	37,954,544	36,176,900	42,717,443	40,844,575	53,823,235	52,361,505
Silver (recoverable content of ores, etc.)......troy ounces..	42,406,376	38,379,912	39,733,909	35,961,195	39,419,344	35,676,497	37,535,451	33,971,479
Tin (content of ore and concentrate)......long tons..	15	31,165	19	55,757	17	45,324	(2)	(2)
Titanium concentrate:								
Ilmenite......gross weight..	452,370	5,607,584	510,840	7,689,272	522,515	8,022,752	512,176	7,222,641
Rutile......do....	(2)	(2)	(2)	(2)	(2)	(2)	6,476	702,791
Tungsten concentrate......60 percent WO_3 basis..	4,807	8,156,758	6,265	22,936,638	7,603	28,943,162	9,587	35,932,751
Zinc (recoverable content of ores, etc.)......	623,369	178,667,197	681,188	249,330,389	666,001	222,981,864	547,430	125,320,890
Zirconium concentrate......	(2)	(2)	(2)	(2)	(2)	(2)	21,234	793,685
Undistributed: Magnesium chloride for magnesium metal, platinum-group metals (crude), vanadium, and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 2)......	......	[4] 10,218,983	......	[4] 18,571,347	......	[4] 26,782,134	......	28,818,831
Total metals......	......	1,351,000,000	......	1,671,000,000	......	1,614,000,000	......	1,796,000,000

For footnotes, see end of table.

TABLE 2.—Mineral production in continental United States, 1950–53 [1]—Continued

Mineral	1950		1951		1952		1953	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
NONMETALLIC MINERALS (EXCEPT FUELS)								
Abrasive stone:[5]								
Grindstones and pulpstones	4,468	$232,562	5,571	$315,871	3,974	$247,434	2,499	$169,951
Millstones	(6)	11,300	(6)	6,000	(6)	9,285	(6)	18,375
Pebbles (grinding)	1,923	53,007	3,062	84,306	2,804	93,949	2,472	81,159
Tube-mill liners (natural)	1,523	62,535	1,408	77,027	1,739	67,724	1,219	68,688
Asbestos	42,434	2,925,050	51,645	3,912,500	53,864	4,713,032	54,456	4,857,359
Barite	695,414	6,193,906	860,669	7,968,023	941,825	8,797,944	944,212	9,435,749
Boron minerals	647,735	15,890,000	862,797	20,030,000	583,828	14,105,000	715,228	17,668,000
Bromine ... pounds	98,502,300	18,794,978	129,563,073	26,179,556	156,201,577	30,639,292	164,143,348	35,372,386
Calcium-magnesium chloride-75-percent (Ca, Mg) Cl_2 basis	299,821	3,801,508	328,042	4,756,242	(7)	(7)	(7)	(7)
Cement ... 376-pound barrels	228,787,765	537,651,523	240,331,112	611,751,089	250,821,410	637,746,171	260,696,761	698,268,154
Clays	39,381,446	95,249,933	43,415,779	128,622,316	42,287,073	131,032,163	42,307,853	125,033,896
Emery	5,949	75,308	11,634	160,212	10,352	141,911	10,562	143,974
Epsom salts from epsomite			(7)	(7)	(7)	(7)	200	8,000
Feldspar ... long tons	407,925	2,558,390	400,439	2,815,587	420,831	3,696,018	452,600	4,594,450
Fluorspar	301,510	10,619,717	347,024	14,369,521	331,273	15,353,634	318,036	15,736,908
Garnet (abrasive)	9,304	793,558	14,050	1,246,947	11,390	981,841	10,520	988,797
Gem stones (estimated)	(6)	450,000	(6)	450,000	(6)	490,000	(6)	492,000
Graphite	5,605	427,908	6,808	771,434	5,081	594,618	6,281	(7)
Gypsum	8,192,625	22,734,568	8,665,534	24,024,101	8,415,300	22,896,051	8,292,876	23,175,073
Lime (open-market)	7,462,109	82,847,301	8,236,422	96,507,144	8,055,609	94,795,435	9,659,414	111,777,018
Lithium minerals	9,306	579,922	12,897	896,000	15,611	1,052,000	(7)	(7)
Magnesite	429,392	3,091,135	670,167	4,506,712	510,750	2,871,548	553,147	3,223,759
Magnesium compounds from sea water and brines (except for metal) ... MgO equivalent	[4] 94,926	[4] 8,054,378	[4] 118,638	[4] 9,638,085	[4] 121,525	[4] 9,392,913	136,824	10,459,502
Marl:								
Calcareous (except for cement)	347,843	246,451	269,955	233,787	260,213	187,148	277,354	173,347
Greensand	3,935	304,321	5,067	263,944	4,600	177,847	6,821	193,404
Mica:								
Scrap	69,360	1,742,616	71,871	1,884,087	75,236	1,954,286	73,259	1,823,840
Sheet ... pounds	578,818	125,928	594,884	160,322	697,989	908,135	1,068,706	2,153,584
Olivine	4,103	59,402	(7)	(7)	(7)	(7)	(7)	(7)
Perlite	101,536	649,162	153,502	858,099	164,845	1,002,920	198,751	1,439,658
Phosphate rock[8] ... long tons	11,114,159	63,333,978	10,775,032	64,761,149	12,064,892	72,458,982	12,503,830	76,631,755
Potassium salts ... K_2O equivalent	1,276,164	39,774,447	1,408,408	44,788,880	1,598,354	53,754,316	1,731,607	59,620,083
Pumice and pumicite	719,356	2,661,052	749,192	2,739,907	597,044	2,266,981	1,338,206	2,509,501
Pyrites ... long tons	931,163	4,059,000	1,017,769	4,656,000	994,342	4,947,000	922,647	5,006,499
Quartz from pegmatites and quartzite	160,508	706,724	281,047	1,165,370	246,604	1,013,637	241,722	1,360,200
Salt (common)	16,616,264	59,774,118	20,196,565	69,615,662	19,532,276	70,870,767	20,775,073	78,129,657
Sand and gravel	367,304,408	292,559,011	393,644,618	329,870,466	424,605,508	344,568,531	431,975,569	368,935,099
Sand and sandstone (ground)	750,673	6,462,503	818,479	7,163,343	792,802	6,922,586	[3] 784,792	[3] 6,873,591
Slate	930,370	15,047,481	819,360	14,534,327	739,640	12,706,651	698,589	12,638,465

Sodium carbonate (natural)	351,075	7,543,769	350,688	8,368,037	323,479	7,828,033	419,206	10,627,460
Sodium sulfate (natural)	186,537	2,199,336	(7)	(7)	236,825	3,217,000	248,230	3,340,760
Stone [9]	[4] 250,813,949	[4] 387,147,111	[4] 284,146,601	[4] 433,044,352	[4] 301,736,339	[4] 460,115,552	[3] 302,833,084	[3] 474,082,522
Strontium minerals (crude)							50	1,000
Sulfur:								
Frasch-process mines ... long tons	5,504,714	104,000,000	4,988,101	107,300,000	5,141,392	110,925,000	5,224,202	141,054,000
Other mines ... do	3,247	60,115	3,945	75,609	4,686	91,310	152,473	769,140
Sulfur, recovered elemental ... do	81,713	1,984,702	197,496	5,050,149	229,261	5,660,794	317,689	8,059,243
Talc, pyrophyllite and soapstone	[10] 620,750	[10] 10,620,743	[10] 636,068	[10] 11,322,830	[10] 593,147	[10] 11,347,317	[11] 631,538	[11] 3,524,035
Titanium-iron concentrate (non-titanium use)			(7)	(7)	(7)	(7)	1,585	7,500
Tripoli	43,720	1,173,647	37,476	1,105,135	35,459	1,043,124	36,183	1,138,635
Vermiculite	208,096	2,122,427	209,008	2,679,148	208,906	2,657,826	189,535	2,445,381
Wollastonite	800	16,200	(7)	(7)	(7)	(7)	(7)	(7)
Undistributed: Aplite, brucite, diatomite, iodine, kyanite, quartz crystal (1950), sharpening stones, and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 7). Excludes value of clays used for cement		[4] 4,249,925		[4] 7,992,344		[4] 6,484,763		12,546,766
Total nonmetallic minerals		[4] 1,822,000,000		[4] 2,079,000,000		[4] 2,163,000,000		2,337,000,000
MINERAL FUELS								
Asphalt and related bitumens (native):								
Bituminous limestone and sandstone	1,184,676	3,522,308	1,378,434	4,159,259	1,570,698	4,687,512	1,440,544	4,349,327
Gilsonite	66,186	1,774,330	65,521	1,895,374	60,740	1,779,815	60,505	2,184,328
Carbon dioxide, natural (estimated) .. thousand cubic feet	472,334	369,000	547,436	161,000	737,000	226,250	670,600	203,450
Coal:								
Bituminous [12]	512,528,632	2,489,228,604	529,879,295	2,614,219,188	463,137,264	2,276,189,066	453,577,946	2,232,698,609
Lignite	3,369,966	8,111,730	3,291,104	8,043,962	3,017,300	7,211,912	2,851,032	6,793,648
Pennsylvania anthracite	44,076,703	392,398,006	42,669,997	405,817,963	40,582,558	379,714,076	30,949,152	299,139,687
Helium (shipments) ... cubic feet	80,888,990	1,027,913	108,970,000	1,387,000	145,810,332	1,896,096	[3] 157,652,134	[3] 2,102,720
Natural gas (marketed production) ... million cubic feet	6,282,060	408,521,516	7,457,359	542,964,400	8,013,457	623,649,460	8,396,916	774,966,250
Natural-gas liquids:								
Natural gasoline and cycle products. thousand gallons	4,606,518	321,832,000	4,971,834	369,718,000	5,102,244	371,468,000	5,327,448	406,242,000
LP-gases ... do	3,035,844	97,773,000	3,627,834	138,443,000	4,285,386	161,692,000	4,692,870	191,598,000
Peat	130,723	1,142,566	194,416	1,489,225	210,582	1,729,511	204,209	1,617,947
Petroleum (crude) ... thousand 42-gallon barrels	1,973,574	4,963,380,000	2,247,711	5,690,410,000	2,289,836	5,785,230,000	[3] 2,357,082	[3] 6,327,100,000
Total mineral fuels		8,689,000,000		9,779,000,000		9,615,000,000		10,249,000,000
Grand total mineral production		[4] 11,862,000,000		[4] 13,529,000,000		[4] 13,392,000,000		14,382,000,000

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

[2] Value included with "Metals undistributed."

[3] Final figure. Supersedes preliminary figure given in commodity chapter.

[4] Revised figure.

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

[6] Weight not recorded.

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

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

[10] Sold or used by producers. Quantity and value of ground material included.

[11] Mine production of crude material.

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

TABLE 3.—Metals and nonmetals (except fuels) produced in continental United States and principal producing States in 1953

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

28	Magnesium compounds from sea water and brines (except for metal).	California, Michigan, New Jersey, Texas	Michigan, California, New Jersey, Texas.
25	Manganese ore	Montana, Nevada, Virginia, Arkansas	Rank same as for quantity.
32	Manganiferous ore	Minnesota, Michigan, New Mexico, Nevada	Minnesota, Michigan, Nevada, New Mexico.
45	Manganiferous residuum	New Jersey	Rank same as for quantity.
	Marl:		
63	Calcareous	Michigan, Virginia, Wisconsin, Indiana	Michigan, Nevada, Virginia, California.
62	Greensand	New Jersey	Rank same as for quantity.
43	Mercury	California, Nevada, Idaho, Oregon	Do.
38	Mica	North Carolina, Georgia, Arizona, South Dakota	North Carolina, New Hampshire, Georgia, Idaho.
	Scrap	do	Rank same as for quantity.
	Sheet	North Carolina, New Hampshire, Connecticut, Maine	North Carolina, New Hampshire, Idaho, South Dakota.
15	Molybdenum (content of ore and concentrate)	Colorado, Utah, Arizona, New Mexico	Rank same as for quantity.
65	Olivine	North Carolina, Washington	Do.
49	Perlite	New Mexico, Nevada, Colorado, California	Do.
12	Phosphate rock	Florida, Tennessee, Idaho, Montana	Do.
76	Platinum-group metals (crude)	California	Do.
14	Potassium salts	New Mexico, California, Utah, Michigan	Do.
44	Pumice and pumicite	New Mexico, California, Arizona, Idaho	New Mexico, California, Arizona, Oregon.
34	Pyrites	Tennessee, Virginia, Montana, California	Tennessee, Virginia, California, Montana.
50	Quartz from pegmatites and quartzite	Washington, North Carolina, California, Idaho	Washington, Connecticut, North Carolina, California.
11	Salt (common)	Michigan, New York, Louisiana, Ohio	Rank same as for quantity.
5	Sand and gravel	California, Michigan, Ohio, Wisconsin	California, Ohio, New York, Michigan.
33	Sand and sandstone (ground)	Illinois, West Virginia, New Jersey, Ohio	Rank same as for quantity.
18	Silver (in ores, etc.)	Idaho, Utah, Montana, Arizona	Do.
24	Slate	Pennsylvania, Vermont, New York, Georgia	Pennsylvania, Vermont, New York, Virginia.
26	Sodium carbonate (natural)	California, Wyoming	Rank same as for quantity.
41	Sodium sulfate (natural)	California, Texas, Wyoming	Do.
4	Stone	Pennsylvania, Ohio, Illinois, Michigan	Pennsylvania, Ohio, Illinois, New York.
79	Strontium minerals	California	Rank same as for quantity.
6	Sulfur, from Frasch-process mines	Texas, Louisiana	Do.
56	Sulfur, from other mines	California, Nevada	Do.
30	Sulfur, recovered elemental	Wyoming, Texas, Arkansas, California	Wyoming, Texas, California, Arkansas.
39	Talc, pyrophyllite, and soapstone	New York, California, North Carolina, Vermont	California, New York, North Carolina, Vermont.
75	Tin (content of ore and concentrate)	Colorado	Rank same as for quantity.
	Titanium concentrate:		
31	Ilmenite	New York, Florida, Virginia	Do.
58	Rutile	Florida	Do.
78	Titanium-iron concentrate	Idaho	Do.
52	Tripoli	Illinois, Missouri, Pennsylvania	Missouri, Illinois, Pennsylvania.
16	Tungsten concentrate	Nevada, California, North Carolina, Colorado	Rank same as for quantity.
46	Vermiculite	Montana, South Carolina, Wyoming, North Carolina	Do.
73	Wollastonite	New York	Do.
7	Zinc (in ores, etc.)	Montana, Idaho, New York, New Jersey	Do.
55	Zirconium concentrate	Florida	Do.

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TABLE 4.—Value of metals and nonmetals (except fuels) produced in continental United States, 1950–53, by States, in thousand dollars and principal minerals produced in 1953

State	1950	1951	1952	1953 Value	1953 Rank	1953 Percent of U. S. total	1953 Principal minerals in order of value
Alabama	68,606	79,197	84,623	104,439	11	2.53	Iron ore, cement, stone, lime.
Arizona	207,379	243,856	231,669	256,584	3	6.21	Copper, zinc, cement, gold.
Arkansas	[1] 27,424	[1] 29,619	[1] 30,034	34,891	30	.84	Bauxite, stone, sand and gravel, barite.
California	[1] 202,009	[1] 248,005	[1] 245,350	271,474	2	6.57	Cement, sand and gravel, stone, boron minerals.
Colorado	72,472	85,848	87,588	90,457	16	2.19	Molybdenum, cement, zinc, sand and gravel.
Connecticut	5,640	6,213	7,063	7,887	44	.19	Stone, sand and gravel, lime, clays.
Delaware	522	584	677	659	48	.02	Sand and gravel, stone, clays.
District of Columbia	60	82	7	15	49	(2)	Clays.
Florida	[1] 69,745	[1] 75,635	[1] 81,623	91,118	15	2.20	Phosphate rock, cement, stone, sand and gravel.
Georgia	[1] 43,253	[1] 46,629	[1] 51,251	51,284	25	1.24	Clays, stone, cement, sand and gravel.
Idaho	[1] 79,329	[1] 83,171	[1] 77,848	66,987	21	1.62	Lead, zinc, silver, phosphate rock.
Illinois	80,320	93,225	97,606	99,378	13	2.41	Stone, cement, sand and gravel, fluorspar.
Indiana	57,714	65,135	[1] 63,825	69,767	20	1.69	Cement, stone, sand and gravel, clays.
Iowa	[1] 34,777	[1] 41,488	[1] 47,074	46,599	28	1.13	Cement, stone, sand and gravel, gypsum.
Kansas	52,221	54,508	[1] 56,423	51,464	24	1.25	Cement, stone, salt, sand and gravel.
Kentucky	20,422	23,249	25,151	21,542	37	.52	Stone, cement, clays, sand and gravel.
Louisiana	42,464	47,279	[1] 56,953	69,933	19	1.69	Sulfur, cement, salt, sand and gravel.
Maine	7,399	8,479	8,923	10,429	42	.25	Cement, sand and gravel, stone, slate.
Maryland	[1] 19,531	[1] 22,688	23,692	24,375	35	.59	Sand and gravel, cement, stone, clays.
Massachusetts	[1] 16,103	[1] 17,072	[1] 17,808	17,175	40	.42	Stone, sand and gravel, lime, clays.
Michigan	[1] 185,528	[1] 218,454	[1] 217,436	248,876	5	6.02	Iron ore, cement, sand and gravel, salt.
Minnesota	331,554	432,577	397,440	542,545	1	13.13	Iron ore, sand and gravel, stone, manganiferous ore.
Mississippi	4,285	6,698	6,902	8,460	43	.20	Cement, clays, sand and gravel, stone.
Missouri	100,672	121,712	128,825	118,289	10	2.86	Lead, cement, stone, lime.
Montana	[1] 74,457	[1] 95,208	[1] 92,332	99,075	14	2.40	Copper, zinc, manganese ore, silver.
Nebraska	10,720	11,678	12,853	14,624	41	.35	Cement, sand and gravel, stone, clays.
Nevada	48,499	57,674	64,231	73,523	17	1.78	Copper, tungsten, gold, iron ore.
New Hampshire	1,711	1,295	[1] 1,944	1,805	46	.04	Stone, sand and gravel, mica, feldspar.
New Jersey	[1] 46,630	[1] 59,886	[1] 57,276	51,731	23	1.25	Stone, sand and gravel, iron ore, zinc.
New Mexico	73,904	97,497	107,384	103,167	12	2.50	Potassium salts, copper, zinc, sand and gravel.
New York	[1] 140,088	[1] 170,019	[1] 161,726	169,820	8	4.11	Cement, iron ore, stone, sand and gravel.
North Carolina	26,156	29,474	34,713	38,446	29	.93	Stone, tungsten. sand and gravel, feldspar.
North Dakota	1,825	2,389	1,866	2,215	45	.05	Sand and gravel, clays, stone.
Ohio	111,506	137,839	137,448	153,024	9	3.70	Stone, lime, cement, sand and gravel.
Oklahoma	35,450	44,422	47,288	33,370	32	.81	Cement, zinc, stone, sand and gravel.

Oregon	21,483	28,374	26,637	24,427	36	.59	Sand and gravel, cement, stone, diatomite.
Pennsylvania	195,204	226,567	[1] 213,278	229,072	6	5.54	Cement, stone. sand and gravel, lime.
Rhode Island	1,425	1,278	1,250	1,462	47	.04	Sand and gravel, stone, graphite.
South Carolina	11,394	[1] 11,444	[1] 14,686	17,771	39	.43	Cement, clays, stone, sand and gravel.
South Dakota	32,593	29,553	30,455	33,819	31	.82	Gold, stone, cement, sand and gravel.
Tennessee	[1] 63,007	[1] 73,049	[1] 75,331	72,847	18	1.76	Cement, stone, phosphate rock, zinc.
Texas	[1] 170,453	[1] 189,131	[1] 199,618	223,463	7	5.41	Sulfur, cement, bromine, magnesium chloride.
Utah	[1] 193,059	219,395	[1] 227,255	253,776	4	6.14	Copper, iron ore, gold, molybdenum.
Vermont	18,563	18,516	17,891	20,302	38	.49	Stone, asbestos, slate, copper.
Virginia	40,774	45,224	49,509	49,983	26	1.21	Stone, cement, sand and gravel, lime.
Washington	43,176	48,396	[1] 50,013	49,381	27	1.19	Cement, sand and gravel, zinc, stone.
West Virginia	[1] 26,902	[1] 33,026	[1] 29,801	30,950	33	.75	Stone, cement, sand and gravel, lime.
Wisconsin	41,683	48,345	55,706	55,269	22	1.34	Sand and gravel, stone, iron ore, cement.
Wyoming	[1] 12,535	[1] 18,711	[1] 20,206	24,966	34	.60	Clays, sodium carbonate and sulfate, iron ore, sulfur.
Total	[1] 3,173,000	[1] 3,750,000	[1] 3,777,000	4,133,000	--------	100.00	Iron ore, cement, copper, stone.

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

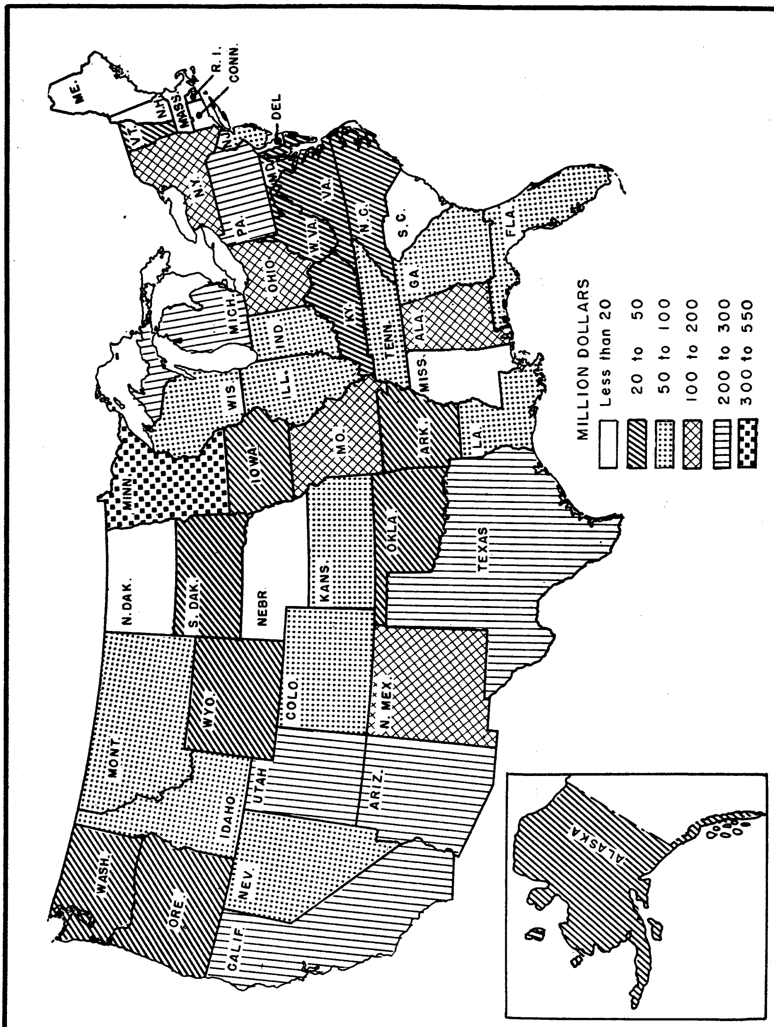

FIGURE 2.—Value of metals and nonmetals (except fuels) produced in continental United States and Alaska, 1953, by States.

TABLE 5.—Mineral production in the United States, 1950–53, by States [1]

ALABAMA

Mineral	1950 Short tons (unless otherwise stated)	1950 Value	1951 Short tons (unless otherwise stated)	1951 Value	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value
Cement [2] ... 376-pound barrels	10,574,955	$23,175,772	10,586,825	$24,523,073	10,642,409	$25,084,379	10,427,542	$25,701,421
Clays	1,349,977	1,313,073	1,269,697	1,718,644	1,264,412	1,903,956	1,198,093	1,815,606
Iron ore (usable) ... long tons, gross weight	7,402,208	28,932,801	8,181,737	34,799,951	7,243,214	37,940,412	7,446,130	55,640,338
Lime (open-market)	389,071	3,577,850	455,953	4,395,922	424,028	4,458,604	470,541	5,018,156
Manganese ore (35 percent or more Mn) ... gross weight	138	(3)	---	---	---	---	---	---
Sand and gravel	3,616,363	2,463,722	3,535,871	2,806,540	3,722,555	2,955,630	3,710,707	3,002,683
Stone (except for cement and lime)	2,587,500	6,038,220	2,818,421	7,254,671	3,052,150	7,948,410	4,111,889	8,953,656
Undistributed: Bauxite, puzzolan cement, graphite, mica (1952–53), salt (1952–53), 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	---	[4] 3,105,124	---	[4] 3,697,837	---	[4] 4,331,360	---	4,307,314
Total	---	[illegible]606,000	---	79,197,000	---	84,623,000	---	104,439,000
Total mineral fuels	---	90,369,000	---	85,083,000	---	73,759,000	---	83,461,000
Total Alabama	---	158,975,000	---	164,280,000	---	158,382,000	---	187,900,000

ARIZONA

Mineral	1950 Short tons (unless otherwise stated)	1950 Value	1951 Short tons (unless otherwise stated)	1951 Value	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value
Brucite	---	---	---	---	---	---	100	$1,250
Clays	223,586	$512,025	226,672	$471,973	247,329	$579,175	197,401	715,248
Copper (recoverable content of ores, etc.)	403,301	167,773,216	415,870	201,281,080	395,719	191,527,996	393,525	225,883,350
Fluorspar	952	(3)	1,623	(3)	434	(3)	1,951	113,270
Gold (recoverable content of ores, etc.) ... troy ounces	118,313	4,140,955	116,093	4,063,255	112,355	3,932,425	112,824	3,948,840
Gypsum	(3)	(3)	(3)	(3)	11,314	28,285	13,484	43,824
Lead (recoverable content of ores, etc.)	26,383	7,123,410	17,394	6,018,324	16,520	5,319,440	9,428	2,470,136
Lime (open-market)	51,530	717,885	54,023	772,899	53,019	757,390	96,408	1,238,204
Manganese ore (35 percent or more Mn) ... gross weight	222	(3)	173	(3)	203	(2)	(3)	(3)
Manganiferous ore (5 to 35 percent Mn) ... do	---	---	224	(3)	---	---	---	---
Mica (scrap)	(3)	(3)	1,763	50,030	(3)	(3)	3,721	114,870
Molybdenum (content of ore and concentrate) ... pounds	(2)	(3)	1,172,740	1,101,641	2,022,832	1,987,418	1,446,557	1,425,552
Perlite	1,923	10,487	1,520	10,795	2,747	14,568	(3)	(3)
Pumice	---	---	(3)	(3)	(3)	(3)	123,797	425,985
Sand and gravel	2,498,777	1,590,001	2,691,100	2,203,345	1,824,330	1,635,903	3,446,821	2,680,470
Silver (recoverable content of ores, etc.) ... troy ounces	5,325,441	4,819,793	5,120,985	4,634,750	4,701,330	4,254,941	4,351,429	3,938,263

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1950–53, by States [1]—Continued

ARIZONA—Continued

Mineral	1950 Short tons (unless otherwise stated)	1950 Value	1951 Short tons (unless otherwise stated)	1951 Value	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value
Stone (except limestone for cement and lime)	228,490	$139,810	308,881	$353,872	235,020	$355,709	442,358	$618,748
Tungsten concentrate ... 60-percent WO_3 basis	1	(3)	11	36,663	71	251,136	134	468,858
Zinc (recoverable content of ores, etc.)	60,480	17,176,320	52,999	19,291,636	47,143	15,651,476	27,530	6,331,900
Undistributed: Asbestos, barite, beryllium concentrate (1950–51 and 1953), cement, feldspar, gem stones, lithium (1951), mercury (1951), quartz, vanadium, and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)		3,374,993		[4] 3,566,376		[4] 5,373,512		6,165,553
Total		207,379,000		243,856,000		231,669,000		256,584,000
Total mineral fuel		27,000		30,000		33,000		32,000
Total Arizona		207,406,000		243,886,000		231,702,000		256,616,000

ARKANSAS

Mineral	1950 Short tons (unless otherwise stated)	1950 Value	1951 Short tons (unless otherwise stated)	1951 Value	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value
Barite	343,168	[5] $3,088,512	407,085	[5] $3,765,536	428,522	[5] $3,963,828	380,763	[5] $3,945,583
Bauxite ... long tons, dried equivalent	1,307,335	7,531,535	1,815,274	12,259,742	1,603,833	10,235,254	1,529,976	12,975,992
Clays	475,159	1,007,003	491,459	1,206,858	552,576	1,513,934	529,126	1,734,414
Iron ore (usable) ... long tons, gross weight	1,444	(3)	1,343	(3)	115	(3)	254	(3)
Lead (recoverable content of ores, etc.)	9	2,430	33	11,418	4	1,288		
Manganese ore (35 percent or more Mn) ... gross weight	1,224	(3)	3,718	(3)	2,246	(3)	6,123	526,647
Manganiferous ore (5 to 35 percent Mn) ... do	6,359	(3)	1,429	(3)	896	(3)		
Sand and gravel	4,118,080	3,446,578	3,868,940	3,569,114	5,011,095	4,977,219	4,903,835	4,955,383
Slate	(3)	(3)	27,080	174,329	(3)	(3)	34,516	315,858
Stone (except limestone for cement and lime)	3,952,720	7,419,110	2,535,746	3,216,426	[6] 2,967,479	[6] 3,346,201	[11] 3,545,350	[11] 5,069,750
Zinc (recoverable content of ores, etc.)	8	2,272	50	18,200	26	8,632		
Undistributed: Abrasive stones, cement, gypsum, lime, soapstone (1953), 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). Excludes value of clays used for cement		[4] 4,926,998		[4] 5,396,967		[4] 5,987,245		5,367,669
Total		[4] 27,424,000		[4] 29,619,000		[4] 30,034,000		34,891,000
Total mineral fuels		92,218,000		90,225,000		87,653,000		92,199,000
Total Arkansas		[4] 119,642,000		[4] 119,844,000		[4] 117,687,000		127,090,000

CALIFORNIA

Antimony ore and concentrate ... gross weight	------	------	------	------	9	(3)	------	------
Boron minerals	647, 735	$15, 890, 000	862, 797	$20, 030, 000	583, 828	$14, 105, 000	715, 228	$17, 668, 000
Cement ... 376-pound barrels	26, 685, 004	65, 258, 675	28, 956, 470	77, 753, 697	29, 786, 245	79, 457, 745	32, 002, 317	90, 872, 741
Chromite ... gross weight	404	(3)	6, 302	447, 769	14, 713	[5] 1, 269, 000	26, 512	2, 078, 461
Clays	2, 285, 147	3, 527, 477	2, 590, 040	4, 732, 124	2, 743, 130	4, 852, 266	2, 429, 888	4, 952, 723
Copper (recoverable content of ores, etc.)	646	268, 736	921	445, 764	800	387, 200	382	219, 268
Gem stones	(7)	(3)	(7)	(3)	(7)	100, 000	(7)	(3)
Gold (recoverable content of ores, etc.) ... troy ounces	412, 118	14, 424, 130	339, 732	11, 890, 620	258, 176	9, 036, 160	234, 591	8, 210, 685
Gypsum	962, 373	2, 462, 604	1, 092, 883	2, 602, 758	1, 236, 430	2, 721, 134	1, 199, 489	2, 855, 983
Iron ore (usable) ... long tons, gross weight	849, 489	(3)	1, 182, 799	(3)	1, 463, 239	(3)	1, 697, 652	(3)
Lead (recoverable content of ores, etc.)	15, 831	4, 274, 370	13, 967	4, 832, 582	11, 199	3, 606, 078	8, 664	2, 269, 968
Lime (open-market)	171, 440	2, 722, 835	203, 344	3, 366, 959	238, 957	3, 752, 738	301, 422	4, 653, 303
Magnesium compounds from sea water and bitterns (partly estimated) MgO equivalent	(3)	(3)	(3)	(3)	[4] 50, 277	3, 529, 362	55, 886	3, 483, 483
Manganese ore (35 percent or more Mn) ... gross weight	37	(3)	------	------	8, 081	(3)	5, 413	(3)
Manganiferous ore (5 to 35 percent Mn) ... do	640	5, 766	------	------	56	(3)	534	10, 355
Marl, calcareous	------	------	------	------	------	------	6, 028	21, 102
Mercury ... 76-pound flasks	3, 850	312, 851	4, 282	899, 777	7, 241	1, 441, 683	9, 290	1, 793, 249
Perlite	(3)	(3)	(3)	(3)	(3)	(3)	15, 282	112, 790
Pumice and pumicite	157, 497	970, 826	264, 411	1, 228, 569	129, 780	793, 716	433, 105	647, 910
Salt (common)	868, 496	3, 816, 655	1, 275, 574	5, 261, 780	1, 148, 693	4, 880, 392	1, 123, 365	6, 263, 059
Sand and gravel	41, 894, 039	35, 547, 558	46, 927, 452	41, 279, 835	53, 051, 260	43, 633, 125	58, 429, 528	53, 224, 203
Silver (recoverable content of ores, etc.) ... troy ounces	1, 071, 917	970, 139	1, 145, 219	1, 036, 481	1, 099, 658	995, 246	1, 036, 372	937, 969
Stone (except limestone for cement and lime)	11, 764, 630	13, 998, 432	12, 537, 344	14, 714, 524	14, 374, 930	17, 697, 085	14, 514, 180	18, 479, 152
Sulfur ore ... long tons	1, 463	27, 797	(3)	(3)	(3)	(3)	152, 203	(3)
Talc, pyrophyllite and soapstone	[8] 109, 747	[8] 2, 069, 211	[8] 126, 784	[8] 2, 269, 771	[8] 120, 574	[8] 2, 868, 255	[9] 126, 442	[9] 1, 132, 700
Tungsten concentrate ... 60-percent WO_3 basis	2, 025	3, 392, 244	3, 007	11, 557, 325	2, 980	11, 360, 569	2, 382	8, 939, 146
Zinc (recoverable content of ores, etc.)	7, 551	2, 144, 484	9, 602	3, 495, 128	9, 419	3, 127, 108	5, 358	1, 232, 340
Undistributed: Asbestos (1950–51 and 1953), barite, bromine, calcium-magnesium chloride, diatomite, feldspar, iodine, lithium minerals, magnesite; molybdenum, platinum group metals (crude), potassium salts, pyrites, quartz, ground sand and sandstone, slate, sodium carbonate and sulfate, 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	------	[4] 29, 924, 517	------	[4] 40, 159, 867	------	[4] 35, 735, 838	------	41, 414, 895
Total	------	[4] 202, 009, 000	------	[4] 248, 005, 000	------	[4] 245, 350, 000	------	271, 474, 000
Total mineral fuels	------	854, 365, 000	------	962, 071, 000	------	969, 776, 000	------	1, 121, 501, 000
Total California	------	[4] 1,056,374,000	------	[4] 1,210,076,000	------	[4] 1,215,126,000	------	1, 392, 975, 000

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1950–53, by States [1]—Continued

COLORADO

Mineral	1950 Short tons (unless otherwise stated)	1950 Value	1951 Short tons (unless otherwise stated)	1951 Value	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value
Beryllium concentrate ……gross weight	97	$30,500	97	$32,339	54	$24,588	75	$39,215
Clays	501,689	762,483	657,397	1,172,109	568,730	1,087,154	777,969	1,429,780
Copper (recoverable content of ores, etc.)	3,141	1,306,656	3,212	1,554,608	3,606	1,745,304	2,941	1,688,134
Feldspar ……long tons	59,457	329,120	50,451	283,153	38,268	224,385	43,508	267,642
Fluorspar	18,489	654,089	20,661	820,322	29,185	1,505,968	53,276	2,872,360
Gold (recoverable content of ores, etc.) ……troy ounces	130,390	4,563,650	116,503	4,077,605	124,594	4,360,790	119,218	4,172,630
Gypsum	62,150	183,976	(3)	(3)	(3)	(3)	62,936	233,043
Iron Ore (usable) ……long tons, gross weight							900	3,825
Lead (recoverable content of ores, etc.)	27,007	7,291,890	30,336	10,496,256	30,066	9,681,252	21,754	5,699,548
Manganiferous ore (5 to 35 percent Mn) ……gross weight					76	(3)		
Mica (scrap)	1,467	27,068	1,882	32,901	(3)	(3)	1,599	19,455
Molybdenum (content of ore and concentrate) ……pounds	24,090,200	(3)	22,911,949	(3)	24,557,149	(3)	33,851,083	(3)
Perlite	13,691	95,842	(3)	(3)	(3)	(3)	(3)	(3)
Pumice and pumicite	(3)	(3)	(3)	(3)	(3)	(3)	47,919	99,700
Sand and gravel	5,154,287	3,940,439	6,916,631	4,452,489	8,461,039	6,268,367	12,438,600	8,609,151
Silver (recoverable content of ores, etc.) ……troy ounces	3,492,278	3,160,688	2,787,882	2,523,174	2,813,643	2,546,489	2,200,317	1,991,398
Stone (except limestone for cement and lime)	[6] 1,679,960	[6] 2,776,331	1,470,123	2,334,376	1,708,872	2,566,401	[6] 883,646	[6] 1,741,926
Tin (content of ore and concentrate) ……long tons	15	31,165	18	54,033	13	33,723	(3)	(3)
Tungsten concentrate ……60-percent WO_3 basis	196	302,248	336	1,092,780	625	2,354,664	817	2,902,490
Zinc (recoverable content of ores, etc.)	45,776	13,000,384	55,714	20,279,896	53,203	17,663,396	37,809	8,696,070
Undistributed: Cement, columbium-tantalum concentrate, gem stones, lithium minerals (1953), pyrites, stone (dimension unclassified 1950, crushed basalt, 1953), sulfur ore (1950), vanadium, vermiculite (1950), 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		[4] 34,015,845		[4] 36,642,254		[4] 37,524,891		49,990,828
Total		72,472,000		85,848,000		87,588,000		90,457,000
Total mineral fuels		82,426,000		93,587,000		100,001,000		121,129,000
Total Colorado		154,898,000		179,435,000		187,589,000		211,586,000

CONNECTICUT

Beryllium concentrate							33	$14,321
Clays	292,367	$236,317	275,900	$252,725	157,500	$157,500	438,200	448,260
Feldspar ... long tons	13,580	101,851	13,811	107,083	10,929	87,432	9,829	63,049
Quartz from pegmatites and quartzite	27,560	166,810	29,273	175,638	(3)	(3)	(3)	(3)
Sand and gravel	2,998,424	1,861,741	2,321,715	1,708,910	2,581,247	1,933,214	3,025,840	2,347,750
Stone (except limestone for lime)	[6] 1,860,700	[6] 2,789,532	2,278,466	3,360,378	2,837,045	4,101,060	[6] 2,826,568	[6] 4,235,327
Undistributed: Columbium-tantalum ores (1953), lime, mica, stone (dimension basalt and crushed granite, 1950 and dimension basalt, 1953), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)		483,981		608,407		783,691		778,303
Total		5,640,000		6,213,000		7,063,000		7,887,000
Total mineral fuels		35,000		34,000		62,000		30,000
Total Connecticut		5,675,000		6,247,000		7,125,000		7,917,000

DELAWARE

Clays	41,000	$40,375	35,950	$35,450	(3)	(3)	(3)	(3)
Sand and gravel	367,524	291,715	454,563	303,643	515,399	$382,484	520,817	$399,685
Stone	77,050	190,113	99,201	245,002	94,911	251,759	80,364	215,382
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
Total Delaware		522,000		584,000		677,000		659,000

FLORIDA

Clays	210,842	$2,017,634	202,821	$2,359,113	197,711	$2,071,185	257,911	$2,952,359
Phosphate rock [10] ... long tons	8,597,227	48,377,981	8,211,820	48,612,762	9,205,138	54,085,524	9,331,002	56,524,701
Sand and gravel	2,793,865	2,806,431	4,418,573	4,300,682	4,154,613	3,848,077	3,731,432	3,199,368
Stone (except limestone for cement and lime)	5,313,400	6,885,394	8,032,966	9,419,682	7,836,634	9,577,541	9,428,959	11,309,421
Titanium concentrate:								
Ilmenite	(3)	(3)	(3)	(3)	(3)	(3)	151,109	2,322,451
Rutile	(3)	(3)	(3)	(3)	(3)	(3)	6,476	702,791
Zirconium concentrate	(3)	(3)	(3)	(3)	(3)	(3)	21,234	793,685
Undistributed: Cement, abrasive garnet (1951-53), lime, stone (dimensions limestone, 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		[4] 9,657,539		[4] 10,943,100		[4] 12,040,989		13,313,637
Total		[4] 69,745,000		[4] 75,635,000		[4] 81,623,000		91,118,000
Total mineral fuels		972,000		1,262,000		1,255,000		1,218,000
Total Florida		[4] 70,717,000		[4] 76,898,000		[4] 82,878,000		92,336,000

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1950–53, by States [1]—Continued

GEORGIA

Mineral	1950 Short tons (unless otherwise stated)	1950 Value	1951 Short tons (unless otherwise stated)	1951 Value	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value
Clays	2,408,890	$21,028,266	2,603,338	$23,199,758	2,562,182	$23,137,507	2,651,153	$23,455,315
Gold (recoverable content of ores, etc.) troy ounces			3	105			[11] 2	[11] 70
Iron ore (usable) long tons, gross weight	202,427	677,248	357,754	1,339,248	319,959	1,439,251	259,964	1,100,725
Lime (open-market)	11,998	121,556	10,616	104,626	7,854	87,587	9,345	95,484
Mica (sheet) pounds	(3)	(3)	(3)	(3)	13,010	18,852	14,063	73,806
Sand and gravel	[12] 1,211,782	[12] 936,726	1,226,231	1,041,561	2,133,970	2,029,367	2,051,058	1,900,987
Sand and sandstone (ground)	1,176	11,760	1,874	18,740	1,765	17,650	(3)	(3)
Stone (except limestone for cement and lime)	[4,6] 6,137,899	[4,6] 11,154,055	[4] 5,225,233	[4] 13,933,240	[4] 7,132,082	[4] 17,166,108	[11] 7,112,024	[11] 17,756,302
Talc and soapstone	[8] 70,749	[8] 774,148	[8] 77,895	[8] 823,133	[8] 56,491	[8] 653,144	[9] 57,891	[9] 202,619
Undistributed: Asbestos, barite, bauxite, beryllium concentrate (1952–53), cement, feldspar (1950–51), scrap mica, sand and gravel (noncommercial, 1950), slate, stone (marble and dimension unclassified 1950), 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		[4] 8,548,981		[4] 6,168,477		[4] 6,701,729		6,698,962
Total		[4] 43,253,000		[4] 46,629,000		[4] 51,251,000		51,284,000
Total mineral fuels		141,000		46,000		199,000		111,000
Total Georgia		[4] 43,394,000		[4] 46,675,000		[4] 51,450,000		51,395,000

IDAHO

Mineral	1950 Short tons (unless otherwise stated)	1950 Value	1951 Short tons (unless otherwise stated)	1951 Value	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value
Antimony ore and concentrate gross weight	6,868	(3)	8,805	(3)	4,173	(3)	(3)	(3)
Beryllium concentrate							1	$491
Clays	25,858	$30,811	28,281	$42,545	23,533	$24,683	26,229	21,339
Cobalt (content of ore) pounds					196,516	(3)	1,211,039	(3)
Copper (recoverable content of ores, etc.)	2,107	876,512	2,160	1,045,440	3,213	1,555,092	3,136	1,800,064
Gold (recoverable content of ores, etc.) troy ounces	79,652	2,787,820	45,064	1,577,240	32,997	1,154,895	17,630	617,050
Gypsum (crude)			65	293	400	1,200	150	450
Lead (recoverable content of ores, etc.)	100,025	27,006,750	76,713	26,542,698	73,719	23,737,518	74,610	19,547,820
Mercury 76-pound flasks			357	75,016	887	176,602	(3)	(3)
Mica: Scrap					170	5,100		
Sheet pounds					20,020	115,572	24,216	223,266
Phosphate rock [10] long tons	(3)	(3)	693,127	2,122,824	866,330	2,950,160	1,001,969	4,149,943

Pumice and pumicite	93,990	121,044	83,528	133,192	88,085	141,253	85,224	159,833
Sand and gravel	4,281,908	3,043,905	4,057,391	2,971,264	3,925,863	2,745,201	3,776,180	2,841,440
Sand and sandstone (ground)	3,700	29,600	11,968	107,738	9,500	80,000	5,304	43,865
Silver (recoverable content of ores, etc.) troy ounces	16,095,019	14,566,805	14,753,023	13,352,231	14,923,165	13,506,218	14,639,740	13,249,704
Stone (except limestone for cement)	[6] 644,020	[6] 861,290	1,457,182	1,811,422	[6] 1,630,034	[6] 2,441,236	1,141,626	2,260,875
Titanium-iron concentrate (nontitanium use)			(3)	(3)			1,585	7,500
Tungsten concentrate 60-percent WO_3 basis	222	(3)	377	1,402,866	333	1,245,499	441	1,665,983
Zinc (recoverable content of ores, etc.)	87,890	24,960,760	78,121	28,436,044	74,317	24,673,244	72,153	16,595,190
Undistributed: Barite, cement, columbium-tantalum concentrate, abrasive garnet, fluorspar (1951–53), quartz (1953), stone (crushed sandstone and limestone, 1950; crushed limestone, 1952), titanium concentrate (1951), vanadium, and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)		[4] 5,043,866		[4] 3,550,445		[4] 3,294,115		3,801,999
Total Idaho		[4] 79,329,000		[4] 83,171,000		[4] 77,848,000		66,987,000

ILLINOIS

Cement 376-pound barrels	7,857,969	$16,920,234	8,377,387	$19,853,132	8,710,621	$20,600,347	8,651,385	$21,961,761
Clays	2,520,163	3,405,952	2,589,464	4,026,294	2,337,023	3,871,051	2,305,202	4,573,001
Fluorspar	154,623	6,110,765	204,328	9,294,703	188,293	9,481,223	163,303	8,567,026
Lead (recoverable content of ores, etc.)	2,729	736,830	3,160	1,093,360	4,262	1,372,364	3,391	888,442
Lime (open-market)	367,485	4,465,413	462,690	5,878,289	460,775	5,917,038	519,992	6,986,560
Sand and gravel	18,695,433	16,531,797	20,130,567	19,146,502	19,584,308	19,214,195	21,521,806	20,540,549
Sand and sandstone (ground)	263,122	2,278,237	262,488	2,300,102	267,180	2,342,549	276,215	2,461,767
Silver (recoverable content of ores, etc.) troy ounces	2,001	1,811	3,465	3,136	3,781	3,422	2,338	2,116
Stone (except limestone for cement and lime)	17,911,480	21,970,537	19,298,968	23,474,516	22,334,887	28,326,060	22,938,732	29,736,966
Zinc (recoverable content of ores, etc.)	26,982	7,662,888	21,776	7,926,464	18,816	6,246,912	14,556	3,347,880
Undistributed: Nonmetallic minerals. Excludes value of clays used for cement		[4] 235,183		[4] 228,884		[4] 230,988		312,187
Total		80,320,000		93,225,000		97,606,000		99,378,000
Total mineral fuels		407,824,000		396,709,000		362,399,000		363,065,000
Total Illinois		488,144,000		489,934,000		460,005,000		462,443,000

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1950–53, by States [1]—Continued

INDIANA

Mineral	1950 Short tons (unless otherwise stated)	1950 Value	1951 Short tons (unless otherwise stated)	1951 Value	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value
Clays	1,412,733	$1,605,419	1,524,731	$1,914,457	1,331,298	$1,700,209	1,654,112	$2,514,227
Marl, calcareous (except for cement)	20,380	13,977	12,960	18,129	16,414	9,021	13,540	6,398
Sand and gravel	9,723,033	7,516,509	11,030,814	8,763,936	11,546,014	9,279,908	11,203,059	9,500,914
Stone (except limestone for cement and lime)	6,994,670	20,686,160	[6] 8,641,670	[6] 23,729,433	9,126,837	21,965,454	[11] 9,212,887	[11] 22,297,183
Undistributed: Abrasive stones, cement, lime, pyrites, stone (dimension sandstone 1951), and recovered elemental sulfur (1952–53). Excludes value of clays used for cement		[4] 27,891,881		[4] 30,708,809		[4] 30,870,155		35,448,379
Total		57,714,000		65,135,000		[4] 63,825,000		69,767,000
Total mineral fuels		108,918,000		109,253,000		98,206,000		100,014,000
Total Indiana		166,632,000		174,388,000		[4] 162,031,000		169,781,000

IOWA

Mineral	1950 Short tons (unless otherwise stated)	1950 Value	1951 Short tons (unless otherwise stated)	1951 Value	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value
Cement ... 376-pound barrels	7,231,807	$16,157,979	8,024,492	$19,800,084	9,336,727	$22,849,597	9,111,358	$23,330,177
Clays	862,790	857,583	915,802	1,061,898	864,667	2,681,789	913,413	974,539
Gypsum	981,647	2,507,651	1,127,705	2,881,150	1,122,409	2,797,704	1,151,692	2,939,654
Sand and gravel	8,994,822	4,795,835	9,943,372	5,916,950	10,796,979	6,032,898	10,385,322	6,400,827
Stone (except limestone for cement)	[6] 8,425,490	[6] 10,668,427	9,261,317	12,170,082	9,899,404	13,036,726	10,715,078	13,215,352
Total		[13] 34,777,000		[13] 41,488,000		[13] 47,074,000		[13] 46,599,000
Total mineral fuels		6,996,000		6,218,000		5,407,000		5,395,000
Total Iowa		[13] 41,773,000		[13] 47,706,000		[13] 52,481,000		[13] 51,994,000

KANSAS

Mineral	1950 Short tons (unless otherwise stated)	1950 Value	1951 Short tons (unless otherwise stated)	1951 Value	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value
Cement [14] ... 376-pound-barrels	8,759,103	$19,400,068	8,163,916	$19,413,144	8,811,762	$20,956,886	8,546,250	$21,428,536
Clays	725,282	601,014	731,960	728,921	665,582	789,293	670,694	749,579
Lead (recoverable content of ores, etc.)	9,487	2,561,490	8,947	3,095,662	5,916	1,904,952	3,347	876,914
Salt (common)	846,374	5,914,514	900,917	6,639,343	911,744	6,850,027	905,227	7,480,556
Sand and gravel	9,781,123	6,782,285	7,676,888	4,747,544	8,380,065	5,023,593	8,728,291	5,668,308

Stone (except limestone for cement)	7,630,300	8,920,207	7,191,483	9,058,512	8,830,871	12,051,740	8,769,152	11,303,950
Zinc (recoverable content of ores, etc.)	21,176	7,717,984	28,904	10,521,056	25,482	8,460,024	15,515	3,568,450
Undistributed: Natural cement, gypsum, and pumicite. Excludes value of clays used for cement		[4] 323,479		[4] 303,946		[4] 386,847		387,870
Total		52,221,000		54,508,000		56,423,000		51,464,000
Total mineral fuels		316,393,000		345,579,000		346,947,000		361,767,000
Total Kansas		368,614,000		400,087,000		403,370,000		413,231,000
KENTUCKY								
Clays	718,212	$3,595,965	880,240	$5,274,285	880,874	$5,101,266	711,209	$3,118,352
Fluorspar	80,137	2,554,668	68,635	2,334,485	48,308	1,863,262	47,244	2,100,493
Lead (recoverable content of ores, etc.)	66	17,820	107	37,022	60	19,320	52	13,624
Sand and gravel	2,382,672	2,262,964	2,801,639	2,434,799	3,334,261	2,656,053	3,052,155	2,899,932
Stone (except limestone for cement)	[6] 7,417,200	[6] 8,865,913	7,048,771	8,609,609	[6] 8,817,859	[6] 10,816,707	[6] 7,429,505	[6] 9,268,237
Zinc (recoverable content of ores, etc.)	731	207,604	3,457	1,258,348	3,280	1,088,960	489	112,470
Undistributed: Cement and stone (crushed sandstone, 1950, dimension sandstone, 1952–53). Excludes value of clays used for cement		[4] 2,917,521		[4] 3,300,461		[4] 3,605,658		4,028,752
Total		20,422,000		23,249,000		25,151,000		21,542,000
Total mineral fuels		439,534,000		419,015,000		373,295,000		360,200,000
Total Kentucky		459,956,000		442,264,000		398,446,000		381,742,000
LOUISIANA								
Clays	327,067	$273,116	306,542	$306,542	390,136	$433,808	624,427	$951,612
Salt (common)	2,278,811	6,902,502	2,737,149	7,662,179	2,553,448	7,807,693	3,061,234	9,189,526
Sand and gravel	5,505,362	6,310,425	6,384,328	7,419,570	6,005,119	6,736,524	4,538,387	5,162,248
Sulfur (Frasch-process) long tons	1,256,026	23,700,000	1,152,821	25,400,000	1,449,668	32,015,000	1,609,364	43,453,000
Undistributed: Cement, gypsum, lime (1953), stone (except limestone for cement (1950 and 1952), recovered elemental sulfur (1952–53). Excludes value of clays used for cement		[4] 5,277,588		[4] 6,490,595		[4] 9,959,888		11,176,929
Total		42,464,000		47,279,000		[4] 56,953,000		69,933,000
Total mineral fuels		651,143,000		740,399,000		791,448,000		895,304,000
Total Louisiana		693,607,000		787,678,000		[4] 848,401,000		965,237,000

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1950–53, by States [1]—Continued

MAINE

Mineral	1950 Short tons (unless otherwise stated)	1950 Value	1951 Short tons (unless otherwise stated)	1951 Value	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value
Cement .... 376-pound barrels..	1,127,220	$2,705,034	1,236,299	$3,182,918	1,457,250	$3,750,483	2,001,464	$5,422,272
Clays	31,917	26,561	21,885	21,885	26,050	26,050	29,661	27,476
Feldspar .... long tons..	17,487	124,821	19,273	154,695	18,644	147,371	17,637	117,090
Mica (scrap)	23	592	(3)	(3)	(3)	(3)	(3)	(3)
Sand and gravel	4,897,143	1,726,217	5,366,694	1,817,317	7,078,078	2,187,531	8,071,937	2,608,386
Stone (except limestone for cement and lime)	[6] 309,740	[6] 2,214,164	644,594	2,582,541	[6] 316,874	[6] 1,795,768	[6] 248,501	[6] 1,215,439
Undistributed: Beryllium concentrate, columbium-tantalum concentrate (1951 and 1953), gem stones (1951), lime, lithium minerals (1950), sheet mica, quartz from pegmatites or quartzite, slate, stone (crushed sandstone, 1950, and crushed limestone, 1952–53), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)	....	601,873	....	720,095	....	1,015,827	....	1,038,883
Total	....	7,399,000	....	8,479,000	....	8,923,000	....	10,429,000
Total mineral fuels	....	62,000	....	37,000	....	58,000	....	74,000
Total Maine	....	7,461,000	....	8,516,000	....	8,981,000	....	10,503,000

MARYLAND

Mineral	1950 Short tons (unless otherwise stated)	1950 Value	1951 Short tons (unless otherwise stated)	1951 Value	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value
Clays	741,738	$1,207,523	756,987	$1,414,342	771,922	$1,426,556	671,029	$1,135,495
Gold (recoverable content of ores, etc.) .... troy ounces..	20	700	1	35	....	....	....	....
Lime (open-market)	64,687	691,843	67,684	722,011	72,885	746,893	71,705	707,736
Sand and gravel	5,864,472	7,789,764	7,054,488	8,170,851	6,956,640	8,136,697	7,379,511	8,919,088
Stone (except limestone for cement and lime)	1,975,690	3,459,605	3,181,434	5,983,380	[6] 3,391,679	[6] 6,330,443	[6] 3,578,249	[6] 6,275,124
Undistributed: Cement, potassium salts, quartz (1952), noncommercial sand and gravel (1950), slate, stone (dimension limestone and crushed marble, 1952–53), recovered elemental sulfur (1950–51), and talc and soapstone. Excludes value of clays used for cement	....	[4] 6,381,853	....	[4] 6,396,886	....	[4] 7,051,145	....	7,337,486
Total	....	[4] 19,531,000	....	[4] 22,688,000	....	23,692,000	....	24,375,000
Total mineral fuels	....	3,209,000	....	3,465,000	....	3,155,000	....	2,710,000
Total Maryland	....	[4] 22,740,000	....	[4] 26,153,000	....	26,847,000	....	27,085,000

MASSACHUSETTS

Clays	155,279	$139,060	150,370	$167,646	140,148	$160,371	152,117	$195,809
Lime (open-market)	139,357	1,830,625	143,316	1,930,225	132,135	1,999,545	135,383	2,156,205
Quartz from pegmatites and quartzite	2,145	23,646	2,186	17,489	(3)	(3)	(3)	(3)
Sand and gravel	7,111,067	5,430,790	7,232,088	5,592,640	7,645,728	6,128,744	7,308,190	5,930,894
Sand and sandstone (ground)	1,829	9,882	(3)	(3)	(3)	(3)		
Stone (except limestone for lime)	[6] 3,284,470	[6] 8,484,999	[6] 3,225,839	[6] 9,172,425	[6] 3,355,819	[6] 9,331,871	3,457,708	8,821,108
Undistributed: Nonmetallic minerals and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)		[4] 183,610		[4] 191,994		[4] 187,442		71,368
Total		[4] 16,103,000		[4] 17,072,000		[4] 17,808,000		17,175,000
Total mineral fuels		7,000		5,000		4,000		16,000
Total Massachusetts		[4] 16,110,000		[4] 17,077,000		[4] 17,812,000		17,191,000

MICHIGAN

Cement .... 376-pound barrels	12,854,423	$29,619,766	14,112,639	$35,121,324	14,760,783	$36,819,042	15,853,096	$41,860,464
Clays	1,427,993	1,139,490	1,511,087	1,581,815	1,775,917	1,810,916	1,645,804	1,686,113
Copper (recoverable content of ores, etc.)	25,608	10,652,928	24,979	12,089,836	21,699	10,502,316	24,097	13,831,678
Gypsum	1,474,210	4,090,777	1,566,276	4,402,725	1,487,642	4,200,418	1,446,973	4,091,002
Iron ore (usable) .... long tons, gross weight	12,821,344	72,358,822	13,611,621	81,765,748	11,779,366	76,088,935	13,312,766	94,691,612
Magnesium compounds from well brines (partly estimated) MgO equivalent	[4] 36,020	[4] 4,123,608	[4] 38,306	[4] 4,355,820	[4] 38,449	[4] 3,917,138	43,190	4,591,922
Manganiferous ore (5 to 35 percent Mn) .... gross weight	117,619	(3)	[4] 69,626	(3)	22,095	(3)	76,251	(3)
Marl, calcareous (except for cement)	218,429	122,212	178,010	96,639	164,519	86,529	183,685	72,781
Salt (common)	4,446,667	18,178,765	5,137,639	21,221,330	4,778,347	21,446,382	5,127,387	22,171,988
Sand and gravel	24,556,911	16,699,203	27,540,921	20,976,632	29,193,763	22,400,879	30,459,663	23,170,802
Stone (except limestone for cement and lime)	19,095,540	15,391,366	20,851,733	17,514,720	17,973,685	15,770,816	21,615,686	17,639,525
Undistributed: Bromine, calcium-magnesium chloride, lime, magnesium chloride for magnesium metal (1951–53), 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		[4] 13,150,829		[4] 19,327,250		[4] 24,392,809		25,067,772
Total		[4] 185,528,000		[4] 218,454,000		[4] 217,436,000		248,876,000
Total mineral fuels		44,666,000		40,017,000		37,082,000		37,611,000
Total Michigan		[4] 230,194,000		[4] 258,471,000		[4] 254,518,000		286,487,000

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1950–53, by States [1]—Continued

MINNESOTA

Mineral	1950 Short tons (unless otherwise stated)	1950 Value	1951 Short tons (unless otherwise stated)	1951 Value	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value
Clays	129,220	$151,074	129,942	$187,605	113,492	$160,408	91,401	$149,384
Iron ore (usable) long tons, gross weight	64,538,759	311,716,341	78,164,527	411,468,895	63,906,069	375,765,251	80,533,670	517,850,509
Manganiferous ore (5 to 35 percent Mn) gross weight	869,838	(3)	[4] 1,010,651	(3)	912,118	(3)	1,091,491	(3)
Marl, calcareous (except for cement)	19,375	7,600	2,925	1,549	1,449	722	(3)	(3)
Sand and gravel	15,472,815	5,903,025	17,229,526	6,008,994	19,825,157	6,808,763	19,774,411	7,304,351
Stone (except limestone for cement and lime)	[6] 1,953,450	[6] 5,334,028	[6] 1,906,407	[6] 5,613,157	[6] 2,394,178	[6] 5,498,177	2,270,528	6,587,096
Undistributed: Abrasive stones, cement, lime, stone (crushed sandstone, 1950–51 and crushed basalt, 1952), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)		8,442,083		[4] 9,296,790		[4] 9,206,865		10,653,888
Total		331,554,000		[4] 432,577,000		[4] 397,440,000		542,545,000
Total mineral fuels		13,000						
Total Minnesota		331,567,000		[4] 432,577,000		[4] 397,440,000		542,545,000

MISSISSIPPI

Mineral	1950 Short tons (unless otherwise stated)	1950 Value	1951 Short tons (unless otherwise stated)	1951 Value	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value
Clays	561,951	$2,184,429	673,078	$4,250,253	509,099	$2,681,563	560,047	$3,158,385
Sand and gravel	2,764,444	1,985,908	3,012,152	2,279,034	2,296,577	1,833,306	2,653,646	2,173,871
Stone	100,000	115,000	171,131	168,933	90,000	103,500	38,000	43,700
Undistributed: Nonmetallic minerals. Excludes value of clays used for cement						[4] 2,283,312		3,083,749
Total		4,285,000		6,698,000		6,902,000		8,460,000
Total mineral fuels		98,660,000		96,332,000		94,973,000		99,408,000
Total Mississippi		102,945,000		103,030,000		101,875,000		107,868,000

MISSOURI

Mineral	1950 Short tons (unless otherwise stated)	1950 Value	1951 Short tons (unless otherwise stated)	1951 Value	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value
Barite (crude)	212,736	$1,924,520	281,895	$2,697,200	304,080	$2,919,795	330,763	$3,338,395
Cement 376-pound barrels	9,779,657	22,751,226	10,217,421	25,760,473	10,086,850	25,523,038	9,860,179	26,238,460
Clays	1,946,727	4,656,268	2,354,857	10,558,438	2,991,019	12,098,420	2,231,596	11,182,096
Copper (recoverable content of ores, etc.)	2,982	1,240,512	2,422	1,172,248	2,576	1,246,784	2,374	1,362,676

Iron ore (usable)......long tons, gross weight..	194,138	(3)	172,466	(3)	268,218	(3)	274,693	(3)
Lead (recoverable content of ores, etc.)......	134,626	36,349,020	123,702	42,800,892	129,245	41,616,890	125,895	32,984,490
Lime (open-market)......	1,035,176	9,447,669	1,122,299	11,285,877	1,130,970	11,326,941	1,212,107	12,084,130
Sand and gravel......	6,232,411	5,267,939	6,809,857	5,969,849	6,790,422	6,122,195	5,792,058	5,233,999
Silver (recoverable content of ores, etc.)......troy ounces..	236,273	213,839	184,424	166,913	517,432	468,302	359,781	325,620
Stone (except limestone for cement and lime)......	10,300,400	14,406,627	11,294,227	15,255,427	15,106,544	20,676,958	6 13,942,531	6 19,908,540
Zinc (recoverable content of ores, etc.)......	8,189	2,325,676	11,476	4,177,264	13,986	4,643,352	9,981	2,295,630
Undistributed: Manganese ore (1953), ground sand and sandstone, stone (dimension marble, 1953), tripoli, tungsten concentrate (1950), 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......	......	4 2,089,152	......	4 1,867,254	......	4 2,182,213	......	3,335,056
Total......	......	100,672,000	......	121,712,000	......	128,825,000	......	118,289,000
Total mineral fuels......	......	12,519,000	......	13,537,000	......	12,152,000	......	10,008,000
Total Missouri......	......	113,191,000	......	135,249,000	......	140,977,000	......	128,297,000
MONTANA								
Antimony ore and concentrate......gross weight..	......	......	29	(3)	......	......	(3)	(3)
Chromite......	......	......	......	......	......	......	26,089	$869,958
Clays......	37,617	$37,617	39,231	$41,631	51,304	$73,601	36,994	38,312
Copper (recoverable content of ores, etc.)......	54,478	22,662,848	57,406	27,784,504	61,948	29,982,832	77,617	44,552,158
Fluorspar......	41	(3)	......	......	16,160	(3)	5,932	(3)
Gold (recoverable content of ores, etc.)......troy ounces..	51,764	1,811,740	30,502	1,067,570	24,161	845,635	24,768	866,880
Iron ore (usable)......long tons, gross weight..	......	......	......	......	......	......	6,709	(3)
Lead (recoverable content of ores, etc.)......	19,617	5,296,590	21,302	7,370,492	21,279	6,851,838	19,949	5,226,638
Manganese ore (35 percent or more Mn)......gross weight..	131,201	(3)	100,562	(3)	100,070	(3)	113,429	(3)
Manganiferous ore (5 to 35 percent Mn)......do....	6,810	(3)	7,598	(3)	9,357	(3)	5,598	(3)
Phosphate rock 10......long tons..	244,361	1,732,904	(3)	(3)	(3)	(3)	(3)	(3)
Pumice and pumicite......	(3)	(3)	(3)	(3)	......	......	3,000	15,000
Sand and gravel......	9,044,125	5,140,207	9,582,843	6,201,888	6,765,955	3,579,932	6,203,480	2,993,575
Silver (recoverable content of ores, etc.)......troy ounces..	6,590,747	5,964,959	6,393,768	5,786,683	6,138,185	5,555,367	6,689,556	6,054,386
Stone (except limestone for cement and lime)......	919,090	949,545	871,508	986,327	6 690,081	6 792,897	6 802,735	6 1,124,731
Tungsten concentrate......60-percent WO_3 basis..	......	......	1	2,832	......	......	14	(3)
Zinc (recoverable content of ores, etc.)......	67,678	19,220,552	85,551	31,140,564	82,185	27,285,420	80,271	18,462,330
Undistributed: Barite (1951-53), cement, gem stones (1950-51), gypsum, lime, 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)......	......	11,640,301	......	4 14,825,330	......	4 17,365,016	......	18,871,812
Total......	......	4 74,457,000	......	4 95,208,000	......	4 92,332,000	......	99,075,000
Total mineral fuels......	......	29,168,000	......	31,168,000	......	29,737,000	......	33,109,000
Total Montana......	......	4 103,625,000	......	4 126,376,000	......	4 122,069,000	......	132,184,000

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1950–53, by States [1]—Continued

NEBRASKA

Mineral	1950		1951		1952		1953	
	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	153,830	$149,442	115,845	$116,345	167,228	$167,703	175,856	$186,893
Sand and gravel	5,077,792	3,167,659	4,969,243	3,477,409	5,436,540	3,874,106	5,969,858	4,340,163
Stone (except limestone for cement)	[6] 736,660	[6] 1,042,035	942,967	1,437,899	1,245,106	1,946,448	1,407,158	2,069,984
Undistributed: Cement, pumice and pumicite, and stone (sandstone, 1950). Excludes value of clays used for cement		[4] 6,360,470		[4] 6,646,760		[4] 6,864,888		8,026,904
Total		10,720,000		11,678,000		12,853,000		14,624,000
Total mineral fuels		3,302,000		6,791,000		7,744,000		18,657,000
Total Nebraska		14,022,000		18,469,000		20,597,000		33,281,000

NEVADA

Mineral	1950		1951		1952		1953	
	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	20	(3)	156	(3)	152	(3)	20	(3)
Barite	47,608	$268,874	63,201	$387,026	68,062	$391,242	99,525	$614,686
Clays	(3)	(3)	3,220	33,420	3,958	36,278	(3)	(3)
Copper (recoverable content of ores, etc.)	52,569	21,868,704	56,474	27,333,416	57,537	27,847,908	61,850	35,501,900
Fluorspar	7,577	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Gold (recoverable content of ores, etc.) ... troy ounces	178,447	6,245,645	121,036	4,236,260	117,203	4,102,105	101,799	3,562,965
Gypsum	604,604	1,614,107	643,637	1,811,757	608,284	1,666,938	701,584	1,975,053
Iron ore (usable) ... long tons, gross weight	5,465	(3)	299,010	898,306	911,657	3,991,970	444,081	2,647,859
Lead (recoverable content of ores, etc.)	9,408	2,540,160	7,148	2,473,208	6,790	2,186,380	4,371	1,145,202
Manganese ore (35 percent or more Mn) ... gross weight			328	(3)	695	(3)	20,150	1,684,555
Manganiferous ore (5 to 35 percent Mn) ... do	8,942	102,348	1,250	(3)	7,947	(3)	25,064	431,559
Mercury ... 76-pound flasks	680	55,257	1,400	294,182	3,523	701,429	3,254	628,120
Pumice and pumicite	(3)	(3)	(3)	(3)	(3)	(3)	21,269	86,366
Sand and gravel	2,617,052	2,253,258	2,616,629	2,657,654	2,098,211	2,380,419	2,266,064	2,088,948
Silver (recoverable content of ores, etc.) ... troy ounces	1,537,217	1,391,259	981,669	888,460	941,195	851,829	697,086	630,898
Stone (except limestone for lime)	[6] 274,460	[6] 269,478	834,807	959,815	830,712	1,158,608	1,035,568	1,399,529
Sulfur ore ... long tons	867	15,173	(3)	(3)	(3)	(3)	(3)	(3)
Talc and soapstone	[8] 8,581	[8] 170,736	[8] 6,919	[8] 152,878	[8] 7,580	[8] 180,328	[9] 10,906	[9] 72,971
Tungsten concentrate ... 60-percent WO_3 basis	1,123	(3)	1,482	4,780,237	2,329	8,820,598	3,683	13,824,238
Zinc (recoverable content of ores, etc.)	21,606	6,136,104	17,443	6,349,252	15,357	5,098,524	5,812	1,336,760

Undistributed: Brucite, diatomite, gem stones (1952-53), lime, magnesite, calcareous marl, molybdenum, perlite, salt, stone (crushed limestone, 1950), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)		5,567,815		4,418,333		4,816,659		5,891,368
Total Nevada		48,499,000		57,674,000		64,231,000		73,523,000
NEW HAMPSHIRE								
Beryllium concentrate	106	$40,310	50	$16,670	(3)	(3)	57	$32,640
Clays	22,719	17,115	28,501	28,501	30,135	$30,135	45,198	41,427
Columbium-tantalum concentrate pounds, gross weight							770	1,309
Feldspar	(3)	(3)	(3)	(3)	(3)	(3)	28,961	286,069
Mica (sheet)					(3)	(3)	90,716	382,680
Sand and gravel	[15] 1,713,284	[15] 226,424	2,260,410	517,927	3,200,232	1,001,591	2,249,001	506,156
Stone	[6] 15,760	[6] 383,667	[6] 62,355	[6] 349,606	69,850	546,177	76,701	538,897
Undistributed: Abrasive stones, scrap mica, sand and gravel (commercial 1950), stone (crushed unclassified, 1950, and crushed granite, 1951), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)		1,043,718		382,691		[4] 366,197		15,617
Total		1,711,000		1,295,000		[4] 1,944,000		1,805,000
Total mineral fuels						400		
Total New Hampshire		1,711,000		1,295,000		[4] 1,945,000		1,805,000
NEW JERSEY								
Clays	602,369	$1,277,860	683,439	$2,106,628	598,775	$1,962,599	532,185	$1,326,297
Iron ore (usable) long tons, gross weight	588,199	5,651,563	657,930	7,810,776	685,466	6,760,467	815,905	10,114,970
Manganiferous residuum gross weight	183,842	(3)	267,751	(3)	215,255	(3)	293,758	(3)
Marl (greensand)	3,935	304,321	5,067	263,944	4,600	177,847	6,821	193,404
Sand and gravel	[12] 7,620,422	[12] 8,636,141	6,652,383	9,106,052	7,060,074	9,473,428	7,361,935	10,835,948
Sand and sandstone (ground)	131,744	936,817	144,098	1,053,991	138,434	1,011,844	127,921	918,534
Stone (except limestone for lime)	[6] 4,672,050	[6] 9,119,251	6,457,248	10,987,705	6,102,324	12,307,480	6,036,259	13,307,856
Zinc (recoverable content of ores, etc.)[16]	55,029	17,258,637	62,917	24,279,745	59,190	21,520,612	45,700	9,922,990
Undistributed: Lime, magnesium compounds, noncommercial sand and gravel (1950), stone (unclassified, 1950), recovered elemental sulfur, and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)		[4] 3,445,098		[4] 4,276,783		[4] 4,061,840		5,110,629
Total		[4] 46,630,000		[4] 59,886,000		[4] 57,276,000		51,731,000
Total mineral fuels		186,000		213,000		192,000		214,000
Total New Jersey		[4] 46,816,000		[4] 60,099,000		[4] 57,468,000		51,945,000

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1950–53, by States [1]—Continued

NEW MEXICO

Mineral	1950 Short tons (unless otherwise stated)	1950 Value	1951 Short tons (unless otherwise stated)	1951 Value	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value
Beryllium concentrate ..... gross weight	(3)	(3)	141	$47,008	101	$29,185	89	$52,014
Clays	63,337	$77,582	75,653	148,876	57,668	107,633	49,089	103,931
Copper (recoverable content of ores, etc.)	66,300	27,580,800	73,558	35,602,072	76,112	36,838,208	72,477	41,601,798
Fluorspar	20,036	742,408	24,402	1,163,098	16,443	823,320	(3)	(3)
Gold (recoverable content of ores, etc.) ..... troy ounces	3,414	119,490	3,959	138,565	2,949	103,215	2,614	91,490
Iron ore (usable) ..... long tons, gross weight	14,284	(3)	32,210	(3)	7,793	(3)	7,525	(3)
Lead (recoverable content of ores, etc.)	4,150	1,120,500	5,846	2,022,716	7,021	2,260,762	2,943	771,066
Manganese ore (35 percent or more Mn) ..... gross weight	1,320	(3)	226	(3)	2,360	156,745	-----	-----
Manganiferous ore (5 to 35 percent Mn) ..... do	74,348	(3)	79,844	(3)	52,934	(3)	(3)	(3)
Perlite	(3)	(3)	(3)	(3)	(3)	(3)	84,891	661,698
Potassium salts ..... K_2O equivalent	1,072,772	31,944,365	1,217,617	37,209,740	1,411,125	46,385,452	1,552,831	52,293,316
Pumice and pumicite	351,642	1,109,883	245,564	884,311	217,482	755,139	528,649	759,840
Salt (common)	(3)	(3)	(3)	(3)	(3)	(3)	62,087	216,364
Sand and gravel	937,653	923,270	1,080,256	1,087,857	496,921	499,589	1,416,380	1,238,979
Silver (recoverable content of ores, etc.) ..... troy ounces	338,581	306,433	443,267	401,179	479,318	433,807	205,309	185,815
Stone	364,930	243,841	1,022,901	592,179	[6] 317,894	[6] 191,642	624,528	510,713
Zinc (recoverable content of ores, etc.)	29,263	8,310,692	45,419	16,532,516	50,975	16,923,700	13,373	3,075,790
Undistributed: Barite, columbium-tantalum concentrate (1953), diatomite (1953), gem stones, lithium minerals (1950), mica (1950), molybdenum, stone (crushed miscellaneous, 1952), recovered elemental sulfur (1953), vanadium, and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)	-----	1,424,492	-----	1,666,948	-----	1,875,004	-----	1,603,990
Total	-----	73,904,000	-----	97,497,000	-----	107,384,000	-----	103,167,000
Total mineral fuels	-----	136,390,000	-----	158,805,000	-----	181,116,000	-----	227,630,000
Total New Mexico	-----	210,294,000	-----	256,302,000	-----	288,500,000	-----	330,797,000

NEW YORK

Mineral	1950 Short tons (unless otherwise stated)	1950 Value	1951 Short tons (unless otherwise stated)	1951 Value	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value
Cement [14] ..... 376-pound barrels	13,271,469	$30,895,295	13,862,522	$34,687,090	14,624,274	$36,679,379	14,965,164	$39,388,183
Clays	1,443,129	1,155,656	1,559,472	1,632,878	1,218,850	1,291,736	960,791	1,303,281
Emery	5,949	75,308	11,634	160,212	10,352	141,911	10,562	143,974
Gypsum	1,280,100	3,876,176	1,259,484	4,010,766	1,143,920	3,816,148	987,156	3,507,207
Iron ore (usable) ..... long tons, gross weight	2,917,257	27,914,818	3,649,531	39,819,368	2,896,531	34,514,879	3,414,859	36,346,279
Lead (recoverable content of ores, etc.)	1,484	400,680	1,500	519,000	1,120	360,640	1,435	375,970

Salt (common)	2,806,927	14,405,362	3,518,715	16,552,890	3,417,443	16,746,462	3,322,659	17,351,111
Sand and gravel	21,778,089	18,075,237	21,008,701	19,285,299	20,270,058	18,287,623	22,530,891	23,493,857
Silver (recoverable content of ores, etc.) troy ounces	32,628	29,530	47,568	43,051	38,895	35,202	35,398	32,037
Slate	151,160	2,054,725	126,070	2,000,106	125,930	1,810,865	113,575	1,733,332
Stone (except limestone for cement and lime)	13,121,850	19,728,957	15,559,372	24,326,118	16,234,549	25,244,245	[6] 15,961,657	[6] 25,250,576
Talc	[8] 163,974	[8] 4,039,973	[8] 152,652	[8] 4,170,987	[8] 149,837	[8] 4,069,771	[9] 156,299	[9] 940,541
Wollastonite	800	16,200	(3)	(3)	(3)	(3)	(3)	(3)
Zinc (recoverable content of ores, etc.)	38,321	10,883,164	40,051	14,578,564	32,636	10,835,152	51,529	11,851,670
Undistributed: Abrasive stone (1953), natural cement, abrasive garnet, lime, calcareous marl, sheet mica (1950), pyrites (1950–52), stone (crushed unclassified 1953), recovered elemental sulfur (1950–52), 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		[4] 6,537,272		[4] 8,232,758		[4] 7,891,552		8,102,030
Total		[4] 140,088,000		[4] 170,019,000		[4] 161,726,000		169,820,000
Total mineral fuels		16,497,000		18,797,000		19,025,000		17,048,000
Total New York		[4] 156,585,000		[4] 188,816,000		[4] 180,751,000		186,868,000

NORTH CAROLINA

Abrasive stones	(7)	$17,025	(7)	$13,263	(7)	$28,992	(7)	$16,150
Clays	1,437,202	1,766,785	1,462,030	2,177,515	1,357,700	2,080,172	1,466,232	2,534,908
Feldspar long tons	183,027	1,107,061	166,361	1,230,404	240,364	2,416,031	268,042	3,290,495
Mica:								
Scrap	48,193	1,281,584	52,550	1,441,886	58,576	1,551,071	56,834	1,428,793
Sheet pounds	483,736	102,179	464,949	127,204	595,331	664,075	619,895	1,308,494
Olivine	4,063	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Sand and gravel	8,352,475	5,465,067	7,656,370	4,435,702	8,724,748	5,665,169	6,910,982	4,992,991
Stone	7,711,580	11,894,745	[6] 8,612,967	[6] 13,292,690	[6] 9,647,513	[6] 14,694,698	[6] 9,316,823	[6] 14,424,323
Talc, pyrophyllite and soapstone	[8] 116,895	[8] 1,855,163	[8] 113,950	[8] 1,982,927	[8] 115,481	[8] 1,771,518	[9] 119,341	[9] 578,239
Tin (content of ore and concentrate) long tons			1	1,724	4	11,601		
Titanium concentrate (ilmenite)	25,842	(3)	(3)	(3)	25,328	177,296		
Tungsten concentrate 60-percent WO_3 basis	1,240	(3)	1,041	(3)	1,254	(3)	2,074	(3)
Vermiculite	2,366	66,627	(3)	(3)	(3)	(3)	(3)	(3)
Undistributed: Asbestos (1950–51 and 1953), beryllium concentrate (1951 and 1953), columbium-tantalum concentrate (1952–53), lithium minerals (1951–53), manganiferous ores (1953), quartz, ground sand and sandstone (1950), stone (dimension marble 1951–53, and crushed marble 1952–53), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)		[4] 2,599,547		[4] 4,770,371		[4] 5,652,311		9,871,493
Total		26,156,000		29,474,000		34,713,000		38,446,000
Total mineral fuels		182,000		173,000		13,000		
Total North Carolina		26,338,000		29,647,000		34,726,000		38,446,000

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1950–53, by States [1]—Continued

NORTH DAKOTA

Minera	1950 Short tons (unless otherwise stated)	1950 Value	1951 Short tons (unless otherwise stated)	1951 Value	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value
Clays	(3)	(3)	18,250	$35,250	(3)	(3)	23,084	$47,862
Sand and gravel	4,270,838	$1,660,371	4,573,341	2,140,466	6,557,069	$1,841,216	6,173,737	2,164,685
Stone	193,250	135,698	281,219	213,061	67,064	4,968	35,031	2,595
Undistributed: Nonmetallic minerals and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)		28,800				19,900		
Total		1,825,000		2,389,000		1,866,000		2,215,000
Total mineral fuels		7,789,000		7,858,000		10,191,000		17,022,000
Total North Dakota		9,614,000		10,247,000		12,057,000		19,237,000

OHIO

Minera	1950 Short tons (unless otherwise stated)	1950 Value	1951 Short tons (unless otherwise stated)	1951 Value	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value
Cement ... 376-pound barrels	10,512,004	$24,012,983	11,872,278	$29,498,956	11,377.806	$28,488,500	12,532,437	$32,957,308
Clays	4,977,130	9,055,222	5,686,630	13.764,057	5,493,830	13,643.742	5,634,596	9,327,706
Lime (open-market)	2,142,344	26,273,098	2,289,473	29,046,196	2,205.432	28,393,260	2,945,800	35,310,353
Salt (common)	2,515,205	5,491,553	3,112,472	5,848,478	2,827,455	5,991,626	3,040,237	7.484,795
Sand and gravel	15,664,175	16,209,267	19.430,898	21,394,891	20,751.493	23,069,458	24.032,388	27,076,276
Stone (except limestone for cement and lime)	20,466,350	28,628,678	[6] 25,190,277	[6] 36,436,081	[6] 24,693,189	[6] 36,197,485	[6] 25,784,561	[6] 39,642,601
Undistributed: Abrasive stones, bromine (1950–51), calcium-magnesium chloride, gypsum, ground sand and sandstone, stone (crushed unclassified, 1951–52; dimension unclassified, 1952–53), and recovered elemental sulfur (1953). Excludes value of clays used for cement		[4] 1,835,225		[4] 1,850,746		[4] 1,664,191		1,225,540
Total		111,506,000		137,839,000		137,448,000		153,024,000
Total mineral fuels		163,066,000		164,773,000		155,241,000		149,819,000
Total Ohio		274,572,000		302,612,000		292,689,000		302,843,000

OKLAHOMA

Clays	555,910	$493,659	551,200	$561,841	520,050	$577,420	577,557	$637,082
Lead (recoverable content of ores, etc.)	20,724	5,595,480	16,575	5,734,950	15,137	4,874,114	9,304	2,437,648
Sand and gravel	3,286,834	2,356,853	3,183,251	2,321,653	3,769,663	2,911,845	4,701,366	3,969,585
Stone (except limestone for cement and lime)	5,021,660	4,848,223	6,966,676	6,917,548	[6] 9,636,475	[6] 8,974,334	8,404,483	7,467,247
Zinc (recoverable content of ores, etc.)	46,739	13,273,876	53,450	19,455,800	54,916	18,232,112	33,413	7,684,990
Undistributed: Cement, gypsum, lime, pumice and pumicite (1950, 1952–53), salt, ground sand and sandstone, stone (dimension limestone, 1952), and recovered elemental sulfur (1953). Excludes value of clays used for cement		[4] 8,881,438		[4] 9,429,811		[4] 11,718,372		11,173,307
Total		35,450,000		44,422,000		47,288,000		33,370,000
Total mineral fuels		491,645,000		563,064,000		574,063,000		644,790,000
Total Oklahoma		527,095,000		607,486,000		621,351,000		678,160,000

OREGON

Chromite ... gross weight			754	$62,972	6,591	$507,981	6,216	$484,453
Clays	163,148	$129,032	151,920	162,242	277,072	569,968	292,445	296,050
Copper (recoverable content of ores, etc.)	19	7,904	11	5,324	1	484	9	5,166
Gold (recoverable content of ores, etc.) ... troy ounces	11,058	387,030	7,927	277,445	5,509	192,815	8,488	297,080
Lead (recoverable content of ores, etc.)	17	4,590	2	692	1	322	5	1,310
Manganese ore (35 percent or more Mn) ... gross weight							46	(3)
Manganiferous ore (5 to 35 percent Mn) ... do							271	(3)
Mercury ... 76-pound flasks	5	406	1,177	247,323	868	172,819	648	125,083
Perlite	17,397	69,616	(3)	(3)	(3)	(3)	4,540	36,900
Pumice and pumicite	79,653	320,530	47,026	137,136	59,578	201,809	73,080	173,822
Sand and gravel	8,199,900	8,168,293	10,504,339	9,117,343	12,219,486	8,556,218	8,763,078	8,629,632
Silver (recoverable content of ores, etc.) ... troy ounces	13,565	12,277	6,218	5,628	4,037	3,654	12,259	11,095
Stone (except limestone for cement and lime)	[6] 3,836,550	[6] 5,559,010	8,721,799	10,831,483	6,250,849	8,893,368	[6] 4,939,080	[6] 6,301,639
Tungsten concentrate ... 60-percent WO_3 basis			1	2,795	4	15,960	(17)	(3)
Zinc (recoverable content of ores, etc.)	21	5,964	3	1,092	1	332		
Undistributed: Asbestos (1950–51), cement, diatomite, gem stones, lime (1950–52), quartz, stone (dimension and crushed granite, 1950 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		[4] 6,818,599		[4] 7,522,554		[4] 7,521,366		8,064,593
Total		21,483,000		28,374,000		26,637,000		24,427,000
Total mineral fuels		59,000		28,000		37,000		22,000
Total Oregon		21,542,000		28,402,000		26,674,000		24,449,000

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1950–53, by States [1]—Continued

PENNSYLVANIA

Mineral	1950		1951		1952		1953	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
Cement .... 376-pound barrels	39,450,611	$94,604,230	41,560,431	$107,035,506	40,037,761	$103,388,586	42,093,765	$114,002,846
Clays	3,482,194	8,815,318	4,230,567	14,087,550	3,731,130	12,639,864	3,575,422	9,988,133
Cobalt (content of ore) .... pounds	660,025	(3)	755,631	(3)	639,856	(3)	564,450	(3)
Copper (recoverable content of ores, etc.)	4,142	1,723,072	5,297	2,563,748	3,485	1,686,740	3,027	1,737,498
Gold (recoverable content of ores, etc.) .... troy ounces	1,764	61,740	2,179	76,265	1,500	52,500	1,134	39,690
Iron ore (usable) .... long tons, gross weight	1,116,338	11,626,216	1,215,033	(3)	992,110	(3)	1,020,826	(3)
Lime (open-market)	1,086,451	12,663,074	1,181,100	14,260,054	1,202,981	13,842,213	1,335,300	16,010,114
Sand and gravel	13,858,154	17,172,215	15,737,464	21,488,540	14,696,106	19,920,003	14,715,383	20,692,391
Sericite schist	----------	----------	----------	----------	----------	----------	2,463	[5] 4,926
Silver (recoverable content of ores, etc.) .... troy ounces	10,563	9,560	13,575	12,286	9,247	8,369	6,972	6,310
Slate	285,120	5,546,014	268,830	5,688,870	214,860	4,487,648	202,386	4,419,612
Stone (except limestone for cement and lime)	25,493,230	42,205,691	[6] 27,399,564	[6] 46,668,590	[6] 25,609,812	[6] 44,676,456	[6] 26,192,607	[6] 48,094,029
Undistributed: Graphite (crystalline, 1953), mica, pyrites, ground sand and sandstone, stone (dimension unclassified 1951, dimension basalt 1952–53), recovered elemental sulfur (1952–53), 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	----------	[4] 776,949	----------	[4] 14,685,221	----------	[4] 12,575,843	----------	14,076,911
Total	----------	195,204,000	----------	226,567,000	----------	[4] 213,278,000	----------	229,072,000
Total mineral fuels	----------	991,008,000	----------	1,062,659,000	----------	932,355,000	----------	892,550,000
Total Pennsylvania	----------	1,186,212,000	----------	1,289,226,000	----------	[4] 1,145,633,000	----------	1,121,622,000
RHODE ISLAND								
Sand and gravel	579,528	$580,322	534,785	$576,781	589,451	$557,396	898,393	$775,700
Stone	239,400	798,186	239,248	651,931	168,993	654,782	161,632	617,096
Undistributed: Nonmetallic minerals	----------	46,500	----------	48,945	----------	37,500	----------	69,000
Total Rhode Island	----------	1,425,000	----------	1,278,000	----------	1,250,000	----------	1,462,000

SOUTH CAROLINA

Clays	996,033	$5,026,692	949,270	$4,736,276	947,278	$4,675,261	964,356	$4,801,921
Sand and gravel	348,060	166,710	320,195	139,258	1,048,099	892,312	2,975,608	2,564,484
Stone	[6] 2,557,510	[6] 3,836,056	[6] 2,828,868	[6] 3,690,114	[6] 2,914,839	[6] 3,881,178	[6] 2,913,860	[6] 3,976,370
Undistributed: Barite, cement, kyanite, stone (crushed unclassified, 1950; dimension granite, 1951–53), and vermiculite. Excludes value of clays used for cement	----------	[4] 2,364,075	----------	[4] 2,878,338	----------	[4] 5,236,961	----------	6,428,135
Total South Carolina	----------	11,394,000	----------	[4] 11,444,000	----------	[4] 14,686,000	----------	17,771,000

SOUTH DAKOTA

Beryllium concentrate gross weight	96	$29,920	138	$46,007	334	$166,251	392	$157,656
Clays	295,492	2,275,320	381,611	3,061,988	292,791	2,640,640	330,983	2,826,074
Columbium-tantalum concentrate pounds	----------	----------	(3)	(3)	(3)	(3)	4,431	9,022
Feldspar long tons	43,875	249,176	48,559	290,520	40,163	220,954	50,601	321,026
Gold (recoverable content of ores, etc.) troy ounces	567,996	19,879,860	458,101	16,033,535	482,534	16,883,690	534,987	18,724,545
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	1,902	24,989	2,292	42,714	915	24,148	1,687	27,388
Sheet pounds	13,018	1,684	----------	----------	4,308	32,034	11,174	77,352
Sand and gravel	5,392,247	2,750,847	5,037,384	2,502,340	5,846,140	2,478,314	5,402,378	2,827,726
Silver (recoverable content of ores, etc.) troy ounces	142,065	128,576	139,590	126,336	132,102	119,559	138,642	125,478
Stone (except limestone for cement and lime)	[6] 1,205,910	[6] 4,860,858	1,263,322	4,660,074	1,671,187	4,806,882	[6] 1,189,418	[6] 4,996,197
Tungsten concentrate 60-percent WO_3 basis	----------	----------	----------	----------	(17)	335	2	(3)
Undistributed: Cement, lime, lithium minerals, stone (crushed unclassified, 1950, dimension miscellaneous, 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	----------	[4] 2,392,223	----------	[4] 2,788,356	----------	[4] 3,076,258	----------	3,723,387
Total	----------	32,593,000	----------	29,553,000	----------	30,455,000	----------	33,819,000
Total mineral fuels	----------	123,000	----------	99,000	----------	300	----------	82,000
Total South Dakota	----------	32,716,000	----------	29,652,000	----------	30,455,000	----------	33,901,000

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1950–53, by States[1]—Continued

TENNESSEE

Mineral	1950 Short tons (unless otherwise stated)	1950 Value	1951 Short tons (unless otherwise stated)	1951 Value	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value
Cement ... 376-pound barrels	6,663,427	$14,682,487	7,162,841	$17,203,080	7,428,604	$17,834,060	7,276,964	$18,283,366
Clays	1,101,550	3,329,137	1,160,571	3,296,495	1,042,239	3,519,143	1,037,450	3,478,622
Copper (recoverable content of ores, etc.)	6,851	2,850,016	7,069	3,421,396	[4] 7,620	[4] 3,688,080	7,829	4,493,846
Fluorspar			140	(3)	348	(3)	426	(3)
Gold (recoverable content of ores, etc.) ... troy ounces	160	5,600	108	3,780	241	8,435	293	10,255
Iron ore (usable) ... long tons, gross weight			35,908	142,447	(3)	(3)	12,751	82,499
Lead (recoverable content of ores, etc.)	113	30,510	14	4,844	18	5,796	9	2,358
Lime (open-market)	98,232	958,325	108,970	1,097,874	100,189	1,005,235	114,474	1,177,461
Manganese ore (35 percent or more Mn) ... gross weight	133	(3)			126	(3)	2,625	201,898
Phosphate rock[10] ... long tons	1,472,017	10,739,635	1,424,516	10,798,406	1,444,737	11,306,438	1,518,912	11,305,098
Sand and gravel	4,152,684	4,411,105	4,645,041	5,186,617	5,173,401	5,303,321	5,231,329	5,629,687
Silver (recoverable content of ores, etc.) ... troy ounces	39,958	36,164	24,960	22,590	57,569	52,103	68,935	62,390
Stone (except limestone for cement and lime)	7,978,590	13,802,288	[6] 8,838,796	[6] 14,765,988	10,377,320	17,652,763	[6] 10,485,351	[6] 16,948,053
Zinc (recoverable content of ores, etc.)	35,326	10,032,584	38,639	14,064,596	38,020	12,622,640	38,465	8,846,950
Undistributed: Barite, 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		[4] 2,128,638		[4] 3,040,648		[4] 2,333,399		2,324,412
Total		[4] 63,007,000		[4] 73,049,000		[4] 75,331,000		72,847,000
Total mineral fuels		27,398,000		26,998,000		25,601,000		25,203,000
Total Tennessee		[4] 90,405,000		[4] 100,047,000		[4] 100,932,000		98,050,000

TEXAS

Abrasive stone: Pebbles, grinding	343	$4,709	350	$4,710	510	$3,100	400	$5,500
Cement ... 376-pound barrels	17,281,521	39,677,804	17,642,654	42,648,536	19,849,455	48,042,901	19,140,193	48,497,762
Clays	2,039,277	4,015,391	2,217,053	4,944,965	2,069,020	4,470,182	2,370,975	4,678,974
Copper (recoverable content of ores, etc.)	2	832	1	483	18	8,712	----------	----------
Feldspar ... long tons	(3)	(3)	(3)	(3)	2,600	31,200	----------	----------
Fluorspar	719	(3)	----------	----------	----------	----------	----------	----------
Gold (recoverable content of ores, etc.) ... troy ounces	49	1,715	32	1,120	39	1,365	----------	----------
Gypsum	1,076,251	2,771,812	1,136,824	2,987,890	1,021,161	2,682,019	1,067,854	2,860,633
Iron ore (usable) ... long tons, gross weight	1,189,415	(3)	1,053,131	(3)	787,193	(3)	1,014,937	(3)
Lead (recoverable content of ores, etc.)	129	34,830	43	14,878	56	18,032	----------	----------
Lime (open-market)	216,439	2,074,367	279,957	2,532,387	281,604	2,622,975	475,569	4,380,831
Manganese ore (35 percent or more Mn) ... gross weight	----------	----------	----------	----------	56	(3)	----------	----------
Salt (common)	1,852,138	2,846,789	2,401,063	4,000,100	2,640,209	4,402,032	2,845,190	5,010,624
Sand and gravel	17,972,105	15,707,724	18,488,463	15,651,531	18,661,403	17,275,255	15,101,226	12,845,561
Silver (recoverable content of ores, etc.) ... troy ounces	2,454	2,221	1,381	1,250	4,672	4,228	----------	----------
Stone (except limestone for cement and lime)	[6] 4,893,150	[6] 5,580,463	[6] 7,351,069	[6] 7,626,122	7,604,468	8,664,633	[6] 9,095,109	[6] 8,550,320
Sulfur (Frasch-process) ... long tons	4,248,688	80,300,000	3,835,280	81,900,000	3,691,724	78,910,000	3,614,838	97,601,000
Sulfur, recovered elemental ... do	----------	----------	(3)	(3)	38,402	872,134	85,058	2,202,381
Talc and soapstone	(3)	(3)	(3)	(3)	[8] 17,800	[8] 216,569	[9] 16,210	[9] 70,658
Zinc (recoverable content of ores, etc.)	----------	----------	24	8,736	3	996	----------	----------
Undistributed: Bromine, gem stones, graphite, magnesium chloride (for metal), magnesium compounds (except for metal), mercury (1951 and 1953), pumice and pumicite, sodium sulfate, stone (crushed basalt, 1950–51 and 1953, dimension granite, 1950–51), and minerals whose value must be concrealed for particular years (indicated in appropriate column by footnote reference 3). Excludes value of clays used for cement	----------	[4] 17,434,880	----------	[4] 26,807,926	----------	[4] 31,391,991	----------	36,759,112
Total	----------	[4] 170,453,000	----------	[4] 189,131,000	----------	[4] 199,618,000	----------	223,463,000
Total mineral fuels	----------	2,504,003,000	----------	3,080,068,000	----------	3,180,195,000	----------	3,424,450,000
Total Texas	----------	[4] 2,674,456,000	----------	[4] 3,269,199,000	----------	[4] 3,379,813,000	----------	3,647,913,000

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1950–53, by States [1]—Continued

UTAH

Mineral	1950 Short tons (unless otherwise stated)	1950 Value	1951 Short tons (unless otherwise stated)	1951 Value	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value
Clays	303,078	$936,804	293,688	$1,277,763	189,723	$1,125,299	198,348	$1,457,515
Copper (recoverable content of ores, etc.)	278,630	115,910,080	271,086	131,205,624	282,894	136,920,696	269,496	154,690,704
Fluorspar	18,936	337,912	17,827	398,480	17,304	438,699	15,527	374,944
Gold (recoverable content of ores, etc.) troy ounces	457,551	16,014,285	432,216	15,127,560	435,507	15,242,745	483,430	16,920,050
Iron ore (usable) long tons, gross weight	3,111,167	5,746,808	4,637,239	10,141,653	3,990,505	15,025,899	4,617,288	26,496,950
Lead (recoverable content of ores, etc.)	44,753	12,083,310	50,451	17,456,046	50,210	16,167,620	41,522	10,878,764
Lime (open-market)	49,419	456,471	(3)	(3)	(3)	(3)	(4)	(3)
Manganese ore (35 percent or more Mn) gross weight	120	(3)	----------	----------	95	(3)	550	(3)
Manganiferous ore (5 to 35 percent Mn) do	3,041	(3)	1,369	(3)	3,397	(3)	5,155	82,316
Perlite	2,585	13,072	3,422	16,017	(3)	(3)	(3)	(3)
Pumice and pumicite	8,719	10,891	9,422	11,478	(3)	(3)	3,880	4,385
Salt (common)	116,694	511,938	131,444	570,379	136,125	522,721	154,088	772,035
Sand and gravel	3,435,277	2,251,515	2,971,268	2,268,750	3,260,044	2,350,412	4,627,808	3,179,690
Silver (recoverable content of ores, etc.) troy ounces	7,083,808	6,411,204	7,310,665	6,616,521	7,194,109	6,511,032	6,725,807	6,087,195
Stone (except limestone for cement and lime)	929,410	880,667	1,226,710	1,291,118	[6] 852,351	[6] 1,123,108	997,330	1,446,594
Tungsten concentrate 60-percent WO_3 basis	----------	----------	(3)	565	3	9,449	35	123,445
Zinc (recoverable content of ores, etc.)	31,678	8,996,552	34,317	12,491,388	32,947	10,938,404	29,184	6,712,320
Undistributed: Cement, diatomite (1950), gypsum, molybdenum, phosphate rock (1950–51 and 1953), potassium salts, quartz crystal (1950), stone (crushed marble, 1952), vanadium, and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3). Excludes value of clays used for cement	----------	[4] 22,497,331	----------	[4] 20,521,351	----------	[4] 20,878,578	----------	24,549,545
Total	----------	[4] 193,059,000	----------	219,395,000	----------	[4] 227,255,000	----------	253,776,000
Total mineral fuels	----------	36,907,000	----------	37,750,000	----------	38,246,000	----------	44,853,000
Total Utah	----------	[4] 229,966,000	----------	257,145,000	----------	[4] 265,501,000	----------	298,629,000

VERMONT

Copper (recoverable content of ores, etc.)	3, 504	$1, 457, 664	3, 774	$1, 826, 616	3, 774	$1, 826, 616	3, 947	$2, 265, 578
Gold (recoverable content of ores, etc.) troy ounces	146	5, 110	156	5, 460	162	5, 670	171	5, 985
Lime (open-market)	32, 843	415, 910	32, 179	432, 483	(3)	(3)	(3)	(3)
Pyrites long tons					17, 892	(3)	(3)	(3)
Sand and gravel	1, 040, 977	661, 994	965, 702	646, 702	1, 264, 490	749, 835	1, 113, 607	690, 073
Silver (recoverable content of ores, etc.) troy ounces	28, 205	25, 527	41, 300	37, 379	45, 361	41, 054	43, 128	39, 033
Slate	238, 740	4, 471, 869	(3)	(3)	(3)	(3)	(3)	(3)
Stone (except limestone for lime)	447, 310	8, 038, 892	450, 980	7, 253, 824	404, 391	6, 016, 530	527, 150	8, 859, 703
Talc	[8] 72, 135	[8] 906, 396	[8] 78, 694	[8] 998, 792	71, 027	[8] 926, 646	[9] 80, 209	[9] 240, 627
Undistributed: Asbestos, clays, and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)		[4] 2, 579, 909		[4] 7, 315, 198		[4] 8, 324, 329		8, 201, 333
Total Vermont		18, 563, 000		18, 516, 000		17, 891, 000		20, 302, 000

VIRGINIA

Clays	681, 381	$621, 189	775, 245	$825, 097	940, 496	$996, 351	952, 266	$927, 571
Feldspar long tons	26, 879	188, 153	30, 979	232, 099	(3)	(3)	(3)	(3)
Iron ore (usable) long tons, gross weight	5, 245	(3)	7, 248	(3)	(3)	(3)	(3)	(3)
Lead (recoverable content of ores, etc.)	3, 254	878, 580	1, 508	521, 768	3, 792	1, 221, 024	2, 788	730, 456
Lime (open-market)	428, 339	3, 861, 932	452, 680	4, 551, 656	442, 845	4, 448, 924	477, 384	4, 947, 418
Manganese ore (35 percent or more Mn) gross wieght	56	(3)			1, 011	(3)	8, 454	635, 926
Marl, calcareous (except for cement)	52, 181	53, 861	(3)	(3)	(3)	(3)	(3)	(3)
Sand and gravel	4, 373, 984	4, 144, 846	5, 772, 781	5, 750, 409	7, 136, 112	5, 556, 953	5, 276, 350	5, 160, 564
Silver (recoverable content of ores, etc.) troy ounces							1, 169	1, 058
Stone (except limestone for cement and lime)	9, 272, 740	16, 434, 602	9, 277, 252	16, 621, 116	9, 670, 961	16, 969, 952	9, 091, 907	16, 258, 620
Zinc (recoverable content of ores, etc.)	12, 396	3, 520, 464	7, 332	2, 668, 848	13, 409	4, 451, 788	16, 676	3, 835, 480
Undistributed: Abrasive stones (millstones 1950), aplite, cement, gypsum, kyanite, mica, pyrites, salt, ground sand and sandstone, slate, 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		[4] 11, 070, 101		[4] 14, 053, 092		[4] 15, 863, 790		17, 485, 609
Total		40, 774, 000		45, 224, 000		49, 509, 000		49, 983, 000
Total mineral fuels		97, 032, 000		116, 028, 000		115, 170, 000		102, 996, 000
Total Virginia		137, 806, 000		161, 252, 000		164, 679, 000		152, 979, 000

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1950–53, by States [1]—Continued

WASHINGTON

Minera	1950		1951		1952		1953	
	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)	25	$300	28	$336	20	$240	(3)	(3)
Pulpstones	33	2,100	22	1,970	12	908		
Antimony ore and concentrate gross weight			110	(3)	100	(3)		
Clays	283,459	301,781	286,364	366,808	291,134	352,576	259,421	$312,141
Copper (recoverable content of ores, etc.)	5,057	2,103,712	4,089	1,979,076	4,357	2,108,788	3,740	2,146,760
Epsomite					(3)	(3)	200	8,000
Gold (recoverable content of ores, etc.) troy ounces	92,117	3,224,095	67,405	2,359,175	54,776	1,917,160	62,560	2,189,600
Gypsum	(3)	(3)	(3)	(3)	7,900	29,625	3,800	14,250
Lead (recoverable content of ores, etc.)	10,334	2,790,180	8,002	2,768,692	11,744	3,781,568	11,064	2,898,768
Manganese ore (35 percent or more Mn) gross weight					436	(3)	(3)	(3)
Manganiferous ore (5 to 35 percent Mn) do					142	(3)		
Olivine	40	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Pumice and pumicite	11,013	22,672	5,105	10,832	3,604	8,089	(3)	(3)
Sand and gravel	10,605,791	7,435,340	10,546,949	7,595,837	13,322,279	9,422,117	11,182,835	9,317,793
Silver (recoverable content of ores, etc.) troy ounces	363,656	329,127	334,948	303,145	315,645	285,675	321,202	290,704
Stone (except limestone for cement and lime)	4,930,820	5,734,563	5,029,735	5,664,433	4,523,234	5,491,525	4,438,259	5,890,849
Talc and soapstone	(3)	(3)	(3)	(3)	(3)	(3)	5,351	28,833
Tungsten concentrate 60-percent WO_3 basis			9	33,417	4	14,008	5	19,710
Zinc (recoverable conent of ores, etc.)	14,807	4,205,188	18,189	6,620,796	20,102	6,673,864	32,786	7,540,780
Undistributed: Barite (1953), cement, diatomite (1950, 1952–53), gem stones, lime, magnesite, quartz, ground sand and sandstone, recovered elemental sulfur (1950), 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		[4] 17,027,431		[4] 20,691,457		[4] 19,927,089		18,722,830
Total		43,176,000		48,396,000		[4] 50,013,000		49,381,000
Total mineral fuels		5,879,000		6,158,000		6,126,000		5,196,000
Total Washington		49,055,000		54,554,000		[4] 56,139,000		54,577,000

WEST VIRGINIA

Clays	675,101	$1,004,420	1,103,646	$2,295,026	982.030	$2.421,669	968,838	$2,488,938
Salt (common)	367,942	1,238,588	379,299	1,314,818	392,519	1,438,490	419,907	1,490.592
Sand and gravel	3,613.046	6,241,057	4,735,271	8,314,195	4,120,105	7,275,370	3,162,776	6,070,847
Stone (except limestone for cement and lime)	[6] 5,367,510	[6] 7,825,653	[6] 5,754,378	[6] 8,472,639	[6] 4,869,442	[6] 6,826,113	[6] 5,501,148	[6] 8,924,411
Undistributed: Abrasive stones, bromine, calcium-magnesium chloride, cement, lime calcareous marl, ground sand and sandstone, stone (dimension limestone), and recovered elemental sulfur. Excludes value of clays used for cement		[4] 10,592,155		[4] 12,629,965		[4] 11,838,988		11,974,948
Total		[4] 26,902,000		[4] 33,026,000		[4] 29,801,000		30,950,000
Total mineral fuels		802,731,000		908,722,000		795,932,000		759,160,000
Total West Virginia		[4] 829,633,000		[4] 941,748,000		[4] 825,733,000		790,110,000

WISCONSIN

Abrasive stone: Pebbles (grinding)	530	$10,600	1,327	$26,540	723	$17,352	(3)	(3)
Clays	162,611	132,056	141,746	141,746	134,453	134,493	175,311	$175,276
Iron ore (usable) long tons, gross weight	1,701,619	(3)	1,745,120	(3)	1,485,845	(3)	1,655,331	(3)
Lead (recoverable content of ores, etc.)	532	143,640	1,391	481,286	2,000	644,000	2,094	548,628
Lime (open-market)	124,530	1,448,095	124,852	1,562,200	107,813	1,368,556	123,997	1,566,085
Marl, calcareous (except for cement)	22,025	13,931	20,625	12,925	17,000	8,833	15,871	7,327
Sand and gravel	19,117,115	11,959,012	19,391,772	12,392,464	24,895,947	16,938,228	23,656,086	16,173,302
Stone (except limestone for cement and lime)	6,999,630	14,494,750	7,609,323	14,671,858	8,578,882	16,754,675	7,450,396	16,039,183
Zinc (recoverable content of ores, etc.)	5,722	1,625,048	15,754	5,734,456	20,588	6,835,216	16,830	3,870,900
Undistributed: Abrasive stones (tube-mill liners), cement, quartz (1951-53), ground sand and sandstone, 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		[4] 11,855,856		[4] 13,321,829		[4] 13,004,868		16,888,902
Total		41,683,000		48,345,000		55,706,000		55,269.000
Total mineral fuels		10,000		5,000		4,000		2,000
Total Wisconsin		41,693,000		48,350,000		55,710,000		55,271,000

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1950–53, by States [1]—Continued

WYOMING

Mineral	1950		1951		1952		1953	
	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	413,271	$4,102,122	483,050	$5,999,451	706,748	$9,176,507	852,651	$10,036,727
Copper (recoverable content of ores, etc.)							1	574
Gold (recoverable content of ores, etc.) troy ounces			9	315	1	35	1	35
Gypsum	(3)	(3)	(3)	(3)	(3)	(3)	5,493	21,972
Iron ore (usable) long tons, gross weight	491,906	(3)	616,949	(3)	484,945	(3)	654,285	(3)
Phosphate rock [10] long tons	(3)	(3)	166,156	1,088,822	186,715	1,247,256	(3)	(3)
Pumice	1,460	6,353	1,867	9,141	2,851	10,918	648	1,898
Sand and gravel	1,937,943	1,251,220	2,347,078	1,730,900	2,426,999	1,738,548	3,149,376	2,001,197
Silver (recoverable content of ores, etc.) troy ounces			2	2			11	10
Stone (except limestone for cement)	1,841,400	2,214,037	1,645,475	1,857,267	1,466,567	1,688,890	1,431,372	1,839,922
Vermiculite	(3)	(3)	(3)	(3)	(3)	(3)	403	2,418
Undistributed: Cement, feldspar (1953), gem stones, manganiferous ores (1953), sodium carbonate and sulfate, sulfur ore, recovered elemental sulfur, 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		[4] 4,961,465		[4] 8,025,379		[4] 6,343,624		11,061,721
Total		[4] 12,535,000		[4] 18,711,000		[4] 20,206,000		24,966,000
Total mineral fuels		165,209,000		185,646,000		186,622,000		230,940,000
Total Wyoming		[4] 177,744,000		[4] 204,357,000		[4] 206,828,000		255,906,000

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers). Excludes uranium and monazite.
[2] Excludes puzzolan cement, value for which is included with "Undistributed."
[3] Value included with "Undistributed."
[4] Revised figure.
[5] Estimate.
[6] Excludes certain stone, value for which is included with "Undistributed."
[7] Weight not recorded.
[8] Sold or used by producers. Quantity and value of ground material included.
[9] Mine production of crude material.
[10] 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.
[11] Final figure. Supersedes preliminary figure given in commodity chapter.
[12] "Commercial." Value of "Noncommercial" included with "Undistributed."
[13] Includes value of nonmetallic minerals; excludes value of clays used for cement.
[14] Excludes natural cement, value for which is included with "Undistributed."
[15] "Noncommercial." Value of "Commercial" included with "Undistributed."
[16] Value reported for zinc in New Jersey in 1950–52 is estimated smelting value of recoverable zinc content of ore after freight, haulage, smelting, and manufacturing charges are added. In 1953, the recoverable zinc is valued at the yearly average price of Prime Western slab zinc, East St. Louis market.
[17] Less than 1 ton.

TABLE 6.—Mineral production in Territories of the United States, 1950–53, by individual minerals

Territory and mineral	1950		1951		1952		1953	
	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	(1)	420	(1)		
Copper (recoverable content of ores, etc.)	6	$2,496	[2] 1	$387				
Gold (recoverable content of ores, etc.) ... troy ounces	289,272	10,124,520	239,637	8,387,295	240,557	$8,419,495	253,783	$8,882,405
Lead (recoverable content of ores, etc.)	149	40,230	[2] 21	7,266	1	386	9	2,240
Mercury ... 76-pound flasks					28	5,575	40	7,721
Sand and gravel	3,050,020	2,377,407	6,887,646	3,738,516	10,781,926	8,650,582	7,689,278	5,079,681
Silver (recoverable content of ores, etc.) ... troy ounces	52,638	47,640	32,870	29,749	32,986	29,854	35,387	32,027
Stone					(1)	(1)	47,086	169,711
Tin (content of ore and concentrate) ... long tons	79	170,281	69	197,163	82	220,956	49	105,917
Tungsten concentrate ... 60-percent WO_3 basis	13	(1)	10	(1)	8	(1)	3	(1)
Zinc (recoverable content of ores, etc.)	6	1,704	[2] 1	218				
Undistributed: Gem stones (1952-53), platinum group metals, pumice (1950), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 1)		2,054,735		3,441,090		3,195,336		1,520,782
Total		14,819,000		15,802,000		20,523,000		15,800,000
Total mineral fuels		3,033,000		3,767,000		5,780,000		8,452,000
Total Alaska		17,852,000		19,569,000		26,302,000		24,252,000
Hawaii:								
Lime (open-market)	8,141	219,861	8,740	236,052	8,894	240,786	7,431	223,575
Sand and gravel			2,561	5,710	111,716	143,541	110,558	156,853
Stone	696,310	1,554,906	[3] 650,094	[3] 1,337,474	705,994	1,545,301	[3] 1,299,501	[3] 2,654,358
Undistributed: Other nonmetallic minerals				147,063		17,164		297,474
Total Hawaii		1,775,000		1,726,000		1,947,000		3,332,000
Total Territories		19,627,000		21,295,000		28,249,000		27,584,000

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

TABLE 7.—Mineral production in possessions of the United States, 1950–53, by individual minerals

Possession and mineral	1950		1951		1952		1953	
	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							1,320	$425
Stone							74,750	16,500
Total American Samoa								17,000
Canal Zone:								
Sand and gravel [1] [2]	22,000	$15,000	32,000	$26,000	56,600	$53,000	85,914	95,500
Stone (crushed) [1] [2]	53,000	83,000	55,500	112,000	86,000	152,000	171,908	231,752
Total Canal Zone		98,000		138,000		205,000		327,000
Canton: Stone (crushed) [1]	(3)	(3)	360	900	150	375	4,200	8,750
Guam: Stone [1]	[2] 1,528,000	[2] 3,055,000	720,000	675,000	948,000	870,000	2,080,650	5,573,169
Midway: Stone (crushed) [1]	(3)	(3)	(3)	(3)	7,200	[4] 6,000	204	638
Puerto Rico:								
Cement ... 376-pound barrels	3,187,451	8,299,186	4,297,583	11,252,350	3,994,483	10,517,894	3,641,135	9,335,421
Iron ore (usable) ... long tons			39,219	225,509	138,613	797,025		
Lime (open-market)	8,166	180,828	10,350	191,415	8,575	195,000	7,338	157,467
Salt (common)	13,545	137,225	10,566	119,338	12,676	122,158	13,692	131,490
Sand and gravel	101,013	103,806	99,628	99,657	122,730	164,166	226,586	250,202
Stone	[5] 250,010	[5] 574,709	283,697	613,751	[5] 689,320	[5] 1,807,388	[5] 648,400	[5] 1,237,236
Undistributed: Other nonmetallic minerals		1,375				6,328		44,466
Total Puerto Rico		9,297,000		12,502,000		13,610,000		11,156,000
Virgin Islands: Stone (crushed) [1] [2]	[6] 2,540	[4] [6] 4,000	11,600	47,300	12,900	51,900	10,789	45,853
Wake: Stone (crushed) [1]	(3)	(3)	240	600	4,260	8,000	11,980	20,615
Total		12,454,000		13,364,000		14,751,000		17,149,000

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

TABLE 8.—Principal minerals imported for consumption in the United States, 1952–53

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	1952		1953	
	Short tons (unless otherwise stated)	Value (thousand dollars)	Short tons (unless otherwise stated)	Value (thousand dollars)
METALLIC				
Aluminum:				
Metal	128,233	43,505	300,928	115,761
Scrap	6,998	2,592	26,621	8,072
Plates, sheets, bars, etc	15,507	8,551	31,932	18,637
Antimony:				
Ore (antimony content)	7,945	3,201	7,778	2,035
Needle or liquated	34	21	17	9
Metal	3,354	2,339	2,612	1,402
Oxide	1,766	1,056	1,296	580
Arsenic: White	4,483	548	4,717	574
Bauxite:				
Crude ... long tons	3,497,939	23,194	4,388,623	29,588
Calcined, when imported for manufacture of fire brick ... long tons	31,412	705	91,606	2,116
Beryllium ore	5,978	2,548	8,245	3,881
Bismuth ... pounds	708,254	1,452	641,428	1,273
Boron carbide ... do	31,365	47	72,526	122
Cadmium:				
Metal ... do	1,478,770	2,627	1,555,140	2,674
Flue dust ... do	1,991,549	2,447	1,863,538	1,587
Calcium:				
Metal ... do	751,215	808	990,017	1,010
Chloride	1,333	46	2,671	85
Chromite:				
Ore and concentrates (Cr_2O_3 content)	716,485	38,595	942,625	56,041
Ferrochrome (chromium content)	12,105	4,851	20,604	10,398
Metal	151	255	177	300
Cobalt:				
Alloy (cobalt content) ... pounds	2,841,210	(1)	2,412,804	(1)
Ore (cobalt content) ... do	17,384	2	51,323	88
Metal ... do	12,014,920	27,291	14,431,894	33,203
Oxide (gross weight) ... do	386,935	621	610,054	980
Salts and other compounds (gross weight) ... do	12,759	11	273,286	173
Columbium ore ... do	1,878,135	2,369	4,192,694	6,905
Copper (copper content):				
Ore	3,666	1,976	5,560	3,058
Concentrates	96,563	52,620	96,448	53,007
Regulus, black, coarse	4,025	2,554	6,547	4,041
Unrefined, black, blister	173,425	106,325	279,242	179,226
Refined in ingots, etc	347,338	227,214	274,110	182,190
Old and scrap	5,125	2,559	7,827	4,018
Old brass and clippings	7,627	3,765	7,503	3,738
Ferroalloys: Ferrosilicon	2,235	672	2,206	835
Gold:				
Ore and base bullion ... troy ounces	630,714	22,272	661,696	23,112
Bullion ... do	20,508,873	717,894	682,261	23,878
Iron ore:				
Ore ... long tons	9,760,625	82,855	11,074,035	96,812
Pyrites cinder ... do	11,149	48	12,053	54
Iron and steel:				
Pig iron	380,200	19,847	589,825	25,967
Iron and steel products (major):				
Semimanufactures	528,674	64,896	868,498	100,009
Manufactures	701,936	120,144	871,490	119,404
Scrap	105,896	4,054	130,079	4,734
Tinplate scrap	47,778	1,345	42,092	1,115
Lead:				
Ore, flue dust, matte (lead content)	107,621	32,768	67,030	15,214
Base bullion (lead content)	2,951	1,138	742	294
Pigs and bars (lead content)	510,718	165,019	379,119	95,285
Reclaimed, scrap, etc. (lead content)	11,358	3,199	3,660	825
Sheets, pipe, and shot	11	8	178	58
Babbitt metal and solder (lead content)	990	1,348	1,343	1,869
Type metal and antimonial lead (lead content)	9,415	4,154	5,016	1,921
Manufactures	------------	222	------------	243

For footnotes, see end of table.

TABLE 8.—Principal minerals imported for consumption in the United States, 1952–53—Continued

Mineral	1952		1953	
	Short tons (unless otherwise stated)	Value (thousand dollars)	Short tons (unless otherwise stated)	Value (thousand dollars)
METALLIC—continued				
Magnesium:				
Metallic and scrap	252	82	2,443	877
Alloys (magnesium content)	1	2	3	16
Sheets, tubing, ribbons, wire and other forms (magnesium content)	47	88	5	20
Manganese:				
Ore (35 percent or more manganese) (manganese content)	1,001,068	65,835	1,393,000	103,512
Ferromanganese (manganese content)	51,029	14,759	98,207	27,181
Spiegeleisen, less than 30 percent manganese, more than 1 percent carbon (manganese content)	44	4	785	63
Mercury:				
Compounds ... pounds	25,019	58	29,891	78
Metal ... flasks	71,855	12,547	83,393	13,569
Minor metals: Selenium and salts ... pounds	123,135	564	99,865	457
Molybdenum: Ore and concentrates (molybdenum content)	25	41		
Nickel:				
Ore and matte ... pounds	28,859,693	4,995	29,209,949	5,794
Pigs, ingots, shot, cathodes ... do	159,076,885	89,323	169,438,621	102,482
Scrap ... do	1,093,455	127	1,730,580	289
Oxide ... do	48,807,136	18,558	63,700,065	26,286
Platinum group:				
Unrefined materials:				
Ore and concentrates ... troy ounces	689	107	1,200	30
Grain and nuggets, including crude, dust, and residues ... troy ounces	27,567	2,105	46,262	3,444
Sponge and scrap ... do	4,305	386	795	70
Osmiridium ... do	2,792	232	1,814	175
Refined metal:				
Platinum ... do	202,912	16,749	340,632	29,325
Palladium ... do	200,502	4,170	227,080	4,548
Iridium ... do	4,718	782	1,643	252
Osmium ... do	594	138	583	67
Rhodium ... do	6,151	688	12,224	1,315
Ruthenium ... do	2,588	178	3,291	210
Radium:				
Radium salts ... milligrams	173,711	2,874	96,750	1,662
Radioactive substitutes		86		175
Rare earths: Ferrocerium and other cerium alloy ... pounds	6,038	44	4,211	18
Silver:				
Ore and base bullion ... troy ounces	30,779,137	26,278	37,685,219	31,950
Bullion ... do	44,737,809	38,252	43,824,916	37,220
Tantalum: Ore	328,866	399	752,795	1,208
Tin:				
Ore (tin content) ... long tons	26,491	65,287	35,973	82,713
Blocks, pigs, grains, etc ... do	80,543	215,603	74,538	175,858
Dross, skimmings, scrap, residues, and tin alloys, n. s. p. f ... pounds	18,351,019	17,454	15,898,269	11,878
Tinfoil, powder, flitters, etc		448		606
Titanium:				
Ilmenite	184,013	2,478	286,644	5,464
Rutile	19,394	1,729	16,098	1,791
Metal ... pounds	544	3	71,309	269
Ferrotitanium ... do	223,917	117	344,337	115
Compounds and mixtures ... do	72,470	18	180,035	24
Tungsten:				
Ore and concentrates (tungsten content) ... do	17,416,368	57,060	27,923,573	91,050
Metal (tungsten content) ... do	2,264	7	66,546	225
Ferrotungsten (tungsten content) ... do	478,695	1,151	603,299	1,687
Other (tungsten content) ... do	5,717	17	147,948	343
Vanadium:				
Ore (vanadium content) ... do	1,043,797	599	716,977	421
Flue dust (vanadium content) ... do	939	2	1,010	2
Ferrovanadium ... do	21,396	22	17,364	13
Salts and compounds ... do	(3)	(3)	3,090	2

For footnotes, see end of table.

TABLE 8.—Principal minerals imported for consumption in the United States, 1952–53—Continued

Mineral	1952		1953	
	Short tons (unless otherwise stated)	Value (thousand dollars)	Short tons (unless otherwise stated)	Value (thousand dollars)
METALLIC—continued				
Zinc:				
Ores (zinc content)	542,314	105,429	449,391	47,918
Blocks, pigs, and slabs	113,053	36,220	227,654	50,282
Sheets	47	24	196	77
Old, dross, and skimmings	3,489	535	5,915	557
Dust	133	39	1,045	162
Manufactures	----------	12	----------	6
Zirconium: Ore, including zirconium sand	23,907	631	24,667	572
NONMETALLIC				
Abrasives: Diamonds (industrial) carats	13,705,258	52,302	13,522,676	49,249
Asbestos	709,469	61,605	702,838	59,857
Barite:				
Crude and ground	114,538	1,041	335,047	2,523
Witherite	5,174	184	4,928	179
Chemicals	1,356	215	6,073	507
Bromine pounds	2,387	12	575	41
Cement 376-pound barrels	475,986	1,397	386,051	1,266
Clays:				
Raw	141,782	1,882	146,851	2,142
Manufactured	1,274	35	2,260	53
Cryolite long tons	34,262	3,125	26,301	3,528
Feldspar: Crude do	5,576	53	5,901	61
Fluorspar	352,503	10,528	361,219	11,551
Gem stones:				
Diamonds carats	1,147,589	103,864	1,177,877	107,561
Emeralds do	19,952	472	42,513	349
Other	----------	20,363	----------	22,273
Graphite	42,786	2,860	51,323	2,809
Gypsum:				
Crude, ground, calcined	3,088,738	3,278	3,185,180	4,320
Manufactures	----------	416	----------	472
Iodine, crude pounds	791,208	1,363	957,638	1,606
Jewel bearings number	98,021,914	4,227	86,892,637	3,708
Kyanite	9,057	391	6,620	288
Lime:				
Hydrated	109	3	2,177	31
Other	21,557	378	31,149	507
Dead-burned dolomite	2,342	124	3,876	259
Magnesium:				
Magnesite	26,504	1,236	42,010	2,574
Compounds	5,412	308	7,551	318
Mica:				
Uncut sheet and punch pounds	2,481,669	3,521	2,599,007	4,279
Scrap	6,531	106	3,927	72
Manufactures	5,276	11,054	5,763	10,911
Mineral-earth pigments:				
Iron oxide pigments:				
Natural	2,388	119	2,716	123
Synthetic	3,317	432	4,531	523
Ocher, crude and refined	798	47	177	9
Siennas, crude and refined	566	50	700	60
Umber, crude and refined	1,603	44	2,725	78
Vandyke brown	119	7	164	9
Nitrogen compounds (major)	1,672,198	82,567	2,189,725	105,724
Phosphate, crude long tons	110,197	2,332	101,171	2,545
Phosphatic fertilizers do	72,926	4,903	25,478	1,304
Pigments and salts:				
Lead pigments and salts	1,179	500	83	22
Zinc pigments and salts	525	180	1,464	316
Potash	357,437	12,714	253,113	9,941
Pumice:				
Crude or unmanufactured	21,986	135	32,712	166
Whole or partly manufactured	478	10	943	20
Manufactures, n. s. p. f.	----------	6	----------	5
Quartz crystal (Brazilian pebble) pounds	1,576,791	2,885	1,320,683	2,255
Salt	7,056	44	137,308	473

TABLE 8.—Principal minerals imported for consumption in the United States, 1952–53—Continued

Mineral	1952		1953	
	Short tons (unless otherwise stated)	Value (thousand dollars)	Short tons (unless otherwise stated)	Value (thousand dollars)
NONMETALLIC—continued				
Sand and gravel:				
Glass sand	4,016	24	5,690	114
Other sand	300,182	345	313,176	330
Gravel	104,332	14	87,028	10
Sodium sulfate	55,927	944	61,198	1,082
Stone		3,855		5,073
Strontium: Mineral	9,517	186	6,897	124
Sulfur and pyrites:				
Sulfur:				
Ore ... long tons	4,829	99	525	18
Other forms, n. e. s. ... do	34	8	704	33
Pyrites ... do	296,047	882	190,474	664
Talc: Unmanufactured	20,302	727	22,803	717

[1] Data not available.
[2] Less than 1 ton.
[3] Less than $1,000.

TABLE 9.—Principal minerals and products exported from the United States, 1952–53

[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	1952		1953	
	Short tons (unless otherwise stated)	Value (thousand dollars)	Short tons (unless otherwise stated)	Value (thousand dollars)
METALLIC				
Aluminum:				
Ingots, slabs, crude	1,388	519	2,376	937
Scrap	1,027	164	4,581	1,476
Plates, sheets, bars, etc	7,847	5,854	7,764	6,107
Castings and forgings	352	780	622	1,661
Antimony:				
Ores and concentrates	25	13	----------	----------
Metals and alloys, crude	140	124	24	23
Arsenic: Calcium arsenate pounds	5,606,613	458	3,890,246	273
Bauxite, including bauxite concentrates long tons	41,330	845	27,907	886
Aluminum sulfate	19,743	706	14,373	534
Other aluminum compounds	4,152	736	6,084	931
Beryllium pounds	20,014	68	19,331	90
Bismuth:				
Metals and alloys do	244,797	635	117,322	238
Salts and compounds do	233,211	741	51,570	247
Cadmium do	300,918	1,005	65,866	60
Calcium chloride	19,193	595	11,572	371
Chrome:				
Ore and concentrates:				
Exports	1,531	73	1,166	56
Reexports	21,265	1,153	6,071	252
Chromic acid	311	179	312	171
Ferrochrome	1,274	519	607	286
Cobalt pounds	61,288	209	382,630	361
Columbium metals alloys and other forms do	4	(1)	9	(1)
Copper:				
Ores, concentrates, composition metal, and unrefined copper (copper content)	648	495	495	290
Refined copper and semimanufactures	212,390	155,121	171,323	116,171
Other copper manufactures	(2)	211	294	352
Copper sulfate or blue vitriol	43,421	8,483	32,659	6,250
Copper-base alloys	----------	22,127	----------	32,964
Ferroalloys:				
Ferrosilicon pounds	14,479,263	1,439	3,395,617	288
Ferrophosphorus do	88,702,822	2,592	45,918,473	1,148
Gold:				
Ore and base bullion troy ounces	1,835	64	1,124	41
Bullion, refined do	782,526	29,037	853,126	32,319
Iron ore long tons	5,122,644	37,404	4,251,364	32,410
Iron and steel:				
Pig iron	14,085	719	18,837	1,074
Iron and steel products, (major):				
Semimanufactures	2,771,898	390,147	1,813,543	281,314
Manufactured steel mill products	1,641,333	319,036	1,512,828	297,065
Advanced products	----------	58,033	----------	55,783
Iron and steel scrap: Ferrous scrap, including rerolling materials	352,710	12,500	316,542	11,219
Lead:				
Ore, matte, base bullion (lead content)	836	288	1,038	269
Pigs, bars, anodes:				
Exports	1,762	733	803	263
Reexports	2	1	799	188
Scrap	75	18	2,706	523
Magnesium:				
Metal and alloys	1,066	618	2,722	1,718
Semifabricated forms, n. e. c.	97	245	227	771
Powder	43	60	21	42
Manganese:				
Ore and concentrates	9,749	504	6,894	552
Ferromanganese	1,453	475	1,112	389
Mercury:				
Exports flasks	400	86	546	106
Reexports do	259	47	916	158

For footnotes, see end of table.

TABLE 9.—Principal minerals and products exported from the United States, 1952–53—Continued

Mineral	1952 Short tons (unless otherwise stated)	1952 Value (thousand dollars)	1953 Short tons (unless otherwise stated)	1953 Value (thousand dollars)
METALLIC—continued				
Molybdenum:				
Ores and concentrates pounds	6,171,932	6,792	7,037,436	7,308
Metals and alloys, crude and scrap do	172,285	133	21,826	13
Wire do	14,605	204	15,980	235
Primary forms, mainly rods, sheets, and tubes do	8,040	60	13,078	21
Powder do	4,096	13	17,290	46
Ferromolybdenum do	1,090,104	925	646,411	549
Nickel:				
Alloys and scrap (including Monel metal) do	11,648,169	6,163	22,846,005	8,868
Ingots, bars, sheet, etc do	1,966,621	364	6,578,740	806
Nickel-chrome electric resistance wire do	267,473	483	356,222	609
Manufactures do	(2)	503	555,993	936
Platinum:				
Ores and concentrates troy ounces			30	(1)
Bars, ingots, sheets, wire, sponge, and other forms including scrap troy ounces	6,026	568	2,522	238
Palladium, rhodium, iridium, osmiridium, ruthenium, and osmium metals and alloys, including scrap troy ounces	17,697	513	23,206	591
Platinum-group manufactures, except jewelry		1,187		1,555
Radium metal (radium content) milligrams	1,143	25	1,056	35
Rare earths:				
Cerium ores, metal and alloy pounds	48,633	209	83,659	278
Lighter flints do	6,317	44	11,254	70
Silver: Bullion, refined troy ounces	2,004,933	1,733	1,022,773	871
Tantalum:				
Ore, metal, and other forms pounds	2,418	125	172,246	119
Powder do	14	(1)	62	3
Tin:				
Ingots, pigs, bars, etc.:				
Exports long tons	301	581	128	298
Reexports do	79	210	75	142
Tin scrap and other tin-bearing material except tin-plate scrap	7,077	2,087	5,865	2,418
Tin cans finished or unfinished long tons	41,624	16,843	29,841	12,917
Tin compounds pounds	73,131	113	183,328	353
Titanium:				
Ores and concentrates	870	111	3,233	128
Metal and alloys in crude form and scrap	762	31	1,137	26
Semifabricated forms, n. e. c	3	39	31	796
Ferrotitanium	325	89	185	49
Dioxide and pigments	35,636	10,692	39,780	11,716
Tungsten: Ores and concentrates:				
Exports	11	46	13	31
Reexports	3	13	22	61
Vanadium ore and concentrates (vanadium content) pounds	120,367	280		
Zinc:				
Ore, concentrates, dross (zinc content)	3,370	899	2,953	759
Slabs, pigs or blocks	57,714	24,509	17,859	4,592
Sheets, plates, strips or other forms, n. e. s	4,231	2,961	4,628	2,637
Scrap (zinc content)	972	283	1,000	170
Dust	(3)	(3)	502	181
Semifabricated forms, n. e. c	(2)	192	286	151
Zirconium:				
Ores and concentrates	584	42	1,110	89
Metals and alloys and other forms pounds	51,151	43	6,745	9
NONMETALLIC MINERALS				
Abrasives:				
Grindstones and pulpstones pounds	789,786	59	864,357	53
Diamond dust and powder carats	79,183	216	65,853	183
Diamond grinding wheels do	(4)	501	110,847	546
Other natural and artificial metallic abrasives and products		18,420		17,754
Asbestos: Unmanufactured:				
Exports	10,265	2,550	2,780	540
Reexports	459	121	296	52
Boron: Boric acid, borates, crude and refined pounds	206,584,669	6,724	278,634,186	8,972
Bromine, bromides, and bromates do	2,789,749	1,436	3,414,065	1,865

For footnotes, see end of table.

TABLE 9.—Principal minerals and products exported from the United States, 1952–53—Continued

Mineral	1952		1953	
	Short tons (unless otherwise stated)	Value (thousand dollars)	Short tons (unless otherwise stated)	Value (thousand dollars)
NONMETALLIC MINERALS—continued				
Cement ... barrels	3,174,405	11,149	2,535,549	9,261
Clays:				
Kaolin or china clay	40,303	706	43,590	795
Fire clay	88,025	916	90,897	920
Other clays	175,663	5,392	167,901	5,316
Cryolite ... long tons	75	22	117	35
Fluorspar	665	31	695	37
Graphite:				
Amorphous	1,501	139	1,571	154
Crystalline flake, lump or chip	158	57	94	38
Natural, n. e. s.	127	15	95	8
Gypsum:				
Crude, calcined, crushed	19,884	517	23,690	694
Plasterboard, wallboard and tile ... square feet	19,571,037	578	45,767,496	1,195
Manufactures, n. e. c.		121		105
Iodine, iodide, iodates ... pounds	120,789	265	274,690	452
Kyanite and allied minerals	1,129	44	1,032	41
Lime	64,952	1,157	79,934	1,422
Mica:				
Unmanufactured ... pounds	592,901	41	45,046	28
Manufactured:				
Ground or pulverized ... do	4,172,951	234	4,560,883	240
Other ... do	180,482	636	197,370	842
Mineral-earth pigments: Iron oxide, natural and manufactured	3,870	634	4,173	688
Nitrogen compounds (major)	204,110	13,917	133,438	9,231
Phosphate rock ... long tons	1,425,643	12,404	2,100,798	18,368
Phosphatic fertilizers ... do	260,147	6,668	259,215	6,611
Pigments and salts (lead and zinc):				
Lead pigments	2,343	933	2,473	799
Zinc pigments	17,600	4,352	6,898	1,468
Lead salts	128	62	152	83
Potash:				
Fertilizer	94,678	3,321	83,412	2,894
Chemical	6,522	1,516	4,796	1,042
Quartz crystal (raw) ... [4]		18		5
Radioactive isotopes, etc.		239		522
Salt:				
Crude and refined	349,971	3,458	249,521	2,328
Shipments to noncontiguous Territories	8,546	571	8,980	632
Sodium and sodium compounds:				
Sodium sulfate	27,909	782	28,192	805
Sodium carbonate	105,933	4,031	165,405	5,819
Stone:				
Limestone, crushed, ground, broken	803,029	790	691,811	704
Marble and other building and monumental ... cubic feet	277,551	649	411,196	960
Stone, crushed, ground, broken	126,123	1,631	153,105	2,204
Manufactures of stone		315		465
Sulfur:				
Crude ... long tons	1,304,154	33,515	1,241,536	34,554
Crushed, ground, flowers of ... do	34,213	2,451	29,475	2,027
Talc:				
Crude and ground	22,958	615	23,071	602
Manufactures, n. e. c.	265	142	159	96
Powders—talcum (face and compact)		1,245		1,296

[1] Less than $1,000.
[2] Quantity not recorded.
[3] Included with scrap.
[4] 1952: January 1 through June 30—4,992 pounds, $256,946; July 1 through December 31—47,253 carats, $244,293.

TABLE 10.—Comparison of world and United States production of principal metals and nonmetals, 1952–53

[Compiled by Berenice B. Mitchell, Pauline Roberts, Helen Hunt, and Pearl Thompson]

Mineral	1952			1953		
	World	United States		World	United States	
	Thousand metric tons		Percent of world	Thousand metric tons		Percent of world
Nonmetallic minerals:						
Asbestos	1,425	49	3	1,375	49	4
Barite	1,900	919	48	1,975	835	42
Cement	161,000	43,091	27	178,000	45,651	26
Corundum	10	-------	-------	9	-------	-------
Diamonds ---- thousand metric carats	18,694	-------	-------	20,080	-------	-------
Diatomite	590	272	46	600	272	45
Feldspar [1]	820	428	52	810	460	57
Fluorspar	1,190	301	25	1,310	289	22
Graphite	185	5	3	180	6	3
Gypsum	24,300	7,634	31	24,500	7,523	31
Magnesite	3,800	463	12	4,000	502	13
Mica (including scrap)	120	69	58	115	67	58
Nitrogen, agricultural [1] [2]	4,500	1,096	24	[3] 4,800	[3] 1,252	26
Phosphate rock	25,500	12,259	48	25,500	12,705	50
Potash ---- K_2O equivalent	6,400	1,511	24	6,700	1,734	26
Pumice	1,800	542	30	2,500	1,223	49
Pyrites	15,000	1,010	7	14,000	937	7
Salt	53,000	17,731	33	56,000	18,859	34
Sulfur, native ---- thousand long tons	6,000	5,293	88	5,800	5,155	89
Talc, pyrophyllite, and soapstone	1,500	545	36	1,550	564	36
Vermiculite [1]	226	190	84	203	172	85
Metals, mine basis:						
Antimony (content of ore and concentrate) [1]	45	2	4	29	(4)	1
Arsenic [1]	48	14	29	51	10	20
Bauxite	12,740	1,694	13	14,000	1,605	11
Beryllium concentrate [1]	7	(5)	7	9	1	11
Bismuth ---- metric tons	1,800	(6)	(6)	1,900	(6)	(6)
Cadmium ---- do	6,215	3,886	63	7,126	4,430	62
Chromite	3,300	19	(7)	3,600	53	1
Cobalt (contained)	10	(8)	4	12	1	8
Columbium concentrate ---- thousand pounds	3,400	[9] 5	(7)	5,550	[9] 15	(7)
Copper (content of ore and concentrate)	2,730	839	31	2,750	840	31
Gold [10] ---- thousand fine ounces	34,200	1,927	6	33,500	1,970	6
Iron ore	298,000	99,490	33	331,000	119,889	36
Lead (content of ore and concentrate)	1,840	354	19	1,900	310	16
Manganese ore (35 percent or more Mn)	7,800	105	1	9,300	143	2
Mercury ---- thousand 76-pound flasks	151	13	9	161	14	9
Molybdenum (content of ore and concentrate)	22	20	91	28	26	93
Nickel (content of ore and concentrate)	186	1	(7)	203	1	(7)
Platinum group (Pt, Pd, etc.) thousand troy ounces	675	34	5	750	26	3
Silver ---- thousand fine ounces	216,800	39,840	18	216,400	37,736	17
Tantalum concentrate ---- thousand pounds	95	(9)	(9)	150	(9)	(9)
Tin (content of ore and concentrate) [1] thousand long tons	174	(11)	(7)	179	(11)	(7)
Titanium concentrate:						
Ilmenite	895	480	54	941	466	50
Rutile	47	(6)	(6)	46	6	13
Tungsten concentrate ---- 60 percent WO_3	68	7	10	73	9	12
Zinc (content of ore and concentrate)	2,570	604	24	2,580	497	19
Metals, smelter basis:						
Aluminum	2,050	850	41	2,465	1,136	46
Copper	2,825	929	33	2,970	951	32
Iron, pig (including ferroalloys)	152,000	57,507	38	169,000	70,025	41
Lead	1,760	429	24	1,790	424	24
Magnesium	153	96	63	154	84	55
Steel ingots and castings	213,000	84,520	40	236,000	101,250	43
Tin ---- thousand long tons	171	23	13	183	38	21
Zinc	2,200	821	37	2,320	831	36

[1] World total, exclusive of U. S. S. R.
[2] Year ended June 30 of year stated (United Nations).
[3] Estimate.
[4] In 1953 United States production was 337 metric tons.
[5] In 1952 United States production was 467 metric tons.
[6] Bureau of Mines not at liberty to publish United States figure separately.
[7] Less than 1 percent.
[8] In 1952 United States production was 379 metric tons.
[9] Small quantity of tantalite and microlite is included in the columbite concentrates.
[10] Includes Alaska.
[11] In 1952 the United States production was 99 long tons and in 1953, 56 tons.

Employment and Injuries in the Metal and Nonmetal Industries

By Seth T. Reese [1]

THIS CHAPTER of the Minerals Yearbook is confined to the injury and related employment experience in the metal, nonmetal, and quarry industries of the United States. Each industry is treated separately, and no attempt has been made to combine data to present an overall picture for these sections of the mineral industries. The injury and employment experience for all of the mineral industries, including fuels, may be found in volume III.

Statistical data on the injury experience at metal- and nonmetal-mining operations were first compiled by the Bureau of Mines for 1911. Coverage of the industry has grown considerably, and the data in this chapter of the Minerals Yearbook present approximately complete information on the industries represented. There is no Federal law that requires operators of metal and nonmetallic mines to submit reports to the Bureau, such as must be supplied by the coal-mining industry; however, the mining companies that have voluntarily furnished reports on injuries and related employment data have contributed immeasureably to the promotion of safety in the mineral industries of the United States.

METAL MINES

The overall injury experience at metal mines was bettered in 1953. Not only were fewer men killed and injured than during the previous year, but the rate at which these injuries occurred decreased markedly. In fact, the combined fatality and nonfatal-injury rate was lower than in any year since complete statistical data were first made available in 1931. From figures included in table 1 it will be noted that the number of deaths decreased 31 or 26 percent and that nonfatal injuries decreased by 489, an improvement of 7 percent compared with 1952. The rate at which men were killed in the industry dropped from 0.74 to 0.55 per million man-hours of worktime, and the nonfatal-injury rate fell from 42.13 to 39.39. In all, the combined injury rate—fatal and nonfatal—of 39.94 was 7 percent lower than the corresponding rate of 42.87 for the previous year. From table 2 it may be noted that the death rate improved in each group of mines, without an exception. The greatest improvement was recorded for gold-silver and iron mining, with decreases of 41 and 43 percent, respectively, in frequency rates compared with those established at these operations in 1952.

[1] Chief, Accident Analysis Branch.

TABLE 1.—Employment and injury experience at metal mines in the United States, 1931–53 [1] [2]

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	[2] 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	[2] 170,343	150	11,996	[2] .88	[2] 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	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	[2] 70,413	289	[2] 20,349	[2] 163,027	130	[2] 8,894	.80	[2] 54.56
1945	[2] 61,294	288	[2] 17,673	141,295	96	[2] 6,922	.68	[2] 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 (preliminary)	72,200	271	19,572	157,290	86	6,195	.55	39.39

[1] Man-hours not available before 1931.
[2] Revised figure.

Employment, or the average number of men working daily, dropped slightly to 72,200, with the greatest decrease at lead-zinc operations. The aggregate time worked at metal mines was less than 1 percent under that in 1952. The average length of shift for all metal mines was 8.04 hours, and the average employee worked 2,179 hours during 1953—an increase of 53 hours over 1952.

Copper.—The improved injury experience in the copper-mining industry was reflected in a 9-percent decrease in fatality rate—from 0.70 to 0.64 per million man-hours—and an almost 4-percent decrease in the nonfatal-injury rate—31.25 in 1952 to 30.12 in 1953. Although the total number of casualties in each year was about equal, the better rates in 1953 were influenced directly by increased activity in work. The average number of men at work daily increased slightly; but 11 more days were worked by copper plants, resulting in a 4-percent increase in total man-hours. The average employee worked 2,589 hours in 1953, or 89 hours more than during the 313 days the average mine was worked in 1952.

Gold Placer.—The safety record at gold-placer operations was not as favorable in 1953 as in 1952 due entirely to an increase of 64 injuries. The combined injury rate (50.46) was 39 percent higher than the similar rate for 1952. The average number of men working daily showed only a slight increase (64); but, with 1 less operating day, the total man-hours of worktime was not materially affected. The average employee in 1953 had a workyear of 1,712 hours, whereas in 1952 each employee accumulated 12 more hours or 1,724 hours for the year.

Gold-Silver Lode.—The death rate at gold-silver lode mines decreased sharply in 1953, although little change was made in the nonfatal-injury rate. The total of 7 fatalities (5 less than in 1952) occurred at the rate of 0.95 per million man-hours compared with the corresponding rate of 1.62 in 1952; and, as there was no change in the total man-hours of worktime and in the number of nonfatal injuries, the nonfatal frequency rate remained virtually unchanged.

Iron.—The fatality-frequency rate at iron mines in 1953—0.25 per million man-hours—was the lowest for this section of the mineral industries in a statistical history covering 23 years. This performance is noteworthy and was accomplished in a year of increased activity. Although the average daily workforce at iron mines in 1953 was slightly less than that in the previous year, mines were operated 22 more days, and the total man-hours of exposure to hazard rose to 68 million from 63 million in 1952. The average employee at iron mines had a workyear of exposure totaling 2,164 hours, or 173 hours more than in the preceding year. The nonfatal-injury rate at iron mines in 1953, however, was not as favorable as it had been in 1952; the number of such injuries rose to 1,185, or 11 percent over the number injured in 1952, an increase too great to be affected by the increase in man-hours.

Lead-Zinc.—The injury experience at lead-zinc mines improved in 1953, both in number of men killed and injured and in the rate at which these injuries occurred. In numbers the improved safety record was more pronounced than was indicated by the lower frequency rates, due to a marked decrease in activity. The average number of men employed daily fell to 13,700 from 16,745; the average active mine days from 272 in 1952 to 244 in 1953; and the aggregate total man-hours from 36.4 million to 26.7 million, or 27 percent. During 1953 the average worker accumulated a total of 1,952 hours or 219 less than during the previous year.

Miscellaneous Metals.—This group includes mines that produced antimony, bauxite, chromite, cobalt, manganese, mercury, molybdenum, pyrite, titanium, tungsten, and vanadium-uranium. The safety record for this group improved considerably over 1952. There were 9 fatalities, and the frequency rate dropped from 0.99 to 0.75, or 24 percent. The number of nonfatal injuries, however, increased from 702 to 790, or 13 percent; but, due to a 19-percent increase in man-hours worked, the rate at which nonfatal injuries occurred declined from 69.45 to 65.45 per million man-hours, or 6 percent. The average employee at miscellaneous metal operations worked 2,012 hours, or 25 hours more than in 1952.

TABLE 2.—Employment and injury experience at metal mines in the United States, by industry groups, 1944–48 (average) and 1949–53

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:								
1944–48 (average)	15,654	303	4,738,215	37,908,038	29	1,754	0.77	46.27
1949	16,027	271	4,341,202	34,729,944	13	1,190	.37	34.26
1950	15,383	305	4,688,299	37,345,430	17	1,176	.46	31.49
1951	16,274	305	4,959,135	39,676,673	19	1,304	.48	32.87
1952	14,910	313	4,661,726	37,279,930	26	1,165	.70	31.25
1953 (preliminary)	15,000	324	4,857,000	38,840,000	25	1,170	.64	30.12
Gold placer:								
1944–48 (average)	2,851	210	597,505	5,146,954	1	148	.19	28.75
1949	3,523	216	760,202	6,087,196		187		30.72
1950	3,457	218	753,922	6,037,624		184		30.48
1951	2,649	210	557,482	4,475,624	3	198	.67	44.24
1952	2,436	215	524,577	4,200,622	1	151	.24	35.95
1953 (preliminary)	2,500	214	535,000	4,280,000	1	215	.23	50.23
Gold-silver:								
1944–48 (average)	4,499	264	1,188,479	9,277,998	9	820	.97	88.38
1949	5,309	258	1,369,960	10,651,525	9	1,190	.84	111.72
1950	5,112	261	1,333,387	10,328,735	10	1,270	.97	122.96
1951	4,261	251	1,070,753	8,294,331	15	963	1.81	116.10
1952	3,645	255	931,214	7,400,300	12	763	1.62	103.10
1953 (preliminary)	3,600	257	924,000	7,400,000	7	765	.95	103.38
Iron:								
1944–48 (average)	25,523	271	6,924,959	55,602,631	34	1,357	.61	24.41
1949	27,792	249	6,907,048	55,422,388	21	1,158	.38	20.89
1950	27,686	268	7,407,111	59,406,348	23	1,126	.39	18.95
1951	30,576	276	8,446,483	67,931,038	33	1,264	.49	18.61
1952	31,802	248	7,879,534	63,307,839	28	1,066	.44	16.84
1953 (preliminary)	31,400	270	8,468,000	67,960,000	17	1,185	.25	17.44
Lead-zinc:								
1944–48 (average)	15,979	276	4,415,902	35,267,670	31	3,190	.88	90.45
1949	16,333	243	3,971,971	31,738,565	24	2,810	.76	88.54
1950	14,038	257	3,612,051	28,878,165	28	2,411	.97	83.49
1951	14,520	271	3,937,874	31,488,680	18	2,497	.57	79.30
1952	16,745	272	4,548,345	36,351,719	40	2,837	1.10	78.04
1953 (preliminary)	13,700	244	3,344,000	26,740,000	27	2,070	1.01	77.41
Miscellaneous:[1]								
1944–48 (average)	3,415	271	925,091	7,450,403	5	548	.67	73.55
1949	2,680	267	716,405	5,738.514	2	405	.35	70.58
1950	2,616	278	727,325	5,768,379	6	444	1.04	76.97
1951	3,323	283	941,591	7,550,962	7	598	.93	79.20
1952	5,088	241	1,224,861	10,108,156	10	702	.99	69.45
1953 (preliminary)	6,000	241	1,444,000	12,070,000	9	790	.75	65.45
Total:								
1944–48 (average)	67,921	277	18,790,151	150,653,694	109	7,817	.72	51.89
1949	71,664	252	18,066,788	144,368,132	69	6,940	.48	48.07
1950	68,292	271	18,522,095	147,764,681	84	6,611	.57	44.74
1951	71,603	278	19,913,318	159,417,308	95	6,824	.60	42.81
1952	74,626	265	19,770,257	158,648,566	117	6,684	.74	42.13
1953 (preliminary)	72,200	271	19,572,000	157,290,000	86	6,195	.55	39.39

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

TABLE 3.—Employment and injury experience at nonmetal mines (except stone quarries) in the United States, 1931–53 [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] 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	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 (preliminary)	10,200	298	3,041	25,140	25	1,090	.99	43.36

[1] Man-hours not available before 1931.
[2] Revised figure.

TABLE 4.—Employment and injury experience at nonmetal mines (except stone quarries) in the United States, 1944–48 (average) and 1949–53 [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
1944–48 (average)	11,414	289	3,294,592	26,768,670	17	1,256	0.64	46.92
1949	12,077	277	3,340,482	26,948,124	10	1,125	.37	41.75
1950	11,977	293	3,512,094	28,455,936	19	1,238	.67	43.51
1951	12,500	298	3,728,821	30,130,424	17	1,351	.56	44.84
1952	12,447	288	3,588,289	28,954,402	14	1,171	.48	40.44
1953 (preliminary)	10,200	298	3,041,000	25,140,000	25	1,090	.99	43.36

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

NONMETAL MINES (EXCEPT STONE QUARRIES)

This group of mines comprises those producing barite, feldspar, fluorspar, gypsum, magnesite, mica, phosphate rock, rock salt, and sulfur and miscellaneous nonmetallic operations. Employment in this catagory decreased in 1953 to an average total daily employment of 10,200 men. Regardless of this decreased daily employment, operations were worked 10 more days, but the ultimate result was a 13-percent decrease in total man-hours worked. The industry had its worst fatality experience in 23 years and recorded the highest death frequency—0.99 per million man-hours. Twenty-five persons were killed during the year. Although there were 81 fewer nonfatal injuries, the rate at which these injuries occurred increased from 40.44 to 43.36 per million man-hours, or 7 percent. The average employee worked 2,465 hours during 1953, or 139 hours more than in 1952. The injury and employment data for nonmetallic mines are shown in tables 3 and 4.

METALLURGICAL PLANTS

The injury experience at metallurgical plants improved sharply in 1953, when the combined (fatal and nonfatal) frequency rate fell to 19.12 per million man-hours—a decrease of 17 percent below the corresponding rate of 22.96 for 1952. In fact, the 1953 performance was next best in a 23-year statistical history of the industry. In 1932 a rate of 18.84 was established. Employment at metallurgical plants rose to an average daily work force of 53,800 men, a gain of almost 10 percent over the previous year's daily employment. The average employee was able to work 2,534 hours in a year, or 15 hours less than in 1952, primarily because plants were operated 2 days less than during the preceding year. Data on employment and injuries at metallurgical plants can be found in table 5.

TABLE 5.—Employment and injury experience at metallurgical plants in the United States, 1931–53 [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	16,918	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 (preliminary)	53,800	317	17,046	136,330	12	2,595	.09	19.03

[1] Man-hours not available before 1931.

ORE-DRESSING PLANTS

This group includes crushing, screening, washing, jigging, magnetic separating, flotation, and other milling operations on metallic ores. The injury experience at metal mills was considerably better in 1953 than in 1952. Although there was no change in the number of deaths—4 in each year—nonfatal injuries decreased by 42, which, coupled with a 15-percent increase in total man-hours worked, lowered the combined fatal- and nonfatal-injury rate from 20.69 in 1952 to 17.07 per million man-hours in 1953, or 17 percent. The overall injury experience was improved at copper, lead-zinc, and miscellaneous-metal mills, the greatest improvement being made at copper mills. Iron and gold-silver plants had safety records that were not as good as in 1952. The average number of men working daily increased at iron, lead-zinc, and miscellaneous-metal mills. The overall gain was 15 percent, which reflected a like increase in total man-hours of worktime for all plants, although the average mill was active 294 days, the same as in 1952. The average metal-mill employee had 2,360 hours of work during 1953, or only 3 hours more than during the previous year.

TABLE 6.—Employment and injury experience at ore-dressing plants in the United States, by industry groups, 1944–48 (average) and 1949–53 [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:								
1944–48 (average)	6, 036	319	1, 927, 618	15, 415, 644	2	329	0. 13	21. 34
1949	6, 582	294	1, 937, 717	15, 526, 435	3	233	. 19	15. 01
1950	5, 828	337	1, 966, 475	15, 731, 325	2	243	. 13	15. 45
1951	6, 033	336	2, 025, 542	16, 205, 429	-------	226	-------	13. 95
1952	6, 141	345	2, 121, 019	16, 968, 809	1	306	. 06	18. 03
1953 (preliminary)	6, 100	349	2, 128, 000	17, 020, 000	1	210	. 06	12. 34
Gold-silver:								
1944–48 (average)	853	280	238, 895	1, 874, 731	1	91	. 53	48. 54
1949	935	288	269, 389	2, 106, 362	-------	83	-------	39. 40
1950	769	285	219, 266	1, 707, 555	-------	75	-------	43. 92
1951	708	287	203, 161	1, 579, 353	2	55	1. 27	34. 82
1952	676	295	199, 571	1, 590, 554	-------	39	-------	24. 52
1953 (preliminary)	600	302	181, 000	1, 450, 000	-------	55	-------	37. 93
Iron:								
1944-48 (average)	3, 311	244	808, 837	6, 564, 098	1	97	. 15	14. 78
1949	3, 701	215	794, 121	6, 446, 190	3	96	. 47	14. 89
1950	3, 401	239	814, 406	6, 568, 250	3	74	. 46	11. 27
1951	3, 756	250	937, 338	7, 588, 231	-------	69	-------	9. 09
1952	3, 914	222	869, 203	7, 037, 046	-------	54	-------	7. 67
1953 (preliminary)	4, 800	246	1, 183, 000	9, 560, 000	1	75	. 10	7. 85
Lead-zinc:								
1944–48 (average)	4, 465	284	1, 269, 865	10, 178, 441	5	331	. 49	32. 52
1949	4, 018	241	968, 005	7, 747, 429	1	220	. 13	28. 40
1950	3, 489	259	903, 009	7, 223, 114	2	226	. 28	31. 29
1951	3, 441	270	930, 091	7, 444, 528	2	222	. 27	29. 82
1952	3, 648	273	994, 480	7, 953, 964	3	221	. 38	27. 78
1953 (preliminary)	4, 200	257	1, 080, 000	8, 650, 000	2	205	. 23	23. 70
Miscellaneous metals: [2]								
1944–48 (average)	1, 553	282	437, 709	3, 516, 312	1	117	. 28	33. 27
1949	1, 452	270	391, 600	3, 147, 204	-------	166	-------	52. 75
1950	1, 469	303	444, 660	3, 584, 752	-------	167	-------	46. 59
1951	2, 401	331	793, 658	6, 361, 298	2	206	. 31	32. 38
1952	3, 172	308	977, 165	7, 819, 987	-------	232	-------	29. 67
1953 (preliminary)	4, 500	306	1, 375, 000	11, 000, 000	-------	265	-------	24. 09
Total:								
1944–48 (average)	16, 218	289	4, 682, 924	37, 549, 226	10	965	. 27	25. 70
1949	16, 688	261	4, 360, 832	34, 973, 620	7	798	. 20	22. 82
1950	14, 956	291	4, 317, 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 (preliminary)	20, 200	294	5, 947, 000	47, 680, 000	4	810	. 08	16. 99

[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.

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NONFERROUS REDUCTION PLANTS AND REFINERIES

The reduction plants and refineries that make up this section of the mineral industries are engaged in the primary extraction of nonferrous metals from ores and concentrates and the refining of crude primary nonferrous metals; iron and steel plants are excluded. The safety record at nonferrous plants and refineries improved in 1953 compared with 1952. The total of 8 deaths—4 less than in the previous year—occurred at a rate of 0.09 per million man-hours compared with a rate of 0.14 in 1952. There were also 216 fewer nonfatal injuries, and their rate of occurrence decreased from 23.94 in 1952 to 20.14. The improved fatality experience was more pronounced at copper and lead plants, and the improvements in the nonfatal-injury rates were markedly better at lead, zinc, and miscellaneous reduction plants and refineries. Employment and man-hours worked increased at copper and miscellaneous smelters and remained stable at zinc plants. The overall increase in employment was 7 percent, but, as the smelters were operated 2 days fewer than in 1952, the total man-hours worked was not affected.

TABLE 7.—Employment and injury experience at primary nonferrous reduction and refinery plants in the United States, by industry groups, 1944–48 (average) and 1949–53 [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:								
1944–48 (average)	11,531	328	3,787,365	30,322,464	6	605	0.20	19.95
1949	11,626	305	3,549,484	28,395,270	8	511	.28	18.00
1950	11,756	323	3,799,981	30,401,750	7	521	.23	17.14
1951	11,928	325	3,874,388	31,198,141	3	506	.10	16.22
1952	10,629	323	3,438,403	27,507,902	6	367	.22	13.34
1953 (preliminary)	11,200	323	3,612,000	28,900,000	1	360	.03	12.46
Lead:								
1944–48 (average)	3,742	311	1,165,597	9,322,431	1	172	.11	18.45
1949	4,045	306	1,239,792	9,918,334	2	164	.20	16.54
1950	3,946	305	1,202,755	9,606,222	4	166	.42	17.28
1951	3,939	302	1,189,986	9,520,909	2	112	.21	11.76
1952	3,639	318	1,158,368	9,266,594	2	105	.22	11.33
1953 (preliminary)	3,800	288	1,096,000	8,760,000	1	80	.11	9.13
Zinc:								
1944–48 (average)	10,176	347	3,528,289	27,912,801	3	917	.11	32.85
1949	9,573	318	3,044,234	24,118,138	5	791	.21	32.80
1950	9,106	350	3,187,484	25,314,896	9	779	.36	30.77
1951	9,160	353	3,236,675	25,744,087	2	788	.08	30.61
1952	9,671	356	3,440,024	27,384,308	4	876	.15	31.99
1953 (preliminary)	9,600	357	3,428,000	27,290,000	4	660	.15	24.18
Miscellaneous metals: [2]								
1944–48 (average)	7,604	311	2,363,300	18,722,535	2	581	.11	31.03
1949	5,731	320	1,836,176	14,689,399	1	303	.07	20.63
1950	6,513	307	2,001,201	16,292,286	2	323	.12	19.83
1951	6,653	309	2,056,024	16,445,647	3	530	.18	32.23
1952	7,542	322	2,429,697	19,438,096	-------	653	-------	33.59
1953 (preliminary)	9,000	329	2,963,000	23,700,000	2	685	.08	28.90
Total:								
1944–48 (average)	33,053	328	10,844,551	86,280,231	12	2,275	.14	26.37
1949	30,975	312	9,669,686	77,121,141	16	1,769	.21	22.94
1950	31,321	325	10,191,421	81,615,154	22	1,789	.27	21.92
1951	31,680	327	10,357,073	82,908,784	10	1,936	.12	23.35
1952	31,481	332	10,466,492	83,596,900	12	2,001	.14	23.94
1953 (preliminary)	33,600	330	11,099,000	88,650,000	8	1,785	.09	20.14

[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.

STONE QUARRIES

The safety performance in the quarrying industries was improved in 1953, when both the fatality and nonfatal injury rates hit record lows in a 30-year statistical history. The combined rate of 22.27 injuries (fatal and nonfatal) was 9 percent lower than the corresponding rate for 1952 (24.54). Substantial decreases were made in the number of men killed and injured, with only a slight change in operating activity. The average number of men working daily was slightly more than 1,000 above the 1952 daily workforce, and the man-hours of worktime increased slightly more than 1 percent. The average employee worked 2,283 hours, or 5 hours more than in 1952.

Cement.—Seventeen cement-mill and quarry employees died from accidents in 1953, the same number as during the previous year; but, because of increased activity in this section of the industry, the fatality rate fell from 0.23 to 0.22 per million man-hours. The nonfatal-injury rate of 4.82, however, resulted directly from a decrease of 101 lost-time injuries. Employment in cement-rock quarries and mills during the year increased slightly, the average daily work force being approximately 600 more than in 1952. Cement operations were worked 2 days more than in the previous year, and the average employee accumulated 2,721 hours of worktime, or 107 hours more than in 1952, owing chiefly to working 15 minutes more each day the plants were active.

Granite.—The overall injury experience at granite quarries remained virtually unchanged during 1953, although there was a noteworthy reduction in the number of fatalities and a corresponding decrease in the rate at which the deaths occurred. The rate of 0.36 per million man-hours was 59 percent lower than the 1952 rate—0.88. Employment per day increased slightly, plants were active 1 day more than in the previous year, and the total man-hours of worktime rose 3 percent. The average employee at granite quarries worked 2,064 hours during the year, or 20 hours more than in 1952.

Lime.—The fatality record at lime plants and associated quarries improved in 1953. There were 4 deaths during the year compared with 7 in 1952. The death rate of 0.18 per million man-hours was significantly lower than the previous year's rate—0.32. The nonfatal-injury record was also bettered in 1953. The rate of 23.00 injuries per million man-hours was an improvement over the corresponding rate for 1952—24.13. Plant activity changed little, however. A total of 131 fewer men worked 1 day more in 1953 than in 1952, and the total man-hours of worktime showed no appreciable change. The average employee had a workyear of 2,389 hours, or 19 hours more than in 1952.

Limestone.—Fatality experience at limestone plants improved sharply in 1953. The 13 fatalities (14 less than for the previous year) occurred at the rate of 0.25 per million man-hours or 50 percent less frequently. The nonfatal-injury rate was also a little lower than that in the previous year, due chiefly to a decrease of 85 injuries. Although the average daily working force was slightly larger than in 1952, limestone quarries were worked 20 fewer days, resulting in a decrease of approximately 2 million man-hours of worktime. The average employee's worktime totaled 1,929 hours for the year, or 94 hours less than in 1952.

Marble.—The injury experience at marble quarries was more favorable in 1953 than in 1952 due mainly to a decrease of 51 nonfatal injuries. One man was killed each year. Although marble plants were less active than in 1952, there was a slight increase in the average number of men working daily. However, 11 fewer days were worked, and the total man-hours of worktime decreased approximately 200,000. The average employee worked 2,000 hours, or 114 hours less than in the previous year.

Sandstone.—The safety record at sandstone quarries was more favorable than in 1952, due chiefly to a 17-percent reduction in the number of nonfatal injuries. Employment per day increased slightly; but, because 11 fewer days were worked by sandstone quarries, the total man-hours of worktime changed very little. The average employee worked 1,953 hours during the year, or 72 hours less than during the previous year.

Slate.—After the slate industry had attained a 2-year fatality-free record, 1 man was killed at a slate plant in 1953, which raised the combined injury (fatal and nonfatal) rate from 61.20 to 61.34 per million man-hours. This increase in rate was also affected to a certain degree by a 13-percent decrease in man-hours worked. Although slate plants were operated 5 days more than in 1952, the average number of men employed daily was over 200 less than in the previous year. The average employee worked 2,282 hours during 1953, or virtually the same as in 1952.

Traprock.—The injury experience at traprock plants improved sharply in 1953. The combined rate of 36.41 for the 2 fatalities and 235 nonfatal injuries was a 13-percent decline from the corresponding rate of 42.05 in 1952. Employment per day at traprock plants improved slightly, but plants were active 3 fewer days. The total man-hours of worktime for all plants increased 8 percent, and the average employee was able to work 2,100 hours during the year, or 30 hours more than during the preceding year.

TABLE 8.—Employment and injury experience at stone quarries in the United States, 1924–53 [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 (preliminary)	82, 900	272	22, 588	189, 256	49	4, 165	. 26	22. 01

[1] Man-hours not available before 1924.

TABLE 9.—Employment and injury experience at stone quarries in the United States, by industry groups, 1944–48 (average) and 1949–53

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
Cement:[1]								
1944–48 (average)	24,765	306	7,578,816	60,510,569	17	735	0.28	12.15
1949	28,824	327	9,411,961	73,540,505	18	597	.24	8.12
1950	29,003	324	9,383,895	73,758,750	17	548	.23	7.43
1951	29,096	329	9,561,969	75,325,959	15	480	.20	6.37
1952	28,384	329	9,338,887	74,193,087	17	481	.23	6.48
1953 (preliminary)	29,000	331	9,609,000	78,900,000	17	380	.22	4.82
Granite:								
1944–48 (average)	5,013	252	1,260,974	10,593,711	6	503	.57	47.48
1949	6,972	247	1,719,109	14,216,896	5	574	.35	40.37
1950	7,400	249	1,842,512	15,237,563	2	587	.13	38.52
1951	7,211	247	1,777,947	14,775,534	7	596	.47	40.34
1952	6,646	245	1,630,766	13,585,369	12	565	.88	41.59
1953 (preliminary)	6,800	246	1,670,000	14,032,000	5	600	.36	42.76
Lime:[1]								
1944–48 (average)	8,854	301	2,665,522	21,430,324	8	995	.37	46.43
1949	9,138	297	2,709,511	21,344,370	8	798	.37	37.39
1950	8,837	295	2,607,969	20,970,469	6	677	.29	32.28
1951	9,085	296	2,688,965	21,674,253	9	692	.42	31.93
1952	9,231	294	2,716,061	21,877,280	7	528	.32	24.13
1953 (preliminary)	9,100	295	2,688,000	21,740,000	4	500	.18	23.00
Limestone:								
1944–48 (average)	20,050	241	4,826,250	40,946,250	26	1,696	.63	41.42
1949	25,710	232	5,954,282	49,828,625	27	1,829	.54	36.71
1950	28,588	232	6,621,221	55,337,191	22	1,922	.40	34.73
1951	27,626	236	6,528,367	54,952,659	21	2,055	.38	37.40
1952	26,818	241	6,462,276	54,265,172	27	1,890	.50	34.83
1953 (preliminary)	27,100	221	5,984,000	52,270,000	13	1,805	.25	34.53
Marble:								
1944–48 (average)	2,296	262	601,943	5,024,256	1	161	.20	32.04
1949	2,815	255	719,207	5,962,020		227		38.07
1950	2,600	246	640,281	5,330,295	3	168	.56	31.52
1951	2,584	254	656,579	5,486,709		191		34.81
1952	2,376	254	604,640	5,021,773	1	196	.20	39.03
1953 (preliminary)	2,400	243	583,000	4,800,000	1	145	.21	30.21
Sandstone:								
1944–48 (average)	3,201	252	806,292	6,712,244	3	341	.45	50.80
1949	4,115	227	934,969	7,800,638	2	344	.26	44.10
1950	4,204	242	1,015,370	8,437,247	1	365	.12	43.26
1951	4,199	240	1,009,415	8,288,499	2	389	.24	46.93
1952	3,890	248	964,804	7,876,133	6	367	.76	46.60
1953 (preliminary)	4,000	237	946,000	7,810,000	6	305	.77	39.05
Slate:								
1944–48 (average)	1,415	265	374,955	3,340,754	2	175	.60	52.38
1949	1,820	260	472,868	4,061,750	3	217	.74	53.43
1950	2,032	268	544,213	4,633,830	1	203	.22	43.81
1951	2,093	270	565,624	4,773,785		239		50.07
1952	1,616	271	438,334	3,692,983		226		61.20
1953 (preliminary)	1,400	276	386,000	3,195,000	1	195	.31	61.03
Traprock:								
1944–48 (average)	2,308	238	548,941	4,659,441	3	232	.64	49.79
1949	2,815	230	647,414	5,503,529	3	240	.55	43.61
1950	3,066	225	691,022	5,829,466	2	292	.34	50.09
1951	2,908	234	680,826	5,835,796	3	303	.51	51.92
1952	2,918	236	687,908	6,040,033	4	250	.66	41.39
1953 (preliminary)	3,100	233	722,000	6,509,000	2	235	.31	36.10
Total:								
1944–48 (average)	67,902	275	18,663,693	153,217,549	66	4,838	.43	31.58
1949	82,209	275	22,569,321	182,258,333	66	4,826	.36	26.48
1950	85,730	272	23,346,483	189,534,811	54	4,762	.28	25.12
1951	84,802	277	23,469,692	191,113,194	57	4,945	.30	25.87
1952	81,879	279	22,843,676	186,551,830	74	4,503	.40	24.14
1953 (preliminary)	82,900	272	22,588,000	189,256,000	49	4,165	.26	22.01

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

Abrasive Materials

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THE ABRASIVES INDUSTRIES in the United States operated at a high level during 1953. Records were established in the abrasive-grinding-wheel and surface-coated-abrasive industries, and an upward trend was noted in the output of nearly all abrasive materials. However, during the latter half of the year there was a marked reduction in the sales of abrasive products, reflecting the end of hostilities in Korea.

The quantity and unit value of the industrial diamonds imported into the United States declined slightly during 1953 as compared with the preceding year. Corundum imports were also lower, and no importation of emery was reported.

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

TABLE 1.—Salient statistics of the abrasives industries in the United States, 1952–53

	1952		1953		Percent of change in—	
	Short tons	Value	Short tons	Value	Short tons	Value
Natural abrasives (domestic) sold or used by producers:						
Tripoli	35,459	$1,043,124	36,183	$1,138,635	+2	+9
Quartz	246,604	1,013,637	241,723	1,360,200	−2	+34
Ground sand and sandstone	792,802	6,922,586	780,641	6,813,401	−2	−2
Grindstones	3,962	246,526	2,499	169,951	−37	−69
Pulpstones	12	908				
Millstones	(1)	9,285	(1)	18,375		+98
Tube-mill liners	1,083	66,218	1,219	68,688	+13	+4
Grinding pebbles	2 3,460	2 95,455	2,472	81,159	−29	−15
Garnet	11,390	981,841	10,520	988,797	−8	+1
Emery	10,352	141,911	10,562	143,974	+2	+1
Artificial abrasives:						
Silicon carbide—production 3	91,531	12,040,946	62,301	8,190,431	−32	−32
Aluminum oxide—production 3	180,375	17,813,760	244,136	23,807,806	+35	+34
Metallic abrasives (steel shot and grit)—shipments	157,034	17,582,275	160,500	18,038,046	+2	+3
Foreign trade (natural and artificial abrasives):						
Imports		2 67,510,654		77,651,172		+15
Exports		19,196,200		18,535,491		−3

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

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NATURAL SILICA ABRASIVES

Tripoli.—Sales of tripoli, amorphous silica, and rottenstone in 1953 were 36,000 short tons, valued at $1,139,000. This represented an increase of 2 percent in tonnage and 9 percent in value over 1952. Illinois, Missouri, Pennsylvania, and Oklahoma were the only States reporting output of these materials during 1953.

The tonnage of tripoli used as an abrasive and as a filler showed but little change from 1952, while that for foundry facings and for other uses increased.

Tripoli, amorphous silica, or rottenstone were produced during 1953 by the following firms: American Tripoli Corp., Seneca, Mo., with mines in Newton County, Mo., and Ottawa County, Okla., (tripoli); Ozark Minerals Co., Cairo, Ill. (amorphous silica); Tamms Industries, Inc., 228 North LaSalle St., Chicago, Ill. (amorphous silica); Penn Paint & Filler Co., Antes Fort, Pa. (rottenstone); and Keystone Filler & Manufacturing Co., Muncy, Pa. (rottenstone).

TABLE 2.—Tripoli [1] sold or used by producers in the United States, 1944–48 (average) and 1949–53, by uses [2]

Year	Abrasives		Filler		Other, including foundry facings		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1944–48 (average)	19,519	$413,222	3,428	$62,815	2,463	$46,910	25,410	$522,947
1949	20,972	587,241	2,820	53,938	1,733	49,385	25,525	690,564
1950	34,865	968,497	6,744	147,379	2,111	57,771	43,720	1,173,647
1951	28,000	869,000	7,000	155,000	2,476	81,135	37,476	1,105,135
1952	25,000	771,000	7,000	156,000	3,459	116,124	35,459	1,043,124
1953	25,000	852,000	7,000	163,000	4,183	123,635	36,183	1,138,635

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

No price changes were reported for tripoli in 1953 by the E&MJ Metal and Mineral Markets from the preceding year. The following prices were quoted (per short ton, paperbags, 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; air-floated through 200-mesh, $35.

Importations of tripoli and rottenstone into the United States in 1953 totaled 372 short tons valued at $39,451. The principal countries of origin, in order named, were: France, Mexico, British East Africa, and West Germany.

Quartz.—Sales of crude, crushed, and ground quartz from pegmatite veins or dikes and from quartzite in 1953 decreased 2 percent in tonnage but increased 34 percent in value from the preceding year. Output of crude and of ground quartz increased while that of crushed quartz declined. Uses for the 188,983 short tons of vein quartz produced in 1953 included: Ferrosilicon, glass, foundry, pottery, porcelain and tile, abrasives, filter purposes, and other minor uses. Of the 241,700 tons reported, 52,700 was quartzite.

TABLE 3.—Quartz (crude, crushed, and ground) sold or used by producers in the United States, 1944–48 (average) and 1949–53 [1]

Year	Crude		Crushed		Ground [2]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1944–48 (average)	28,244	$116,631	57,287	$183,686	9,769	$98,148	95,300	$398,465
1949	15,816	74,562	72,432	257,213	19,304	143,716	107,552	475,491
1950	11,062	52,591	117,499	430,256	31,947	223,877	160,508	706,724
1951	8,236	23,098	237,806	890,918	35,005	251,354	281,047	1,165,370
1952	14,473	79,317	207,935	739,882	24,196	194,438	246,604	1,013,637
1953	38,945	182,242	166,736	801,391	36,041	376,567	241,722	1,360,200

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

TABLE 4.—Quartz (crude, crushed, and ground) [1] sold or used by producers [2] in the United States, 1951–53, by States

State	1951		1952		1953	
	Short tons	Value	Short tons	Value	Short tons	Value
Arizona, California, Idaho [3], Oregon, Washington	193,444	$747,161	178,437	$670,061	167,803	$879,816
Connecticut, Massachusetts	31,459	193,127	20,199	123,600	29,410	254,050
Other States [4]	56,144	225,082	47,968	219,976	44,509	226,334
Total	281,047	1,165,370	246,604	1,013,637	241,722	1,360,200

[1] To avoid duplication, the ground material included is only that ground by the original producers of the crude quartz or by grinders who purchase from small miners not reporting their production.
[2] Does not include sales of quartzite to cement mills or certain sales of quartzite for use in the manufacture of ferrosilicon.
[3] 1953 only.
[4] Maine, Maryland (1952), North Carolina, and Wisconsin.

The average value of the quartz reported was $5.63 compared with $4.11 in 1952 and $4.15 in 1951.

Ground Sand and Sandstone.—The tonnage and total value of the ground sand and sandstone sold or used during 1953 showed a slight decline from the previous year. The average value per ton of $8.73 in 1953 was the same as in 1952, and compared with $8.75 in 1951. Illinois, with 35 percent of the total, was the largest ground-sand- and sandstone-producing State; output from the State increased slightly both in tonnage and value over 1952.

TABLE 5.—Ground sand and sandstone sold or used by producers in the United States, 1944–48 (average) and 1949–53

Year	Short tons	Value	Year	Short tons	Value
1944–48 (average)	601,086	$4,551,503	1951	818,479	$7,163,343
1949	610,789	5,258,464	1952	792,802	6,922,586
1950	750,673	6,462,503	1953	780,641	6,813,401

TABLE 6.—Ground sand and sandstone sold or used by producers in the United States, 1951–53, by States

State	1951		1952		1953	
	Short tons	Value	Short tons	Value	Short tons	Value
Georgia	1,874	$18,740	1,765	$17,650	(1)	(1)
Idaho	11,968	107,738	9,500	80,000	5,304	$43,865
Illinois	262,488	2,300,102	267,180	2,342,549	276,215	2,461,767
New Jersey	144,098	1,053,991	138,434	1,011,844	127,921	918,534
Ohio, Virginia, and West Virginia	249,345	2,305,825	227,878	2,090,278	232,890	2,146,019
Other States [2]	148,706	1,376,947	148,045	1,380,265	138,311	1,243,216
Total	818,479	7,163,343	792,802	6,922,586	780,641	6,813,401

[1] Included with "Other States" to avoid disclosure of individual company operations.
[2] California, Georgia (1953), Massachusetts (1951–52), Michigan, Missouri, Oklahoma, Pennsylvania, Washington, and Wisconsin.

Firms producing 86 percent of the ground sand and sandstone output reported the end uses of the material. They reported that the pottery, porcelain, and tile industries took 39 percent; abrasive industries (chiefly cleaning and scouring compounds), 26 percent; foundries, 13 percent; fillers, 11 percent; and all other, 11 percent.

TABLE 7.—Ground sand and sandstone sold or used by producers in the United States in 1953, by uses

Use	Short tons	Value	
		Total	Average per ton
Abrasive:			
Cleansing and scouring compound	166,590	$1,296,908	$7.79
Other	7,275	46,306	6.37
Enamel	30,281	244,593	8.08
Filler	75,170	591,247	7.87
Foundry	84,927	759,594	8.94
Glass	9,503	90,489	9.52
Pottery, porcelain, and tile	263,810	2,488,638	9.43
Other uses [1]	32,471	266,283	8.20
Use reported, total	670,027	5,784,058	8.63
Use unspecified	110,614	1,029,343	9.31
Grand total	780,641	6,813,401	8.73

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

Abrasive Sands.—Glass grinding, stone polishing, sand blasting, and similar industries use as an abrasive material substantial tonnages of natural sands with a high silica content. Sales of these sands in 1953 totaled 1,492,000 short tons valued at $3,375,000 compared with 1,230,000 (revised figure) short tons valued at $2,920,000 (revised figure) in 1952. The 1953 figures include 651,000 short tons of blast sand valued at $2,157,000, an increase of 17 percent in quantity and 7 percent in value compared with 1952. The quantity and value of these sands are included in the figures given in the Sand and Gravel chapter of this volume, where detailed data regarding tonnages produced in each State appear.

SPECIAL SILICA-STONE PRODUCTS

Grindstones and Pulpstones.—Ohio and West Virginia were the only States reporting sales of grindstones. The domestic production of this commodity decreased 37 percent in tonnage and 31 percent in value from the 1952 figures. No sales of pulpstones were reported in 1953.

Oilstones and Other Sharpening Stones.—The output of natural sharpening stones during 1953 increased 23 percent over 1952, but the total value of the product remained about the same. The Bureau of Mines is not at liberty to publish the statistics, because production of individual companies would thereby be revealed. Producing States in 1953 were: Arkansas—oilstones and whetstones; Indiana—whetstones; and New Hampshire—scythestones. No production of hones or rubbing stones was reported in 1953.

TABLE 8.—Grindstones and pulpstones sold by producers in the United States, 1944–48 (average) and 1949–53

Year	Grindstones		Pulpstones		
			Quantity		
	Short tons	Value	Pieces	Equivalent short tons	Value
1944–48 (average)	9,910	$427,319	[1] 19	[1] 60	[1] $3,652
1949	4,479	244,704	7	28	1,975
1950	4,435	230,462	12	33	2,100
1951	5,549	313,901	6	22	1,970
1952	3,962	246,526	4	12	908
1953	2,499	169,951			

[1] Represents 1946–48 (average).

TABLE 9.—Value of millstones and chasers sold by producers in the United States, 1944–48 (average) and 1949–53 [1]

Year	Number of producers	Value	Year	Number of producers	Value
1944–48 (average)	4	$16,084	1951	1	$6,000
1949	2	9,400	1952	1	9,285
1950	2	11,300	1953	2	18,375

[1] Produced in Minnesota (1945 only), New York (1944–48 and 1953), North Carolina, and Virginia (1944–50 only).

Millstones.—Ulster County, N. Y. and Rowan County, N. C., were the only localities from which domestic production of millstones was reported in 1953. The value of this product increased 98 percent over the preceding year. No production of chasers or dragstones was reported.

Grinding Pebbles and Tube-Mill Liners.—Sales of grinding pebbles in 1953 declined 29 percent in tonnage and 15 percent in value from 1952, but the sales of tube-mill liners increased 13 percent in tonnage and 4 percent in value during the same period. Grinding-pebble production was reported from Minnesota, North Carolina, Texas, Washington, and Wisconsin and tube-mill liners from Minnesota, North Carolina, and Wisconsin.

TABLE 10.—Grinding pebbles and tube-mill liners sold or used by producers in the United States, 1944–48 (average) and 1949–53

Year	Grinding pebbles		Tube-mill liners		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1944–48 (average)	6,233	$140,147	1,843	$42,174	8,076	$182,321
1949	2,374	64,038	1,166	47,093	3,540	111,131
1950	1,923	53,007	1,523	62,535	3,446	115,542
1951	3,062	84,306	1,408	77,027	4,470	161,333
1952	[1] 3,460	[1] 95,455	1,083	66,218	[1] 4,543	[1] 161,673
1953	2,472	81,159	1,219	68,688	3,691	149,847

[1] Revised figure.

NATURAL SILICATE ABRASIVES

Garnet.—Garnet sales in the United States declined during 1953, the total being 10,500 short tons valued at $988,800 compared with 11,400 valued at $981,800 in 1952. Figure 1 shows the domestic output (sales) of garnet since 1930. New York was the leading garnet-producing State in 1953, with Idaho second. Most of the production of garnet in the United States came from deposits operated solely for their garnet content, and only small quantities were produced as byproducts of other minerals. Domestic garnet producers reporting sales in 1953 were: Barton Mines Corp., North Creek, N. Y.; Cabot Carbon Co., Willsboro, N. Y.; Idaho Garnet Abrasive Co., Fernwood, Idaho; and Florida Ore Processing Corp., Melbourne, Fla.

Recovery of garnet as a byproduct of beach sand worked principally for ilmenite in India is to be taken over and operated by the Government of that country.[3]

A short history of the use and occurrence of garnet appeared in a scientific journal.[4]

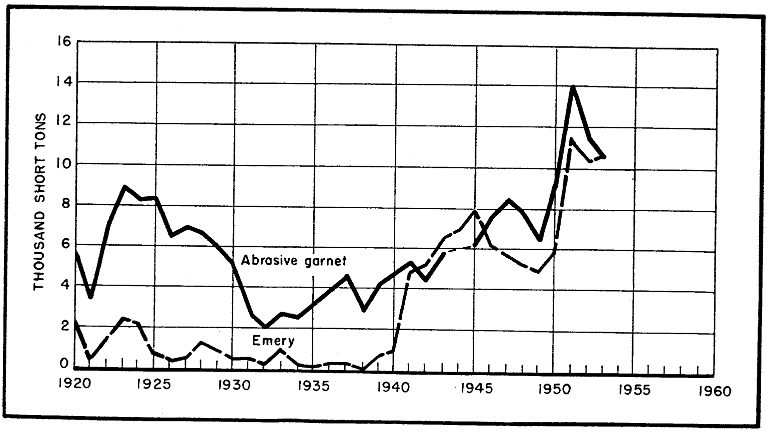

FIGURE 1.—Marketed production of abrasive garnet and domestic emery in the United States, 1920–53.

[3] Chemical Age (London), Indian Newsletter: Vol. 68, No. 1764, May 2, 1953, p. 667.
[4] Mineralogist (London), Garnet Again Popular: Vol. 21, No. 11, November 1953, p 404.

TABLE 11.—Abrasive garnet sold or used by producers in the United States, 1948–53

Year	Short tons	Value	Year	Short tons	Value
1948	8,039	$587,797	1951	14,050	$1,246,947
1949	6,578	505,231	1952	11,390	981,841
1950	9,304	793,558	1953	10,520	988,797

NATURAL ALUMINA ABRASIVES

Corundum.—As in recent years, the Union of South Africa was the world's principal source of corundum. The production in that country totaled 1,700 metric tons in 1953. No commercial production was reported in the United States.

A study of South African corundum, including its occurrence, various uses, and its abrasive qualities compared with those of aluminum oxide appeared in the technical press.[5]

Geological reports regarding corundum deposits in Nyasaland have appeared in technical journals.[6]

A description of a method of evaluating natural corundum ores was presented at a meeting of a technical society.[7]

Although formerly an important producer, Canada has had no commercial output of corundum since 1946.[8]

No changes were reported in the price of corundum in 1953 from the previous year. An abrasive company quoted the following prices: Per pound, in ton lots, grinding wheel grain, 12¼ cents, delivered; optical grain, sizes 120 and coarser, 10½ cents, f. o. b.; optical grain, sizes 140 and finer, 11½ cents, f. o. b.; optical powders, size 500 and finer, 31½ cents, f. o. b.

TABLE 12.—World production of corundum [by] countries,[1] 1944–48 (average) and 1949–53, in metric tons[2]

[Compiled by Helen L. Hunt]

Country[1]	1944–48 (average)	1949	1950	1951	1952	1953
Argentina	[3] 30	(4)	(4)	(4)	(4)	(4)
Australia	2	-----	-----	-----	55	-----
Brazil	[3] 45	(4)	(4)	(4)	(4)	(4)
Canada	405	-----	-----	-----	-----	-----
French Equatorial Africa	39	-----	-----	-----	-----	-----
India	264	1,493	304	557	647	(4)
Kenya	-----	-----	2	-----	-----	-----
Madagascar	29	7	-----	-----	-----	-----
Malaya[3]	-----	-----	10	25	-----	-----
Mozambique	253	-----	16	-----	(4)	(4)
Nyasaland	202	113	187	101	47	(4)
Southern Rhodesia	25	-----	-----	-----	-----	765
South-West Africa	-----	-----	10	-----	-----	-----
Union of South Africa	2,923	2,464	3,201	4,563	3,791	1,692
Total (estimate)[1]	7,940	9,000	9,000	10,000	10,000	9,000

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

[5] Chemical Age (London), Corundum: Vol. 68, No. 1761, Apr. 11, 1953, pp. 565–566.
[6] South African Mining and Engineering Journal, The Tambane Corundum Deposits: Vol. 64, Part 2, Oct. 3, 1953, p. 171. Mining World, Nyasaland: Vol. 15, No. 12, November 1953, p. 77.
[7] Carl, Howard F., Jaffe, Howard W., and Hockman, Arthur, New Techniques for Evaluating Natural Corundum Ores: AIME Tech. Paper 3742 H, Los Angeles Meeting, February 1953, 22 pp.
[8] Janes, T. H., Natural Abrasives in Canada, 1953 (preliminary): Rept. of Dept. of Mines and Tech. Survey, Ottawa, 4 pp.

Emery.—Domestic production of emery showed a slight increase, both in quantity and value, during 1953, but it was still below the high point of the industry in 1951. No importations of emery were reported. DiRubbo & Ellis and Joe DeLuca, both of Peekskill, N. Y., were the only domestic miners of emery reporting production.

The average value of domestic emery at the mine in 1953 was $13.63 a short ton. The sales of emery since 1920 are presented graphically in figure 1.

A new product, "Emeri-crete," a form of crushed emery stone which is used as an aggregate to make a "slipproof" concrete flooring for industrial plants, is being produced at Peekskill, N. Y., using an emery of local origin.[9]

Emery mines of Greece and Turkey continue to supply the European market with that type of abrasive,[10] and the U. S. S. R. is reported to have extensive deposits of both emery and corundum.

TABLE 13.—Emery sold or used by producers in the United States, 1944–48 (average) and 1949–53

Year	Short tons	Value	Year	Short tons	Value
1944–48 (average)	6,437	$67,854	1951	11,634	$160,212
1949	4,909	60,917	1952	10,352	141,911
1950	5,949	75,308	1953	10,562	143,974

INDUSTRIAL DIAMONDS

Diamond production continued to increase during 1953, the world output, including all types, being approximately 20,100,000 metric carats, a 7-percent increase over 1952. Over 98 percent of this pro-

TABLE 14.—World production of industrial diamonds, by countries, 1951–53, in metric carats [1]

Country	1951	1952	1953
Africa:			
Angola	[2] 320,000	305,000	307,000
Belgian Congo	[2] 10,000,000	11,200,000	12,000,000
French Equatorial Africa	[2] 118,000	147,000	92,000
French West Africa	[2] 80,000	[2] 109,000	120,000
Gold Coast	[2] 1,500,000	1,860,000	1,515,000
Sierra Leone	[2] 310,000	312,000	322,000
South-West Africa	[2] 100,000	108,000	123,000
Tanganyika	[2] 43,000	62,000	73,000
Union of South Africa:			
"Pipe" mines:			
Premier	[2] 850,000	1,000,000	978,000
DeBeers group	[2] 410,000	393,000	564,000
Others	[2] 8,000	7,000	59,000
Alluvial mines	[2] 145,000	140,000	90,000
Total Africa	[2] 13,884,000	[2] 15,643,000	16,243,000
South America:			
Brazil [3]	100,000	100,000	100,000
British Guiana	[2] 22,000	[2] 19,000	21,000
Venezuela	[2] 42,000	[2] 63,000	62,000
Australia, Borneo, India, and U. S. S. R.[3]	3,000	3,000	3,000
World total	14,100,000	15,800,000	16,400,000

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

[9] Rock Products, vol. 56, No. 7, July 1953, p. 34.
[10] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 1, July 1953, pp. 39–40, and vol. 37, No. 5, November 1953, pp. 56–57.

duction was accredited to Africa. Of this total some 16,400,000 carats was classified as industrial material, an increase of 4 percent over the preceding year. Belgian Congo continued to be the largest producer of industrials, and its 1953 output (12,000,000 carats) was 73 percent of the world supply of that material.

TABLE 15.—Industrial diamonds (including diamond dust and manufactured bort) imported for consumption in the United States, 1952–53, 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
1952										
Argentina							1,855	$20,405		
Australia					1,778	$18,885				
Belgian Congo			6,408,006	$13,771,019	454,041	1,612,265			24,570	$75,279
Belgium-Luxembourg	4,355	$55,411	3,136	21,608	156,969	1,911,979			12,368	19,566
Bermuda					3,115	36,111				
Brazil					30,519	611,230	8,188	115,101		
British Guiana					255	5,005				
Canada	23	453	232,105	813,495	455,780	2,627,566			26,857	68,225
France	2,459	148,380			7,865	121,981			1,100	6,000
French Equatorial Africa					3,703	130,398	2,284	19,557		
Germany, West	784	28,296			12	105			200	1,334
India					3,101	59,334				
Israel					1,543	17,234				
Japan					520	8,628				
Netherlands	3,429	144,981			66,624	723,920			125	250
Surinam					237	4,104				
Sweden					91	2,100				
Switzerland	163	4,129			[1] 140,808	[1] 1,226,166				
Union of South Africa			344,850	817,927	[1] 62,865	[1] 375,800			9,222	21,416
United Kingdom	418	9,750	1,817,702	4,483,597	[1] 3,231,278	[1] 20,950,872	131	1,469	149,987	600,881
Venezuela			674	13,322	29,152	595,950	11	30		
Total	11,631	391,400	8,806,473	19,920,968	[1] 4,650,256	[1] 31,039,633	12,469	156,562	224,429	792,951
1953										
Belgian Congo			6,175,633	13,901,119	350,794	1,327,076			189,805	517,396
Belgium-Luxembourg	3,084	10,550	2,550	7,643	173,428	1,224,331			8,000	25,146
Bermuda					5,467	50,513				
Brazil					46,576	850,095	1,813	15,414	50	160
British Guiana					162	2,669				
British West Africa, n. e. c.					48	520				
Canada			254,084	739,270	566,926	2,711,169			15,121	34,087
France	2,968	176,725	268	1,116	14,516	127,531			400	1,200
French Equatorial Africa					16,614	151,134	29	450		
Germany, West	538	17,555			179	3,585				
Gold Coast					815	7,432				
India					599	24,059				
Israel					1,988	17,053				
Netherlands	766	69,641	9,025	28,380	440,706	6,930,184			705	2,068
Nigeria					11	108				
Portuguese Asia, n. e. c.					157	1,800				
Sweden					100	265				
Switzerland	20	3,907			1,984	11,917				
Union of South Africa	6	525	606,073	1,560,337	104,494	451,826			24,700	75,928
United Kingdom	509	13,622	1,679,290	3,925,796	2,297,775	12,435,108			510,509	1,451,468
Venezuela					13,391	341,410				
Total	7,891	292,525	8,726,923	20,163,661	4,036,730	26,669,785	1,842	15,864	749,290	2,107,453

[1] Revised figure.

Importation of industrial diamonds, excluding diamond dust and manufactured bort, into the United States during 1953 totaled 12,-765,500 metric carats, valued at $46,849,000, a decrease of 5 percent in weight and 8 percent in value from the preceding year. The average value was $3.67 a carat. Purchases of industrial diamonds by the United States Government for the National Strategic Stockpile continued during 1953.

TABLE 16.—Industrial diamonds (excluding diamond dust and manufactured bort) imported for consumption in the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Year	Carat	Value		Year	Carat	Value	
		Total	Average			Total	Average
1944–48 (average)	8,484,177	$19,203,679	$2.26	1951	12,120,647	$46,327,622	$3.82
1949	6,279,096	17,392,288	2.77	1952	[1] 13,469,198	[1] 51,117,163	[1] 3.80
1950	11,039,036	36,792,832	3.33	1953	12,765,495	46,849,310	3.67

[1] Revised figure.

Table 15 shows the country of origin of the industrial diamonds imported into the United States and also classifies them into five groups: (1) Bort, manufactured, which includes diamond dies; (2) crushing bort, including bort that has been crushed or is suitable for crushing; (3) other industrial diamonds, which includes unset glaziers' and engravers' diamonds, and die, wheel-dressing, and drill stones; (4) carbonado and ballas (carbonado being a closely knit aggregate of very small diamond crystals and ballas being a globular mass of diamond crystals); and (5) diamond dust and powder.

An exact definition of the term "bort" (also spelled "boart") has not been formulated by the industrial diamond industry.[11] The term is commonly applied to diamond material that is crushed before use by industry (crushing bort); however, the term also is used commercially to designate any diamonds that are unsuitable for use as gem stones, owing to color, size, or other imperfections.

The question of domestic supply of industrial diamonds and diamond grinding wheels was the subject of several articles in trade journals. Current consumption of this material and future requirements, should a national emergency arise, were analyzed.[12]

A general survey of the various diamond tools used by the American mining industry was presented in an article on that subject in the technical press. It was stated that in 1952 only 8 percent of the total industrial diamonds imported into North America were used for drill

[11] Industrial Diamond Review, Meaning of the Word "Bort": Vol. 13, No. 146, January 1953, pp. 21–22, and vol. 13, No. 147, February 1953, p. 46.
Kraus, E. H., Classification and Description of Varieties of Diamond: Ind. Diamond Rev., vol. 13, No. 149, April 1953, p. 86.
[12] Beaudet, E. C., Diamond-Wheel Shortage Looms Large: Iron Age, vol. 171, No. 7, February 12, 1953, p. 99.
Taeyaerts, J., Diamond Grinding Wheels in National Emergencies Tool Eng., vol. 31, No. 3, September 1953, p. 136.
Western Machinery and Steel World, Diamonds in Industry: July 1953, pp. 81–82, and August 1953, pp. 96–97.

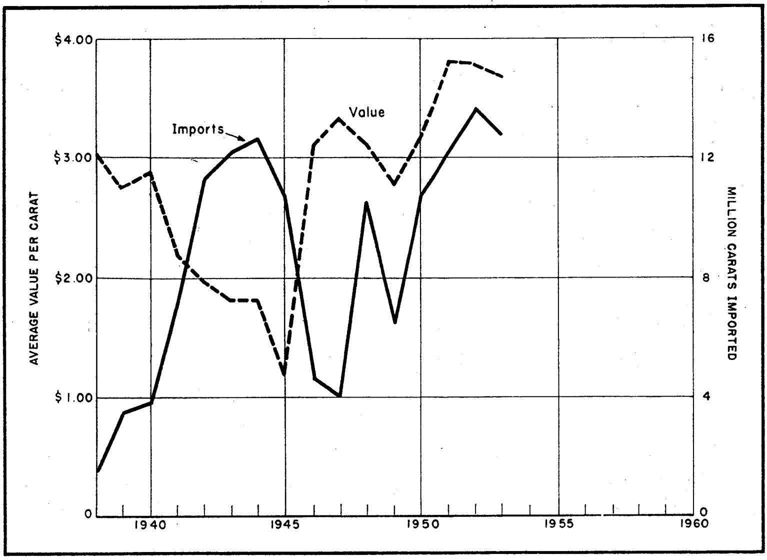

FIGURE 2.—United States imports and average price per carat of industrial diamonds, 1938–53.

bits, whereas in 1926 perhaps 80 percent of all industrial diamonds imported were used for that purpose.[13]

Improvements in the technique of making diamond grinding wheels and other industrial diamond products, with resultant savings in production costs, were discussed in trade publications.[14]

Grinding of cemented carbides without the use of diamond grinding wheels was given much study by industry making and using such carbides, and articles on that subject appeared in the technical press.[15]

Surveys of the relative advantages of silicon carbide and diamond grinding wheels have been presented in publications by abrasive manufacturers and diamond companies.[16]

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[13] Long, Albert E., Industrial Diamonds in the Mineral Industry of North America: Ind. Diamond Rev., vol. 13, No. 147, February 1953, pp. 29–33.

[14] Howard, J. H., Making Diamond Wheels: Ind. Diamond Rev., vol. 13, No. 148, March 1953, p. 66.
Lennon, F. J., Economic Factors Must Govern Wheel Selection for Grinding Carbides: Am. Machinist, Feb. 16, 1953.
Young, R. S., Benfield, D. A., Dauncey, G. B., Water-Soluble Pastes for Diamond Powder: Ind. Eng. Chem., vol. 45, February 1953, pp. 402–404.
Close, G. C., Research on Diamond Lapping Techniques Improves Production: Western Machinery and Steel World, September 1953, pp. 80–22.

[15] DeGroat, G. H., Grinding Carbides With Abrasive Belts: Am. Machinist, vol. 97, No. 2, Jan. 10, 1953, pp. 54–56.
Sperison, E., Carbide Tools Ground Without a Diamond Wheel: Am. Machinist, vol. 97, No. 6, March 16, 1953, p. 195.
Ashburn, E., Silicon Carbide Wheels for Carbide Grinding: Am. Machinist, vol. 97, No. 9, April 27, 1953, pp. 142–144.
Gardner, A. G., Recent Developments in the Machinery of Hard Metals: Mech. World, vol. 133, No. 3406, May 1953, pp. 202–204.
Tool Engineering, Silicon Carbide Wheels Save Diamonds: Vol. 31, No. 1, July 1953, p. 100.
Ripple, J. W., Practical Carbide-Tool Maintenance: Am. Machinist, vol. 97, No. 15, July 20, 1953, pp. 126–128.
Redmond, J. C., How Sharp Are Carbide Tools Finished With Silicon Carbide?: Am. Machinist, vol. 97, No. 37, Sept. 12, 1953, p. 1529.
Thibault, N. W., and Anderson, B. H., Grinding Carbide Tools With Electrostatic Assistance: Metal Prog., vol. 64, No. 2, August 1953, pp. 161–164.

[16] Carborundum Co., Grinding Cemented Carbides With Green Grit and Diamond Wheels: Niagara Falls, N. Y., 1953, 39 pp.
Olivieri, O. E., Use of Diamonds-vs.-Silicon Carbide: Diamonds in Industry, J. K. Smit & Son, Murray Hill, N. J., vol. 15, No. 1, spring 1953, pp. 4, 7, 14.

More efficient use of diamond grinding wheels and the recovery of industrial diamond material from grinding sludges has been urged as a conservation measure.[17]

Several firms were engaged in such salvage and in the processing of the salvaged industrial diamond material.[18]

The alleged production of synthetic diamonds by a group in West Germany was reported in the newspapers; however, under controlled conditions no diamonds were produced, and in a subsequent court action the promoters received prison sentences.[19]

United States National Production Authority Order M–103, covering the use of diamond wheels, was withdrawn as of September 28, 1953.[20]

Further studies on the orientation of diamonds in core bits indicate improvements over previous methods.[21]

ARTIFICIAL ABRASIVES

Total production of aluminum oxide in the United States and Canada increased 35 percent in tonnage and 34 percent in value during 1953 over the preceding year. On the other hand, silicon carbide output decreased 32 percent both in tonnage and value. Metallic abrasives manufactured in the United States increased 2 percent in tonnage and 3 percent in value. The aluminum oxide production included 19,600 short tons of "white high-purity" material valued at $2,674,200, representing for that product an increase of 18 percent in tonnage and 17 in value over 1952. Of the production of artificial abrasives, 3 percent of the aluminum oxide and 46 percent of the silicon carbide were used for refractories or other nonabrasive purposes, the same percentages as in 1952.

The ratio of production to plant capacity for aluminum oxide was 89 percent compared with 71 percent in 1952; for silicon carbide, 56 percent compared with 82 percent; and for metallic abrasives, 62 percent compared with 68 percent.

Unit sales of abrasive grinding wheels and surface-coated abrasives reached new records in 1953, slightly exceeding the 1951 sales figures and also the World War II peak sales value of grinding wheels by 12 percent and of coated abrasives by nearly 200 percent. However, the sales of abrasives during the latter half of 1953 showed a decline. As long as the steel and automotive industries operated at a high level, a steady demand for abrasive products was maintained.[22]

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17 Machinery (N.Y.), Conserving Diamond Boart by More Efficient Use of Wheels: Vol. 59, No. 7, March 1953, p. 163.
Industrial Diamond Review, Detroit Industrial Diamond Use and Salvage Clinic: Vol. 13, No. 149, April 1953, pp. 87–92; and vol. 13, No. 150, May 1953, pp. 116–118.
Swimmer, J., Separating Diamond From Aluminum Oxide and Silicon Carbide: Ind. Diamond Rev., vol. 13, No. 155, October 1953, p. 225.

18 Danforth, C. W., Chemist Makes Profitable Business of Diamond Mining in Sludge: Chem. and Engi. News, vol. 31, No. 19, May 11, 1953, p. 2010.
Industrial Diamond Review, Cleaning Diamond Powders: Vol. 13, No. 149, April 1953, pp. 77–78.
Proudfoot, C. B., Cleaning Diamond Powders: Ind. Diamond Rev., vol. 13, No. 151, June 1953, p. 139.
Modern Industry, Bagging Diamonds: Vol. 26, No. 1, July 15, 1953, p. 10.

19 Schwenk, E. H., Alleged Production of Synthetic Diamonds in West Germany: Consular Dispatch 2137, Bonn, West Germany, Jan. 26, 1953.
Gemmologist, Arrests Follow German Diamond-Synthesis Claim: Vol. 22, No. 258, January 1953, p. 8.

20 Journal of Commerce, Sept. 29, 1953, p. 2.

21 Ross, A. E., and Long, A. E., Oriented Diamond Bits Cut Drilling Costs: Min. Cong. Jour., vol. 39, No. 8, August 1953, pp. 71–73.

22 Steel, Grinding Wheels: Vol. 132, No. 26, June 29, 1953, p. 42.

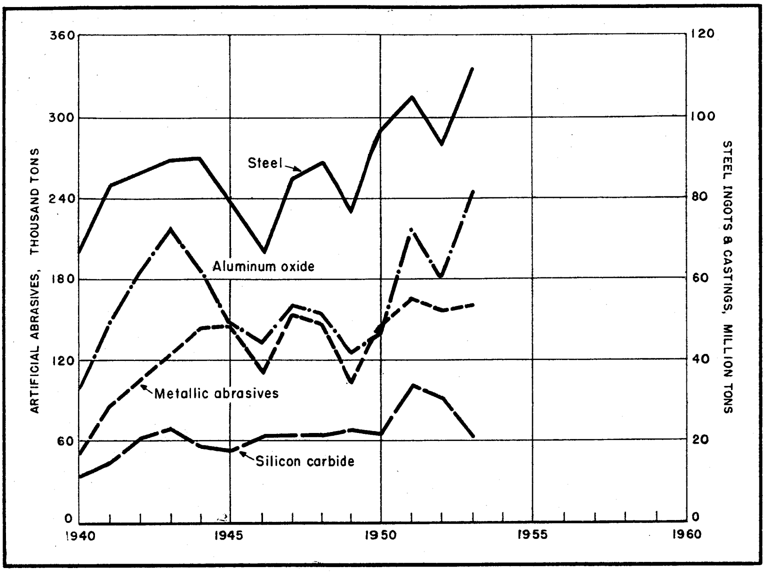

FIGURE 3.—Relationship between ingot-steel and artificial abrasive production.

TABLE 17.—Crude artificial abrasives produced in the United States and Canada, 1944–48 (average) and 1949–53

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
1944–48 (average)	60,134	$5,184,555	155,933	$9,920,821	140,846	$10,195,605	356,913	$25,300,981
1949	67,539	6,055,763	125,806	8,500,074	104,778	9,312,368	298,123	23,868,205
1950	65,004	7,303,671	140,352	11,958,035	144,333	11,699,764	349,689	30,961,470
1951	100,498	11,734,812	216,329	21,444,343	165,138	17,923,301	481,965	51,102,456
1952	91,531	12,040,946	180,375	17,813,760	157,034	17,582,275	428,940	47,436,981
1953	62,301	8,190,431	244,136	23,807,806	160,500	18,038,046	466,937	50,036,283

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

A study of the application of abrasives in industry was published[23] and a method for determining the hardness and toughness of abrasives described.[24]

An American abrasive-manufacturing firm opened a new plant in Northern Ireland.[25]

One of the larger abrasive-manufacturing companies issued brochures on aluminum oxide and on silicon carbide, describing the

[23] Ball, A. L., and Kline, A. A., Applications of Abrasives. ASTM Bull. 191, July 1953, p. 37. Ceramic Age, Application of Abrasives: Vol. 62, No. 3, September 1953, pp. 26–27.
[24] Pemberton, A., Determining Hardness and Toughness of Abrasives: Ind. Diamond Rev., vol. 13, No. 148, March 1953, pp. 67–70.
[25] Steel, Norton Opens a Plant in Ireland: Vol. 133, No. 7, Aug. 17, 1953, p. 98.

methods of manufacture and the uses of the various products made from them.[26]

TABLE 18.—Stocks of crude artificial abrasives and capacity of manufacturing plants, as reported by producers in the United States and Canada, 1944–48 (average) and 1949–53, 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
1944–48 (average)	5,503	72,226	31,712	233,438	8,048	219,533
1949	21,964	81,121	49,505	237,072	10,144	231,650
1950	8,766	84,398	22,025	238,500	7,291	209,850
1951	11,786	106,741	32,428	249,000	9,843	244,178
1952	25,347	111,200	60,354	255,100	9,801	226,427
1953	18,587	110,900	25,165	273,200	11,913	255,624

[1] Figures pertain to United States plants only.

Recent developments in the abrasive industry were described in the technical press.[27]

MISCELLANEOUS MINERAL-ABRASIVE MATERIALS

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

FOREIGN TRADE [28]

Imports.—Abrasive materials imported into the United States during 1953 showed an increase in value of 15 percent over 1952, imported aluminum oxide being the principal factor in this increase. Importation of industrial diamonds declined slightly; corundum imports also declined, and no imports of emery or garnet were reported. Sample shipments of corundum were received from India and Mozambique. The importation of manufactured abrasive grain and coated abrasives from Europe showed an increase.

Exports.—Total value of the abrasive materials exported during 1953 declined 3 percent from the preceding year. Included in the exports of natural, artificial, and metallic abrasives and products were: 9,500 short tons of aluminum oxide, valued at $2,434,000; 5,300 short tons of silicon carbide, valued at $1,640,000; 4,500 short tons of metallic abrasives, valued at $624,000; 1,800 short tons of

[26] Carborundum Co., Facts About Aluminum Oxide (55 pp.) and Facts About Silicon Carbide (52 pp.): Research and Development Division, Niagara Falls, N. Y., May 1953.
[27] Finley, G. R., and Upper, J. A., Developments in the Abrasive Industry in the Niagara Area: Jour. Electrochem. Soc., vol. 100, No. 3, March 1953, pp. 61–64.
[28] 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.

grinding wheels, valued at $3,093,000; and 198,500 reams and rolls of coated paper and cloth, valued at $5,071,000.

TABLE 19.—Abrasive materials (natural and artificial) imported for consumption in the United States, 1951–53, by kinds

[U. S. Department of Commerce]

Kind	1951		1952		1953	
	Quantity	Value	Quantity	Value	Quantity	Value
Burrstones:						
Unmanufactured........short tons..	----------	----------	----------	----------	152	$3,022
Bound up into millstones.....do....	18	$3,142	7	$1,236	3	594
Grindstones, finished or unfinished do....	213	15,892	195	16,367	286	12,974
Hones, oilstones, and whetstones do....	12	28,098	17	39,058	21	35,392
Corundum (including emery):						
Corundum ore.................do....	4,754	261,809	4,571	273,527	2,675	205,208
Emery ore....................do....	2,810	33,519	----------	----------	----------	----------
Grains, ground, pulverized, or refined....................pounds..	20,872	1,154	25.644	1,791	65,450	3,269
Paper and cloth coated with emery or corundum..............reams..	4,669	141,068	2,005	106,133	11,908	173,133
Wheels, files, and other manufactures of emery...........pounds..	59,829	49,171	10,278	10,591	20,397	19,153
Wheels of corundum or silicon carbide......................do....	2,343	4,064	6,439	16,523	6,960	9,962
Garnet in grains, ground, etc...do....	----------	----------	3,000	250	----------	----------
Tripoli or rottenstone, and diatomaceous earth...........short tons..	11	430	1,636	116,407	372	39,451
Diamonds:						
Bort, manufactured..........carats..	6,659	412,705	11,631	391,400	7,891	292,525
Crushing bort (including all types of bort suitable for crushing) carats..	12,118,408 (includes other industrial diamonds)	46,295,993 (includes other industrial diamonds)	8,806,473	19,920,968	8,726,923	20,163,661
Other industrial diamonds (including glaziers' and engravers' diamonds unset and miners') carats..			[1] 4,650,256	[1] 31,039,633	4,036,730	26,669,785
Carbonado and ballas.........do....	2,239	31,629	12,469	156,562	1,842	15,864
Dust and powder..............do....	166,760	471,496	224,429	792,951	749,290	2,107,453
Flint, flints, and flintstones, unground short tons..	17,780	419,572	7,871	186,688	9,103	195,055
Grit, shot, and sand, of iron and steel pounds..	3,068,156	729,050	434,693	194,689	1,398,687	244,521
Artificial abrasives:						
Crude, not separately provided for:						
Carbides of silicon (carborundum, crystalon, carbolon, and electrolon................pounds..	131,969,230	5,684,492	101,367,729	4,862,990	92,588,383	5,326,018
Aluminous abrasives, alundum, aloxite, exolon, and lionite pounds..	333,578,195	10,751,288	266,541,342	9,164,982	479,444,598	21,796,319
Other......................do....	1,624,240	59,130	1,601,853	70,063	1,098,120	54,485
Manufactures:						
Grains, ground, pulverized, refined, or manufactured pounds..	1,951,005	204,450	1,192,390	125,221	2,574,315	271,928
Wheels, files, and other manufactures, not separately provided for..................pounds..	37,711	28,960	23,685	22,624	13,674	11,400
Total.........................	----------	65,627,112	----------	[1] 67,510,654	----------	77,651,172

[1] Revised figure.

TABLE 20.—Abrasive materials (natural and artificial) exported from the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Year	Grindstones and pulpstones		Diamond dust and powder		Diamond grinding wheels		Other natural, artificial, and metallic abrasives, and products [1] (value)	Total value
	Pounds	Value	Carats	Value	Pounds	Value		
1944–48 (average)	4,341,683	$208,522	100,730	$156,089	7,066	$153,356	$15,592,476	$16,110,443
1949	1,407,680	82,090	55,637	133,917	10,285	321,936	16,909,456	17,447,399
1950	1,027,599	55,283	58,563	126,089	12,807	502,523	15,491,157	16,175,052
1951	1,344,458	76,330	60,621	166,539	15,317	539,770	24,374,394	25,157,033
1952	789,786	59,258	79,183	216,115	(2)	501,239	18,419,588	19,196,200
1953	864,357	52,971	65,853	182,838	(2)	545,618	17,754,064	18,535,491

[1] Exclusive of steel wool.

[2] 1952: January 1 through June 30: 4,992 pounds ($256.946); July 1 through December 31: 47,253 carats ($244,293); 1953: 110,847 carats ($545,618).

Aluminum

By Delwin D. Blue[1] and Horace F. Kurtz[2]

SHORTAGES and the associated difficulties of procurement in the markets for aluminum changed to adequate supplies and strong sales efforts during the latter half of 1953. Production rates increased as a result of new primary aluminum capacity being put into operation, but consumption declined because of rescheduling of defense contracts and inventory adjustments. Government controls on distribution and use were abolished for all aluminum items except those going into defense or atomic energy applications.

TABLE 1.—Salient statistics of the aluminum industry, in the United States, 1944–48 (average) and 1949–53

	1944–48 (average)	1949	1950	1951	1952	1953
Primary production short tons	575, 268	603, 462	718, 622	836, 881	937, 330	1, 252, 013
Value	$164, 294, 600	$190, 303, 000	$235, 977, 000	$305, 074, 000	$344, 320, 000	$494, 128, 000
Quoted price per pound cents	15. 1	17. 0	17. 7	19. 0	19. 4	20. 9
Secondary production short tons	306, 744	180, 762	243, 666	292, 608	304, 522	368, 566
Imports (crude and semi-crude) short tons	138, 270	125, 326	255, 692	161, 834	150, 738	359, 481
Exports (crude and semi-crude) short tons	67, 592	39, 358	23, 236	14, 817	10, 614	15, 355
World production short tons	1, 255, 000	1, 445, 000	1, 655, 000	1, 975, 000	2, 260, 000	2, 715, 000

DOMESTIC PRODUCTION

PRIMARY

The record domestic aluminum production obtained in 1953 was largely an outgrowth of the Government-planned expansion, which was initiated in 1950 under authority of the Defense Production Act. The 1,252,000 short tons produced in 1953 was a 315,000-ton increase from 1952, and of this increase 300,000 tons came from plants constructed or expanded under the Government program. Primary production data given in this chapter represent output from reduction cells and include a small quantity of alloying constituents that were sometimes introduced into the cell feed and recovered with the aluminum.

The plants in the Pacific Northwest, which represented 30 percent of the United States operable reduction capacity at the end of 1953 were operating below capacity in January and February because of an electric power shortage that started in the fall of 1952. However, in contrast with production in that area in foregoing years, plants were operating at capacity during the fall and early winter of 1953. In the Tennessee Valley power shortages were more serious than in

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[2] Commodity-industry analyst.

1952, and curtailment of production at Alcoa, Tenn., and Badin, N. C., resulted in an estimated 20,000-ton production loss during the latter half of 1953.

TABLE 2.—Production of primary aluminum in the United States 1949–53 by quarters,[1] in short tons

Quarter	1949	1950	1951	1952	1953
First	157,957	161,213	200,716	226,377	287,004
Second	165,169	180,353	202,875	235,158	311,687
Third	157,520	185,973	215,943	240,425	329,163
Fourth	122,816	191,083	217,347	235,370	324,159
Total	603,462	718,622	836,881	937,330	1,252,013

[1] Quarterly production adjusted to final annual totals.

The construction of new plants and the expansion of facilities at established plants by the three companies producing primary aluminum resulted in redistribution of the production: In 1953 the Aluminum Co. of America produced 48 percent of the domestic primary aluminum compared with 50 percent in 1952 and 51 percent in 1951; Reynolds Metals Co. accounted for 26 percent in 1953 compared with 29 percent in each year 1952 and 1951; Kaiser Aluminum & Chemical Co. production accounted for 25 percent in 1953 compared with 21 and 20 percent in the 2 previous years. Alcoa's production increased 31 percent, Reynolds 20 percent, and Kaiser 60 percent from 1952. In the last quarter of 1953 Kaiser's production exceeded that of Reynolds.

Although no new plants started production in 1953, plants at Point Comfort, Rockdale, and San Patricio (near Corpus Christi), Tex.; Wenatchee, Spokane, Takoma, and Longview, Wash.; and Chalmette, La., increased output steadily through the year as new reduction cells were placed in operation and as operational difficulties associated with new production facilities were overcome. Reduction plants that were under construction but had not started operating were at Arkadelphia, Ark. (Reynolds Metals Co.), with an annual capacity of 55,000 tons, and at Columbia Falls, Mont. (Anaconda Aluminum Co.), 54,000 tons.

Expansion.—A third upward revision for the Government-programmed expansion was announced on October 1, 1952, for 200,000 annual additional tons of aluminum capacity, and in the latter part of 1952 3 companies—Olin Industries, Inc., East Alton, Ill.; Harvey Machine Co., Torrance, Calif.; and the Wheland Co., Chattanooga, Tenn.—were approved or were negotiating for entry into aluminum production under that program. A combination of circumstances, including a reevaluation of expansion goals, reorganization of Government agencies responsible for operating the Defense Production Act, and technical and financial difficulties encountered by interested companies delayed firm plans during 1953 either by Government or industry for implementing the expansion.

The plans of Harvey Machine Co. for constructing a 54,000-annual-ton capacity plant at The Dalles, Oreg., were advanced when the company signed a procurement agreement with General Services Administration on May 21 for disposal of aluminum from the proposed plant. However, the funds for construction of a powerline to The Dalles were not included in Government appropriations granted in 1953, and the effect of this deletion on Harvey's plans had not been determined at the end of 1953.

Olin Industries and Wheland Co. stated that, unless financial aid in addition to that given in previous expansions could be provided by the Government, they would not press their plans for entering into primary-aluminum production.

Kennecott Copper Corp., often suggested as a potential aluminum producer, entered the primary-aluminum industry through a large purchase of Kaiser Aluminum & Chemical Co. stock. Kennecott purchased $16,250,000 of a new series of convertible preferred stock and 100,000 shares of Kaiser common stock. Apex Smelting Co. and American Smelting & Refining Co. joined in forming a new corporation, the National Metallurgical Corp., for constructing and operating a pilot plant to produce aluminum-silicon metal from clay at Springfield, Oreg.

The Air Force heavy-press program, which originally called for 17 presses, was cut back to 10 presses—4 forge and 6 extrusion. The companies participating in the program and the planned capacity, types, and locations of the presses were as follows: Alcoa, a 14,000-ton extrusion press at Lafayette, Ind., and a 35,000- and a 50,000-ton forge press at Cleveland, Ohio; Kaiser, two 8,000-ton extrusion presses at Halethorpe, Md.; Harvey Machine, an 8,000- and a 12,000-ton extrusion press at Torrance, Calif.; Wyman-Gordon, a 35,000- and a 50,000-ton forge press at North Grafton, Mass.; and Curtiss-Wright, a 12,000-ton extrusion press at Buffalo, N. Y. The only one of the heavy presses that had been installed and operated during 1953 was the 14,000-ton extrusion press at Lafayette, Ind. A stretcher to treat extrusions from the 14,000-ton press with 3 million pounds of pull was also installed.

The Aluminum Co. of America completed new facilities for producing rod and extrusion ingots at Vancouver, Wash., and installation of two extrusion presses and enlargement of the rod and cable production plant were scheduled for completion in 1954. Installation of a tapered sheet-rolling mill at Davenport, Iowa, was almost complete, and initial production from new foil facilities at Alcoa, Tenn., was expected early in 1954. A new plant at Lancaster, Pa., for producing aluminum screw machine products was in partial operation. Alcoa also announced an increase in its forging, foundry and ingotmaking capacity at Cuyahoga Heights near Cleveland, as well as expansion of its boring and turning melting capacity.

Kaiser Aluminum & Chemical Corp. was producing aluminum tubing made on a continuous welding machine designed by the Yoder Co., Cleveland, Ohio, at its plant at Trentwood, Wash. A new plate stretcher with 5 million pounds of pull was in operation. Kaiser announced plans for constructing a new aluminum-sheet mill at Mentor, Ky.

Olin Industries, Inc., announced plans to expand fabrication facilities for aluminum- and copper-base alloys at East Alton, Ill. Scovill Manufacturing Co. established a new aluminum strip mill at Waterbury, Conn. A new firm, North American Extrusions Corp., was established to produce extrusions in Kalamazoo, Mich. Aluminum extrusion presses were also being installed at the Decatur, Ala., plant of Calumet & Hecla, Inc. Sonken-Galamba Corp. started operation in November of a smelter in Florida for producing extrusion billets.

SECONDARY

Domestic recovery of aluminum from nonferrous metal scrap in 1953 was 369,000 short tons. Recovery from new scrap was 290,000 tons and from old scrap 79,000 tons. The secondary-aluminum recovery was from 413,000 tons of aluminum scrap (322,000 tons of new and 91,000 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). Aluminum scrap was consumed by the three primary-aluminum producers, by secondary-metal smelters that produced smelter ingot for sale to fabricators, by fabricators, and by miscellaneous small users, largely chemical producers. Secondary-aluminum recovery in 1953 was the highest on record, despite a decline during November and December, when the recovery was 14 and 7 percent, respectively, below the average monthly recovery for the year.

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

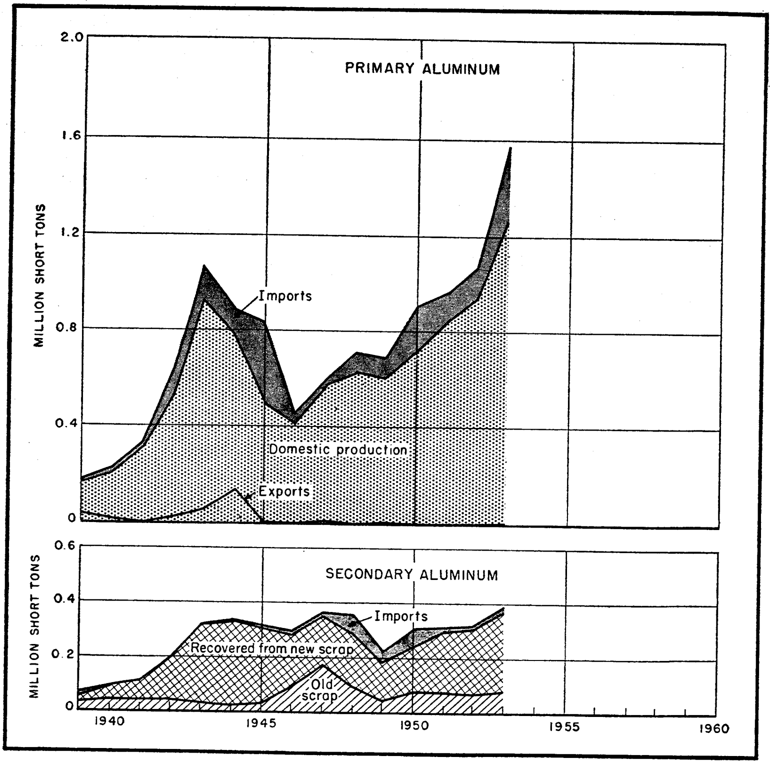

FIGURE 1.—United States production, imports, and exports of primary- and secondary-aluminum pig and ingot, 1939–53.

CONSUMPTION AND USES

Apparent consumption of primary aluminum in 1953 was 1,542,000 short tons, as computed by adding primary production and net imports of pig, ingot, slab, plate, sheet, bar, and other crude and semifabricated forms and adjusting for stock changes at primary reduction plants. This computed apparent consumption included metal going into the National Stockpile and did not reflect stock changes by aluminum-metal consumers.

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

TABLE 3.—Apparent consumption of primary aluminum and ingot equivalent of secondary aluminum in the United States, 1944–48 (average) and 1949–53, in short tons

Year	Primary			Secondary		
				Domestic recovery		
	Sold or used by producers	Imports (net) [1] [2]	Apparent consumption [2]	From old scrap	From new scrap	Imports (net) [3]
1944–48 (average)	586,665	49,522	636,187	80,048	226,696	19,041
1949	587,532	46,245	633,777	44,596	136,166	35,751
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

[1] Crude and semifabricated, excluding scrap. May include some secondary.
[2] Figures revised to 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.

TABLE 4.—Sources of aluminum supply—crude and scrap,[1] 1944–48 (average) and 1949–53, in short tons

Year	Primary production	Recovery from scrap		Imports [2]	Total supply	Exports [2]
		Old	New			
1944–48 (average)	575,268	80,048	226,696	133,998	1,016,011	30,515
1949	603,462	44,596	136,166	113,450	897,674	8,375
1950	718,622	76,358	167,308	237,941	1,200,229	1,382
1951	836,881	76,591	216,017	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

[1] Ingot equivalent of scrap.
[2] Crude metal (ingot, pig, slabs, etc.) plus ingot equivalent (wt. × 0.9) of scrap.

The calculated new supply of aluminum in 1953 was the sum of domestic primary production, secondary recovery from both old and new purchased and toll-treated scrap, imports of pig and ingot, and ingot equivalent of imported scrap. Home scrap was omitted from this total. Exports of crude forms of aluminum were not considered as a decrease in the supply of crude aluminum but as a form of consumption. The new-supply figure represents the quantity of aluminum available at the ingot or ingot-equivalent stage of aluminum consumption, that is, for use in producing castings, semifabricated wrought shapes, for dissipative uses, such as hardeners, deoxidizers, chemicals, etc., and ingot for export, and for increases in stocks. Stock changes were not included at any level of production or consumption because of the lack of complete statistical data. (See section on Stocks.)

TABLE 5.—Net shipments [1] of aluminum wrought and cast products by producers, 1949–53, in short tons

[U. S. Department of Commerce]

	1949	1950	1951	1952	1953
Wrought products:					
Plate, sheet and strip	395,012	581,567	536,683	542,849	684,083
Rolled structural shapes, rod, bar, and wire	101,825	134,890	172,582	221,773	211,023
Extruded shapes, tube bloom, and tubing	74,998	129,038	156,472	173,771	225,961
Powder flake and paste	7,238	11,230	12,385	23,982	22,366
Total	579,073	856,725	878,122	962,375	1,143,433
Castings:					
Sand	61,302	92,391	96,689	97,308	107,277
Permanent mold	61,761	90,683	80,005	73,442	100,012
Die	49,170	83,600	75,733	84,866	119,665
Other	3,656	4,867	5,139	3,874	2,057
Total	175,889	271,541	257,566	259,490	329,011
Grand total	754,962	1,128,266	1,135,688	1,221,865	1,472,444

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

This total new supply of aluminum pig and ingot was 1,945,000 tons, an increase of 569,000 tons from the new supply of 1952. In comparison, shipments of aluminum cast and wrought products increased only 250,000 tons from 1952. No data on the other major consumption classification, destructive uses, were available for 1953. These data indicate that the supply of aluminum in 1953 was running well ahead of fabrication and consumption. This was particularly accented during the latter part of the year when production of primary metal was increasing, imports were maintained at a relatively constant rate, and shipments of semifabricated products were declining. Shipments of wrought and cast aluminum products dropped from 140,000 tons in April—the high month—to 100,000 tons per month in November and December. This drop was reflected in secondary-aluminum recovery which also decreased during November and December.

Distribution of wrought aluminum, by type of mill shape as compiled from data collected by the United States Bureau of the Census, was:

	Percen
Plate, sheet and strip:	
Non-heat-treatable	38.5
Heat-treatable	14.5
Foil	5.3
Rolled structural shapes:	
Rod, bar, etc	9.8
Wire, bare (nonconductor)	2.1
Cable, bare (including steel-reinforced)	6.0
Wire and cable, covered or insulated and bare conductor wire	1.1
Extruded shapes (including tube blooms):	
Soft alloys	14.0
Hard alloys	3.6
Tubing:	
Soft alloys	2.5
Hard alloys	.6
Powder, flake and paste	2.0

Effective July 1, 1953, the Defense Materials System replaced the Controlled Materials Plan, and the distribution and use of all aluminum except that required for defense programs was free of Government controls. DMS Regulation 1, issued March 23, 1953, established the basic rules of the Defense Materials System for persons who produced certain products and materials for the defense program; NPA Order M-5A, issued May 6, 1953, established special rules for aluminum to supplement DMS regulations and provided for equitable distribution of controlled materials orders by producers and distributors. Under the Government purchase program for aluminum produced at the new facilities constructed under the Government programmed expansion, a certain percentage of the output from the new facilities was reserved for nonintegrated aluminum consumers. On June 24 a special interagency committee was set up in the General Services Administration to oversee the distribution of aluminum provided for under the GSA supply contracts with the domestic producers. Members of the committee were selected from the GSA, Business and Defense Services Adminstration of the United States Department of Commerce, and the Office of Defense Mobilization.

The transportation industries were a major consumer of aluminum. Despite the increasing use of magnesium and the much publicized future use of titanium in aircraft construction, it appeared unlikely that any metal would, in the near future, seriously challenge aluminum as the major structural metal for airframes. A typical Canadian airframe contained 88 percent aluminum alloys, 9 percent steel, and 3 percent magnesium.[3] Greater availability of magnesium-alloy sheet would have resulted in an increase of the magnesium percentage at the expense of aluminum. In shipbuilding aluminum alloys were playing an increasingly important part, especially in superstructures where weight reduction contributed to ship stability. Such engineering improvement and technical advancement resulted in a tendency toward increased initial cost; however, increases in the use of aluminum were a function of the economic gains, taking into account not

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[3] Smallman-Tew, R., Strategic Metals in Aircraft Construction: Canadian Metals, February 1953.

only construction cost but also the relative economics of operation and maintenance in service.[4]

The trend toward increased use of aluminum in automotive equipment continued during 1953. Most of the aluminum going into automobiles was in the form of castings, such as in stators for torque converters, clutch and transmission housings, in brackets, mounting and support sections. Extrusions were gaining in use, as demonstrated by the door design of the Nash automobiles, in which the upper section was an extruded aluminum part completely subassembled and bolted onto the lower door section. Aluminum extruders were anticipating greater use of their products for garnish and rub moldings because of a nickel shortage and improved anodic finishes for aluminum alloys. Chrysler Corp. announced that its 1954 sedan contained 64 pounds of light metals, representing a weight saving of 183 pounds. The use of aluminum for automobile radiators had been held back because of a lack of low-cost fabrication methods. Experimental use under service conditions had shown aluminum radiators to be entirely satisfactory for periods of over a year and mileages up to 30,000. Problems involved in the manufacture of brazed-aluminum radiators on a production basis were nearing solution, and other possible methods of fabrication were being intensively investigated.[5] A new lightweight jeep with an all aluminum body shell weighing 81 pounds was being tested by the Army. Alcoa issued a revised manual, Truck Bodies From Alcoa Aluminum; Kaiser offered a new extruded-aluminum truck or trailer floor assembly; a new 6-ton capacity mine car developed by Reynolds Metals and the Wheel & Car Corp. of Bristol, Va., and made of aluminum was being tested by the Pocahontas Fuel Co. at its Ittmann mine. The mine car weighed 1,614 pounds in contrast to a similar car that weighed 4,417 pounds.

A survey conducted by the Nichols Wire & Aluminum Co., Davenport, Iowa, indicated that the quantity of aluminum used in building products increased 33 percent in 1953 from 1952.[6] The most spectacular use of aluminum in building was for the exterior skin of large commercial buildings, as exemplified by the new Alcoa office building in Pittsburgh, Pa., and a skyscraper on Park Avenue in New York. New aluminum building products and installation procedures were being developed, such as the combination aluminum-panel and glass-fiber insulation acoustical system developed by Reynolds. This system provided a noise-reduction coefficient up to 0.90 and could be simply and easily installed.[7] A paper and aluminum sandwich panel, called Reynocell, consisted of embossed-aluminum sheet bonded to a honeycombed paper core to give a sturdy, lightweight heat- and noise-insulating panel. A novel method of installing aluminum roof coverings, known as Roliton, was developed for on the job forming of coils of aluminum to exact measurements needed for any given roof.[8]

[4] Boykin, C. V., and Sellers. M. L., Practical Problems Relative to the Use of Aluminum Alloys in Ship Construction: Pres. at annual meeting, Society of Naval Architects and Marine Engineers, New York, N. Y., Nov. 12 and 13, 1953; excerpts reproduced in Am. Metal Market, vol. 40, 1953, No. 226, Nov. 24, p. 10, and Nov. 25, p. 11.

[5] American Metal Market, Aluminum Radiators for Autos Seen in Offing: Vol. 40, No. 47, Mar. 11, 1953, p. 11.

[6] Iron Age, Aluminum for Building: Vol. 172, No. 24, December 1953, p. 250.

[7] American Metal Market, Reynolds Metals Develops New Acoustical System Using Aluminum Panels: Vol. 40, No. 211, Oct. 30, 1953, p. 9.

[8] American Metal Market, Mobile Rolling Unit Applies Aluminum Sheet to Roof: Vol. 40, No. 125, June 30, 1953, p. 1.

The larger gains in aluminum consumption in building materials were a result of wider acceptance in established uses, such as awnings, window frames, flashings, gutters, and store fronts.

The greatest deterrents in the use of aluminum for electrical conductors were the problems associated with joining. Alcoa released an educational film, Electrical Wiring With Alcoa Aluminum, that explained and demonstrated aluminum-wiring techniques.[9] The proper selection of connectors was largely a matter of educating electrical workers, although the limited number of connectors approved by various agencies was a restricting factor in use of aluminum.[10] New methods and machines were being developed for applying aluminum cable sheathing.[11] An aluminum sheathing tube, largest ever produced, was extruded by Northern Aluminum Co., Ltd., for sheathing conductors to be used by the Aluminum Co. of Canada at its new installation in British Columbia.[12]

Aluminum foil was being used in increasing quantities as a packaging material. One refrigerator manufacturer had installed a built-in aluminum-foil dispenser in the door. Reynolds Metals released a motion picture, Packaging Payoff, showing the increasing use of aluminum foil for labels and all types of protective packaging.[13]

Three new aluminum-paint pigments were announced by Metals Disintegrating Co., Elizabeth, N. J.: MD–515, said to provide superior covering capacity coupled with an average coarser mesh size, to produce films of brighter more diffuse appearance; MD–584 nonleafing paste, recommended for improved appearance and workability in metalliscent finishes for industrial use; and MD–784 nonleafing paste, developed specifically for hammer finishes and metallic enamels. An aluminum paint designed for uses where temperature up to 1,200° F. were encountered was marketed by Sapolin Paints, Inc., N. Y.

Expanded aluminum, a form of aluminum mesh, was introduced in the United States by British Industries Corp., N. Y. Manufactured in England in plain or anodized colors, the material had many industrial and decorative applications, particularly for construction of guards or grilles.

STOCKS

During 1953 aluminum was on the Government purchase list of strategic materials for the National Stockpile. Figures on acquisitions and total stocks were classified security information.

Stocks of primary aluminum at reduction plants rose from 7,300 short tons on January 1 to 39,300 tons, about 11 days' production, by the end of 1953. As expected, working inventories were accumulated at the new plants that went into operation during 1952, but stocks at all other reduction plants also increased from the abnormally low levels of the beginning of 1953. Inventories of secondary ingot at independent smelters declined during the first 2 months of 1953

[9] Available upon request to Motion Pictures Division, Aluminum Co. of America, 181 Alcoa Bldg., Pittsburgh 19, Pa. Estimate of potential audience should accompany request.
[10] Dupre, Henry, How to Select Connectors for Aluminum Conductors: Materials and Methods, vol. 38, No. 2, August 1953, pp. 96–99.
[11] Wyatt, K. S., Will Aluminum Displace Lead as a Cable-Sheathing Material: Am. Metal Market, vol. 40, No. 70, Apr. 14, 1953, p. 10.
[12] Metal Industry, Aluminum Cable Sheathing Tube: Vol. 82, No. 22, May 29, 1953, p. 449.
[13] Available by arrangement with Motion Picture Department, Reynolds Metals Co., 2500 South 3d St., Louisville 1, Ky.

but increased in September, so that year-end stocks totaled 15,000 tons or 19 percent higher than the start of the year. Closing stocks were equivalent to about 3 weeks' production. No statistics were available regarding inventories of primary and secondary ingot at consuming plants or on the quantity of aluminum in the process of fabrication.

Inventories of aluminum-base scrap at plants of the primary-aluminum companies, the independent smelters, and the fabricators and other scrap consumers all increased during 1953. The total scrap stocks at consumers on December 31 was estimated at 27,000 tons. Data on inventories at collectors' and dealers' yards were not available.

PRICES

During 1953 the base price of primary-aluminum ingot, 99 plus percent pure, f. o. b. shipping point, increased 1.5 cents to 21.5 cents per pound. On January 21, after several weeks of negotiations between the Government and the aluminum producers, the Office of Defense Mobilization and the Office of Price Stabilization agreed to raise the ceiling price on aluminum pig and ingot 0.5 cent per pound to 19.5 and 20.5 cents, respectively, and to grant a 4-percent increase on semifabricated products. As part of the agreement, the companies waived for 6 months their right to cancel contracts for delivery of aluminum to the GSA. Government purchase contracts concerned new plants that had been granted rapid amortization assistance and previously contained a clause permitting companies to stop metal shipments to the Government if price controls resulted in unreasonably low profit margins. The Government abandoned its right to terminate contracts after half of the 5-year contracts had been completed. The Government also obtained options to buy any plants that became idle for 90 days, instead of the previous 1-year provision.

On February 25 price controls on primary aluminum were removed, but there were no immediate changes in base prices.

TABLE 6.—Prices of aluminum, other selected metals, and the Bureau of Labor Statistics' wholesale price index, 1936–53 [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:					
First quarter	20.39	26.66	4.98	11.70	109.8
Second quarter	20.50	30.01	5.04	11.00	109.6
Third quarter	21.33	29.44	5.24	10.73	110.8
Fourth quarter	21.50	29.57	5.24	10.00	110.0
Average	20.93	28.92	5.12	10.86	110.1
Increase from 1936–40 average to 1953 average percent	5.4	161.0	92.5	97.5	110.9

[1] Source: Metal Statistics, 1954 (American Metal Market).

The year-end price quotations of 20.0 cents per pound for pig and 21.5 cents for ingot were established by the Aluminum Co. of America on July 15. Alcoa announced that the 0.5- and 1.0-cent increases in base prices resulted from an 8.5-cent-an-hour wage increase granted early in July. Other producers' prices followed the Alcoa increases.

Prices of primary-aluminum ingot followed a long downward trend until 1942, when a minimum of 15 cents per pound was reached. Since 1948 all price changes have been upward. If prices are converted to allow for depreciation of the dollar value, however, the downward trend continues well beyond the establishment of the 15-cent base price. Table 6 shows that, unlike its major competitive metals, aluminum prices were nearly the same in 1953 as they were during the years immediately before World War II. On the other hand, aluminum has not improved its relative position pricewise since 1948.

The December 31, 1953, issue of American Metal Market quoted secondary-aluminum ingot prices per pound as follows: AXS–679, 20.75–21.25 cents; 319, 20.75–21.25 cents; No. 12, 19.75–20.25 cents. Aluminum-base scrap prices were given at: Duralumin clippings, 10.00–10.50 cents; borings and turnings, 6.00 cents; 2S clippings, 12.00–12.50 cents; and industrial castings, 9.00–9.50 cents. From the available quotations it was estimated that aluminum-scrap prices averaged 1.75–2.00 cents per pound more than on January 1, 1953. Since the average secondary-ingot prices increased less than 1 cent per pound from the beginning of the year it appeared that about 1 cent of the scrap-price rise was absorbed by the secondary smelters. Beginning with decontrol of ceiling prices on secondary aluminum on February 13, prices fluctuated above and below the closing 1953 quotations. Immediately after decontrol all prices rose at least 1.5 cents per pound. Secondary-ingot prices reached a peak by April 1 but declined through most of the remainder of 1953. The highest prices for aluminum scrap were paid early in April, during July, and at the end of November.

FOREIGN TRADE [14]

Imports.—United States imports of aluminum during 1953 more than doubled the 1952 quantity. As shown in table 7, receipts of aluminum in each of the major import classifications and from all of the leading foreign suppliers except Italy contributed to the increase. Canada, historically the source of most imports into the United States, shipped 74 percent of the total pig and ingot, Western Europe provided 23 percent, and Japan most of the remainder. Of the semifabricated shapes, 66 percent was received from Europe and 34 percent from Canada. Europe supplied 56 percent of the scrap imports and Canada 39 percent. The average value of imported aluminum in crude form increased from 17.0 cents per pound in 1952 to 19.2 cents in 1953; semifabricated metal rose from 27.6 cents per pound to 29.2 cents, but scrap values declined from 18.5 cents per pound to 15.2 cents.

[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.

TABLE 7.—Aluminum imported for consumption in the United States, 1952–53, by classes and countries, in short tons

[U. S. Department of Commerce]

Country	1952			1953		
	Metal and alloys, crude	Plates, sheets, bars, etc.	Scrap	Metal and alloys, crude	Plates, sheets, bars, etc.	Scrap
Austria	2,991	15	----------	13,608	201	50
Canada	115,829	9,890	3,839	224,017	10,779	10,428
France	----------	----------	----------	10,827	1,023	3,024
Germany, West	2,159	702	799	23,124	555	1,471
Italy	1,102	1,017	54	6	348	16
Japan	4,263	230	565	6,795	----------	1,071
Netherlands	1,102	65	688	----------	375	1,614
Norway	592	----------	----------	16,439	----------	1,021
Switzerland	28	28	110	4,485	278	479
United Kingdom	80	3,084	319	394	17,623	6,955
Other countries	87	476	624	1,233	750	492
Total	128,233	15,507	6,998	300,928	31,932	26,621
Value	$43,504,881	$8,551,176	$2,591,609	$115,761,297	$18,636,894	$8,072,379

The significant increase in receipts of ingot from West Germany resulted from deliveries under a contract between the Mutual Security Agency and the Greek mining company, Eleusis Bauxite Mines Co.; ore was converted to aluminum in West Germany and shipped to the United States as repayment for loans made to the mining company.

About 44,000 tons of Canadian primary aluminum scheduled for delivery to the United Kingdom was diverted to the United States during the early part of 1953. In the arrangements for this diversion, United Kingdom was given an option on future aluminum supplies of United States companies, but Government stockpiles of aluminum were not obligated. Approximately 50,000 tons had been imported during 1952 under similar agreements. Additional quantities of aluminum were diverted to the United States in the latter part of 1953, but details were worked out independently between the Aluminum Import Corp. (subsidiary of Aluminium, Ltd.) and the domestic consumers.

Early in 1953 Aluminium, Ltd., of Canada, offered to sell large quantities of primary aluminum to consumers in the United States. In May it was announced that contracts had been signed to sell 186,000 tons to Kaiser Aluminum & Chemical Corp. and 600,000 tons to Aluminum Co. of America during the 6-year period 1953–58. In July the United States Department of Justice petitioned the United States District Court in New York to cancel the Alcoa contract and to terminate an earlier judgment of the Court, which prescribed methods for separating control of Alcoa and Alted.[15] The Department of Justice contended that the procedure for disposing of common ownership in the two companies was not effecting a separation that would further competition in the aluminum industry. Alcoa filed an answer to the Department of Justice's petition in August in which it requested that the petition and motion be denied.[16] Subsequently, Aluminum

[15] Petition of the United States of America to the Honorable the Judges of the United States District Court for the Southern District of New York: Equity No. 85-73, United States of America, Plaintiff, v. Aluminum Co. of America et al, Defendants.

[16] American Metal Market, Text of Alcoa's Answer to Court in Antitrust Case: Vol. 60, No. 157, Aug. 13, 1953, pp. 9, 13.

Import Corp., a subsidiary of Aluminium, Ltd., also filed a reply disputing the allegations of the Department of Justice.[17] The Court had not held hearings nor rendered a decision by the end of 1953.

During 1953 an issue arose as to whether Department of Defense regulations included fabricated products in the aluminum exemption from the domestic preference provisions of the Buy-American legislation.[18] The Department of Defense ultimately issued statements to clarify its policy. As resolved, the domestic preference provisions applied to contracts of less than $25,000 in value; larger contracts were awarded without discrimination between foreign and domestic firms, on a low-bid basis, except where there were certain conditions, specified in the regulations, which in the judgment of the department warranted preferential treatment for domestic suppliers.

The duties on aluminum were unchanged throughout 1953 at 1½ cents per pound for ingot and pig and 3 cents per pound for semifabricated aluminum. Legislation to suspend the tariff on primary and secondary aluminum in crude form and bars, billets, and blooms for 1 year was introduced in the Senate and House of Representatives during 1953. These bills were not enacted, although Public Law 221, 83d Congress, renewed suspension of the 1½-cent-per-pound duty on aluminum scrap through June 30, 1954.

Exports.—Larger shipments of aluminum-base scrap in the latter half of 1953 and of ingot in the final quarter caused most of the annual increase in aluminum exports shown in table 8. Aluminum in classifications listed under CMP were subject to an export quota during the first half of 1953, and shipments of scrap were limited during the first quarter. There were no quantitative controls on exports during the remainder of 1953, despite protests from secondary-aluminum smelters who maintained that the prices offered by exporters were forcing increases in secondary ingot and restricting the flow of scrap from dealers.

TABLE 8.—Aluminum exported from the United States, 1952–53, by classes and countries, in short tons

[U. S. Department of Commerce]

Country	1952			1953		
	Ingots, slabs, and crude	Plates, sheets, bars, etc.[1]	Scrap	Ingots, slabs, and crude	Plates, sheets, bars, etc.[1]	Scrap
Canada	63	3,797	531	61	3,609	124
Cuba		799		5	588	
Finland		254			881	
Germany, West	234	(2)	58			905
Japan		(2)			12	2,660
Mexico	887	339		2,272	200	
Philippines	12	553			497	10
Venezuela	1	496			1,189	
Other countries	191	1,961	438	38	1,422	882
Total	1,388	8,199	1,027	2,376	8,398	4,581
Value	$519,071	$6,633,945	$163,987	$937,207	$7,785,990	$1,475,904

[1] Includes plates, sheets, bars, rods, extrusions, castings, forgings, and unclassified "primary forms." Data for 1952 exclude a small quantity of "primary forms" valued at $66,600.

[2] Less than 1 ton.

[17] American Metal Market, Text of Aluminum Import Corporation's Answer in Antitrust Suit: Vol. 60, No. 176. Sept. 10, 1953, pp. 9, 13; vol. 60, No. 177, Sept. 11, 1953, p. 9: and vol. 60, No. 178, Sept. 12, 1953, p. 11.

[18] American Metal Market, Text of Aluminum Importer's Memorandum Protesting Proposed Changes in Buy-American Act Exemptions: Vol. 60, No. 197, Oct. 9, 1953, pp. 9, 13.

Most of the primary ingot and semifabricated shapes exported were shipped to countries in the Western Hemisphere, as they had been in previous years, while Japan—a newcomer to export market—received most of the scrap. The average value of exported crude was 19.7 cents per pound (18.7 cents in 1952), semifabricated products were 46.4 cents per pound (40.5 cents in 1952), and scrap was 16.1 cents per pound (8.0 cents in 1952).

TECHNOLOGY

The most noteworthy technologic advances for aluminum in 1953 were in alloy development, fabricating techniques and equipment, and new finishes. The electrolytic reduction of pure alumina continued as the only commercial method for extracting aluminum from its ores, although a process for direct smelting of aluminum silicates was being tested by the Bureau of Mines and the National Metallurgical Co. A Bureau of Mines study of the raw materials requirements for metal production indicated that, of all material requirements, electrical energy and cryolite offered the greatest procurement problems.[19]

For information on developments in aluminum-ore utilization technology, refer to the Bauxite chapter of this volume.

The development of new alloys for specific applications and for improved performance in accepted applications continued in 1953. Reynolds Metals Co. and Kaiser Aluminum & Chemical Co. announced new general metal-working alloys, R305 and K155. A high-strength, low-creep, high-conductivity alloy, Cond-Al, was developed by General Electric for use in electrical conductors. Sintered aluminum powder (SAP) alloys had shown great promise for high-temperature (up to 900° F.) applications and were being investigated by a number of organizations to determine optimum powder characteristics, compacting and sintering techniques, and fabrication and physical properties.[20] Aluminum bearing materials tested by Morgan Construction Co. in rolling mills were found to have exceptional merit because of their high resistance to corrosion from atmospheres and lubricants, elimination of a bonding plane, and performance at high operating temperatures (as compared to softer bearing materials). Alcoa alloys KA750–T5 or 750–T5 proved to be satisfactory bushing materials.[21] Cadmium silicon-aluminum alloy bearings on steel backings tested by General Motors were found to outlast 3 or 4 crankshafts and blocks, and aluminum-tin bearing alloys showed promise as a substitute for copper-lead bearings.[22] A new series of alloys based on high-purity (99.99 percent) aluminum was announced; these would develop an exceptionally high brilliance by anodic polishing and were practically nontarnishable under atmospheric conditions.[23] An aluminum-antimony compound studied by the Battelle Memorial

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

[20] VonZeerleder, A., Aluminum in Powder Metallurgy: Modern Metals, vol. 8, No. 12, January 1953, pp. 40–44.

Haertlein, J. B., and Sachse, J. F., Review and Progress Report—Aluminum Powder Metallurgy: Modern Metals, vol. 9, No. 8, September 1953, pp. 54–61.

[21] Wood, D. B., Aluminum Alloys Make Good Bearings: Iron Age, vol. 172, No. 11, Sept. 10, 1953, pp. 168–169.

[22] E&MJ Metal and Mineral Markets: Vol. 24, No. 12, Mar. 19, 1953, and No. 38, Sept. 17, 1953.

[23] Materials and Methods, New High-Purity Aluminum Alloys: Vol. 37, No. 6, June 1953, pp. 110–111.

Institute was shown to have semiconductor properties that indicated its future wide application in the electronics industries.[24]

New and improved methods for fabricating aluminum were developed as consumption increased. Shot peening was found to be the only feasible way to produce chordwise curvature in a 32-foot wing skin made of 75ST6 alloy for the Lockheed Super Constellation.[25] The manufacture of aluminum tubing used in large quantities for irrigation installations was accelerated by a new tube manufacturing machine announced by Yoder Co.[26] An ingenious new expansion forming technique for forming large, circular sections was developed by Ryan Aeronautical Co., San Diego, Calif.[27] An extrusion technique for producing thin-walled, high-precision aluminum tubing to meet specifications for aircraft heat exchangers was perfected by AiResearch Mfg. Co., Los Angeles, Calif.[28]

Ultrasonic soldering, which was applied commercially in England, was finding increased acceptance in the United States.[29] A new soldering flux, announced in 1953, was Aluma-Flux, manufactured by Essex Wire Corp. and distributed by Insulation & Wires, Inc. A new-type solder, trade-named AluTin 51, was developed by Eutectic Welding Alloys Corp., Flushing, N. Y., for production, filling, sealing and repair operations on wrought and cast alloys. A new surface treatment for aluminum with a material called Kromolloy reportedly permitted solder joining of aluminum to other metals.[30] The development of salt-bath brazing had advanced to the point where it was possible to produce specialty parts with tolerances as high as ±0.002 inch.[31]

A new product called Kolmetal, developed by Emjay Manufacturing Co., was a mixture of aluminum powder (85 percent by volume) in a special plastic vehicle. The new material could reportedly be polished, ground, drilled, or bent to a 45° angle without chipping or cracking. Tests of Kolmetal as a coating on heat-exchanger units showed that it was an excellent corrosion retardant.[32]

The new MHC (Martin Hard-Coating) process which gave a hard coating by an anodizing treatment was licensed to Anodic, Inc., Bridgeport, Conn., by the Aluminum Co. of America. In addition to great surface hardness, high resistance to corrosion, and a low coefficient of friction, the MHC coating created high dielectric strength, indicating potential applications in electrical and electronic equipment.[33] An anodizing process, known as Ec Electrodizing (Philton Co., 200 W. Ninth St., Wilmington, Del.), claimed to give economic advantages over other comparable coating processes through power savings, decreased electrolyte costs, lower cost equipment, and greater output

[24] Lewis, Elliot L., Aluminum-Antimony Alloy Has Wide Application in Electronics: Light Metals Age, August 1953, pp. 11-13.
[25] Materials and Methods, vol. 38, No. 2, August 1953, p. 3.
[26] American Metal Market, New Machine that Speeds up Production of Tubes Introduced by Yoder: Vol. 40, No. 143, July 24, 1953, pp. 1, 7.
[27] Modern Metals, Radial Forming Aluminum: Vol. 9, No. 9, October 1953, p. 46.
[28] Close, Gilbert C., Aluminum Tubing—Small Diameter and Thin Walls Obtained by Extrusion: Light Metal Age, vol. 11, Nos. 9 and 10, October 1953, pp. 8, 9, 28.
[29] Walter, Leo, Ultrasonics—the Answer to Aluminum Soldering: Materials and Methods, vol. 38, No. 1, July 1953, p. 59.
[30] Modern Metals, Super-Hard Aluminum: Vol. 9, No. 4, May 1953, p. 24.
[31] Rudolph, William J., Close-Tolerance Aluminum Parts Brazed in Salt Bath: Materials and Methods, vol. 39, No. 1, January 1954, pp. 96-97.
[32] Obrzut, J. J., New Corrosion-Resistant Coating: Iron Age, vol. 172, No. 26, Dec. 24, 1953, pp. 76-77.
[33] ASTM Bulletin, Hard-Coating Process for Aluminum Now Available: No. 194, December 1953, pp. 43-44.

per unit of equipment.[34] The D'orium electrochemical oxidation process developed in Switzerland was reported to produce a finished appearance that was indistinguishable from gold, silver, or chromium (licensed to Miracle Finishes, Inc., 10 Water St., Brooklyn 1, N. Y.).[35] A new electrolytic silver-plating process was developed by General Electric engineers for use on aluminum conductor connections.[36] The Alodine process, a chemical oxidation treatment, was used on aluminum for aircraft to produce amorphous coatings for paint bonding and protection against corrosion.[37] A frit for porcelain enameling of aluminum was developed by DuPont and licensed to Ferro Corp. of Cleveland, Ohio, and Pemco Corp. of Baltimore, Md., for manufacture.[38] A method by which aluminum could be coated with Kel-F, one of the inert fluorocarbons, was announced by the Connecticut Hard Rubber Co. Kel-F-coated aluminum was reported to have approximately the same corrosion-resistant properties as glass, and the coated metal could be bent, drawn, and otherwise formed without damaging the coating.[39]

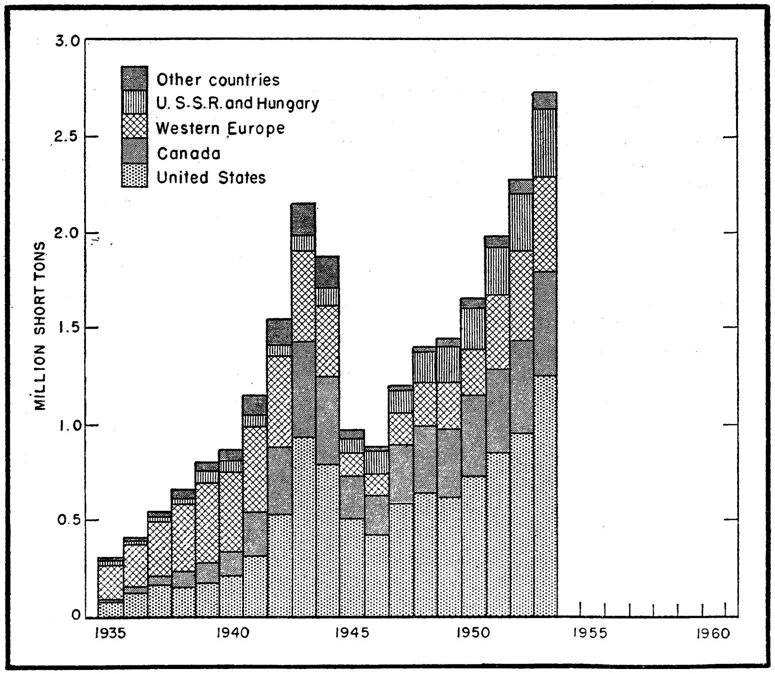

FIGURE 2.—Trends in world production of primary aluminum, 1935–53.

[34] Materials and Methods, Anodizing Process Gives Corrosion and Abrasion-Resistant Film: Vol. 37, No. 5, May 1953, p. 152.
[35] Chemical and Engineering News, Treated Aluminum Resembles Gold, Silver, or Chromium: Vol. 31, No. 10, March 9, 1953, pp. 1008, 1010.
[36] American Metal Market, Silver Plating of Aluminum and Uses Described: Vol. 60, No. 15, Jan. 22, 1953, pp. 1, 7.
[37] Armstrong, Durwood, Protective Finishing of Aluminum for Aircraft: Metal Progress, vol. 63, No. 6, June 1953, pp. 104–107.
[38] Chemical Engineering, Aluminum Coated With Frit Will Find Many Markets: Vol. 60, No. 8, August 1953, p. 146.
American Metal Market, Pemco Offers Services on Aluminum Porcelain Coating to Other Firms: Vol. 60, No. 160, Aug. 18, 1953, p. 11.
[39] Materials and Methods, Two New Developments in the Fluorocarbon Plastics: Vol. 38, No. 8, December 1953, p. 102.

WORLD REVIEW

Every country that produced primary aluminum except Switzerland, showed gains in 1953; however, 90 percent of the 415,000-metric ton increase was accomplished by the 3 leading producers—the United States, U. S. S. R., and Canada—which supplied 78 percent of the world production. The United States showed the largest gain, or about 70 percent of the world increase. Of the total estimated world production of 2,465,000 tons, North America provided 66 percent, Europe (exclusive of U. S. S. R. and Hungary) 18 percent, U. S. S. R. and Hungary 13 percent, and Asia 2 percent.

TABLE 9.—World production of aluminum, by countries,[1] 1944–48 (average) and 1949–53, in metric tons [2]

[Compiled by Pearl J. Thompson]

Country [1]	1944–48 (average)	1949	1950	1951	1952	1953
Austria	12, 848	14, 796	17, 988	26, 380	36, 712	43, 476
Brazil	96	----	----	403	1, 085	1, 199
Canada	278, 925	335, 172	360, 043	405, 600	453, 370	495, 139
China	1, 900	----	----	----	(3)	(3)
France	45, 685	53, 943	60, 638	91, 080	106, 087	113, 060
Germany, West	43, 661	28, 848	27, 840	74, 136	100, 474	106, 940
Hungary	6, 423	[4] 14, 000	16, 650	22, 000	24, 000	[4] 30, 000
India	2, 807	3, 547	3, 650	3, 911	3, 623	3, 819
Italy	18, 066	25, 876	37, 042	49, 750	52, 830	55, 462
Japan	27, 756	21, 222	24, 764	36, 900	42, 661	45, 492
Korea, North (estimate)	3, 677	1, 500	1, 000	----	----	(3)
Norway	18, 820	35, 697	47, 056	50, 261	51, 102	53, 563
Spain	666	1, 212	2, 167	4, 158	4, 111	4, 374
Sweden (includes alloys)	3, 339	3, 929	4, 038	6, 714	8, 244	9, 600
Switzerland	13, 091	21, 600	19, 200	27, 000	29, 500	28, 000
Taiwan (Formosa)	2, 219	1, 312	1, 761	2, 984	3, 856	4, 905
U. S. S. R. (estimate)	104, 462	165, 000	190, 000	200, 000	250, 000	300, 000
United Kingdom	32, 086	30, 832	29, 941	28, 170	28, 455	31, 412
United States	521, 872	547, 449	651, 920	759, 202	850, 327	1, 135, 801
Yugoslavia	955	2, 493	1, 931	2, 828	2, 563	2, 792
Total (estimate)	1, 140, 000	1, 310, 000	1, 500, 000	1, 790, 000	2, 050, 000	2, 465, 000

[1] Aluminum is also produced in East Germany.
[2] This table incorporates a number of revisions of data published in previous Aluminum chapters.
[3] Negligible.
[4] Estimate.

Australia.—The Australian Aluminum Production Commission formed by the Commonwealth and the State of Tasmania, continued construction of its new primary aluminum facilities at Bell Bay, Tasmania. Production from the alumina plant was expected by early 1955 and from the 13,000-ton reduction plant by the third quarter of 1955. It was reported that delays in completing the Trevallyn hydroelectric power scheme, which was to make power available for the aluminum plant, became another factor to retard initial operations of the plant. The new plant was expected to provide aluminum at appreciable savings in Australian money. The Chemical and Engineering Mining Review quoted prices of 99.5 percent ingot, f. o. b. warehouses in Melbourne, Sydney, and Adelaide at £236, s. 10 (24.0 cents per pound U. S.) in January 1953. The price dropped to £224 (22.8 cents per pound U. S.) by March, but increased to £229, s. 10, (23.3 cents per pound U. S.) by May, where it remained for the rest of 1953. Most of the aluminum came from Canada; smaller quantities were imported from Norway and other countries.[40]

Austria.—Primary-aluminum production in the American zone of occupation in 1953 increased 18 percent from 1952 to 43,476 tons. Austrian aluminum production surpassed this total only in 1943, when its production was part of the German aluminum combine. The production capacity of Austria was approximately 59,000 annual tons (Ranshofen, 50,000; Lend, 9,000 tons), but winter power shortages prohibited capacity operation. A semifabrication plant at Ranshofen increased its rodmaking capacity 50 percent by adding a third rodmaking press. Exports of semifabricated and alloy aluminum were 30,000 tons in 1953 compared to 14,000 tons in 1952.

Brazil.—The only primary-aluminum production in Brazil during 1953 was at the plant of Electroquimica Brasileira at Ouro Preto, Minas Gerais. Although the plant was not operated between July and October, the annual output was about the same as in 1952. Imports of aluminum ingot in 1953 were 7,392 tons. France supplied 44 percent of the imports, Canada 22 percent, Japan 13 percent, and the United States 10 percent. Imports of aluminum as semifabricated products and manufactures probably equaled ingot receipts.

Construction of the new aluminum facilities of Cia. Brasileira de Aluminio near Sorocaba, São Paulo, was virtually completed by the end of 1953, although the reduction plant had not yet been operated. The initial project included an 80-ton-per-day alumina plant, an electrode plant, a 30-ton-per-day reduction plant, a foundry, extrusion and rolling mills, a foil mill, wire-drawing units, a products and utensil plant, and sulfuric acid and aluminum sulfate plants. It was reported that some of the fabricating facilities had begun operations. Company plans included expansion of aluminum capacity to 50,000 tons per year and construction of its own hydroelectric power station on the Juquia River.

Canada.—The record Canadian aluminum production in 1953, which increased 9 percent over 1952, came from 4 reduction plants in Quebec Province. The expansion program planned for Quebec was completed early in 1953, when the second of two new hydroelectric installations on the Peribonka River was completed. This brought Aluminium, Ltd.'s (Alted) installed generating capacity in eastern Canada to 2,580,000 hp. and the reduction capacity in Quebec to 496,000 tons annually.

A new electric power installation and aluminum smelter in British Columbia was nearing completion, and metal production was anticipated in mid-1954. By the end of 1953 the lake system had been dammed at its Nechako River outlet, and the storage reservoir (357 square miles in area) was filling. A 10-mile tunnel through a mountain range was completed in December, and turbines and generating equipment with an initial capacity of 450,000 hp. were being installed at the Kemano powerhouse in the base of the mountain range. A 50-mile transmission line from the powerhouse to the smelter at Kitimat was completed. An initial annual smelter capacity of 83,000 tons was being readied for production. Ultimate planned

[40] Johnston, L. F., Eighth Annual Report of the Australian Aluminum Production Commission for Year 1st July 1952 to 30th June 1953: Printed and published by the Government of the Commonwealth of Australia, Commonwealth Government Printer, Canberra, No. 24 (Group F)—F.4698, price 1s, 6d.

capacity of the British Columbia project was 500,000 annual tons supported by a hydroelectric generating capacity of 2,240,000 hp. Total cost of the expansion in Quebec and British Columbia was estimated at about $400 million.

Canada continued to be the world's second largest producer and major exporter of aluminum. Shipments of Canadian aluminum in ingot form during 1949–53 follow:[41]

	1949	1950	1951	1952	1953
United Kingdom	145,100	132,700	181,300	233,800	167,500
United States	79,700	147,200	93,500	103,900	215,000
Canada	58,000	59,900	78,300	80,300	81,800
Others	70,800	37,700	48,800	35,500	34,400
Total	353,600	377,500	401,900	453,500	498,700

In May Alted announced that it would, for 7 years, reserve 110,000 tons of aluminum annually for nonintegrated fabricators in the United States. Aluminum Import Corp. (Alted's distributing subsidiary) entered into contracts to supply Alcoa with 545,000 tons and Kaiser with 169,000 tons of primary aluminum during 1953–58. These contracts were made possible by revision of contracts with the Government of the United Kingdom, so that metal would be available in 1953 and 1954 for delivery to the United States.

The United Kingdom Government agreed to purchase, if requested to do so, the difference between Alted sales in the United Kingdom and 460,000 tons previously contracted for 1954 and 1955. In addition, the United Kingdom Government made a commitment for 1956–60 to purchase the difference (up to 20,000 tons annually) between Alted sales in the United Kingdom and 250,000 tons annually (the quantity of Canadian production on which the United Kingdom has first call until 1971, under terms of loan agreements).

Czechoslovakia.—A new aluminum-reduction works in Czechoslovakia was in operation at the end of 1953, according to reports that stated the plant was at Svaty Kriz on the middle reaches of the Hron River in Central Slovakia. No information on the capacity of the plant was available, other than a statement that, when completed, its production would meet Czechoslovakia's normal aluminum requirements.[42]

France.—The record aluminum production of 113,000 tons obtained in France in 1952 was representative of the practical maximum that could be obtained from French reduction plants. Although an output of 10,400 tons was possible during each of the peak months July and August, decreased hydroelectric power generation during the winter made it impractical to maintain such a production rate throughout the year. Exports of aluminum from France increased to 44,000 tons in 1953 compared with 16,500 tons during 1952; United Kingdom and United States were the major recipients. The French domestic base price of primary aluminum for domestic consumption was 180 francs per kilogram (23.3 cents per pound).

[41] Aluminium, Ltd., Twenty-Sixth Annual Report for the Year Ending Dec. 31, 1953: Montreal, Canada, Mar. 17, 1954, 22 pp.
[42] Metal Bulletin (London), Light Metals, Aluminum: No. 3825, Sept. 11, 1953, p. 23.
Mining World, Europe: Vol. 15, No. 13, December 1953, p. 78.

French aluminum producers were looking to locations outside of France to establish additional reduction capacity. French Guiana had been studied as a possible site because of the availability of bauxite; however, the production of electrical power at a low rate was not promising. A location in the French Cameroons also was being considered more seriously. In the Cameroons plans called for a 105,000-kw. power station to permit an annual aluminum output of 40,000 tons.

Germany, West.—The German Parliament approved reintroduction of the 10-percent import duty on aluminum as a means of safeguarding primary producers from excessive imports of metal produced in countries with lower electric power rates, particularly Canada and the United States. The German aluminum-semifabricating capacity was considerably greater than aluminum-production capacity, and raw aluminum imported under reexport contracts was to be exempt from the new duty. Part of the works at the Erftwerke aluminum plant, Grevenbroich, was rebuilt and resumed production in the third quarter of 1953. It was expected that, when this plant was running at full capacity, planned for 1954, the total annual West German aluminum production could be increased to 130,000 tons. The price of primary aluminum declined from 232 DM per 100 kilograms (25.1 cents per pound) at the beginning of 1953 to 223 DM per 100 kilograms (24.1 cents per pound) at year end. This price reduction was necessary to meet foreign competition.

Gold Coast.—The proposal for establishing an integrated plant for producing aluminum in Gold Coast was studied further by the United Kingdom and Gold Coast Governments, Aluminium, Ltd., and the British Aluminium Co. On February 25 the Legislative Assembly of Gold Coast approved "Continuation of negotiations and establishment of a Preparatory Commission with a view to arriving at a final agreement which will be in the best interests of the Gold Coast * * *"

The Volta River plan was divided into three parts. The first involved construction of a dam and power station, with a 2,000-square-mile reservoir at Ajena, 70 miles from the mouth of the Volta. Power would be available 5 to 7 years after the work begins. The second part of the plan centered around smelting facilities with an annual capacity of 80,000 tons, eventually increasing to 210,000 tons. The reserves of bauxite in Gold Coast exceeded 200 million tons. The smelter was to be built at Kpong, 12 miles south of Ajena. The final section of construction in the plan was extensive railway building, new and increased port facilities, roads, houses, and various other public works.

Italy.—From an installed reduction capacity of around 66,000 annual tons, Italy produced 55,500 tons of primary aluminum in 1953. The major factors holding back Italian production were the seasonal variation in electric energy supply and high production costs. The price of primary aluminum was 365 lire per kilogram (26.5 cents per pound).

Japan.—Despite the high price of Japanese-produced aluminum and a decrease in aluminum exports, primary production was increased in 1953 for the fourth successive year. Aluminum for domestic consumption was priced at 235,000 yen per ton (29.6 cents per pound). Despite a 15,000-yen-per-ton (2 cents per pound) lower price for aluminum fabricated for export consumption, the producers of rolled aluminum requested greater price reductions for ingot to maintain their competitive export position, and in October primary aluminum to be rolled for export consumption was reduced to 177,000 yen per ton (23 cents per pound). Exports of rolled aluminum declined to about 3,000 tons in 1953 from 7,000 tons in 1952. It was expected that lower prices would stimulate exports.

Norway.—Construction of Norway's largest aluminum plant at Sunndalsora was ahead of schedule, with initial production expected about the middle of 1954. Initial output of the plant was planned for 40,000 tons per year. The plant was designed for further expansion to 50,000 tons per year, which would almost double Norway's 1953 production.

United Kingdom.—Government controls on aluminum, which had been in effect since September of 1939, were removed July 1, 1953, and for the first time in nearly 14 years trading in primary aluminum reverted to private companies. A decline in aluminum consumption, which began in the latter half of 1952, continued in 1953. Shipments of primary aluminum in 1953 were 180,600 long tons, an 18 percent decrease from the 220,400 tons shipped in 1952. Imports of aluminum were 177,400 tons in 1953 (234,200 tons in 1952). Output of secondary metal increased to 90,000 tons from 79,000 tons in 1952. Shipments of aluminum products, sheet strip, extrusions, forgings, foil, etc., were 246,600 tons, a drop of 49,300 tons from 1952. One exception to the general downward trend in shipments occurred in foil, of which 14,300 tons were delivered in 1953 against 12,200 tons in 1952. The price of primary ingot dropped from £161 per long ton (20.1 cents per pound) to £150 per long ton (18.8 cents per pound) in July, when Government controls were removed.

Antimony

By Abbott Renick[1] and E. Virginia Wright[2]

WORLD mine production of antimony totaled 32,000 short tons in 1953—the lowest since 1946, was 17,600 tons (35 percent) less than in 1952, and represented a decrease of 15 percent from the 1944–48 average (37,500 tons).

Domestic mine production of antimony (antimony content) was 370 short tons in 1953 compared with 2,200 tons in 1952. The Sunshine Mining Co. resumed production of electrolytic antimony from complex lead-silver-copper ore mineral in Shoshone County, Idaho, and was the only substantial producer of antimony in the United States. The total number of mines that contributed to the production of antimony was 3 compared with 8 in 1952. The decreased production in 1953 was due principally to the Bradley Mining Co. at the Yellow Pine mine, Stibnite, Idaho, continuing idle since midyear 1952, as well as to suspension of operations at a number of mines (mostly small producers) caused by reduced domestic prices for antimony ores; the fact that foreign brands of antimony metal sold at prices considerably below domestic levels was another contributing factor.

The price of domestic antimony metal, RMM brand, 99½ cents f. o. b., Laredo, Tex., averaged 33.93 cents per pound in 1953 and ranged from a high of 34.50 cents at the beginning of the year to a low of 28.50 cents at the end of the year. The New York price for antimony metal, RMM brand, in cases, averaged 35.90 cents per pound in 1953 compared with 44.02 cents per pound in the previous year.

The United States "new supply" of primary antimony in 1953, in terms of recoverable metal,[3] was 14,000 short tons. A breakdown of this supply shows that domestic antimony ores and concentrates contributed 2 percent (340 tons); domestic and foreign lead-silver ores 20 percent (2,800 tons); and imports 78 percent (10,900 tons). The types of antimony material imported for consumption arrived as follows: Ore and concentrates (in terms of recoverable metal), 7,200 short tons; metal, 2,600 tons; oxide, 1,100 tons; and a small quantity of antimony sulfide. The supply from secondary sources was 22,000 tons.

The total consumption of antimony in the United States during 1953 was 39,100 short tons and comprised 14,300 tons of primary antimony, 2,800 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.

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[1] Commodity-industry analyst.
[2] Statistical assistant.
[3] Calculated at 92 percent of the antimony contained in domestic and foreign antimony ores and concentrates.

Government Regulations.—Effective June 30, 1953, the National Production Authority revoked the monthly mandatory reporting on the production, receipts, consumption, shipments, and inventories of antimony (in excess of 1,999 short tons of contained antimony) in effect since January 1951. Statistical data are being collected on a quarterly voluntary basis.

On May 15 antimony was removed from the list of minerals eligible for exploration benefits under provisions of the Defense Production Act, as amended.

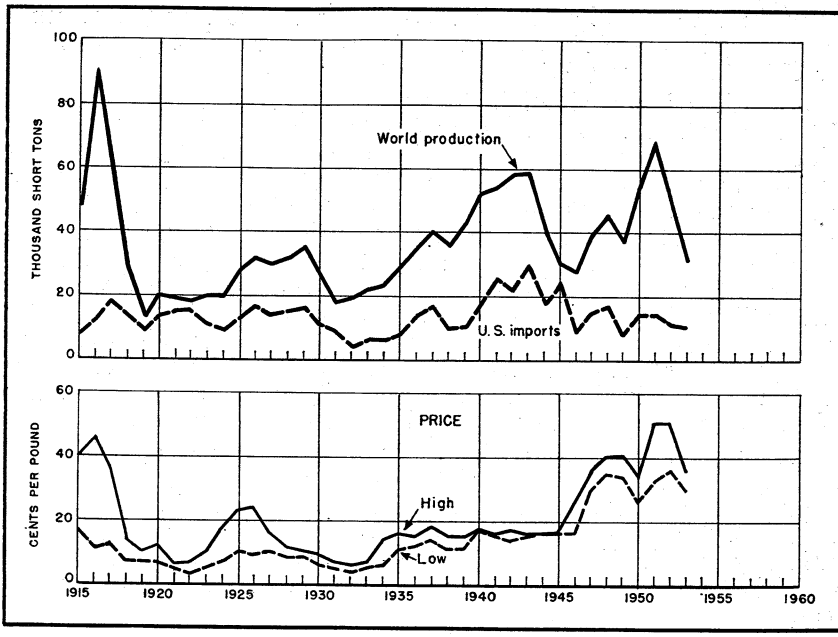

FIGURE 1.—Trends in world production, United States imports for consumption, and New York price of antimony, 1915–53.

TABLE 1.—Salient statistics of antimony in the United States, 1944–48 (average) and 1949–53, in short tons (antimony content)

	1944–48 (average)	1949	1950	1951	1952	1953
Production:						
Primary:						
Mine (shipments)	4,195	1,636	2,497	3,472	2,160	372
Smelter, from domestic and foreign ores	16,302	8,099	9,471	[1] 13,800	11,860	[2] 7,100
Secondary	19,345	18,061	21,862	23,943	23,089	22,360
Imports for consumption	16,266	9,429	15,354	15,673	12,789	11,478
Ore and concentrates	13,669	7,473	9,746	11,746	7,945	7,778
Metal	2,519	1,853	4,632	2,231	3,354	2,612
Oxide		46	963	1,692	1,466	1,076
Sulfide	78	57	13	4	24	12
Exports of ore, metal and alloys [3]	535	485	154	168	161	24
Consumption of primary antimony [4]	19,827	11,266	15,167	17,370	[1] 14,988	14,300
Average price of antimony at New York,[5] cents per pound	23.82	38.73	29.41	44.17	44.02	35.90
World production [6]	37,500	40,800	48,500	[1] 67,200	[1] 49,600	32,000

[1] Revised figure. [2] Partly estimated. [3] Gross weight.
[4] Data does not include antimony contained in domestic and foreign silver and lead ores, recovered at primary lead refineries and marketed in antimonial lead.
[5] American Metal Market. [6] Exclusive of U. S. S. R.

DOMESTIC PRODUCTION

MINE PRODUCTION

During 1953 domestic mine production (shipments) of antimony ore and concentrates totaled 2,200 short tons containing 370 tons of antimony, of which 340 tons was estimated as recoverable. In addition, 2,800 tons of antimony contained in domestic and foreign lead-silver ores was recovered by primary lead refineries in the production of antimonial lead. Compared with 1952 the 1953 production of antimony contained in antimony ores and concentrates decreased 83 percent and in silver and lead ores remained the same as in 1952.

TABLE 2.—Antimony-bearing ores and concentrates produced (shipments) in the United States,[1] 1944–48 (average) and 1949–53, in short tons

Year	Gross weight	Antimony content		Year	Gross weight	Antimony content	
		Quantity	Average percent			Quantity	Average percent
1944–48 (average)	15, 738	4, 195	26. 7	1951	9, 401	3, 472	37. 0
1949	5, 260	1, 636	31. 1	1952	4, 854	2, 160	44. 5
1950	6, 888	2, 497	36. 3	1953	2, 161	372	17. 2

[1] Includes Alaska.

TABLE 3.—Salient statistics of the antimony industry, 1929–53, in short tons (antimony content)

Year	Average price of metal at New York [1]	Mine production	Imports for consumption	Exports [2]	Consumption of primary antimony [3]	Production of secondary antimony [4]
1929	$8. 94		15, 770	509	15, 261	11, 131
1930	7. 67		9, 635	493	9, 142	8, 082
1931	6. 72		9, 690	697	8, 993	7, 900
1932	5. 62	419	3, 475	123	3, 771	6, 450
1933	6. 51	587	5, 097	98	5, 586	7, 400
1934	8. 92	404	5, 171	402	5, 173	7, 550
1935	13. 62	559	7, 274	318	7, 515	9, 600
1936	12. 25	755	13, 543	392	13, 906	9, 900
1937	15. 35	1, 266	16, 329	437	17, 158	12, 340
1938	12. 35	650	9, 550	711	9, 489	8, 500
1939	12. 36	393	10, 797	58	11, 132	9, 810
1940	14. 00	494	16, 025	276	16, 243	11, 421
1941	14. 00	1, 214	27, 304	70	28, 448	21, 629
1942	15. 55	2, 944	21, 438	230	24, 152	18, 200
1943	15. 92	5, 556	29, 688	291	19, 508	15, 483
1944	15. 84	4, 735	17, 373	745	23, 756	15, 886
1945	15. 84	1, 930	23, 270	333	25, 761	17, 148
1946	17. 31	2, 505	8, 496	462	17, 515	19, 115
1947	33. 45	5, 316	15, 148	808	16, 647	22, 984
1948	36. 67	6, 489	17, 038	327	15, 455	21, 592
1949	38. 73	1, 636	9, 429	485	11, 266	18, 061
1950	29. 41	2, 497	15, 354	154	15, 167	21, 862
1951	44. 17	3, 472	15, 673	168	17, 370	23, 943
1952	44. 02	2, 160	12, 789	161	14, 988	23, 089
1953	35. 90	372	11, 478	24	14, 300	22, 360

[1] American Metal Market.
[2] Data are foreign antimony, 1929–42, and ore, metal, and alloys for subsequent years. Data reported in terms of gross weight.
[3] Data are "apparent consumption" (mine production plus imports minus exports), 1929–42; and reported consumption, 1943–53. Excludes antimony contained in domestic and foreign lead-silver ores, recovered at primary lead refineries and marketed as antimonial lead.
[4] Includes antimony content of antimonial lead produced at primary lead refineries from scrap.

The Sunshine Mining Co. reactivated the electrolytic antimony plant it constructed during World War II in Shoshone County, Idaho, which had been idle since January 1944. In 1953 the company produced 2,100 tons of copper-silver-antimony concentrate, which was treated for the recovery of antimony; 375 short tons of cathode metal, containing 360 tons of antimony, was recovered.

SMELTER PRODUCTION

Primary.—United States smelter production of antimony in 1953, the lowest recorded for the past decade, totaled 7,100 tons, a 40-percent decrease from the 11,900 tons produced in 1952. Of the total produced 28 percent was in the form of metal (2,000 tons); 65 percent in the form of oxide (4,600 tons); 6 percent as primary residues and slags (400 tons); and 1 percent in the form of sulfide (100 tons).

During 1953, 2,800 short tons of antimony was recovered as antimonial lead by primary lead refineries from domestic and foreign lead and silver ores. This was identical with the 2,800 tons recovered in 1952. (See Lead chapter of this volume for detailed discussion of antimonial lead production.)

Secondary.—Antimony production at secondary metal plants in 1953 was 20,300 short tons, plus 1,700 tons recovered from scrap at

TABLE 4.—Smelter production of antimony, 1944–48 (average) and 1949–53, by type of material, in short tons (antimony content)

Year	Metal	Oxide	Sulfide	Residues	Total
1944–48 (average)[1]					16,302
1949	3,242	4,786	71	(2)	8,099
1950	2,899	6,492	80	(2)	9,471
1951	3,870	7,475	100	[3] 2,355	[3] 13,800
1952	2,533	6,805	108	2,414	11,860
1953	2,000	[4] 4,600	100	400	[4] 7,100

[1] Breakdown by type of material not available.
[2] Not reported separately.
[3] Revised figure.
[4] Partly estimated.

TABLE 5.—Antimony metal, alloys, and compounds produced in the United States, 1944–48 (average) and 1949–53, 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	
1944–48 (average)	16,302	70,343	1,729	583	2,248	4,560	6.5	19,345
1949	8,099	41,402	1,214	396	1,775	3,385	8.2	18,061
1950	9,471	61,912	2,253	597	1,654	4,504	7.3	21,862
1951	[4] 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	[5] 7,100	62,373	1,684	1,106	1,747	4,537	7.3	22,360

[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.
[4] Revised figure.
[5] Partly estimated.

primary lead refineries, a total output of 22,000 tons of secondary antimony and a decrease of 4 percent from the 23,000 tons produced in 1952. (See Secondary Metals—Nonferrous chapter of this volume for detailed review.)

CONSUMPTION AND USES

The total consumption of antimony in 1953 was 39,100 short tons, a 4-percent decrease from the 40,800 tons consumed in 1952. Primary antimony used totaled 14,300 tons (15,000 in 1952); the antimony content of lead-silver ores consumed by primary lead refineries in the manufacture of antimonial lead 2,800 tons (the same as in 1952); and secondary 22,000 tons (23,000 in 1952).

Consumption of primary antimony in the manufacture of finished products decreased 5 percent from 1952. Of the total consumed 54 percent was in the form of metal products and 46 percent in the form of nonmetal products.

Consumption of secondary antimony, chiefly in metallic products, decreased 4 percent from 1952.

TABLE 6.—Industrial consumption of primary antimony 1944–48 (average) and 1949–53, by type of material, in short tons (antimony content)

Year	Ore and concentrates	Metal	Oxide	Sulfide	Residues	Total
1944–48 (average)[1]						19,827
1949	2,472	4,163	4,492	139	(2)	11,266
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	[3] 1,309	[3] 14,988
1953 [4]	2,100	5,400	5,800	100	900	14,300

[1] Breakdown by type of material not available.
[2] Not reported separately.
[3] Revised.
[4] Estimated 100 percent coverage based on reports from respondents that consumed 89 percent of the grand total antimony in 1952.

STOCKS

At the end of 1953 industry stocks—the lowest reported since the end of 1949—were 7,100 short tons, an 8-percent decrease from the 7,700 tons on hand December 31, 1952. Mine stocks, which are included in industry stocks, remained unchanged at 200 tons the beginning and end of the year.

PRICES

The price of antimony metal, RMM brand, 99½ percent, f. o. b. Laredo, Tex., averaged 33.93 cents per pound, ranging from a high of 34.50 cents at the beginning of the year to a low of 28.50 cents at the end of the year. The New York price for antimony metal, RMM brand, in cases, averaged 35.90 cents a pound in 1953 compared with 44.02 in 1952, according to American Metal Market.

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TABLE 7.—Industrial consumption of primary antimony, 1944–48 (average) and 1949–53, in short tons (antimony content)

Product	1944–48 (average)	1949 [1]	1950	1951	1952	1953 [2]
Metal products:						
Ammunition	55	6	9	4	3	3
Antimonial lead	6,586	2,588	4,440	2,282	[3] 2,196	2,300
Battery metal	(4)	1,521	1,738	2,774	[3] 2,253	3,000
Bearing metal and bearings	2,441	873	1,518	1,308	1,119	1,000
Cable covering	180	172	72	95	43	60
Castings	165	49	126	79	80	80
Collapsible tubes and foil	109	14	23	18	32	60
Sheet and pipe	266	306	300	180	70	170
Solder	151	155	162	123	145	200
Type metal	1,244	587	766	709	624	700
Other	(4)	364	145	52	61	127
Total metal products	11,197	6,635	9,299	7,624	[3] 6,626	7,700
Nonmetal products:						
Ammunition primers	29	9	9	18	24	30
Antimony sulfide (precipitated)	(5)	(5)	(5)	68	67	50
Fireworks	(6)	(6)	(6)	20	36	50
Flameproofed coatings and compounds	(6)	(6)	(6)	463	980	450
Flameproofed textiles	3,086	273	369	2,590	2,059	780
Frits and ceramic enamels	1,313	1,155	1,462	1,476	959	1,000
Glass and pottery	368	296	579	570	579	700
Matches	23	28	56	31	22	20
Paints and lacquers	1,965	874	267	962	853	340
Pigments	(6)	(6)	(6)	705	766	780
Plastics	(6)	498	737	747	632	560
Rubber products	(6)	55	103	19	66	20
Other [7]	1,846	1,443	2,286	2,077	1,319	1,820
Total nonmetal products	8,630	4,631	5,868	9,746	8,362	6,600
Grand total	19,827	11,266	15,167	17,370	[3] 14,988	14,300

[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] Revised figure.
[4] Included with "Antimonial lead."
[5] Not reported as an end-use product.
[6] Included with "Other nonmetal products."
[7] Antimony trichloride and sodium antimonate included to avoid disclosure of individual company operations.

TABLE 8.—Industry stocks of antimony in the United States at end of year, 1952–53, in short tons (antimony content)

Raw material	Dec. 31, 1952			Dec. 31, 1953		
	Mine [1]	Other	Total	Mine [1]	Other [2]	Total [2]
Ore and concentrates	[3] 197	1,565	[3] 1,762	200	1,700	1,900
Metal		2,041	2,041		1,600	1,600
Oxide		3,114	3,114		2,900	2,900
Sulfide		142	142		100	100
Residues and slags		632	632		600	600
Total	[3] 197	7,494	[3] 7,691	200	6,900	7,100

[1] Includes Alaska.
[2] Estimated 100 percent coverage based on reports from respondents that held 91 percent of the total stocks of antimony at the end of 1952.
[3] Revised figure.

The price of domestic antimony was reduced by 6 cents per pound to 28.50 cents for RMM brand, f. o. b. Laredo, carlots in bulk, effective November 27, 1953. This was the first change in the domestic price since November 3, 1952.

According to E&MJ Metal and Mineral Markets, opening and subsequent changes in nominal quotations for antimony ore during 1953, per unit (20 pounds) of antimony contained, were as follows:

1953 antimony ore

Date	50-55 percent	55-60 percent	60-65 percent
Jan. 1	$2.50-$2.70	$2.60-$2.80	$3.50-$3.75
Feb. 5	2.60- 2.70	2.75- 2.85	3.60- 3.70
Mar. 5	2.60- 2.70	2.75- 2.85	3.50- 3.60
Apr. 16	2.70- 2.80	2.80- 2.90	3.50- 3.60
May 21	2.45- 2.50	2.50- 2.60	3.30- 3.35
June 18	2.50- 2.60	2.75- 2.85	3.40- 3.50
July 23	2.50- 2.60	2.75- 2.85	3.40- 3.50
Aug. 20	2.50- 2.60	2.75- 2.85	3.40- 3.50
Sept. 17	2.50- 2.60	2.75- 2.85	3.40- 3.50
Nov. 12	2.55- 2.65	2.80- 3.00	3.40- 3.50
Dec. 31	2.55- 2.65	2.80- 3.00	3.50- 3.60

The New York antimony price for foreign brands of metal, duty paid in lots of 5 tons or more, was as follows, in cents:

Date	Antimony, percent		
	99.6	99.5	99
Apr. 23, 1953		26.00-27.00	25.00-26.00
June 2, 1953		26.00-27.00	25.00-26.00
Dec. 1, 1953	26.00-26.50	25.50-26.00	25.00-25.50
Dec. 31, 1953	26.00-26.50	25.50-26.00	25.00-25.50

FOREIGN TRADE[4]

Imports.—During 1953 the contained antimony imported for consumption—the lowest recorded since 1949—totaled 11,500 tons, a

TABLE 9.—Antimony imported for consumption in the United States, 1944–48 (average), and 1949–53 [1]

[U. S. Department of Commerce]

Year	Antimony ore			Needle or liquated antimony		Antimony metal		Type metal and antimonial lead [2] (short tons)	Antimony oxide	
	Short tons (gross weight)	Antimony content		Short tons (gross weight)	Value	Short tons	Value		Short tons (gross weight)	Value
		Short tons	Value							
1944–48 (average)	36,217	13,670	$3,135,026	110	$64,545	2,519	$1,324,345	754		
1949	17,855	7,473	2,488,271	81	42,537	1,853	1,242,582	654	56	$27,290
1950	22,307	9,746	1,850,162	19	8,895	4,632	2,204,091	1,936	1,160	428,386
1951	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

[1] Does not include antimony contained in lead-silver ore.
[2] Estimated antimony content; for gross weight and value, see Lead chapter of this volume.

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

10-percent decrease compared with the 12,800 tons imported in 1952. In terms of recoverable metal, however, imports totaled 10,900 tons, comprising 7,200 tons of ore and concentrates, 2,600 tons of metal, 1,100 tons of antimony oxide, and a small quantity of antimony sulfide.

Imports of ore and concentrates, principally from Bolivia and Mexico, decreased only 2 percent; the grade of ore averaged 45 percent. Imports of metal, chiefly from Mexico, Yugoslavia, and Belgium-Luxembourg, decreased 22 percent. Imports of antimony oxide, 71 percent of which came from United Kingdom, decreased 27 percent; and imports of antimony sulfide, supplied solely by United Kingdom, decreased 50 percent.

TABLE 10.—Antimony imported into the United States, 1944–48 (average), 1949–51 (totals), and 1952–53, by countries [1]

[U. S. Department of Commerce]

Country	Antimony ore			Needle or liquated antimony		Antimony metal		Antimony oxide	
	Gross weight (short tons)	Antimony content: Short tons	Antimony content: Value	Gross weight (short tons)	Value	Short tons	Value	Gross weight (short tons)	Value
1944–48 (average)	36,170	[2]13,648	$3,123,760	110	$64,545	2,546	$1,341,688		
1949	17,855	7,473	2,488,271	81	42,537	2,065	1,357,634	56	$27,290
1950	24,095	10,367	1,957,699	19	8,895	4,488	2,121,499	1,160	428,386
1951	26,320	11,517	4,559,702	8	7,032	2,231	1,780,388	2,039	1,525,016
1952									
Belgium-Luxembourg				11	9,273	[2] 545	[2] 377,735	245	131,837
Bolivia [3]	7,505	4,967	2,281,717						
Chile [3]	133	86	55,899						
Czechoslovakia						356	126,707		
France	5	2	645			[2] 5	2,912		
Germany, West						77	32,723		
Greece	43	15	3,231						
Italy						[2] 41	[2] 34,785		
Mexico	9,564	2,272	556,759			1,055	926,948		
Netherlands						[2] 3	[2] 2,514		
Peru [3]	409	251	107,180			25	20,935		
Turkey						143	115,873		
Union of South Africa	580	348	192,166						
United Kingdom	7	4	3,292			320	212,601	1,521	924,449
Yugoslavia				23	11,446	[2] 819	[2] 505,792		
Total	18,246	7,945	3,200,889	34	20,719	3,389	2,359,525	1,766	1,056,286
1953									
Belgium-Luxembourg						548	244,616	365	163,879
Bolivia [3]	8,696	5,558	1,518,466						
Chile [3]	395	261	74,324						
France	55	22	3,762			253	113,690		
Germany, West								16	7,080
Greece	91	50	15,682						
Honduras	1	1	200						
Italy						11	5,768		
Japan						6	3,975		
Mexico	7,556	1,662	365,596			815	570,543		
Netherlands						6	2,501		
Peru [3]	431	212	49,200						
United Kingdom	17	12	7,895	15	7,582	361	172,205	915	408,641
Yugoslavia						627	294,126		
Total	17,242	7,778	2,035,125	15	7,582	2,627	1,407,424	1,296	579,600

[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.

Exports.—In 1953 exports (reported in terms of gross weight) of metal and alloys totaled 24 tons valued at $23,000 and of salts and compounds 120 tons valued at $69,500. There were no exports of ore and concentrates.

In 1952 exports (gross weight) of ore and concentrates were 25 tons valued at $13,300; metal and alloys 140 tons valued at $124,400; and salts and compounds 210 tons valued at $184,800.

TECHNOLOGY

What is reputed to be the world's richest antimony mine was described in an article.[5] The mine is the Gravelotte, owned and operated by the Consolidated Murchison (Transvaal) Goldfields & Development Co., Ltd.; it is in the eastern part of the Transvaal, Union of South Africa.

A brief account of the beneficial results obtained with mechanization of work formerly done by hand has been published.[6]

The metallurgy of antimony was described in a recent book.[7] The third edition of Wang's work has been revised and brought up to date.

A technical paper on the production of antimony by the Sunshine Mining Co. was presented; among other things it stated:[8]

> The principal economic mineral of the Sunshine Mine is argentiferous tetrahedrite, a copper-antimony-silver sulfide mineral which cannot be broken down and separated physically. This product has always been a problem to market due to the antimony content. ***
>
> *** At the start of 1953 it again became economical to run the antimony plant. Reconditioning was undertaken and in April leaching was started. ***
>
> *** To sum up the procedure:
>
> 1. The tetrahedrite concentrate is leached in hot concentrated sodium sulfide to dissolve the antimony.
> 2. The clear solution from leaching is electrolyzed to produce metallic antimony.
> 3. The residue is washed and filtered to recover all the solution possible.
> 4. The spent anolyte is discarded to control the impurities in the circuit.

The use of antimony in transistors was discussed in an article published during the year, as follows:[9]

> A new semiconductor in the form of an alloy of aluminum and antimony was developed in research carried on at Battelle Memorial Institute, Columbus, Ohio. Sponsored by the Bradley Mining Co. of San Francisco, the research program indicates a possibility that the aluminum-antimony combination might serve as a substitute for germanium or silicon in transistors or rectifiers.

The Hermada antimony deposit in Elmore County, Idaho, is described in Bureau of Mines Report of Investigations 4950.[10]

> Examination of the Hermada antimony deposit disclosed stibnite mineralization occurs over an area as much as 1 mile wide and 2 miles long in the Swanholm district. The investigation showed that ore bodies in the Hermada deposit occur as quartz filled fissure veins; and they differ from veins of adjoining districts by the abundance of stibnite and the absence of precious metals. Quartz, the principal gangue mineral, is not gold-bearing in this area and sulfides of other minerals are rarely present.

A United States patent relative to antimony was issued in 1953.[11]

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[5] Mining World, World's Richest Antimony Mine: Vol. 15, No. 7, June 1953, pp. 47–52.

[6] Kulpaca, R. L., and Archibald, J. C., Jr., Mechanization Program Results in Savings at Laredo Antimony Smelter: Jour. Metals, vol. 5, No. 6, June 1953, pp. 786–788.

[7] Wang, C. Y., Antimony, Its Geology, Metallurgy, Industrial Uses and Economics: 3d ed. (rev.), Charles Griffin & Co., Ltd., London, 1952, 170 pp.

[8] Gould, Wayne D., The Production of Antimony: Northwest Mining Assoc., 59th Ann. Conv., Spokane, Wash., Dec. 4, 1953.

[9] Engineering and Mining Journal, Transistors—New Use for Antimony?: Vol. 154, No. 6, June 1953, p. 99.

[10] Popoff, Constantine C., Hermada Antimony Deposit, Elmore County, Idaho: Bureau of Mines, Rept. of Investigations 4950, 1953, 21 pp.

[11] Lebedeff, Yurii E., and Klein, William C., Process Relates to the Removal of Tellurium From Antimony: U. S. Patent 2,661,280, Dec. 1, 1953.

WORLD REVIEW

Algeria.—Antimony ore is produced by the Société des Mines d'Ain Kerma, which, notwithstanding the price drop, increased its production to 6,400 tons in 1953 from 4,460 tons in 1952.[12]

Canada.—Preliminary data for 1953 show Canada's production of antimony as 765 short tons valued at $344,290 compared with 1,250 tons valued at $601,483 in 1952. The only producer is Consolidated Mining & Smelting Co., which recovers the metal as an antimonial lead alloy from residues of lead refining.

China.—China's known reserves of antimony, estimated at 3,500,000 to 4,000,000 tons of metal, are the largest in the world. From 1929 to 1937 annual output ranged from 18,000 to 20,000 tons and represented 37 to 76 percent of the world total. Current production has declined to an estimated 5,000 tons owing to limited domestic demands and difficulty in reaching western markets. The most important mine is Hsi-kwang-shan, Hunan, which normally produces over half of the Chinese output.[13]

France.—The Société de Mines et Metallurgie de Penarroya, Noyelles Godault (Pas-de-Calais), erected an antimony smelter to handle both sodium antimonate, obtained as a byproduct from lead refining, and Moroccan antimonial ores.[14]

French Morocco.—The output of antimony in French Morocco during 1953 totaled 100 metric tons compared with 1,490 tons in 1952. At the end of 1953 only 3 antimony mines were in operation, on a very reduced scale, compared with 18 mines in a normal period.[15]

Italy.—Antimony ore and metal production was at a very low level in 1953. One mine in Tuscany was shut down, and the Gerrei group (Sardinia) operated well below capacity. 1953 production of antimony ore was reported as 2,585 metric tons compared with 4,478 metric tons in 1952. Production of metal was 233 metric tons in 1953 compared with 413 metric tons in 1952.[16]

Mexico.—During 1953 production of antimony concentrates (metal content) was 3,686 metric tons compared with 5,531 tons in 1952. Exports from Mexico totaled 2,539 tons in 1953—2,520 to the United States and 19 to Brazil.

United Kingdom.—The following table provides data on the consumption of antimony in 1953 by principal uses.[17]

	Long tons
Batteries	1, 184
Other antimonial lead	315
Bearings	426
Oxides and compounds	2, 151
Miscellaneous uses	283
Total, all trades	4, 359

12 Mining World, vol. 16, No. 5, Apr. 15, 1954, p. 92.
13 Mining Journal (London), vol. 241, No. 6154, July 31, 1953, p. 133.
14 Metal Bulletin (London), Special French Non-Ferrous Issue: September 1953, p. 25.
15 Work cited in footnote 12, p. 93.
16 Work cited in footnote 12, p. 85.
17 Metal Age (London), No. 27, March 1954, p. 16.

The above figures exclude the consumption of antimony in scrap, which is as follows:

	Long tons
Antimonial lead	3, 114
All other purposes	953
Total consumption in scrap	4, 067

TABLE 11.—World production of antimony (content of ore),[1] by countries, 1944–48 (average) and 1949–53, in metric tons [2]

[Compiled by Pauline Roberts]

Country	1944–48 (average)	1949	1950	1951	1952	1953
North America:						
Canada [3]	518	72	292	591	1, 134	694
Honduras	21	9	(4)	(4)		
Mexico [3]	8, 112	5, 753	5, 868	6, 824	5, 531	3, 686
United States	3, 806	1, 484	2, 265	3, 150	1, 960	337
South America:						
Argentina	28	(5)	(5)	(5)	(5)	(5)
Bolivia	[6] 8, 613	[6] 10, 275	[6] 8, 781	[6] 11, 816	[6] 9, 806	[7] 2, 200
Peru	1, 390	729	971	1, 107	505	(5)
Europe:						
Austria	258	[8] 379	[8] 409	[8] 498	[8] 389	[7,8] 450
Czechoslovakia	2, 811	(5)	2, 000	(5)	(5)	(5)
France	198	338	413	611	470	(5)
Greece		49	350	500	350	(5)
Hungary	[7,9] 310	(5)	(5)	(5)	(5)	(5)
Italy	457	503	671	794	779	[7] 470
Portugal	22	21	15	19	141	(5)
Spain	181	259	200	167	261	[10] 600
Yugoslavia	[7] 1, 450	2, 789	3, 205	1, 973	2, 237	[7] 1, 840
Asia:						
British Borneo: Sarawak	1	1	2			
Burma [7]	371	70	40	200	(5)	(5)
China	1, 158	[7] 4, 000	[7] 6, 000	[7] 8, 000	[7] 8, 000	[7] 8, 000
Indochina	6					
Iran	1	[11] 175	[11] 230	[7,11] 230	160	(5)
Japan	222	172	161	221	209	[7] 320
Thailand (Siam)	62	265	87	65	70	(5)
Turkey	184	460	1, 288	2, 166	1, 400	(5)
Africa:						
Algeria	304	1, 326	1, 250	1, 462	1, 321	[7] 1, 860
French Morocco	343	700	689	957	839	[7] 50
Southern Rhodesia	53	41	24	62	100	[7] 25
Spanish Morocco	134	150	353	213	431	(12)
Union of South Africa	3, 038	4, 461	8, 311	15, 858	7, 211	[7] 3, 600
Oceania:						
Australia	316	198	227	420	243	[7] 70
New Zealand	1	3			6	(5)
Total (except U. S. S. R.)	34, 000	37, 000	44, 000	61, 000	45, 000	29, 000

1 Approximate metal content of ore produced, exclusive of antimonial lead ores.
2 This table incorporates a number of revisions of data published in previous tables.
3 Includes antimony content of antimonial lead.
4 Negligible.
5 Data not available; estimate by author of chapter included in total.
6 Exports.
7 Estimate.
8 Excludes Soviet zone, data for which are not available, but estimates for which are included in the totals.
9 Trianon Hungary after October 1944.
10 Including Spanish Morocco.
11 Year ended March 20 of year following that stated.
12 Included in Spain.

Union of South Africa.—Consolidated Murchison (Transvaal) Goldfields & Development Co., Ltd.—the only South African antimony producer in the Transvaal—in 1953 confined development to a gold lens, broken stibnite ore being drawn from stopes as required. Cobbed ore and concentrate stocks increased, but overall output decreased to 4,773 short tons (12,958 tons in 1952); sales were 9,450 short tons (11,229 tons in 1952).[18]

Yugoslavia.—Mine production of antimony ore during 1953 was 61,450 metric tons, an 18-percent decrease from 1952. The Yugoslav smelter production of antimony was 1,410 tons, an increase of about 80 tons or 6 percent from the previous year. At Brassina (Western Serbia) a new concentrator (gravity and flotation) began operation in September 1953. A new aerial tramway connects Brassina with the Zajaca smelters. At Split (Dalmatia) a pilot plant was erected to treat antimony concentrates by a hydrometallurgical (amalgam) process.[19]

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[18] Work cited in footnote 12, p. 104.
[19] Work cited in footnote 12, p. 90.

Arsenic

By Abbott Renick [1]

ESTIMATED world production of 56,200 short tons of white arsenic in 1953 was 3,300 tons higher than in 1952 but decreased from the 1944–48 average (62,000 tons) by 9 percent.

Domestic output of white arsenic in the United States decreased 31 percent in 1953 under that in 1952 and was 29 percent less than the 1948–52 average (15,300 short tons).

Shipments exceeded production and reduced producers' stocks on hand at the end of 1953 to 10,800 tons, nearly 500 tons below those held at the 1952 year end. Producers' stocks at the end of 1952 had reached the highest point on record. Of the total white arsenic newly available in the United States in 1953, domestic production (from domestic and foreign ores) constituted 70 percent and imports 30 percent. Apparent consumption was 400 tons greater than supply.

The strong trend in consumer preference for organic chemicals over arsenicals continued unabated in 1953 and, because of generally hot and dry weather which prevailed in the cotton belts, infestations and the use of pesticides to control them were below normal.

The price of white arsenic (arsenic trioxide) in 1953 was steady through the year at 5½ cents a pound in barrels, carlots, delivered.

During 1953 apparent consumption of white arsenic was 16,000 short tons compared with 14,000 tons in 1952, an increase of 14 percent. Data are not available on total domestic consumption of various arsenic insecticides and fungicides; however, domestic producers of white arsenic reported that shipments slightly exceeded their output. The chief uses of arsenic in 1953 were as an insecticide and as a weed killer; however, in addition to such uses, substantial quantities of arsenic are consumed in glass manufacture, as a wood preservative, and in the manufacture of sheep dip, poisoned baits, pharmaceuticals, acid-resistant copper, and antimonial lead alloys.

TABLE 1.—Salient statistics of the white arsenic industry in the United States, 1944–48 (average) and 1949–53, in short tons

Year	Production	Shipments	Imports	Exports [1]	Apparent consumption [2]	Producers' stocks	Price per pound [3]
1944–48 (average)	21,610	20,895	12,042	1,052	31,885	2,256	$0.05
1949	12,795	10,181	4,696		14,877	7,326	$0.06–.05¼
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

[1] Figures for 1944–45 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.

DOMESTIC PRODUCTION

Reports from producers indicate that the output of crude and refined white arsenic in the United States totaled 10,900 tons in 1953, 4,800 tons less than in 1952.

Crude and refined white arsenic was produced in 1953 by the Anaconda Copper Mining Co. at Anaconda, Mont. (copper smelter); United States Smelting, Refining & Mining Co. at Midvale, Utah (lead smelter); and American Smelting & Refining Co. at Tacoma, Wash. (copper smelter). Arsenic metal was not produced during 1953.

TABLE 2.—Production and shipments of white arsenic by United States producers, 1944–48 (average) and 1949–53

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
1944–48 (average)	19,274	18,531	$1,107,146	2,336	2,364	$161,450	21,610	20,895	$1,268,596
1949	12,289	9,597	713,984	506	584	50,527	12,795	10,181	764,511
1950	11,903	15,778	955,739	1,370	1,552	113,240	13,273	17,330	1,068,979
1951	15,485	13,656	972,832	705	695	69,242	16,190	14,351	1,042,074
1952	15,046	8,719	563,719	627	525	46,751	15,673	9,244	610,470
1953	10,345	10,816	495,673	528	499	43,383	10,873	11,315	539,056

[1] Excludes crude consumed in making refined.

CONSUMPTION AND USES

During 1953 apparent consumption of white arsenic was 16,000 short tons, a 14-percent increase from 1952. The major portion of white arsenic produced is employed in manufacturing lead and calcium arsenate insecticides.

In the insecticide industry 1953 was a poor year. Production of lead and calcium arsenate decreased 2 and 6 percent, respectively. This reduced production was due largely to the generally hot and dry climatic conditions, which discouraged serious insect infestations, and to the greatly expanded use of organic insecticides, such as DDT, and benzene hexachloride. The uptrend in the use of organic insecticides has been reported: [2]

> The agricultural consumption of pesticides has grown enormously in the last 6 or 7 years. At the end of World War II, the pesticidal materials in general use were mostly inorganic chemicals, such as lead arsenate, calcium arsenate, and copper compounds, and botanical products, such as rotenone, pyrethrum, nicotine, and red squill. Beginning about 1945, a radical change occurred in the kinds and quantities of chemicals used as pesticides, so that the pattern of consumption as late as 1944 is not at all like the present pattern.

In 1953 the major uses of arsenic and its compounds, in order of importance are: As insecticides and weed killers, in the manufacture of glass, and as a wood preservative. Sodium arsenite is used as a weed killer and a 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

[2] Production and Marketing Administration, United States Department of Agriculture, The Pesticide Situation for 1952–53: March 1953, 36 pp.

used in the glass industry. Wolman salts (25 percent sodium arsenate) and, to a smaller extent, zinc meta-arsenate, are used as wood preservatives.

Sodium arsenite is employed as a weed killer. A recent publication reported:[3]

Sodium arsenite is a soluble arsenical compound widely sold for many years in weed control where all plant growth must be removed. Over 10,000,000 pounds on the basis of white arsenic content, were used annually in herbicides for several years prior to 1950. Sodium arsenite is used to some extent also for dipping cattle, for termite control, and so forth. The overall consumption in the United States at the present time is about 4,500,000 pounds a year, a large proportion of which is used along railroad rights-of-way.

TABLE 3.—Production of arsenical insecticides and consumption of arsenical wood preservatives in the United States, 1944–48 (average) and 1949–53

Year	Production of insecticides (short tons)[1]		Consumption of wood preservatives (pounds)[2]
	Lead arsenate (acid and basic)	Calcium arsenate (100 percent $Ca_3(AsO_4)_2$)	Wolman salts (25 percent sodium arsenate)
1944–48 (average)	27,271	17,981	1,125,490
1949	8,434	8,003	1,003,992
1950	19,750	23,750	1,197,617
1951	12,708	20,450	1,544,181
1952	[3] 7,143	[3] 3,817	1,658,426
1953 [4]	7,000	3,600	1,900,692

[1] Bureau of Foreign and Domestic Commerce, U. S. Department of Commerce.
[2] Forest Service, U. S. Department of Agriculture.
[3] Revised figures.
[4] Preliminary figures.

STOCKS

Year-end producers' stocks of white arsenic totaled 10,800 short tons compared with 11,300 at the end of 1952. 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 1953, according to the Oil, Paint and Drug Reporter. The pesticide industry experienced a relatively stable market in 1953. 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 35–36 cents per pound in January and rose to 36–40 cents per pound in June, which held until the end of 1953. The domestic price for arsenic metal averaged 70 cents per pound in 1953, according to the Oil, Paint and Drug Reporter. The London price of white arsenic, per long ton, 98–100 percent, opened in January at £58½ (equivalent to 7.31 cents per pound) and in the latter part of December was quoted at £45–£50 nominal (5.63 to 6.25 cents per pound).

[3] Commodity Stabilization Service, United States Department of Agriculture, The Pesticide Situation for 1953-54: April 1954, 13 pp.

FOREIGN TRADE [4]

Imports.—White arsenic imports for 1953 totaled 4,700 short tons and were 4 percent above 1952 receipts and 51 percent below the 5-year average for 1948–52.

Mexico continued to be the principal supplier of white-arsenic imports, accounting for 93 percent of the total. Receipts from Canada, the second largest supplier in 1953, increased 141 percent.

Imports of metallic arsenic totaled 71 short tons; Sweden supplied 85 percent and West Germany 15 percent.

TABLE 4.—White arsenic (As_2O_3 content) imported for consumption in the United States, 1944–48 (average) and 1949–53, by countries

[U. S. Department of Commerce]

Country	1944–48 (average)		1949		1950		1951		1952		1953	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Belgium-Luxembourg	1	$192	30	$1,997	952	$43,544						
Bolivia	2	208										
Canada	95	8,188	96	11,816	179	16,194	742	$69,036	121	$14,470	292	$26,018
France	11	1,246			497	39,397	1,919	247,443	110	12,992	47	4,605
Germany					11	755						
Italy	67	11,496										
Japan							276	39,180				
Mexico	9,094	580,364	4,511	544.895	12,659	1,290,712	10,899	1,147,395	4,252	520,112	4,378	543,443
Peru	1,676	80,177					61	6,468				
Poland-Danzig	35	4,984	48	4,866	39	2,950						
Portugal	17	2,523			50	3,204						
Sweden	615	72,769	11	1,261	387	29,427	621	72,317				
U. S. S. R	429	44,923										
United Kingdom											(1)	3
Total	12,042	807,070	4,696	564,835	14,774	1,426,183	14,518	1,581,839	4,483	547,574	4,717	574,069

1 Less than 1 ton.

Exports.—Producers of white arsenic reported no direct foreign sales in 1953. Exports of calcium arsenate decreased 31 percent from those in 1952; however, exports of lead arsenate increased 19 percent. Peru was the principal recipient of calcium arsenate; Colombia, Mexico, Nicaragua, Canada and others followed in order. Cuba was the principal recipient of lead arsenate; Venezuela, Canada, Chile, Colombia and others followed in order.

Tariff.—White arsenic, arsenic sulfide, and paris green and sheep dip, certain varieties of which contain arsenic, are all free of duty. Arsenic acid is dutiable at 3 cents a pound, lead arsenate is dutiable at 1½ cents a pound, and metallic arsenic is duitable at 3 cents a pound. Compounds of arsenic not specified in the tariff act are dutiable at 12½ percent of their foreign market value.

4 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.

TABLE 5.—Arsenicals imported into and exported from the United States by classes, 1944–48 (average) and 1949–53, in pounds

[U. S. Department of Commerce]

Class	1944–48 (average)	1949	1950	1951	1952	1953
Imports for consumption:						
White arsenic (As_2O_3 content)	24,084,184	9,392,699	29,547,402	29,036,555	8,966,906	9,434,212
Metallic arsenic	44,095	45,369	137,533	220,668	60,220	141,472
Sulfide	489,489	44,092	147,055	148,299	----------	20,018
Sheep dip	96,051	55,830	77,219	62,050	102,415	52,436
Lead arsenate	24,110	----------	----------	13,669	161,316	----------
Arsenic acid	----------	200	2,000	5,600	----------	----------
Calcium arsenate	----------	----------	228,000	1,554,207	192,205	----------
Sodium arsenate	----------	----------	110,152	180,040	65,221	79,520
Paris green	----------	----------	88,640	----------	41,255	----------
Exports:						
Calcium arsenate	4,464,932	4,047,406	3,857,107	5,356,867	5,606,613	3,890,246
Lead arsenate	3,708,266	860,530	1,040,100	626,184	255,268	303,030

TECHNOLOGY

The production of arsenic in Devon and Cornwall was described in an article.[5]

The results of a recent study of exposure to arsenic trioxide during its recovery in a smelter were reported.[6]

The principal effects produced by exposure to arsenic trioxide are dermatitis, perforation of the nasal septa, irritation of the nasal turbinates and pharynx, conjuctivitis, and systemic poisoning. Of these, dermatitis is the most common.

The use of a 40-percent sodium arsenate solution for chemical debarking of trees was the subject of a paper.[7]

Five United States patents were issued during 1953 relative to arsenic.[8]

WORLD REVIEW

Canada.—Production of arsenious oxide decreased from 850 short tons valued at C$76,876 in 1952 to about 700 tons valued at C$78,333 in 1953.

Exports to the United States increased from 121 tons valued at C$14,470 in 1952 to 292 tons valued at C$26,018 in 1953.

Finland.—Output of arsenic concentrates in Finland declined from 726 metric tons (22.74 percent arsenic) in 1951, to 496 tons (28.22 percent arsenic) in 1952.[9]

Peru.—White arsenic output and exports totaled 15,172 kilograms valued at 27,186 sols in 1952 (1 sol equaled over US$0.065 in 1951 and US$0.06 in 1952). No output was reported in 1951, but exports totaled 363,451 kilograms valued at 705,813 sols.[10]

Spain.—Spanish output of arsenic ore in 1952 was 995 metric tons, 134 tons from Leon Province, 628 tons from Lugo Province, 209 tons

[5] Toll, R. W., Arsenic in West Devon and East Cornwall: Mining Mag. (London), vol. 89, No. 2, August 1953, pp. 83–88.

[6] Schrenk, H. H., New Information Available on Effects of Arsenic Trioxide and Selenium Gases and Fumes From Burned-Out Rectifiers: Ind. Eng. Chem., vol. 45, No. 12, December 1953, pp. 111A–114A.

[7] Jahn, Edwin C., Chemical Debarking of Trees: Pulpwood Annual, 1953, pp. 7–10. (Pub. by Pulp & Paper Magazine.)

[8] Rohrback, Glen H., McCloud, D. M., and Scott, W. R., Patents Related to Corrosion Inhibiting Compositions for Use in Retarding the Corrosion of Ferrous Metal Piping and Tubing in Producing Oil Wells and in Pipelines Transporting Produced Crude Oil: U. S. Patents, 2,635,996–2,636,000, Apr. 21, 1953.

[9] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 6, June 1953, p. 3.

[10] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 5, November 1953, p. 3.

from Palencia Province, and 24 tons from Salamanca Province. White arsenic output in 1952 was 334 tons.

Preliminary figures on the production of arsenic ore show 987 tons produced during the first 10 months of 1953.[11]

TABLE 6.—World production of white arsenic, by countries,[1] 1944–48 (average), and 1949–53, in metric tons [2]

[Compiled by Pauline Roberts]

Country [1]	1944–48 (average)	1949	1950	1951	1952	1953
North America:						
Canada	668	239	360	1,068	775	646
Mexico	11,445	3,576	8,967	12,766	2,866	2,951
United States	19,604	11,607	12,041	14,687	14,218	9,864
South America:						
Argentina	[3] [4] 237	(5)	(5)	(5)	(5)	(5)
Brazil	923	959	1,067	1,321	963	(5)
Peru	2,494	----------	----------	----------	15	(5)
Europe:						
Austria	[6] 162	(5)	(5)	(5)	(5)	(5)
Belgium (exports)	[6] 330	527	1,909	325	1,003	9,809
France	2,228	1,964	2,460	5,680	6,290	(5)
Germany:						
East	[6] 940	(5)	(5)	(5)	(5)	(5)
West (exports)	[6] 603	1,081	1,124	3,504	111	612
Greece	8	20	33	56	88	(5)
Italy	830	1,440	726	1,769	2,144	1,164
Portugal	744	975	255	561	1,317	(5)
Spain	445	124	159	375	273	(5)
Sweden	10,468	8,967	14,512	18,531	(5)	(5)
United Kingdom	[7] 119	(5)	(5)	(5)	(5)	(5)
Asia:						
Iran [6] [8]	[9] 25	80	25	(5)	(5)	(5)
Japan	1,080	2,001	1,327	1,374	[6] 1,500	(5)
Africa:						
Southern Rhodesia	479	148	114	76	515	378
Union of South Africa	26	----------	----------	----------	----------	----------
Oceania:						
Australia	1,556	257	163	122	122	----------
New Zealand	13	19	10	----------	----------	(5)
Total (estimate)	56,000	35,000	47,000	63,000	48,000	51,000

[1] Arsenic is also believed to be produced in China, Czechoslovakia, Hungary, and U. S. S. R., but data are not available, and there is too little information to permit an estimate.
[2] This table incorporates a number of revisions of data published in previous Arsenic chapters.
[3] Arsenic content of ore mined.
[4] Average for 1944 and 1945.
[5] Data not available; estimate by author of chapter included in total.
[6] Estimate.
[7] White arsenic, including arsenic soot.
[8] Year ended March 20 of year following that stated.
[9] Average for 1946–48.

[11] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 3, March 1954, p. 5.

Asbestos

By Oliver Bowles[1] and Flora B. Mentch[2]

TOTAL production of asbestos in Canada, principal source for the United States, was 2 percent less in 1953 than in 1952, but the decline was confined to spinning-, shingle-, and paper-fiber grades. Sales of short fibers increased. Thus the trend was reversed from 1952, when the demand was stronger for mill fibers than for shorts. Rhodesian production of chrysotile increased moderately, but in the Union of South Africa there was a substantial decline in the quantity of all types produced; sales declined 29 percent from the alltime high of 1952.

Domestic sales advanced 1 percent from the alltime high of 1952. Production in Arizona was lower than in 1952.

Imports, consumption, and exports all declined compared to 1952. Imports of low-iron chrysotile of spinning grade from Southern Rhodesia were a little higher than in 1952, but spinning grades from Canadian sources declined about 20 percent.

As the supply of the better grades of asbestos had caught up with demand, the upward trend in prices that had characterized recent years had been checked. Prices were virtually unchanged from 1952.

TABLE 1.—Salient statistics of the asbestos industry in the United States, 1944–48 (average) and 1949–53

	1944–48 (average)	1949	1950	1951	1952	1953
Domestic asbestos:						
Produced short tons	19, 590	42, 918	41, 358	51, 730	53, 888	57, 950
Sold or used do	18, 819	43, 387	42, 434	51, 645	53, 864	54, 456
Value	$811, 192	$2, 614, 416	$2, 925, 050	$3, 912, 500	$4, 713, 032	$4, 857, 359
Imports (unmanufactured) short tons	491, 158	509, 366	705, 458	761, 873	[1] 709, 469	692, 245
Value	$24, 285, 424	$33, 939, 582	$47, 284, 205	$58, 521, 046	[1]$61,604,601	$59, 753, 583
Exports (unmanufactured) [2] short tons	6, 556	20, 045	20, 890	16, 526	10, 724	3, 076
Value	$928, 938	$4, 152, 344	$4, 084, 384	$3, 662, 270	$2, 670, 970	$592, 222
Apparent consumption short tons	503, 421	532, 708	727, 002	796, 992	[1] 752, 609	743, 625
Exports of asbestos products [2] [3]	$8, 121, 013	$9, 667, 847	$8, 147, 141	$14, 321, 278	$13, 028, 857	$10, 627, 293

[1] Revised figure.
[2] Includes material that has been imported and subsequently exported without change.
[3] 1944–45 figures include value of "Magnesia and manufactures."

DOMESTIC PRODUCTION

As indicated in table 1, domestic sales were 1 percent higher in 1953 than in 1952. Chrysotile was produced in Vermont, Arizona, and California and amphibole in Georgia and North Carolina. So few companies have produced amphibole during recent years that separate figures cannot be published.

Production in Arizona was much lower in 1953 than in the previous year, but the decline was confined to the shorter grades. Sales of the

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

better grades increased moderately. The following firms and individuals were active: American Asbestos Cement Corp., 115 West Oak St., Globe; Arizona Asbestos Mining Co., P. O. Box 923, Globe; American Fiber Co., Globe; Ancha Asbestos Co., P. O. Box 1593, Globe; Bear Canyon Mining Co., P. O. Box 1730, Globe; Crown Asbestos Mines, Inc., P. O. Box 1443, Globe; Chemical Sales Corp., Globe; Arthur Enders, P. O. Box 362, Globe; O. W. Guthrie, Globe; Jaquays Mining Corp., 1219 South 19th Ave., Phoenix; Kyle Asbestos Mines of Arizona, P. O. Box 302, Globe; Metate Asbestos Corp., P. O. Box 1506, Globe; Phillips Asbestos Mines, Drawer 71, Globe; Pine Top Asbestos Mine (Grady B. Gulledge), Globe; Sorsen Asbestos Corp., P. O. Box 1431, Globe; Western Chemical Co., 625 So. 5th St., Phoenix.

Materials Branch, Emergency Procurement Service, General Services Administration (formerly DMPA) has established a receiving depot at Globe, Ariz., and is purchasing asbestos for defense and other essential uses. The Government is paying $1,500 a ton for crude No. 1, $900 for crude No. 2, and $400 for crude No. 3. The program will run until October 1, 1957, or until 1,500 tons, grades 1 and 2 combined, have been purchased.

The Mount Shasta Mining Co., P. O. Box 944, Mount Shasta, Calif., mined a small quantity of chrysotile in Shasta County.

W. Zimdars and J. Delmue, 365 Foresthill Ave., Auburn, Calif., shipped a small quantity of tremolite from Placer County.

The Powhatan Mining Co., Woodlawn, Baltimore, Md., reported a small production of amphibole asbestos from Rabun County, Ga.

Mining & Milling Corp. of America, a subsidiary of Mastic Tile Corp. of America, Newburgh, N. Y., operated its mill at Spruce Pine, N. C., during part of 1953, recovering a considerable tonnage of amphibole fiber from rock obtained at the Blue Rock mine, Yancey County. Most of the output was shipped to the west coast. The Powhatan Mining Co. produced amphibole in Transylvania County. The fiber produced by this company is milled at its plant near Baltimore, Md.

The Vermont Asbestos Mines Division of the Ruberoid Co., 500 Fifth Ave., New York 36, N. Y., continued to operate at a high level during 1953 near Hyde Park, Vt. Exploration, partly under Defense Minerals Exploration Administration assistance, was continued, and significant discoveries have extended the company reserves considerably. Mine and mill operations have been described.[3]

CONSUMPTION AND USES

As indicated in table 2, consumption of raw asbestos in the United States decreased slightly in quantity, and increased in value compared with 1952; thus value of consumption reached an alltime high in 1953. As asbestos has a multitude of industrial uses, its consumption follows the trend of industrial production. Asbestos is also employed extensively in building materials, such as asbestos-cement shingles and siding and floor tile, and various heat-insulating products; therefore its consumption is influenced by the volume of new construction. These trends are indicated graphically in figure 1.

[3] Trauffer, Walter E., Ruberoid Company's New Vermont Asbestos Operation Sets New Standards for Industry: Pit and Quarry, vol. 45, No. 8, February 1953, pp. 70–76.

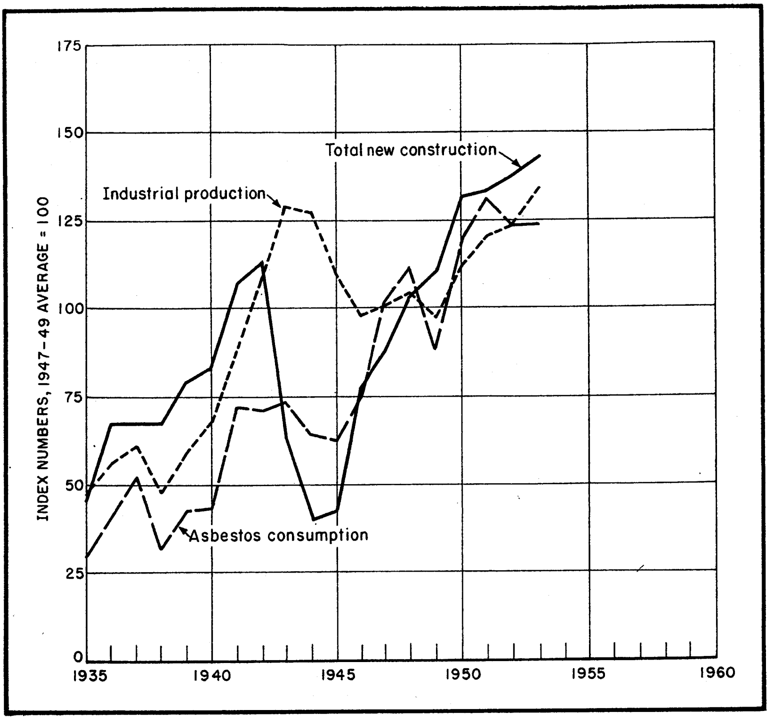

FIGURE 1.—Consumption of asbestos compared with total new construction and industrial production, 1935–53. Statistics on value of construction from Bureau of Foreign and Domestic Commerce and on industrial production from Federal Reserve Board.

TABLE 2.—Apparent consumption of raw asbestos in the United States, 1944–48 (average) and 1949–53

Year	Short tons	Value	Year	Short tons	Value
1944–48 (average)	503,421	$24,167,678	1951	796,992	$58,771,276
1949	532,708	32,401,654	1952 [1]	752,609	63,646,663
1950	727,002	46,124,871	1953	743,625	64,018,720

[1] Revised figure.

PRICES

Prices of asbestos were stable during 1953. No changes occurred in Canadian or Vermont quotations from those recorded in the 1952 chapter. The only change in Arizona quotations was a decline, beginning in April 1953, in the upper limit of filter fiber from $475 to $450 per ton.

There are no market quotations for African asbestos. It is sold by negotiation with individual purchasers. It was reported in the press that South African and Rhodesian prices declined toward the end of 1953.

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FOREIGN TRADE [4]

Imports.—As in 1952, the United States consumed about half of the asbestos produced in the world, but only about 8 percent of its requirements came from domestic sources. It is evident, therefore, that foreign supplies are essential to the asbestos-products industries of the United States. In 1953 imports were 2 percent lower than in 1952. About 94 percent of the total imports originated in Canada, 4 percent in the Union of South Africa, and 1 percent in Southern Rhodesia. On a value basis, however, these percentages were, respectively, 85, 7, and 6. This indicates that imports from overseas consist largely of the higher price fibers because markets are too remote to justify export of low-price asbestos from African countries.

TABLE 3.—Asbestos (unmanufactured) imported for consumption in the United States, 1944–48 (average), 1949–51 (totals), and 1952–53, 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
1944–48 (average)	27,195	$3,670,367	155,743	$12,271,550	308,220	$8,343,507	491,158	$24,285,424
1949	39,272	6,741,789	127,504	14,476,260	342,590	12,721,533	509,366	33,939,582
1950	27,803	5,857,687	177,951	21,381,704	499,704	20,044,814	705,458	47,284,205
1951	35,289	6,618,140	[1] 225,284	[1] 28,844,485	501,300	23,058,421	761,873	58,521,046
1952								
Australia	274	83,353					274	83,353
Bolivia	413	157,289					413	157,289
Canada	555	393,398	[2] 210,333	[2] 30,858,251	458,012	[2] 22,245,162	[2] 668,900	[2] 53,496,811
Italy			11	12,721			11	12,721
Portugal	16	1,323			32	3,584	48	4,907
Southern British Africa	607	164,368					607	164,368
Southern Rhodesia	10,121	3,385,933	422	178,763			10,543	3,564,696
Union of South Africa	[2 3] 26,650	[2 3] 3,863,069	152	33,611	100	12,699	[2 3] 26,902	[2 3] 3,909,379
U. S. S. R.			1,761	206,926			1,761	206,926
United Kingdom	([2 4])	[2] 102			5	1,815	5	[2] 1,917
Venezuela			5	2,234			5	2,234
Total	[2] 38,636	[2] 8,048,835	[2] 212,684	[2] 31,292,506	458,149	[2] 22,263,260	[2] 709,469	[2] 61,604,601
1953								
Australia	1,748	615,614			2	1,022	1,750	616,636
Bolivia	828	369,992					828	369,992
Canada	842	423,949	169,096	27,129,703	482,179	23,129,921	652,117	50,683,573
France			([4])	188			([4])	188
Italy	1	1,340	3	6,321			4	7,661
Madagascar	1	371					1	371
Portugal	5	558					5	558
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
U. S. S. R.	108	12,000	217	24,000			325	36,000
United Kingdom	[5] 110	[5] 30,641	10	3,241			120	33,882
Venezuela	4	2,233	52	20,020			56	22,253
Total	39,201	9,052,007	170,692	27,521,438	482,352	23,180,138	692,245	59,753,583

[1] Includes 11 tons ($1,632) classified by U. S. Department of Commerce as amosite crude, reclassified by Bureau of Mines, as mill fibers.
[2] Revised figure.
[3] Includes 105 tons ($15,759) of amosite crude credited by U. S. Department of Commerce to Mozambique.
[4] Less than 1 ton.
[5] Data includes 7 tons of blue (crocidolite) crude, valued at $3,924, believed to have originated in the Union of South Africa or Australia and processed in the United Kingdom.

[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.

From the standpoint of security the United States is especially interested in supplies of chrysotile of spinning grade. Accordingly, tables 4 and 5 have been introduced to show imports of asbestos from Canada and Southern Rhodesia by grades.

TABLE 4.—Asbestos (chrysotile) imported for consumption in the United States from Canada, by grades, 1944–48 (average) and 1949–53, in short tons

[U. S. Department of Commerce]

	1944–48 (average)	1949	1950	1951	1952	1953
Crude No. 1	269	203	390	126	144	168
Crude No. 2	389	206	260	226	332	207
Other crudes	143	437	1,114	384	79	467
Spinning and textile fiber	19,275	13,738	24,417	22,463	[1] 24,112	19,417
Shingle fiber	70,577	65,544	83,640	104,419	98,577	86,540
Paper fiber	63,657	48,065	69,171	97,888	87,644	63,139
Short fiber	308,212	342,590	499,704	501,264	458,012	482,179
Total	462,522	470,783	678,696	726,770	[1] 668,900	652,117

[1] Revised figure.

TABLE 5.—Asbestos (chrysotile) imported for consumption in the United States from Southern Rhodesia, by grades, 1944–48 (average) and 1949–53, in short tons

[U. S. Department of Commerce]

	1944–48 (average)	1949	1950	1951	1952	1953
Crude No. 1	1,086	1,270	2,124	678	462	1,039
Crude No. 2	3,386	2,905	1,844	1,239	1,363	814
Other crudes	[1] 2,146	9,466	4,940	5,783	8,296	7,304
Spinning and textile fiber	24	81	556	25	177	730
Shingle fiber	45				245	103
Short fiber	6					
Total	6,693	13,722	9,464	7,725	10,543	9,990

[1] Includes small amounts credited by the U. S. Department of Commerce, to Mozambique.

Exports.—Exports of raw asbestos declined to approximately one-fourth of the tonnage shipped to foreign countries in 1952. Such decline indicates that the needs of foreign customers are being supplied more readily from other sources.

TECHNOLOGY

Vermont Asbestos Mines Division of the Ruberoid Co. has developed highly refined methods of asbestos prospecting. As the asbestos occurs in massive serpentine, the serpentine areas are first delineated by magnetometer surveys. Core drill holes are then sunk on a 100-foot grid system. The cores are next logged by measurement of the fiber veins intersected. Both the percentage of the total fiber content and the proportion of various fiber lengths are thus determined. The cores are then milled in the laboratory, and the fiber content is determined by grades. The approximate fiber content determined by these 2 methods is checked further by mining bulk samples up to 3,000 tons obtained by sinking shafts 10 feet in diameter around selected drill holes. These samples are treated as

TABLE 6.—Asbestos and asbestos products exported from the United States, 1944–48 (average) and 1949–53

[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
1944–48 (average)	5,720	$754,640	836	$174,298	$8,116,935	$4,078
1949	17,621	3,618,703	2,424	533,641	9,666,560	1,287
1950	18,980	3,646,828	1,910	437,556	8,097,192	49,949
1951	14,298	3,216,810	2,228	445,460	14,320,389	889
1952	10,265	2,550,065	459	120,905	13,027,739	1,118
1953	2,780	540,273	296	51,949	10,615,832	11,461

[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 1952–53, by kinds

[U. S. Department of Commerce]

Product	1952		1953	
	Quantity	Value	Quantity	Value
Unmanufactured asbestos:				
Crude and spinning fibers ... short tons	1,419	$551,686	752	$252,748
Nonspinning fibers ... do	7,610	1,845,154	1,260	242,182
Waste and refuse ... do	1,236	153,225	768	45,343
Total unmanufactured ... do	10,265	2,550,065	2,780	540,273
Asbestos products:				
Brake blocks ... do	195	454,537	217	462,640
Brake lining:				
Molded and semimolded ... do	2,365	4,657,696	1,959	3,450,282
Not molded ... linear feet	530,906	424,838	447,598	355,814
Clutch facing and lining ... number	1,550,644	996,080	1,241,409	900,725
Construction materials ... short tons	16,692	2,822,802	14,809	2,457,973
Pipe covering and cement ... do	2,324	655,254	2,161	592,054
Textiles, yarn, and packing ... do	1,254	2,428,123	1,006	2,013,852
Manufactures, n. e. c.	(1)	588,409	(1)	382,492
Total products	------------	13,027,739	------------	10,615,832

[1] Quantity not recorded.

regular mill runs. Large-scale operations at the sites selected have confirmed the accuracy of the three-stage evaluation system.

This company has also developed a pressure bagging system for finished asbestos fiber. Each rectangular paper sack containing 100 pounds occupies about 2 cubic feet. Such sacks are convenient for pallet loading and also conserve storage and shipping space.

A type of equipment new to the African industry, known as the Marchioli mill, has recently been introduced in the Pietersburg area to process blue fiber. Although the mill is still in the pilot-plant stage, it is claimed that it gives a high rate of extraction, reduces grit and dust to less than 1 percent, attains a high volume of expansion or "fluffiness," and results in minimum damage to the fibers. It is reported that mills of this type are in successful use at asbestos mines in Italy and Corsica.[5]

A review of the mining, milling and marketing of asbestos recently appeared.[6] The discussion is confined primarily to the Rhodesian asbestos industry.

New equipment for processing fiber has been introduced also at the Lanninhurst mine in Southern Rhodesia. It is claimed that a newly designed cleaning and grading mill will process partly opened, impure asbestos to a clean, well-classified fiber of superior quality. Operation late in 1953 had not passed the pilot-plant stage, but erection of a full-scale plant is in prospect.

A recent report discusses, in some detail, the quantities of the various types of asbestos imported into the United States and the uses to which they are applied. Methods of testing and evaluating the fibers are described. Consignments generally require more or less processing by the consumer before they are in proper condition for use. It is pointed out that the quality of Canadian chrysotile has been maintained at a high level but that the quality of fibers from other countries has declined, in most instances.[7]

As pointed out heretofore, steps are being taken in Africa to improve the classification and preparation of fibers for export trade.

Ordinarily there is no "scrap recovery" of asbestos, but the National Bureau of Standards has developed processes for recovering fiber from discarded asbestos cloth and asbestos-cotton cloth. Contaminating materials consist principally of cement and paint. The former is removed by treatment with a 5-percent hydrochloric acid solution, and the paint is removed by boiling in a 5-percent sodium hydroxide solution. Cotton, a constituent of asbestos fabrics, is burned out in a muffle furnace at temperatures between 400° and 450° C. The temperature must be carefully controlled to avoid damage to the fiber. Recovery from asbestos-glass fabrics and from molded insulation proved to be unsatisfactory.[8]

A publication giving much information on the manufacture and use of asbestos textiles appeared.[9]

WORLD REVIEW

In table 8 world production by countries for 1953 is incomplete, but estimates for unrecorded countries are included in the total. Revisions for previous years have been made as additional information has become available.

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[5] South African Mining and Engineering Journal, The Marchioli Mill Raises Hopes of Brighter Future for Our Asbestos Producers: Vol. 64, pt. 1, June 18, 1953, p. 587.

[6] Sworder, E. H., Preparation and Marketing of Asbestos Fibers: Rhodesian Min. Rev., vol. 18, No. 4, April 1953, pp. 21–26, No. 5, May 1953, pp. 29–35.

[7] Badollet, M. S., Asbestos Fibers; Production and Usage: Canadian Min. and Met. Bull., vol. 56, August 1953, pp. 477–479.

[8] National Bureau of Standards, Reclamation of Asbestos: Tech. News. Bull., vol. 37, No. 9, September 1953, p. 139.

[9] Asbestos Textile Institute, Handbook of Asbestos Textiles: New Brunswick, N. J., 1953, 78 pp.

TABLE 8.—World production of asbestos by countries,[1] 1944–48 (average) and 1949–53, in metric tons [2]

[Compiled by Helen L. Hunt]

Country [1]	1944–48 (average)	1949	1950	1951	1952	1953
North America:						
Canada (sales) [3]	512,187	521,543	794,095	882,866	843,078	826,303
United States (sold or used by producers)	17,072	39,360	38,495	46,851	48,864	49,401
South America:						
Bolivia (exports)	72	182	166	316	465	735
Brazil	1,705	1,415	844	1,321	[4] 720	[4] 720
Chile	297	291	172	(5)	(5)	(5)
Venezuela	99	192	190	260	394	40
Europe:						
Finland [6]	6,976	10,486	10,949	11,850	6,100	10,929
France	650	1,090	6,080	6,940	6,300	9,300
Greece	[7] 18	9	30	34	25	----------
Italy	----------	15,877	21,433	22,612	23,938	20,397
Portugal	114	101	257	312	168	(5)
Spain	7	40	41	41	30	(5)
U. S. S. R. (estimate)	100,060	191,000	220,000	220,000	220,000	220,000
Yugoslavia	[8] 529	1,111	958	1,523	2,506	3,748
Asia:						
Cyprus	4,959	12,556	14,989	17,180	16,556	14,484
India	397	148	211	526	694	(5)
Iran	----------	----------	----------	----------	----------	50
Japan	6,800	5,456	5,664	6,139	3,060	4,078
Korea	[9] 1,907	(5)	(5)	(5)	(5)	(5)
Taiwan (Formosa)	286	410	216	35	24	----------
Turkey	175	250	245	80	----------	----------
Africa:						
Egypt	606	117	260	1,247	60	(5)
French Morocco	528	402	511	604	576	544
Kenya	397	716	229	379	354	151
Madagascar	1	2	1	17	3	(5)
Southern Rhodesia	53,210	72,246	64,888	70,454	76,960	79,595
Swaziland	26,961	30,814	29,635	31,719	31,542	27,309
Union of South Africa	28,830	64,334	79,300	97,402	121,416	86,016
Oceania:						
Australia	2,094	1,671	1,643	2,599	4,124	5,049
New Zealand	4	----------	42	826	693	(5)
Total (estimate)	781,800	975,000	1,300,000	1,425,000	1,425,000	1,375,000

[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: 1949, 32,015 tons; 1950, 43,551 tons; 1951, 30,628 tons; 1952, 35,982 tons; 1953, 19,158 tons.
[4] Produced in Bahía only (incomplete figure).
[5] Data not available; estimate by authors of chapter included in total.
[6] Includes asbestos flour.
[7] Average for 1946–48.
[8] Average for 1947–48.
[9] Estimate.

CANADA

British Columbia.—Cassiar Asbestos Corp., Ltd., McDame Lake, has continued exploratory work, and its fiber-bearing rock reserves were estimated late in 1953 at more than 7 million tons having a fiber value of approximately $30 per ton of asbestos-bearing rock. An experimental mill was operated, and several hundred tons of 3K and 4K fibers were recovered from the talus accumulation. A new mill having a capacity of 500 tons of rock per day was expected to be completed by June 1954.

Western Asbestos & Development, Ltd., is taking active measures to develop two asbestos properties in southern British Columbia—the Okanagan Falls and the Revelstoke. The former consists principally of anthophyllite. The second property, on Sproat Mountain, only 2½ miles from the Canadian Pacific Railway, is more promising. The asbestos is of the chrysotile variety and occurs in crossfiber veins up to ⅝ inch long, also as slip fiber up to 5 inches long. A program of mapping, trenching, and prospect drilling is planned.

TABLE 9.—Sales of asbestos in Canada, 1952–53, by grades

[Dominion Bureau of Statistics]

	1952			1953		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Grade:						
Crudes	741	$726,827	$981	781	$837,623	$1,073
Fibers	351,644	58,822,472	167	326,340	56,226,083	172
Shorts	576,954	29,705,614	51	584,105	28,989,189	50
Total	929,339	89,254,913	96	911,226	86,052,895	94
Rock mined	12,989,320			13,912,839		
Rock milled	10,915,938			11,189,027		

Newfoundland.—It was reported early in 1953 that equipment for an asbestos mill of 200-ton-a-day capacity was being moved to the property of Newfoundland Asbestos, Ltd., at Port-au-Port Bay on the west coast of Newfoundland. The deposit is situated on a hillside into which a 500-foot adit has been driven.

Ontario.—The Munro mine of the Johns-Manville Corp. near Timmins, Ontario, has been operating almost at maximum capacity. The open pit now worked will meet the present production rate for 3 or 4 years, and plans are being prepared for underground mining. Large reserves are said to exist in other nearby properties owned by the company. The mine has been described in some detail in a recent article.[10]

Quebec.—Shipments of Canadian asbestos declined about 2 percent in quantity and 4 percent in value compared with 1952. The following companies produced asbestos in Quebec in 1953: Canadian Johns-Manville Corp., Ltd.; Asbestos Corp., Ltd.; Johnson's Co.; Quebec Asbestos Corp.; Bell Asbestos Mines; Nicolet Asbestos Mines, Ltd.; Flintkote Mines, Ltd.; and Dominion Asbestos Co.

Canadian Johns-Manville Corp., Ltd., has made substantial progress in new mill construction at the Jeffrey mine, Asbestos, Quebec. When completed the mill will have a capacity of about 600,000 tons of asbestos a year. A second vertical shaft has been sunk to a depth of 1,500 feet, and a new concrete headframe has been constructed, and a new office and other contiguous buildings have been erected.

Construction of the new Normandie mill of Asbestos Corp., Ltd., was well-advanced. The mill was expected to be in operation late in 1954. The Johnson's Co. new mill at Black Lake was completed.

[10] Baker, R. D., Asbestos Production in Ontario: Western Miner and Oil Review (Vancouver, B. C.), vol. 26, No. 12, December 1953, pp. 35-37.

It has been repoıted in the press that Lake Asbestos Co., a subsidiary of the American Smelting & Refining Co., has exercised an option to develop the Black Lake property of United Asbestos Corp. and erect a mill of 5,000 tons daily capacity. Development involves drainage of the lake and removal of a heavy burden of silt. The operations proposed are expected to cost over $15 million. Extensive exploratory work has established the presence of a large body of asbestos-bearing rock.

The Dominion Asbestos Co. mill at St. Adrian made experimental runs during 1953 but suspended operation late in the year for financial readjustment. The National Gypsum Co. financed the operation for a time under option but according to press reports has not exercised its option to purchase the property.

Several asbestos companies are cooperating in an extensive project involving relocation of 8 miles of railway and sections of the residential and commercial areas of Thetford Mines to provide access for development of large, unutilized masses of asbestos-bearing rock.

SOUTHERN AFRICA

Southern Rhodesia.—As indicated in table 10, asbestos production in Southern Rhodesia was nearly 3,000 tons greater in 1953 than in 1952. The sales value, however, was lower. Exports from Rhodesia—71,629 tons—were nearly 12,000 tons less than in 1952 and nearly £500,000 less in value. Although demands for asbestos declined during the latter part of 1953, an increasing interest in purchasing was noted early in 1954.

A new company, Rhodesian Asbestos, Ltd., financed jointly by the Johns-Manville Corp., the British Metal Corp., Ltd., Simon I. Patiño, and Southern Minerals & Marketing Corp. (Pty.), Ltd., has been established to develop several asbestos properties in the Mashaba district. Production on a substantial scale is anticipated in the near future.

Rhodesian Monteleo Asbestos, Ltd., which began operation of its new mill in April 1953, was obliged to suspend activity late in 1953 because of decreasing demand and declining prices.

TABLE 10.—Asbestos produced in Southern Rhodesia, 1949–53

Year	Short tons	Value	Year	Short tons	Value
1949	79,638	£3,986,703	1952	84,834	£6,651,975
1950	71,527	4,615,490	1953	87,739	6,542,731
1951	77,663	5,452,108			

Union of South Africa.—The remarkable increases in asbestos production in the Union that characterized recent years were succeeded by an abrupt decline in 1953, when sales were 33 percent lower in quantity and 40 percent lower in value than in 1952. As indicated in table 12, the recession was shared by every variety. Amosite production declined 40 percent, chrysotile 25, Transvaal blue 17, and Cape blue 15.

The asbestos situation changed considerably during 1953. Supply caught up with demand to such an extent that buyers became more selective in their requirements, and prices declined. Accordingly, some high-cost mines were shut down, and some of the smaller companies that had inadequate milling equipment faced difficulty in meeting buyers' specifications. As a step toward improving the situation, the South African Bureau of Standards appointed a special subcommittee to study ways of establishing an official Government grading system for South African fibers. It was believed that more uniform grading would increase confidence in the quality of the asbestos in the minds of overseas consumers.

Noteworthy studies have been made of South African fibers. Research involving X-ray and differential thermal analysis has been applied to the amphibole varieties—anthophyllite, tremolite, actinolite, amosite, and crocidolite. Amosite was found to be a member of the cummingtonite-grunerite series. The composition, character, and origin of the fibers were described.[11]

A detailed discussion of the various asbestiform minerals in the Union of South Africa has recently appeared.[12] The first section of the report deals with the nature and identification of the asbestos minerals: Chrysotile, anthophyllite, tremolite-actinolite, crocidolite, and amosite-montasite. The second part relates to the nature of the impurities, their removal, and the grading of the processed fibers.

TABLE 11.—Asbestos produced in and exported from the Union of South Africa, 1949–53

Year	Production (short tons)			Exports	
	Transvaal	Cape Province	Total	Short tons	Value
1949	58,918	11,999	70,917	63,428	£2,600,323
1950	72,203	15,211	87,414	70,609	3,475,200
1951	89,290	18,078	107,368	89,735	5,056,143
1952	109,398	24,441	133,839	106,576	6,899,086
1953	73,934	20,883	94,817	71,791	4,158,476

TABLE 12.—Asbestos produced in the Union of South Africa, 1949–53, by varieties and sources, in short tons

Variety and source	1949	1950	1951	1952	1953
Amosite (Transvaal)	41,974	42,393	54,053	63,280	38,258
Chrysotile (Transvaal)	7,609	14,334	19,509	24,970	18,840
Blue (Transvaal)	9,181	15,387	15,581	20,294	16,824
Blue (Cape)	11,999	15,211	18,078	24,441	20,883
Anthophyllite (Transvaal)	154	89	147	854	12
Total	70,917	87,414	107,368	133,839	94,817

[11] Vermaas, F. H. S., The Amphibole Asbestos of South Africa: Trans. Geol. Soc. South Africa, 1953.
[12] Frankel, J. J., South African Asbestos Fibers: Min. Mag. (London), vol. 89, No. 2, August 1953, pp. 73–83; No. 3, September 1953, pp. 142–149.

OTHER COUNTRIES

Australia.—Australian Blue Asbestos, Ltd., has increased production at its Hamersley Range crocidolite property in Western Australia. It produces long and medium grades for spinning and shorter grades for use in asbestos-cement products.

Finland.—Finland is the largest producer of anthophyllite asbestos in the world. The fibers have high chemical and fire-resisting qualities. The principal domestic use is for making so-called asbestos-wood slates for siding on house walls. The fibers are also used in flooring, in bitumen compositions, and in other fireproof products. Substantial quantities are exported.[13]

[13] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 6, December 1953, pp. 35–36.

Barite

By Joseph C. Arundale [1] and Flora B. Mentch [2]

THE UNITED STATES continued to lead the world in tonnage of barite produced and consumed in 1953. Domestic output of crude barite was slightly less than in the previous year, but imports increased threefold. Consumption of ground barite in well-drilling muds continued to increase.

TABLE 1.—Salient statistics of the barite and barium-chemical industries in the United States, 1944–48 (average) and 1949–53

	1944–48 (average)	1949	1950	1951	1952	1953
Barite:						
Primary:						
Produced short tons	718, 950	731, 308	693, 424	845, 579	1, 012, 811	920, 025
Sold or used by producers:						
Short tons	714, 594	717, 313	695, 414	860, 669	941, 825	944, 212
Value	$5, 402, 930	$5, 642, 226	$6, 193, 906	$7, 968, 023	$8, 797, 944	$9, 435, 749
Imports for consumption:						
Short tons	55, 174	26, 178	58, 381	52, 755	107, 918	334, 788
Value	$387, 130	$192, 567	$431, 879	$419, 494	$923, 336	$2, 514, 828
Consumption short tons	753, 733	719, 543	[1] 786, 131	[1] 950, 893	[1] 1, 033, 843	[1] 1, 149, 451
Ground and crushed sold by producers:						
Short tons	490, 065	554, 028	573, 359	703, 014	839, 428	920, 084
Value	$8, 071, 710	$10, 156, 590	$11, 305, 209	$14, 590, 000	$16, 608, 546	$20, 372, 002
Barium chemicals sold by producers:						
Short tons	73, 436	57, 012	73, 689	86, 032	83, 156	97, 508
Value	$7, 060, 210	$5, 646, 403	$7, 885, 586	$11, 656, 497	$12, 101, 474	$13, 347, 359
Lithopone sold or used by producers:						
Short tons	146, 225	78, 335	105, 650	102, 837	61, 832	52, 439
Value	$13, 442, 674	$8, 977, 178	$13, 129, 363	$14, 470, 742	$8, 475, 200	$6, 923, 487

[1] Includes some witherite.

DOMESTIC PRODUCTION

Production of crude barite from domestic deposits in 1953 was down slightly from the previous year; but shipments increased, and producers' stocks decreased. Arkansas again was the largest producer, but output dropped. Recently completed expansions of recovery and grinding facilities enabled Missouri operators to increase output. Production from Nevada continued to rise, and that State ranked third in 1953. In Montana a new producer, Finlen & Sheridan Mining Co., sold barite to the well-drilling trade and for chemical purposes.

[1] Assistant chief, Construction and Chemical Materials Branch.
[2] Statistical assistant.

TABLE 2.—Domestic barite sold or used by producers in the United States, 1944–48 (average) and 1949–53, by States

State	1944–48 (average)		1949		1950		1951		1952		1953	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Arkansas [1]	289,424	$2,023,006	363,382	$2,907,056	343,168	$3,088,512	407,085	$3,765,536	428,522	$3,963,828	380,763	$3,945,583
Georgia	82,500	793,306	50,267	465,325								
South Carolina	(2)	(2)	(2)	(2)	72,888	766,711	73,117	841,440	97,540	1,162,249	81,846	1,066,368
Tennessee	33,347	273,917	13,376	137,120								
Missouri	243,351	1,990,151	186,891	1,497,985	212,736	1,924,520	281,895	2,697,200	304,080	2,919,795	330,763	3,338,395
Nevada	34,642	187,305	70,576	416,416	47,608	268,874	63,201	387,026	68,062	391,242	99,525	614,686
Other States [3]	31,330	135,245	32,821	218,324	19,014	145,289	35,371	276,821	43,621	360,830	51,315	470,717
Total	714,594	5,402,930	717,313	5,642,226	695,414	6,193,906	860,669	7,968,023	941,825	8,797,944	944,212	9,435,749

[1] Value estimated.
[2] Included with "Other States."
[3] Includes Arizona (1946–53), California (1946, 1948–53), Idaho (1949–53), Montana (1951–53), New Mexico (1949–53), North Carolina (1944–45), South Carolina (1944 and 1949) and Washington (1953).

Probably the most significant development in the recent past has been the growth of barite-grinding facilities on the Gulf coast—2 new plants near New Orleans, 1 at Brownsville, and 1 at Corpus Christi. Barite ground in these new plants is largely of foreign origin and goes to the well-drilling trade.

TABLE 3.—Ground (and crushed) barite produced and sold by producers in the United States, 1944–48 (average) and 1949–53

Year	Plants	Production (short tons)	Sales	
			Short tons	Value
1944–48 (average)	22	491,498	490,065	$8,071,710
1949	24	561,258	554,028	10,156,590
1950	26	569,129	573,359	11,305,209
1951	24	704,709	703,014	14,590,000
1952	24	839,457	839,428	16,608,546
1953	29	924,392	920,084	20,372,002

The operations of Magnet Cove Barium Corp. in Arkansas were described.[3] This firm originally mined barite at Magnet Cove from an open pit; but the problem of waste disposal from stripping necessitated underground operations, and the barite is now mined by both shrinkage and top-slicing stoping methods. The barite is concentrated by flotation.

Barium Products, Ltd., opened a new mine about 20 miles south of Battle Mountain, Nev. Barite from an open pit is screened and shipped to the firm's chemical plant at Modesto, Calif.[4]

Manufacturers Mineral Co. of Seattle, a new producer in Washington, recovered a small tonnage of barite from an open pit west of Addy in Stevens County, Wash.[5]

A small quantity of barium metal is produced annually by Kemet Laboratories Co., Inc. (a unit of Union Carbide & Carbon Corp.), Cleveland, Ohio, and by King Laboratories, Inc., Syracuse, N. Y.

CONSUMPTION AND USES

Consumption of barite reached an unprecedented high of nearly 1¼ million short tons in 1953. Most of the increase went to well drilling and the manufacture of barium chemicals; consumption for these two purposes has about doubled since 1949.

Because it is inert, and relatively soft and heavy, barite is used extensively as a constituent of oil- and gas-well drilling muds. These muds carry drill cuttings to the surface, cool the bits, and plaster the walls of the holes to prevent escape of the drilling fluid. Barite is added to increase the weight of the mud and thereby help prevent

[3] Wilson, T., Magcobar—Mud Is Their Business: Min. Eng., vol. 6, No. 5, May 1954, pp. 494–496.
[4] Mining World, vol. 15, No. 10, September 1953, p. 109.
[5] Mining World, vol. 15, No. 13, December 1953, p. 92.

gas pressure blowing the mud and equipment out of the drill hole. Total footage of oil and gas wells drilled in the United States in 1953 was nearly 200 million feet; this was 10 percent greater than the footage drilled in the previous year.[6]

Barite is the raw material in the manufacture of barium chemicals, the principal ones being the carbonate, chloride, oxide, hydroxide, and sulfate. Consumption of barite in the manufacture of lithopone continued to decrease, as more titanium dioxide was substituted for lithopone as a pigment.

Rubarite, Inc., opened a new plant at Magnet Cove, Ark., to manufacture a mixture of finely ground barite and synthetic rubber powder. This material is added to asphalt in constructing roads, airstrips, and similar types of installations.

It was reported that a new-type permanent magnet was being produced by compacting and heat-treating powdered iron oxide and barium carbonate. The new material is said to be best suited for use in television focus rings, novelties, toys, and holding devices.[7]

The principal use for barium metal is as a getter. The metal or an alloy with another alkaline-earth metal or magnesium or aluminum is inserted into electronic tubes to absorb residual gases, thus improving the vacuum and increasing the 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, 1944–48 (average) and 1949–53, 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	
1944–48 (average)	501,894	149,872	101,967	753,733	1951	711,531	107,094	[2] 132,268	950,893
1949	567,249	71,710	80,584	719,543	1952	849,246	61,000	[2] 123,597	1,033,843
1950	578,078	99,703	[2] 108,350	786,131	1953	933,673	52,308	[2] 163,470	1,149,451

[1] Includes some crushed barite.
[2] Includes some witherite.

[6] Oil and Gas Journal, vol. 52, No. 38, Jan. 25, 1954, p. 126.
[7] American Metal Market, vol. 61, No. 5, Jan. 8, 1954, p. 1.

TABLE 5.—Ground (and crushed) barite sold by producers, 1944–48 (average) and 1949–53, by consuming industries

Industry	1944–48 (average)		1949		1950		1951		1952		1953	
	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	418, 174	86	494, 579	89	483, 519	84	594, 668	85	758, 240	90	824, 050	90
Glass	27, 263	5	21, 768	4	24, 638	4	25, 779	4	24, 604	3	24, 853	3
Paint	24, 200	5	20, 000	4	28, 000	5	28, 000	4	25, 000	3	24, 000	2
Rubber	15, 000	3	14, 000	2	19, 000	3	15, 000	2	18, 000	2	21, 000	2
Concrete aggregates					15, 784	3	38, 143	5	12, 000	2	25, 000	3
Undistributed	5, 428	1	3, 681	1	2, 418	1	1, 424	(1)	1, 584	(1)	1, 181	(1)
Total	490, 065	100	554, 028	100	573, 359	100	703, 014	100	839, 428	100	920, 084	100

[1] Less than 1 percent.

TABLE 6.—Lithopone sold or used by producers in the United States, 1944–48 (average) and 1949–53

	1944–48 (average)	1949	1950	1951	1952	1953
Plants	8	8	7	6	5	5
Short tons	146, 225	78, 335	105, 650	102, 837	61, 832	52, 439
Value	$13, 442, 674	$8, 977, 178	$13, 129, 363	$14, 470, 742	$8, 475, 200	$6, 923, 487

TABLE 7.—Distribution of lithopone shipments, 1944–48 (average) and 1949–53, by consuming industries

Industry	1944–48 (average)		1949		1950		1951		1952		1953	
	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	116, 150	79	[1] 56, 146	72	78, 177	74	76, 614	75	45, 267	73	37, 452	72
Floor coverings	16, 813 (Floor coverings and Coated fabrics and textiles combined)	12	6, 380	8	5, 297	5	4, 620	4	3, 009	5	2, 575	5
Coated fabrics and textiles			6, 602	8	7, 945	8	4, 814	5	5, 698	9	5, 806	11
Paper	(2)	(2)	2, 375	3	2, 290	2	6, 462	6	3, 089	5	2, 096	4
Rubber	2, 117	1	3, 245	4	4, 092	4	3, 295	3	1, 523	3	1, 723	3
Other	11, 145	8	3, 587	5	7, 849	7	7, 032	7	3, 246	5	2, 787	5
Total	146, 225	100	78, 335	100	105, 650	100	102, 837	100	61, 832	100	52, 439	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, 1944–48 (average) and 1949–53, 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]					
1944–48 (average)	16	158,479	158,032	368	$19,402
1949	15	97,693	97,753	246	16,464
1950	12	130,967	130,305	499	33,084
1951	12	152,792	150,434	455	28,361
1952	12	121,061	120,562	649	42,475
1953	11	138,980	137,801	1,126	81,647
Carbonate (synthetic):					
1944–48 (average)	5	42,440	22,323	19,953	1,270,533
1949	4	36,122	10,077	27,010	1,942,845
1950	4	49,299	13,063	36,266	2,746,628
1951	4	60,181	18,541	40,568	3,322,276
1952	4	57,935	21,591	37,214	3,175,080
1953	4	74,122	26,116	46,846	4,223,525
Chloride (100 percent $BaCl_2$):					
1944–48 (average)	3	14,711	4,254	10,139	933,013
1949	3	10,513	2,872	7,679	848,637
1950	3	12,285	3,324	8,874	992,722
1951	4	17,959	4,911	12,364	1,830,070
1952	4	14,157	3,979	10,409	1,407,986
1953	4	14,838	2,186	12,303	1,703,796
Hydroxide:					
1944–48 (average)	3	3,725	293	3,365	480,794
1949	4	3,849	140	3,737	694,097
1950	4	7,927	82	7,888	1,540,046
1951	5	13,483	231	12,757	3,185,405
1952	5	11,759	585	10,848	2,211,998
1953	5	12,454	304	11,843	2,258,279
Oxide:					
1944–48 (average)	3	6,415	6,004	335	67,555
1949	3	5,795	4,899	1,118	233,733
1950	3	8,129	6,021	2,162	451,277
1951	3	9,347	6,334	3,073	729,379
1952	3	9,843	6,081	3,818	907,762
1953	3	14,578	7,604	6,820	1,678,969
Sulfate (synthetic):					
1944–48 (average)	8	29,177	13,864	15,241	1,189,657
1949	7	15,182		15,371	1,436,557
1950	6	15,821		15,676	1,505,628
1951	6	14,237		13,426	1,448,628
1952	7	13,035		13,274	1,492,324
1953	7	14,390		13,448	1,653,507
Other barium chemicals:[5]					
1944–48 (average)	(6)	28,231	3,945	24,035	3,099,256
1949	(6)	5,320	2,890	1,851	474,070
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
Total:[7]					
1944–48 (average)	20			73,436	7,060,210
1949	20			57,012	5,646,403
1950	17			73,689	7,885,586
1951	18			86,032	11,656,497
1952	19			83,156	12,101,474
1953	18			97,508	13,347,359

[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 include lithopone plants.
[5] Includes barium acetate, chromate, nitrate, perchlorate, peroxide, and sulfide. Specific chemicals may not be revealed by specific years.
[6] Plants included in above figures.
[7] A plant producing more than 1 product is counted but once in arriving at grand totals.

PRICES

According to E&MJ Metal and Mineral Markets the following prices were quoted for barite in 1953: Barytes—f. o. b. mines: Georgia, crude, jig and lump, quoted at $13–$13.50 per long ton at the beginning of the year was increased to $14 per short ton by the end of the year; beneficiated, in paper bags, was quoted at $16–$18 per short ton at the beginning of the year and increased to $19–$20 per short ton by the end of the year. Missouri barite, water ground and floated, bleached, was quoted at $37.60 per short ton, carlots, f. o. b. works, at the beginning of the year and increased to $41.35 by the end of the year. Crude ore, minimum 94 percent, $BaSO_4$, less than 1 percent iron, $10.40 per short ton at the beginning of the year and increased to $13.25 per short ton by the end of the year.

Prices for barium metal are not quoted in the trade journals but may be obtained directly from the producers. Prices vary greatly with the quantity and purity desired.

TABLE 9.—Range of quotations on barium chemicals in 1953

[Oil, Paint and Drug Reporter]

Barium carbonate, precipitated, bags, carlots, works .... short ton..	$85.50–$92.50
Barium chlorate, kegs, works .... pound..	.32– .38
Barium chloride, technical, bags, carlots, works .... short ton..	152.00–158.00
Barium chromate, bags, freight equaled .... pound..	.30– .35
Barium dioxide (peroxide), drums, carlots, works .... do....	.16
Barium hydrate, crystals, bags .... short ton..	190.00–200.00
Barium nitrate, barrels, carlots, works .... pound..	.12½
Barium oxide, ground, drums, carlots, works .... short ton..	250.00–255.00
Blanc fixe (dry):	
Direct process, bags, carlots, works .... do....	90.00–100.00
Byproduct, bags, carlots, works .... do....	100.00–155.00
Lithopone:	
Ordinary, bags, carlots, delivered .... pound..	.07½
Less carlots, same basis .... do....	.08¼– .08½
Titanated (high-strength), bags, carlots, delivered .... do....	.10
Smaller lots .... do....	.11

FOREIGN TRADE [8]

Imports of crude barite into the United States rose abruptly in 1953. Much of the additional tonnage came from Canada (Nova Scotia), but receipts from Mexico, Brazil, and Yugoslavia also increased. Shipments from Italy were resumed after being suspended since 1949.

[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.

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TABLE 10.—Barite imported for consumption in the United States, 1950–53, by countries

[U. S. Department of Commerce]

	1950		1951		1952		1953	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Crude barite:								
Algeria	(1)	$2	----------	----------	----------	----------	----------	----------
Brazil	----------	----------	----------	----------	3,180	$14,425	6,365	$42,031
Canada	44,501	328,689	51,447	$409,506	67,854	571,196	204,362	1,652,076
Italy	----------	----------	----------	----------	----------	----------	9,830	52,989
Mexico	3,296	4,213	1,308	9,988	12,188	97,347	63,450	344,211
Yugoslavia	10,584	98,975	----------	----------	24,696	240,368	50,781	423,521
Total crude barite	58,381	431,879	52,755	419,494	107,918	923,336	334,788	2,514,828
Ground barite:								
Algeria	----------	----------	84	2,870	179	5,900	196	6,295
Canada	----------	----------	----------	----------	6,440	112,265	----------	----------
Germany, West	----------	----------	----------	----------	----------	----------	40	1,368
Greece	478	5,363	31	337	----------	----------	----------	----------
India	----------	----------	28	925	----------	----------	----------	----------
Italy	200	4,535	17	435	1	25	23	434
Total ground barite	678	9,898	160	4,567	6,620	118,190	259	8,097

[1] Less than 1 ton.

TABLE 11.—Barium chemicals imported for consumption in the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Year	Lithopone		Blanc fixe (precipitated barium sulfate)		Barium chloride		Barium hydroxide	
	Pounds	Value	Short tons	Value	Pounds	Value	Short tons	Value
1944–48 (average)	237	$17	----------	----------	----------	----------	26	$2,094
1949	24,003	2,053	1	$54	8	$8	----------	----------
1950	2,402,572	179,197	53	6,174	----------	----------	----------	----------
1951	1,587,900	151,165	12	1,616	1,712,756	99,453	279	55,344
1952	20,950	2,308	32	6,481	167,964	11,065	193	46,979
1953	58,192	5,658	1,005	57,346	99,324	4,567	22	3,018

Year	Barium nitrate		Barium carbonate precipitated		Other barium compounds	
	Short tons	Value	Short tons	Value	Short tons	Value
1944–48 (average)	41	$5,401	----------	----------	3	$1,137
1949	84	7,819	----------	----------	11	5,651
1950	149	21,083	286	$28,222	35	11,669
1951	368	62,277	794	72,977	32	12,503
1952	456	80,654	499	30,427	82	[1] 36,944
1953	235	36,433	4,219	297,187	513	103,100

[1] Revised figure.

No witherite is produced in the United States, except as it may be mined with barite or as an "impurity" in barite. Imports of witherite from United Kingdom, the sole supplier, were slightly less in 1953 than those in the previous year but were large compared with earlier years.

TABLE 12.—Lithopone exported from the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Year	Short tons	Value		Year	Short tons	Value	
		Total	Average			Total	Average
1944–48 (average)	13,489	$1,560,654	$115.70	1951	20,473	$3,615,915	$176.62
1949	14,460	1,918,913	132.70	1952	9,985	1,632,106	163.46
1950	9,357	1,248,538	133.43	1953	3,927	584,279	148.79

TABLE 13.—Witherite, crude, unground, imported for consumption in the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Year	Short tons	Value [1]	Year	Short tons	Value [1]
1944–48 (average)	1,042	$35,780	1951	2,016	$51,673
1949	2,113	63,369	1952	5,174	184,003
1950	2,089	51,381	1953	4,928	178,846

[1] Valued at port of shipment.

TECHNOLOGY

A method for making geophysical gravity surveys in the Washington County barite district of Missouri was outlined in an article. Gravity anomalies were found to be attributable to other factors, as well as barite mineralization, but the results of these tests suggest that areas lacking significant positive gravity anomalies are devoid of near-surface barite bodies of commercial size.[9]

A patent was granted on a method for preparing chemically pure barium hydroxide from an impure barium carbonate containing water-insoluble iron and sulfur compounds. The process involves preparing a dry mixture of the carbonate with carbon particles, calcining the mixture to produce barium oxide, treating with hot water to produce a solution of the hydroxide, filtering the solution to separate the iron and sulfur compounds, adding magnesia or magnesium hydroxide, and filtering the resulting barium hydroxide.[10]

WORLD REVIEW

Algeria.—Output of ground barite in Algeria totaled 10,300 metric tons in 1953 compared with 11,400 in 1952. The price of ground barite in kraft bags in Algerian ports declined from 7,500 Algerian francs per ton at the beginning of the year to 7,300 francs in the latter part of the year (350 Algerian francs equal U. S. $1). Exports of ground barite from Algeria totaled 9,000 metric tons; over half of it went to United Kingdom.[11]

Brazil.—Deposits of barium minerals were reported to have been discovered in the State of Para. The exact locations of the deposits were not revealed, but the São Paulo Institute for Technological Research was said to have made preliminary analyses of the material.[12]

[9] Uhley, Robert P., and Scharon, LeRoy, Gravity Surveys for Residual Barite Deposits in Missouri: Min. Eng., vol. 6, No. 1, January 1954, Trans. AIME, pp. 52–56.
[10] Rentschler, Mahlon J., Method of Preparing Pure Barium and Strontium Hydroxides: U. S. Patent 2,651,563, Sept. 8, 1953.
[11] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 6, June 1954, p. 31.
[12] Engineering and Mining Journal, vol. 145, No. 9, September 1953, p. 189.

TABLE 14.—World production of barite, by countries,[1] 1944–48 (average) and 1949–53, in metric tons [2]

[Compiled by Helen L. Hunt]

Country [1]	1944–48 (average)	1949	1950	1951	1952	1953
North America:						
Canada	109,433	42,763	70,013	89,006	123,378	225,863
Cuba (exports)	2,128	------	------	------	(3)	(3)
Leeward Islands:						
Antigua	100	------	------	------	------	------
United States	652,217	663,428	629,060	767,092	918,802	834,628
Total	765,000	710,200	704,100	861,200	1,092,200	1,065,500
South America:						
Argentina	15,998	(3)	(3)	13,008	[4] 13,000	[4] 13,000
Brazil	7,039	6,010	6,860	50	[5] 6,899	[5] 14,391
Chile	2,616	1,461	1,360	1,095	(3)	(3)
Colombia	[4] 1,384	58	------	(3)	(3)	7,750
Peru	4,425	6,350	3,031	23,015	9,104	15,539
Total	31,000	26,000	25,000	37,300	31,000	52,200
Europe:						
Austria	1,720	8,260	10,119	9,645	5,160	1,920
Belgium	60	------	------	------	------	------
France	33,726	30,295	28,609	37,626	28,449	24,000
Germany:						
East	[4] 150,500 (East and West)	[4] 15,000	[4] 15,000	[4] 20,000	[4] 20,000	[4] 25,000
West		181,467	310,896	417,479	345,840	383,856
Greece	7,741	15,604	20,799	29,399	21,679	25,459
Ireland	12,150	5,968	4,821	8,238	1,829	(3)
Italy	39,532	51,583	54,426	76,541	56,274	69,319
Portugal	465	427	128	719	621	[4] 700
Spain	12,717	7,665	7,147	12,449	15,868	17,896
Sweden	998	923	50	150	(3)	(3)
Switzerland	47	------	------	------	------	------
U. S. S. R. (estimate)	80,000	90,000	95,000	100,000	100,000	100,000
United Kingdom [6]	105,565	119,216	98,160	88,822	71,271	(3)
Yugoslavia	5,730	36,445	29,730	24,822	34,819	81,154
Total	453,000	567,000	680,000	830,000	710,000	790,000
Asia:						
India	23,674	21,457	12,155	10,639	7,621	(3)
Israel—Jordan	5	------	------	------	------	------
Japan	4,896	9,840	14,239	16,706	14,231	17,554
Korea, Republic of	(3)	------	------	------	793	918
Total	33,000	40,000	36,000	37,000	35,000	40,000
Africa:						
Algeria	11,744	16,874	22,890	21,021	9,845	12,840
Egypt	56	30	------	41	30	(3)
French Morocco	------	305	4,912	3,256	3,111	50
Southern Rhodesia	51	488	261	85	271	268
South-West Africa	------	48	------	------	------	------
Swaziland	115	104	441	477	403	413
Tunisia	251	630	25	10	25	------
Union of South Africa	2,431	2,222	2,268	2,038	1,718	1,898
Total	15,000	20,701	30,797	26,928	15,403	15,469
Oceania: Australia	5,006	5,552	6,028	6,277	5,023	5,563
World total (estimate)	1,302,000	1,400,000	1,500,000	1,800,000	1,900,000	1,975,000

[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 senior author of chapter are 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] Includes witherite.

Canada.—Shipments of barite from mines in Canada reached an alltime high of 249,000 short tons in 1953, an increase of 83 percent in tonnage over 1952. Most of this production came from the mine of Canadian Industrial Minerals, Ltd., near Walton, Hants County, Nova Scotia. The high-grade barite deposit is mined by open-pit methods. The product is milled by crushing, screening, and washing, and a portion is ground; all production is shipped either as crude or as finely ground barite for use in well-drilling muds. The mill is at the wharf, where the products are loaded directly on ocean-going ships for export to foreign markets. The company reports estimated reserves of ore to be close to 3 million tons. A smaller tonnage of barite is produced by Mountain Minerals' Ltd., at Parson and Brisco, British Columbia. Part of the production is shipped to the Lethbridge, Alberta, plant of the producing firm for further processing, and the remainder is shipped to eastern Canada, where it is utilized in the paint trade.

A new deposit of witherite (barium carbonate) was reported to have been found during the year in the northernmost portion of British Columbia at Laird River Crossing. The witherite is said to be associated with fluorite, barite, and quartz and is reported to be extensive in size. Exploratory investigations are underway.[13]

Colombia.—Officials of Industria de Pinturas y Minerales, Bogota, reported that barite was being produced from its mines near Bucaramanga and Ocana at the rate of about 150 metric tons a week, and it was planning to increase production and enter the Venezuelan drilling-mud market.[1]

Kenya.—Deposits of barium minerals and other minerals were said to have been located in a geological survey, that covered 1,750 square miles in southeastern Kenya.[15]

Peru.—Peru exported its first sizable lot or crude barite during 1953. The material was shipped from the port of Callao to Venezuela, where it was to be processed for use in oil-well drilling mud. It was reported that by the last of September an additional 12,000 tons had been sold for export. Some of the Peruvian barite production has been used by oil companies operating in Peru, and it was expected that a considerable tonnage would be required if and when extensive drilling gets underway by companies now exploring for petroleum.[16]

Trinidad.—It was reported that a barite-processing industry was being established in Trinidad to produce ground barite for oil-well drilling mud and for sale to South American countries.[17]

United Kingdom.—Anglo-Austral Mines, Ltd., was reported to have closed the barite mine at Cow Green in Teesdale.[18]

Yugoslavia.—According to Slovenski Porocevalec, June 25, 1953, barite deposits have been discovered near the surface in the vicinity of Lokve (Croatia).[19]

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[13] Department of Mines and Technical Surveys, Ottawa, Barite in Canada, 1953 (Preliminary): 4 pp.
[14] Engineering and Mining Journal, vol. 154, No. 5, May 1953, p. 181.
[15] Engineering and Mining Journal, vol. 154, No. 11, November 1953; p. 173.
[16] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 5, November 1953, pp. 39, 40.
[17] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 4, October 1953, pp. 37, 38.
[18] Chemical Age (London), vol. 70, No. 1820, May 29, 1954, p. 1203.
[19] United States Consulate, Zagreb, Yugoslavia, State Department Dispatch 374, June 30, 1953.

Bauxite

By George C. Branner[1]

WORLD production of bauxite in 1953 attained an alltime record of 14.0 million metric tons. Domestic imports and consumption also made high records, but domestic production was 5 percent lower than in 1952. Approximately 82 percent of the bauxite consumed was by aluminum manufacturers. The ratio of the domestic consumption of bauxite to the domestic aluminum production, which averaged 5.1 during the postwar years from 1946 to 1952, was 5.0 in 1953. Imports were 2.8 times the domestic production in 1953—the highest annual ratio on record, indicating an increasing dependence on imports, a trend that began in 1947. Shipments from Jamaica, initiated in 1952, continued the rapid increase anticipated and reached a total of 1.2 million long tons in 1953, or 27 percent of all imports.

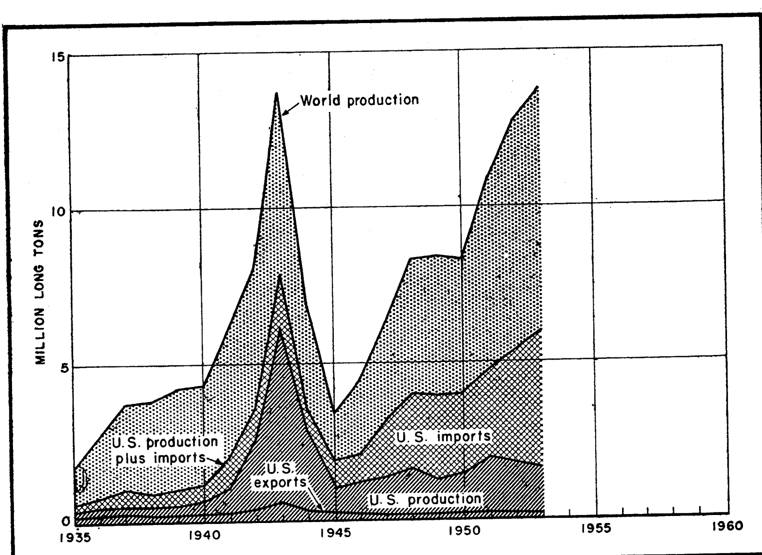

FIGURE 1.—United States supply and world production of bauxite, 1935–53.

One new aluminum oxide plant began production in 1953, making a total of six alumina plants in operation. The combined annual capacity of these plants was 3.5 million short tons, which was to be compared with a domestic production during the year of 2.6 million short tons.

[1] Commodity-industry analyst.

During 1953 the investigation of substitutes for bauxite continued; and, although details of processing aluminum silicate minerals were further developed, indicated production costs precluded commercial use of any source material except bauxite and any process except the Bayer and supplemental Bayer.

Aluminum is discussed in the Aluminum chapter of this volume.

TABLE 1.—Salient statistics of the bauxite industry in the United States, 1944–48 (average) and 1949–53, in long tons

	1944–48 (average)	1949	1950	1951	1952	1953
Crude-ore production (dry equivalent)	1,513,598	1,148,792	1,334,527	1,848,676	1,667,047	1,579,739
Imports (as shipped)	1,292,508	2,688,164	2,516,247	2,819,676	3,497,939	4,388,623
Exports (as shipped)	[1] 103,786	34,902	45,406	89,948	41,330	27,907
Consumption (dry equivalent)	2,614,382	2,677,733	3,325,304	3,945,667	[1] 4,228,404	5,628,276
World production	[1] 5,738,000	[1] 8,100,000	[1] 8,041,000	[1] 10,610,000	[1] 12,539,000	13,779,000

[1] Revised figure.

DOMESTIC PRODUCTION

Domestic mine production in 1953 contributed 28 percent of the domestic consumption and (compared with that of 1952) decreased 5 percent. Arkansas production was 97 percent of the total; Alabama and Georgia contributed the remainder. Total domestic shipments declined 8 percent from 1952. In 1953 the production of dried, calcined, and activated bauxite continued the decline begun in 1952 and represented only 32 percent of the bauxite recovered in 1952. The reduction from 576,430 to 200,970 long tons in the quantity of crude bauxite dried and calcined was due largely to expanded operation of the processing plant of the Aluminum Co. of America at Bauxite, Ark. A considerable tonnage of bauxite, which was formerly dried and shipped to the East St. Louis alumina plant for processing was being processed in the Arkansas alumina plant without drying or calcining.

Arkansas continued to be the major bauxite-producing State in 1953. Eighty-four percent of production was from open-pit operations, the same as in 1952. Reynolds Mining Corp. was the largest producer and consumed its own production at the Hurricane Creek, Ark., alumina plant. The Mining Division of the Aluminum Co. of America was the second largest producer in 1953, the major portion being shipped to the Bauxite, Ark., alumina plant of the Refining Division of the same company. The American Cyanamid Co. mined chemical-grade bauxite in Arkansas and dried its own production. The Norton Co. mined and calcined abrasive-grade bauxite for its affiliated abrasive company. Consolidated Chemical Industries, Inc., shipped chemical-grade bauxite from stocks and did not report production. The Crouch Mining Co. did not report production during 1953, although abrasive-grade bauxite shipments were made from stocks. The Campbell Bauxite Co. processed purchased crude ore and shipped dried and activated bauxite. The Porocel Corp. purchased crude and dried ore for activation and chemical impregnation.

The Dulin Bauxite Co. and the Riffe Construction Co. were the only producers not affiliated with their own consuming industries.

TABLE 2.—Mine production of bauxite in the United States, 1949–53, by quarter years, in long tons [1]

(Dried-bauxite equivalent)

Quarter ended—	1949	1950	1951	1952	1953
March 31	320,157	322,006	378,031	426,269	378,806
June 30	294,023	368,256	502,088	458,612	411,070
September 30	208,926	293,724	453,564	312,370	387,054
December 31	325,686	350,541	514,993	469,796	402,809
Total	1,148,792	1,334,527	1,848,676	1,667,047	1,579,739

[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, 1949–53, by States, in long tons

State and year	Mine production			Shipments from mines and processing plants to consumers		
	Crude	Dried-bauxite equivalent	Value [1]	As shipped	Dried-bauxite equivalent	Value [1]
Alabama, Florida, and Georgia: [2]						
1949	65,137	53,868	$344,217	45,792	46,407	$425,532
1950	32,706	27,192	161,274	35,741	35,473	272,320
1951	38,807	33,402	217,774	39,122	38,123	363,602
1952	76,582	63,214	541,000	50,670	48,463	520,550
1953	61,186	49,763	463,149	59,985	56,085	580,471
Arkansas:						
1949	1,287,358	1,094,924	6,433,964	1,232,883	1,132,330	8,119,574
1950	1,552,047	1,307,335	7,531,535	1,416,724	1,301,374	9,277,076
1951	2,153,786	1,815,274	12,259,742	1,583,320	1,493,557	11,994,882
1952	1,903,101	1,603,833	10,235,254	2,067,241	1,849,287	14,084,274
1953	1,802,797	1,529,976	12,975,992	1,889,206	1,689,207	15,042,236
Total United States:						
1949	1,352,495	1,148,792	6,778,181	1,278,675	1,178,737	8,545,106
1950	1,584,753	1,334,527	7,692,809	1,452,465	1,336,847	9,549,396
1951	2,192,593	1,848,676	12,477,516	1,622,442	1,531,680	12,358,484
1952	1,979,683	1,667,047	10,776,254	2,117,911	1,897,750	14,604,824
1953	1,863,983	1,579,739	13,439,141	1,949,191	1,745,292	15,622,707

[1] Computed from selling prices and values assigned by producers.
[2] Bauxite was processed in Florida in 1949.

TABLE 4.—Recovery of processed bauxite in the United States, 1944–48 (average) and 1949–53, in long tons

Year	Crude ore treated	Processed bauxite recovered			
		Dried	Calcined or activated	Total: As recovered	Total: Dried bauxite equivalent
1944–48 (average)	867,218	560,282	113,484	673,766	731,096
1949	597,536	431,158	55,544	486,702	517,412
1950	657,798	480,623	63,713	544,336	579,884
1951	1,059,645	756,060	103,588	859,648	914,433
1952	576,430	397,067	56,191	453,258	481,705
1953	200,970	100,632	34,288	134,920	155,248

Mine production of bauxite in Alabama and Georgia decreased 21 percent from 1952 to 1953, although shipments increased 16 percent. In Alabama the Mining Division of the Aluminum Co. of America produced chemical and refractory grades in the vicinity of Eufaula, Barbour County, and the D. M. Wilson Co. produced chemical ore from the same area. The only mining operations in Georgia were those of the American Cyanamid Co., with mines in Macon and Bartow Counties.

A list of bauxite producers, mines, and plants for 1953 is given in table 5.

TABLE 5.—Bauxite producers, mines, and plants in the United States, 1953

Producer and mine	Location of mine	Kind of plant	Name and location of plant
ALABAMA			
Aluminum Co. of America Eufaula mine.	Eufaula, Barbour County.	Drying	Eufaula, Barbour County.
D. M. Wilson Bauxite Co.			
M. E. Hudson mine No. 1.	do		
ARKANSAS			
Aluminum Co. of America		Drying [1] and calcining [1 2].	Bauxite, Saline County.
Bauxite mines	Bauxite, Saline County.		
Drury mine	Sweet Home, Pulaski County.	Drying [3] and calcining [3]	Sweet Home, Pulaski County.
American Cyanamid Co		Drying	Berger, Pulaski County.
Lewis mine	Pulaski County		
Quapaw mine	Saline County		
Rauch lease mine [4]	Pulaski County		
Heckler mine [4]	do		
Berry Mahan mine	do		
Campbell Bauxite Co		Drying, activating and screening.	Sweet Home, Pulaski County.
Consolidated Chemical Industries [4].		Drying	Peiser Spur plant, Pulaski County.
Bierman tract	Pulaski County		
Penzil tract	do		
Crouch Mining Co.[4]	Bauxite, Saline County	Calcining	Young plant, Bauxite, Saline County.
Dulin Bauxite Co		Drying	Sweet Home, Pulaski County.
Confederate Home pit	Sweet Home, Pulaski County.		
Illing shaft mine	do		
400 B. C. mine	Saline County		
Dixon pit extension	Sweet Home, Pulaski County.		
Norton Co	Bauxite, Saline County	Calcining	Bauxite, Saline County.
Porocel Corp		(1) Activating (2) Impregnating activated bauxite with chemicals.	Berger, Pulaski County.
Reynolds Mining Corp. Saline County Mines.	Bauxite, Saline County		
Riffe Construction Co. Ratcliffe pit.	Sweet Home, Pulaski County.		
GEORGIA			
American Cyanamid Co		Drying	Halls Station, Adairsville, Bartow County.
Fountain mine	Bartow County		
LaneMcMichael mine	Macon County		
Norris mine	do		
Julia mine	Bartow County		

[1] No operation reported in 1953.
[2] Calcining plant leased to the A. P. Green Co., Mexico, Mo., in 1953 and used for calcining bauxite overburden clays for refractory use.
[3] Shut down in September 1953.
[4] No production reported in 1953.

CONSUMPTION

In 1953 domestic bauxite consumption increased 33 percent above that of 1952 to 5.6 million long tons. The peak war consumption of 4.8 million long tons during 1943 was only 85 percent of the 1953 total. All principal requirements for bauxite increased over 1952, as follows: Alumina 34 percent, abrasives 39 percent, chemical 7 percent, refractory 2 percent, and other uses 23 percent. Ninety-four percent of all aluminum oxide products shipped went to metal producers. The consumption of bauxite of foreign origin increased from 63 to 73 percent of the total consumption from 1952 to 1953.

Domestic consumption of bauxite by industries is given in table 6 and shown graphically in figure 2. Bauxite sold for the National Stockpile is not included in either table 6 or figure 2.

TABLE 6.—Bauxite consumed in the United States, 1952–53, by industries, in long tons

(Dried-bauxite equivalent)

Industry	Domestic	Percent	Foreign	Percent	Total	Percent
1952						
Alumina	[1] 1,369,554	87.1	2,339,588	88.1	[1] 3,709,142	87.7
Abrasive [2]	60,546	3.9	194,269	7.3	254,815	6.0
Chemical	75,670	4.8	82,119	3.1	157,789	3.7
Refractory	13,518	.9	39,861	1.5	53,379	1.3
Others	52,439	3.3	840		53,279	1.3
Total [2]	[1] 1,571,727	100.0	2,656,677	100.0	[1] 4,228,404	100.0
Percent	37.2		62.8		100	
1953						
Alumina	1,332,419	87.4	3,652,915	89.0	4,985,334	88.6
Abrasive [2]	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	0.9	40,225	1.0	54,204	1.0
Others	62,412	4.1	3,054	.1	65,466	1.1
Total [2]	1,524,803	100.0	4,103,473	100.0	5,628,276	100.0
Percent	27.1		72.9		100.0	

[1] Revised figure.
[2] Includes consumption by Canadian abrasives industry.

With the initial operation of the La Quinta (near Corpus Christi), Tex., alumina plant of the Reynolds Metals Co. in 1953 the number of operating domestic alumina plants of aluminum producers increased from 5 to 6. Their combined ultimate capacity was 3,481,000 short tons per year, which should be compared with their actual production during the year—2,612,501 short tons. Individual plant capacities are given in table 8. When fully equipped, the La Quinta plant, which processes only Jamaican ore, will complete the alumina-production-capacity expansion program contemplated under the provisions of the Defense Production Act of 1950. Of the production of all forms of aluminum oxide products in 1953—2,612,501 short tons—2,460,535 short tons (94 percent) was calcined alumina. This was 32 percent above the 1952 production and approximates the 34-percent increase in domestic production of primary aluminum of 1953 from 1952. The production of other forms of aluminum oxide products was 151,966 short tons, a 24-percent increase from 1952. The 15 domestic alu-

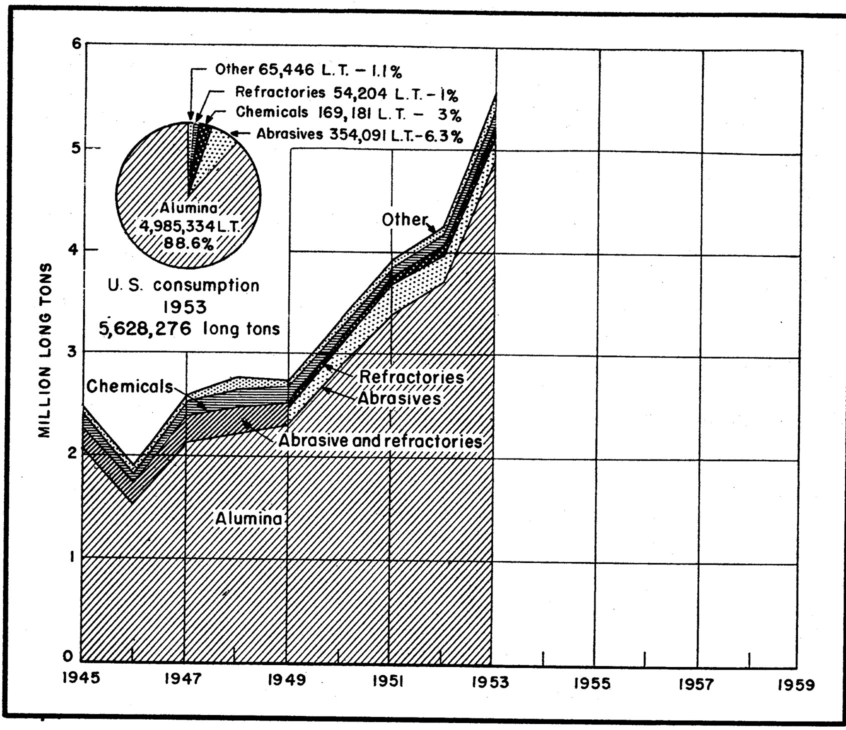

FIGURE 2.—Domestic consumption of bauxite by uses, 1945–53.

minum plants in operation in 1953 consumed 2,375,926 short tons of calcined alumina, an increase of 33 percent with respect to 1952 that approximates the increase in aluminum production. The aluminum industry consumed 91 percent of all aluminum oxide products and an estimated 82 percent of the bauxite consumption.

Five percent of the aluminum oxide products was commercial aluminum trihydrate. The remaining 1 percent was tabular, activated, and other forms. The chemical industries consumed most of the activated alumina. The commercial aluminum trihydrate was used mostly for manufacturing synthetic cryolite and aluminum fluoride. Tabular alumina was used principally for manufacturing spark plugs and refractories.

The Wheland Co. of Chattanooga, Tenn., was granted a certificate of necessity for an alumina plant to cost an estimated $22,160,000. In view of the importance of this plant to the defense program, 85 percent of the cost had been certified for rapid tax amortization.

It was calculated that in 1953 an average of 1.94 long tons (dry basis) of bauxite was required to yield 1 short ton of calcined alumina. An average of 3.68 long tons (dry basis) of bauxite was required to produce 1 short ton of aluminum, and an average of 1.90 short tons of alumina was required to produce 1 short ton of aluminum.

Consumer reports indicated that consumption of crude and processed bauxite was as shown in table 7. Conversion factors to dry equivalent used in table 7 were: from crude to dried, 0.85; and from calcined or activated to dried, 1.55.

TABLE 7.—Consumption of crude and processed bauxite in the United States by grades, 1953 in long tons

(Dried-bauxite equivalent)

	Domestic origin	Foreign origin	Total	Percent
Crude	1,336,799	4,806	1,341,605	23.8
Dried	131,797	3,747,124	3,878,921	68.9
Calcined	45,408	351,543	396,951	7.1
Activated	10,799		10,799	.2
Total	1,524,803	4,103,473	5,628,276	100.0
Percent	27.1	72.9	100.0	

TABLE 8.—Alumina plants in operation in the United States, 1953

	Capacity in short tons per year	Percent
Aluminum Co. of America:		
Mobile, Ala	876,000	25.2
East St. Louis, Ill	328,500	9.4
Bauxite, Ark	401,500	11.5
Total	1,606,000	46.1
Reynolds Metals Co.:		
Hurricane Creek, Ark	730,000	21.0
La Quinta, Tex	365,000	10.5
Total	1,095,000	31.5
Kaiser Aluminum & Chemical Corp.: Baton Rouge, La	780,000	22.4
Grand total	3,481,000	100.0

Although shown for 1952, the separate production, value, and consumption figures for ammonium, potassium, and sodium sulfate for 1953 cannot be shown without disclosing the operations of individual companies. The total value only is included under "Other aluminum salts" in table 9. Bauxite was the principal source of the aluminum salts shown, although clay, alumina, aluminum, and alunite were also used. The most significant change in the 1953 figures compared with those of 1952 was a 9-percent increase in the production of commercial aluminum sulfate.

STOCKS

Year-end stocks of both crude and processed ore (dried, calcined, and activated) were virtually unchanged from 1952 to 1953. There were no sales from the Government-held Nonstrategic Stockpile in Arkansas. Metal- and refractory-grade bauxite remained in the Group 1 list for purchase for the National Stockpile during 1953. Abrasive grade remained in Group 2. Data regarding the quantity objectives of and additions to the National Stockpile were confidential.

Table 10 gives data on producers, processors, consumers, Government nonstrategic, and total stocks.

TABLE 9.—Production and shipments of selected aluminum salts in the United States, 1952–53

Type of salt	1952				1953				
	Production (short tons)	Shipped or used			Production (short tons)	Number of plants producing	Shipments and interplant transfers		Consumed in producing plants (short tons)
		Shippers [1]	Short tons	Value			Quantity (short tons)	Value f. o. b. plant	
Aluminum sulfate:									
Ammonium	5,823	4	5,548	$505,104	(2)	2	(2)	(2)	
Potassium, Sodium	17,296	4, 1	17,666	1,498,298	(2), (2)	2, 1	(2), (2)	(2), (2)	
General:									
Commercial	673,420	16	671,071	20,985,609	731,039	37	678,030	$22,647,000	48,856
Municipal	15,501	6	15,501	394,642	13,577	7			13,577
Iron-free	38,236	8	35,559	1,836,753	31,577	9	23,672	1,478,000	7,359
Sodium aluminate	11,390	7	11,652	1,158,033	13,252	5	11,150	1,149,000	(2)
Aluminum chloride:									
Liquid	12,704	5	12,474	669,806	13,295	8 / 3	13,295	679,000	(2)
Crystal, Anhydrous	25,482	1, 6	25,812	6,563,227	35,139	8	30,534	9,663,000	(2)
Other aluminum salts [3]								27,639,000	
Total	799,852	38	795,283	33,611,472				63,255,000	

[1] Producing companies reporting aluminum salts shipped or used. A company shipping more than 1 kind of salt is counted but once in arriving at total.
[2] Included with "Other aluminum salts."
[3] Includes in order of value, cryolite, aluminum fluoride, aluminum hydrate, sodium-aluminum sulfate, aluminum nitrate, ammonium-aluminum sulfate, and potassium-aluminum sulfate.

SOURCE: 1952 figures based on Form 6-1011-A reports, Aluminum Salts in 1952, Bureau of Mines. 1953 figures based on MA19E reports, Annual Report on Shipments and Production of Inorganic Chemicals and Gases, Bureau of the Census.

TABLE 10.—Stocks of bauxite in the United States December 31, 1949–53, 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
1949	574,983	8,467	34,183	832,083	3,277,090	4,726,806	4,184,786
1950	543,284	17,392	42,150	723,103	3,061,034	4,386,963	3,809,765
1951	890,336	18,552	44,169	1,008,767	2,630,792	4,592,616	4,069,796
1952	755,536	35,440	[3] 473,850	[3] 1,518,641	2,454,584	5,238,051	[3] 4,680,615
1953	759,165	44,097	697,653	1,405,587	2,454,584	5,361,086	4,787,765

[1] Excludes National Stockpile.
[2] Dried, calcined, and activated.
[3] Revised figure.

PRICES

Most of the bauxite mined in the United States was produced by companies for their own use. A relatively small part of the producer's output was sold to consumers on a contract basis at a negotiated price. For these reasons, no established open-market price for bauxite actually existed; the prices shown in table 11 and figure 3 were those reported to the Bureau of Mines by producers and were made up of certain undefined components. These might have been (1) the values set upon the bauxite by the integrated companies as determined by mining and handling costs, or (2) arbitrary book values, or (3) prices that have been set by direct negotiations between two contracting parties. Moreover, the prices quoted were not prices in a strict sense but were, more precisely, average value figures as estimated by the several reporting producers.

In comparison with the unit prices of domestic dried bauxite shown in table 11 the reported average unit value of imported bauxite, as shipped, and delivered to consuming plants in the United States was $15.55 per long ton in 1953.

TABLE 11.—Average value of bauxite produced and shipped in the United States, 1953

Type	Average value per long ton	
	As produced at mines or plants	Shipments f. o. b. mines or plants
Crude (undried)	$7.21	$7.35
Dried	9.71	9.82
Calcined	17.00	17.57
Activated	67.34	67.34

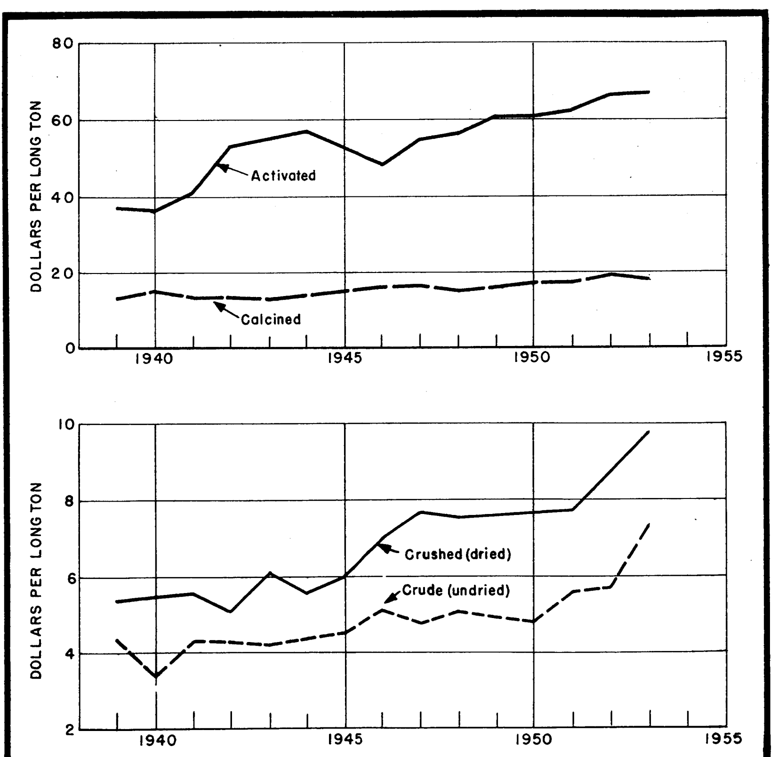

FIGURE 3.—Average domestic price of bauxite f. o. b. mines and processing plants, 1939–53.

The market quotations for bauxite published in E&MJ Metal and Mineral Markets did not vary throughout 1953 and were as shown in table 12.

TABLE 12.—Market quotations on bauxite in the United States in 1953

[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	80–84	17.00
Imported (per long ton):		
Calcined, crushed (abrasive grade) [6]	83–86	19.75
Refractory grade		24.20

[1] F. o. b. Arkansas mines.
[2] F. o. b. Alabama and Arkansas mines.
[3] 1.5 to 2.5 percent Fe_2O_3.
[4] 5 to 8 percent SiO_2.
[5] 8 to 12 percent SiO_2.
[6] F. o. b. port of shipment, British Guiana.

The base price for bauxite in the Nonstrategic Government Stockpile was first adopted by Metals Reserve Company, a subsidiary of the Reconstruction Finance Corporation, in 1943 and was later modified on September 1, 1943. It was finally based on a price of $4.15 per long ton for ore containing 50 percent Al_2O_3, 13 percent SiO_2 and 6 percent Fe_2O_3, with bonuses and penalties as follows:

Bonus:	
For each percent of SiO_2 under 13	$0.20
For each percent of Al_2O_3 above 50	.14
Penalty:	
For each percent of SiO_2 over 13	.43
For each percent of Al_2O_3 under 50	.14
For each percent of FeO over 6	.43

The price schedule of the General Services Administration was the same as the schedule of the Metals Reserve Company, except that it contained an escalator provision to provide for changes in labor cost. This additional charge was calculated at 3 times the difference between the labor rate at the time of Government purchase (63 cents per hour) and the labor rate at the time the bauxite was sold (1951 and 1952 rate—$1.37 per hour). This schedule was the basis for sales from the Government Stockpile at Hurricane Creek, Ark. Under these provisions the average price paid by the Reynolds Metals Co. for 1950 sales was $6.32 per long ton, dry basis. The average price of bauxite sold to the Reynolds Metals Co. in 1951 from the National Stockpile at Hurricane Creek, Ark., was $6.67 per long ton, dry basis. Dry samples analyzed averaged 51 percent Al_2O_3, 11 percent SiO_2, and 4 percent FeO. In 1952 the average price was $6.63 per long ton, dry basis. As stated, there were no withdrawals in 1953.

The average values of bauxite imported in the United States in 1953 have been summarized in table 13. United States exports for 1953 had an average value of $31.76 per long ton, according to the same source.

TABLE 13.—Average value of bauxite imported in the United States, 1953, in long tons

[U. S. Department of Commerce]

Type and country	Average value, port of shipment
Crude and dried:	
Brazil	$6.70
British Guiana	5.72
Greece	6.45
Jamaica	7.44
Surinam	6.51
Average	6.74
Calcined: British Guiana [1]	23.10

[1] For refractory use.

The Oil, Paint and Drug Reporter published the following prices for alumina in the United States in 1953:

Alumina, calcined bags, carlots, works	per pound	$0.0385
Aluminum hydrate, heavy bags, carlots, freight equalized	per ton	60.00
Aluminum sulfate, commercial bulk, carlots, works	per 100 pounds	1.65

The June 1, 1953, issue stated that an increase of 20 cents per 100 pounds on July 1, 1953, for aluminum sulfate was to cover increased production costs.

The average value of calcined alumina shipped as reported by domestic producers in 1953 was $0.02789 per pound. The average value of shipments of aluminum hydrate as reported by producers was $56.63 per short ton.

FOREIGN TRADE [2]

In 1953 United States imports of all grades of bauxite were the highest recorded. Tonnagewise, 1953 imports were 25 percent greater than 1952 imports. From 1952 to 1953 the ratio of foreign to domestic ore consumed in the United States rose from 1.7 to 2.7, also the highest recorded. This increase was clearly indicative of the steadily growing dependence of domestic bauxite consumers on foreign sources of ore, especially on the Jamaican supply.

In February 1953 the Kaiser Bauxite Co. made its first shipment of Jamaican ore to the Baton Rouge, La., alumina plant of the parent company, and in April 1953 the Reynolds Jamaica Mines, Ltd., made its first shipment of Jamaican ore to the La Quinta plant of the parent company near Corpus Christi, Tex.

About 47 percent of the total bauxite imports entered the United States through the Mobile (Ala.) customs district, 40 percent through the New Orleans (La.) customs district, and 9 percent through the Galveston (Tex.) customs district. The remaining 4 percent entered through 10 other ports. The following duties on imports remained unchanged throughout 1953: Crude and dried bauxite, 50 cents per long ton; calcined bauxite for use in the manufacture of firebrick or other refractories, $1 per long ton; other calcined bauxite, 15 percent ad valorem; alumina and aluminum hydroxide, ¼ cent per pound.

[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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Bauxite exports, classified as aluminum ores and concentrates, declined 32 percent in 1953 over 1952. Canada received 96 percent or about 27,000 tons, largely calcined bauxite, and the remaining 4 percent was divided among 9 other countries, of which Italy, Mexico, and the United Kingdom were the leaders. Most of the bauxite exported to Canada was returned to the United States in the form of finished abrasives. Canada, Colombia, and Venezuela were the chief recipients of the aluminum sulfate exported, and Canada and Mexico were the most important foreign markets for other aluminum compounds. Figure 1 shows United States import and export data graphically.

TABLE 14.—Bauxite (crude and dried [1]) imported for consumption in the United States, 1944–48 (average) and 1949–53, in long tons

[U. S. Department of Commerce]

Country	1944–48 (average)	1949	1950	1951	1952	1953
British Guiana	66, 380	99, 821	91, 381	127, 477	178, 379	101, 911
Indonesia	70, 855	575, 137	447, 457	365, 309	19, 425	----------
Jamaica	300	----------	----------	----------	264, 988	1, 176, 494
Surinam	1, 149, 288	2, 013, 187	1, 967, 581	2, 308, 664	3. 023, 145	3, 097, 601
Other countries	5, 685	19	9, 828	18, 226	12, 002	12, 617
Total: Long tons	1, 292, 508	2, 688, 164	2, 516, 247	2, 819, 676	3, 497, 939	4, 388, 623
Value	$8, 554, 586	$16, 353, 298	$15, 729, 855	$17, 794, 192	$23, 193, 991	$29, 587, 943

[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).

TABLE 15.—Bauxite (including bauxite concentrates [1]) exported from the United States, 1944–48 (average) and 1949–53, in long tons

[U. S. Department of Commerce]

Country	1944–48 (average)	1949	1950	1951	1952	1953
Canada	102, 154	34, 269	440, 03	89, 038	40, 012	26, 880
Other countries	[2] 1, 632	633	1, 403	910	1, 318	1, 027
As exported	[2] 103, 786	34, 902	45, 406	89, 948	41, 330	27, 907
Dried-bauxite equivalent [3]	[2] 144, 455	57, 628	72, 014	138, 916	62, 979	43, 256
Total: Value	[2] $2, 006, 209	$512, 779	$1, 155, 673	$2, 217, 426	$845, 452	$886, 275

[1] Classified as "Aluminum ores and concentrates" by the U. S. Department of Commerce.
[2] Revised figure.
[3] Calculated by Bureau of Mines.

The first study, on a world-wide basis, of the international flow of bauxite was completed for 1951. Figure 4 and table 16 show the results of the analysis in terms of exports by countries of origin and destination. Six countries out of the 17 listed received 7.0 million metric tons or 97 percent of the total bauxite shipped; and 2 of these, the United States and Canada, received 5.1 million tons or 71 percent of the total. The 4 other countries, namely, West Germany, U. S. S. R., United Kingdom, and Japan, received a total of 1.9 million tons or 26 percent. Of these 6 major recipients, only 2—the United States and the U. S. S. R.—have reserves of bauxite. The United States reserves constituted an estimated 2.5 percent of the world reserves, while those of the U. S. S. R. were estimated at 1.9 percent.

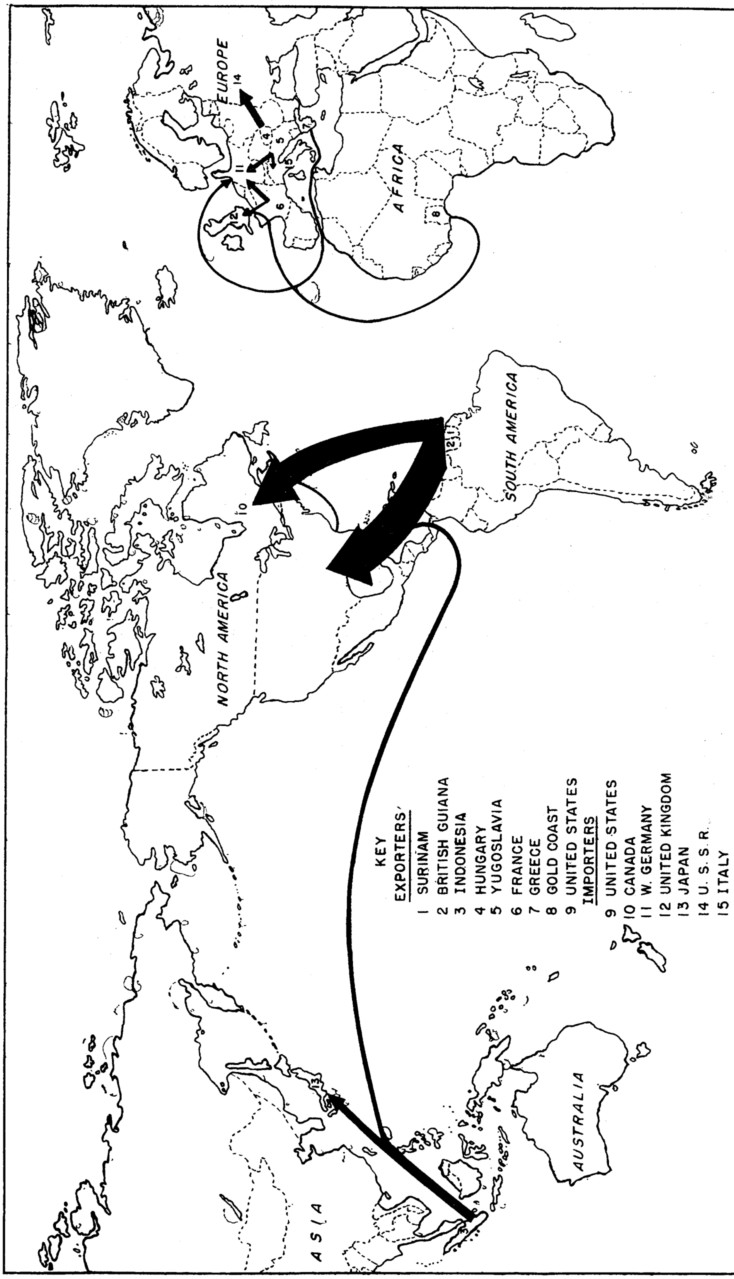

FIGURE 4.—Major world trade of bauxite in 1951.

TABLE 16.—Major world trade of bauxite in 1951, in 1,000 metric tons

[Compiled by Berenice B. Mitchell and John E. McDaniel]

Exports, by countries of origin	Production	Exports	Exports, by countries of destination								
			North America		Europe					Asia	Other
			Canada	United States	Germany, West	Italy	U. S. S. R.	United Kingdom	Other European	Japan	
North America:											
United States	1,878	72	72								
South America:											
British Guiana	2,035	2,035	1,840	170				23	2		
Surinam	2,671	2,675	127	2,512					1		35
Europe:											
France	1,124	366			192	11		157	5		1
Greece	197	180			119			32	29		
Hungary	734	[1] 600					[1] 600				
Yugoslavia	453	449			353	88			8		
Other European	1,058	3			3						
Asia: Indonesia	394	611		371						240	
Africa: Gold Coast	131	131						131			
Other	105	44								31	[2] 13
Total	10,780	7,166	2,039	3,053	667	99	600	343	45	271	49

[1] Estimated.
[2] Shipments between countries not listed.

TECHNOLOGY

The Bureau of Mines alumina demonstration plant at Laramie, Wyo., completed 12 operating runs during 1953 and produced about 210 short tons of calcined alumina. When finally terminated, this project will have well advanced a program begun by the United States Government during World War II for determining the feasibility of producing alumina during an emergency from materials other than bauxite. Plants were constructed during World War II at Harleyville, S. C., and Salem, Oreg., for treating clay; at Salt Lake City, Utah, for treating alunite; and at Laramie, Wyo., for treating anorthosite. However, with the exception of the Laramie-plant operation, none of the experimental work was carried beyond an initial stage.

The Laramie plant was designed to produce alumina from anorthosite (a sodium feldspar rock averaging about 26.8 percent alumina), limestone, and sodium carbonate. These components were ground, sintered, and leached, and the resultant liquor was desilicated under pressure and carbonated to produce a precipitate of aluminum trihydrate that was calcined to make the final product. The calcined alumina obtained has had a typical analysis as follows:

	Percent
Al_2O_3	99.52
SiO_2	.046
Na_2O	.42
Fe_2O_3	.009
H_2O/sorption	.50
K_2O ... Less than	.01
Loss on ignition	.26

Alumina of this grade contained more silica than the maximum of 0.03 percent permitted for metal manufacture, although it was acceptable for abrasive, ceramic, and aluminum-silicon alloy manufacture. However, alumina with a 0.03-percent silica content was produced at the Laramie plant and could probably be produced continuously if certain processing refinements were initiated. The cost of alumina produced in this manner on a commercial basis, however, would have been substantially higher than the market price of metal-grade alumina in 1953.

Experimental work was to be continued in 1954.

The Government-owned plant at Salem, Oreg., was sold to the Harvey Machine Co. for $325,000. That company planned further experimentation on producing alumina from Columbia Basin clays, tying in the operation with primary aluminum production. A second alumina plant was planned by the same company at The Dalles, Oreg. Details were not published.

In October 1953, a comprehensive report entitled "Materials Survey—Bauxite" was published. This 304-page study, prepared by the Bureau of Mines in cooperation with the Geological Survey, was an addition to a series of surveys of strategic materials initially sponsored by the National Security Resources Board and later by the Office of Defense Mobilization. A review and analysis section provided a perspective of the place of bauxite within the domestic economy. Included were discussions of the ores, end products, world reserves, production and distribution, mining, milling, and processing, substitutes, prices and tariffs, and lists of mining firms and plants in current operation. The domestic structure of the industry, its political control, and the controls exercised by the United States Government in World War II, and subsequently, were set forth. The concluding chapter was a bibliography.

At Bauxite, Ark., the Bureau, at the request of the American Cyanamid Co., was engaged in a project to remove iron from bauxite to obtain a product suitable for the production of alum. The ore was crushed and roasted and the iron magnetically separated. The nonmagnetic product contained 88.2 percent of the total alumina and analyzed 1.87 percent Fe_2O_3, which met the maximum specifications for iron.

During 1953 a series of tests was conducted at the Bureau of Mines Northwest Electrodevelopment Laboratory at Albany, Oreg., on the carbothermal (electrical) smelting of a mixture of calcined clay and quartz, blended to simulate an Al_2O_3 content of about 35 percent, for the production of aluminum-silicon alloys. The tests have demonstrated the feasibility of producing such alloys, using wood chips and coke as reductants. Alloys have been obtained with an aluminum content of 16.7 to 33.0 percent. Power consumption has been between 6.7 and 10.0 kw.-hr. per pound of alloy. Utilizing data developed by this experimental work, the Apex Smelting Co. formed the National Metallurgical Corp. for the construction and operation of a pilot plant for production of aluminum-silicon metals from clay at Springfield, Oreg. American Smelting & Refining Co. had a 50-percent interest in the new firm. Construction was completed in December 1953.

Bureau of Mines activities with respect to research on the utilization of low-grade materials for the production of alumina were summarized on October 24, 1953, before the Special Subcommittee on Minerals, Materials, and Fuels Economics of the Committee on Interior and Insular Affairs of the United States Senate by a representative of the Bureau of Mines.[3]

RESERVES

World bauxite reserves were estimated at 1,605.3 million metric tons as of October 1950 by the Office of Defense Mobilization in the report "Materials Survey—Bauxite," a publication prepared by the

TABLE 17.—Summary of estimate of world bauxite reserves, as of October 1950

Country	Million metric tons	Percent
North America:		
United States	40.5	2.5
Caribbean Islands:		
Dominican Republic	6.1	.4
Haiti	23.4	1.5
Jamaica	320.0	19.9
Total	390.0	24.3
South America:		
Brazil	192.0	12.0
British Guiana	65.0	4.0
Surinam	50.0	3.1
Total	307.0	19.1
Europe:		
Austria	.7	
France	60.0	3.7
Greece	60.0	3.7
Hungary	250.2	15.6
Italy	6.3	.4
Rumania	20.0	1.2
U. S. S. R	30.0	1.9
Yugoslavia	105.0	6.6
Total	532.2	33.1
Asia:		
China	50.0	3.1
Federation of Malaya	9.6	.6
French Indochina	.3	
India and Pakistan	25.4	1.6
Indonesia	25.8	1.6
Turkey	5.5	.4
Total	116.6	7.3
Africa:		
French West Africa	6.0	.4
Gold Coast	229.4	14.3
Mozambique	.1	
Total	235.5	14.7
Oceania:		
Australia:		
New South Wales	18.6	1.1
Queensland	.2	
Tasmania	1.2	.1
Victoria	1.0	.1
Palau Islands	2.5	.2
Ponape	.5	
Total	24.0	1.5
Grand total	1,605.3	100.0

[3] U. S. Senate, Hearings Before the Special Subcommittee on Minerals, Materials, and Fuels Economics of the Committee on Interior and Insular Affairs, S. Res. 143, A Resolution to Investigate the Accessibility and Availability of Supplies of Critical Raw Materials: 83d Cong., 1st sess., Oct. 20, 21, 23 and 24, 1953, part 1, pp. 324–325.

Bureau of Mines with the cooperation of the Federal Geological Survey and issued in October 1953. The reserve estimate is summarized in table 17 and shown graphically in figure 5.

World reserves were estimated by Irving Lipkowitz,[4] of the Reynolds Metals Co., to be 2,442.1 million metric tons as of September 1953.

The principal reason for the variance between the two above estimates was the differences in estimates of the reserves of China and India.

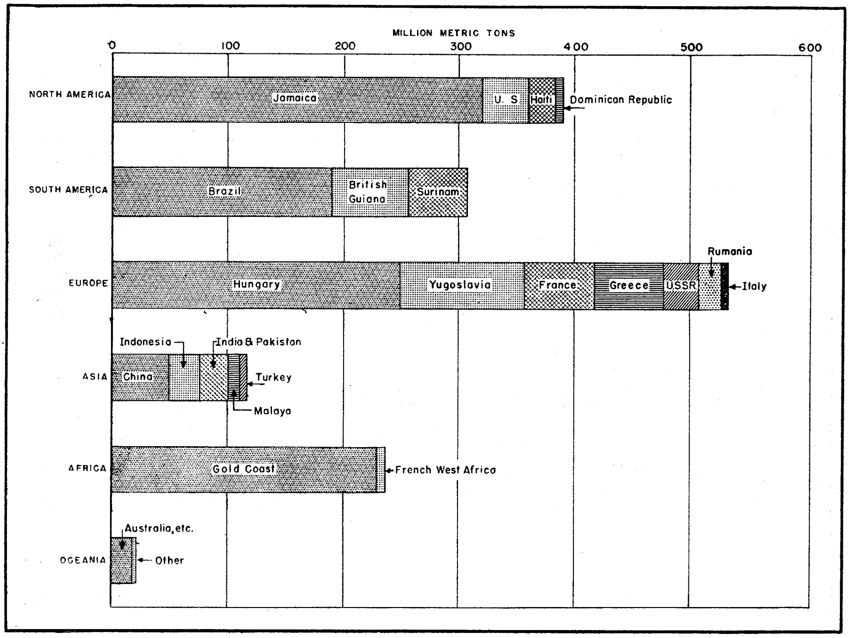

FIGURE 5.—World bauxite reserves, October 1950.

WORLD REVIEW

A recent estimate of world bauxite reserves was 1.6 billion metric tons, about 114 times the 1953 production. A comparison of this reserve figure with 8 previous estimates, made at intervals from 1941 to 1953, indicated that newly discovered reserves were added during that period at an average annual rate of about 50 million tons. This latter figure should be compared with the annual average increase in production between 1941 and 1953 (about 0.6 million tons). The average annual rate of increase of reserves was, therefore, about 80 times the average annual rate of increased production. This relationship, when considered with the fact that great areas exist in South America, Africa, and Asia that have never been thoroughly prospected for bauxite, made the possibility of world bauxite exhaustion very remote.

[4] Lipkowitz, Irving, The Growing Reserves of Aluminum Ore: Modern Metals, vol. 9, No. 12, January 1954, pp. 42–45.

The estimated world bauxite production of 14 million metric tons for 1953 exceeded 1952 production by about 10 percent; the figure reached an alltime high, slightly exceeding the previous World War II high of 1943. World production from 1941–53 is graphed in figure 6. This increasing production was closely tied to the increasing production of aluminum, as is shown in table 18 by comparative world-production figures and ratios.

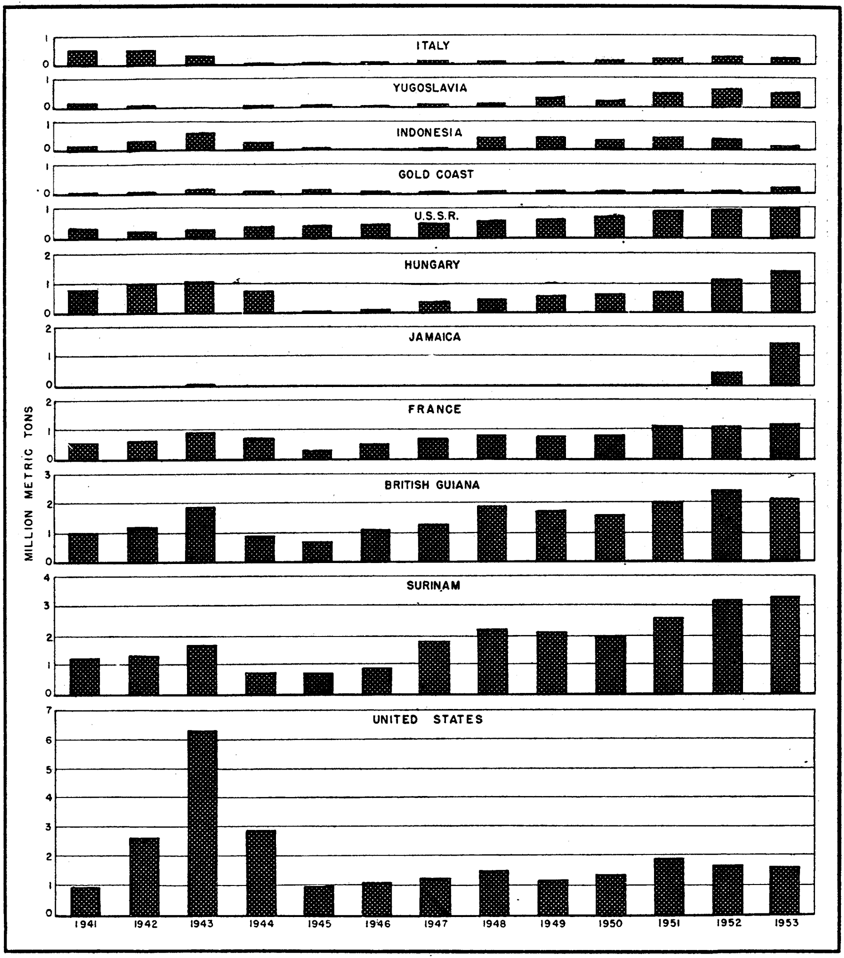

FIGURE 6.—World production of bauxite, 1941–53.

TABLE 18.—Relationship of world production of bauxite and aluminum

(Million metric tons)

Commodity	1946	1947	1948	1949	1950	1951	1952	1953	Total
Bauxite	4.4	6.3	8.4	8.5	8.4	11.0	12.8	14.0	73.8
Aluminum	.8	1.1	1.3	1.3	1.5	1.8	2.1	2.4	12.3
Ratio of bauxite to aluminum production	5.5	5.7	6.5	6.5	5.6	6.1	6.1	5.8	6.0

A comprehensive statement[5] on world bauxite production and reserves was made by a representative of the Bureau of Mines on October 24, 1953, before the Special Subcommittee on Minerals, Materials, and Fuels Economics of the Committee on Interior and Insular Affairs of the United States Senate.

TABLE 19.—World production of bauxite, by countries, 1944–48 (average) and 1949–53, in metric tons [1]

[Compiled by Pauline Roberts]

Country	1944–48 (average)	1949	1950	1951	1952	1953
North America:						
Haiti	120	----------	----------	----------		
Jamaica	----------	----------	----------	----------	381,905	[2] 1,456,800
United States (dried equivalent of crude ore)	1,537,891	1,167,230	1,355,946	1,878,347	1,693,803	1,605,015
South America:						
Brazil	12,020	16,213	18,570	19,033	20,000	(3)
British Guiana	1,193,214	1,785,860	1,608,831	2,034,888	2,426,264	[4] 2,149,415
Surinam	1,203,269	2,126,654	2,080,657	2,671,330	3,153,790	[4] 3,272,924
Europe:						
Austria	6,578	6,526	616	7,795	15,180	18,000
France	581,308	785,321	807,842	1,124,400	1,115,000	1,164,300
Germany, West	[2] 8,800	2,439	4,166	5,327	5,945	(3)
Greece	15,595	48,852	77,448	197,060	348,591	330,749
Hungary	[2] 336,968	560,000	572,400	734,000	1,172,000	(3)
Italy	91,351	104,852	153,384	174,014	281,458	[2] 270,400
Rumania [2]	413	1,000	1,000	10,000	10,000	(3)
Spain	5,119	11,962	12,186	10,581	11,697	[2] 5,000
U. S. S. R.[2]	456,000	650,000	750,000	850,000	900,000	(3)
United Kingdom: Northern Ireland	16,297	----------	----------	----------	----------	----------
Yugoslavia	[2] 96,865	345,953	200,892	453,357	577,196	462,309
Asia:						
India	16,892	43,224	65,433	68,123	64,524	[2] 65,000
Indochina	72	----------	----------	----------	----------	----------
Indonesia [5]	[2] 99,350	[2] 415,700	[2] 325,600	[2] 393,700	343,754	149,552
Japan	400	----------	----------	----------	----------	----------
Malaya	14,469	----------	----------	----------	22,146	154,612
Taiwan (Formosa)	----------		----------	[2] 10,000	[2] 3,000	(3)
Africa:						
French West Africa	----------	----------	10,125	----------	109,750	336,500
Gold Coast (exports)	120,748	147,340	116,793	131,404	75,562	[2] 149,000
Mozambique	3,198	1,369	4,336	3,329	2,448	(3)
Oceania:						
Australia	4,368	5,377	3,523	5,166	7,351	[2] 5,000
Palau Island	6,427	----------	----------	----------	----------	----------
Total (estimate)	5,830,000	8,230,000	8,170,000	10,780,000	12,740,000	14,000,000

[1] This table incorporates a number of revisions of data published in previous Bauxite chapters.
[2] Estimate.
[3] Data not available; estimate by author of chapter included in total.
[4] Exports.
[5] Previously published data have been adjusted at approximately 60 percent to obtain dry weight.

Australia.—Deposits of bauxite on the north coast of Arnhem Land, Northern Territory, were reported to be larger than the deposit reported in 1952 on the Wessel Islands north of Arnhem Land, but details were not available.

The Australian customs minister announced removal of export restrictions on bauxite. Production in 1953 was estimated at 5,000 metric tons. An estimate[6] of the bauxite reserves of Australia was published by the Bureau of Mineral Resources of Australia. As of June 30, 1953, these were given as 21,135,000 long tons of proved dry bauxite containing 30 percent or more of soda-soluble alumina and

[5] Work cited in footnote 3, pp. 301–303.
[6] Owen, H. B., Summary Statement of Australian Bauxite Reserves at 30th June 1953: Australian Bureau of Min. Resources, Geol. and Geophysics, July 15, 1953, pp. 1–7.

11,964,000 long tons of indicated dry bauxite containing 30 percent or more of soda-soluble alumina.

Austria.—The reported production of bauxite in 1953 by the Unterlaussa mine in the Enns Valley was 18,000 metric tons compared with 15,180 in 1952 and 7,795 in 1951. The silica content of the ore was high, and it could be used only when mixed with ores of lower silica content. The Unterlaussa mine was owned by the Ranshofen aluminum plant.

Brazil.—Exports were reported as 600 metric tons of crude, ground bauxite valued at Cr$634,000.[7] Brazilian exports, however, are not indicative of production, as they do not include the bauxite produced to feed the 2,000-ton-per-year aluminum plant of Cia. Eletro-Química Brasileira at Ouro Prêto, Minas Gerais. In 1954 bauxite from Pocos de Caldas will supply the new 10,000-ton-per-year aluminum plant of Cia. Brasileira de Aluminio approaching completion near Sorocaba, São Paulo.

Reserves of the phosphatic bauxite deposit near Pirocaua in the State of Maranhão were estimated at 2,500,200 tons. The ore was analyzed as containing approximately 40 percent Al_2O_3, 27 percent P_2O_5, and 4 percent Fe_2O_3; loss on ignition, 20 percent. Economic separation of the phosphate and alumina has not yet been developed.

British Guiana.—Production of bauxite in British Guiana declined 5 percent, from 2,387,938 long tons in 1952 to 2,274,583 tons in 1953.

The Demerara Bauxite Co., Ltd., produced 1,904,000 long tons of dried (metal-grade) bauxite and 250,000 tons of calcined, abrasive, and refractory grade. A new calcining kiln, reported as the largest in the world, was installed in May 1953 and operated for the last 8 months of the year. Production of calcined ore was expected to reach 290,000 tons in 1954.

Plantation Bauxite Co., partly owned by the Demerara Bauxite Co., was drying or calcining its ore at Mackenzie. Its production was included with that of the Demerara Bauxite Co.

Bauxite exported from British Guiana, shown in Table 20, was subject to an export duty of 4s. 2d. ($0.583) per ton of calcined ore and of 1s. 10½d. ($0.262) per ton on other bauxite. A royalty ranging from 5d. ($0.058) to 1s. 0½d. ($0.145) per ton was also payable on bauxite removed from lands, the mineral rights of which were vested in the crown.

TABLE 20.—Bauxite exported from British Guiana, 1952–53

Country of destination	1952		1953	
	Long tons	Value, BW$[1]	Long tons	Value, BW$[1]
Canada	2,036,576	17,954,686	1,874,583	(2)
United States	210,433	3,319,041	205,167	(2)
United Kingdom	11,101	282,835	14,995	(2)
France	2,000	26,400	(2)	(2)
Netherlands	(2)	(2)	(2)	(2)
Other	25,865	657,609	17,330	(2)
Total	2,285,975	22,240,571	2,112,075	23,536,471

[1] 1 BW$=$0.583-$0.586 U. S.
[2] Figure not available.

[7] 1 cruzeiro=$0.053-$0.054 U. S

Early in 1953 the Reynolds Metals Co. effected an agreement with the Berbice Co., Ltd., a British Guiana subsidiary of the American Cyanamid Co., to acquire all assets of that company in British Guiana. These included mining leases on 6,254 acres, a 99-year lease on a 2,040-acre plant site, and permits to explore 482,210 acres and to acquire leases on acreage selected. The right to these assets was protested by the Harvey Machine Co., which claimed a prior sale agreement by the Berbice Co., Ltd., and court action was in progress to resolve the issue.

Reynolds Metals Co. was reported to have exported 58,320 long tons of bauxite in 1953 from mines at Kwakwani on the Berbice River.

Suspension of the constitution of British Guiana by the British Government, pending settlement of political difficulties arising from Communist activities, was a matter of concern to the Aluminum Co. of Canada, Ltd., as that company has obtained about 90 percent of its bauxite supply from British Guiana and an extended interruption of production there could seriously affect Canadian production of alumina.

China.—A report [8] by the Economic Commission for Asia and the Far East was published, which included an estimate of the bauxite and bauxitic clay reserves of China as 489,500,000 metric tons, containing 45 to 50 percent alumina. This estimate apparently was not based on new data acquired in the field.

French Guiana.—Exploration of an extensive bauxite deposit in the Kaw Range southeast of Cayenne was continued in 1953. Deposits in the region of Saint-Laurent and Mana and along the Maroni and Approuague Rivers were also being investigated by the Bureau Minièr Guyanais.

French West Africa.—Production in 1953 by Bauxites du Midi (subsidiary of Aluminium, Ltd.) on Kassa Island of the Îles de Los near Conakry was 338,000 metric tons, the highest annual production of record. Exports in 1953 were reported as follows:

Country of destination:	*Metric tons*	*Value (C. F. A. francs)* [1]
France	1, 950. 2	2, 068, 000
Canada	353, 070. 8	435, 362, 000
Trinidad	10, 180. 7	12, 899, 000
United States	10, 503. 8	13, 087, 000
Total	375, 705. 5	463, 416, 000

[1] One C. F. A. franc=$0.00571 U. S.

The Société Péchiney was considering a project to mine bauxite deposits between Kindia and Labola. The plan also included development of 2.5 billion kw.-hr. per year of hydroelectric power from a proposed dam on the Konkure River north of Kindia and erection of an aluminum plant with a capacity of 100,000 tons of metal per year. The French Government was reported to be considering a financial interest in the project. It was estimated that construction of the entire project would require 2 years and cost 100 billion francs, C. F. A.

An estimate [9] of the bauxite reserves in French West Africa placed those on the Îles de Los at 10 million tons, at Kindia 50 million tons, and at Boké 60 million to 80 million tons.

[8] Economic Commission for Asia and the Far East, Regional Conference on Mineral Resources Development, Regional Mineral Resources for Nonferrous Metals, Resources of Tin, Copper, Lead, Zinc and Aluminum Ores in China: Apr. 20-30, 1953, pp. 2-5.

[9] Realités (French), Une realisation de l'industrie française en Guinée: September 1953, pp. 49-54.

Germany, West.—Comparative figures for 1952 and 1953 imports of bauxite into West Germany, in metric tons, were:

Country of origin:	*1952*	*1953*
France	116, 612	149, 070
Greece	281, 387	260, 812
Great Britain	6, 181	1, 522
Yugoslavia	489, 054	379, 691
Austria	9, 106	14, 180
Gold Coast	----------	7, 905
Indonesia	113, 554	56, 755
British Guiana	7, 140	11, 279
India	2, 858	----------
Surinam	10, 016	20
Other countries	1, 144	12
Total quantity	1, 037, 052	881, 246
Value DM [1]	58, 627, 000	43, 572, 000

[1] DM=$0.238 U. S.

A treaty was signed between West Germany and Indonesia in which West Germany agreed to exchange iron, steel, and nonferrous finished and semifinished products for the delivery, among other items, of 150,000 tons of bauxite.

Gold Coast.—Crushing and washing equipment was installed at the mines of the British Aluminium Co. 150 miles north of Takoradi. The crusher could take ore as large as 24 by 36 inches and reduced material to —3-inch-diameter for washing.

Plans for constructing an integrated aluminum industry in Gold Coast utilizing hydroelectric power from the Volta River continued to be discussed. The first phase, as planned, included a reduction plant with an annual capacity of 80,000 tons of metal. Costs were to be financed by Gold Coast and British Governments, Aluminum Co. of Canada, Ltd., and the British Aluminium Co.

Greece.—Greek bauxite production in 1953 was 330,749 metric tons, or 5 percent less than the 1952 figure (348,591 tons). All production was from a mine near Eleusis, 10 miles west of Athens. The mine was open pit and had been completely mechanized. Ore was carried 6 miles by a belt conveyor to a loading bridge on the coast. Operation of this mine was made possible by a loan of $1,450,000 from the Mutual Security Agency of the United States Government under an agreement with the Eleusis Bauxite Mining Co., whereby 450,000 tons of bauxite was to be delivered to the credit of the United States by the end of 1954. Two hundred and fifty thousand tons of this quantity had been delivered at the end of 1953. The bulk of the exports have gone to West Germany for conversion to aluminum for the United States, and the remainder is exported to England and Norway. The Eleusis area was reported to have reserves of 3 million tons.

Haiti.—The Reynolds Mining Corp., a subsidiary of the Reynolds Metals Co., began developing facilities on mining bauxite deposits, which were about 80 miles from Port-au-Prince near the port of Miragoane. The deposits were 5 miles from deep water, covered about 1,700 acres, and were on a plateau at elevations of 2,500 to 3,000 feet. Ore was reported to average 48 percent alumina. The company had a 60-year agreement with the Haitian Government for developing these deposits. Under the terms of the agreement, the company was required to resettle at company expense landowners who were moved from the land. Company plans called for the expenditure of $1,760,-000 in Haiti. It was expected that mining would not begin until late 1954.

Hungary.—A study[10] of the heavy minerals in the bauxite of Nézsa, north central Hungary, indicated the presence of zircon, rutile, ilmenite, hematite, chromite, and a small quantity of tourmaline, beryl, corundum, and pyrite. It was concluded that the bauxite was derived from the weatherings of both silica and basic rocks. Chemical and differential thermal analyses[11] of 36 samples of Hungarian bauxite indicated that the principal constituents were gibbsite, boehmite, diaspore, and kaolinite.

India.—Indian production was estimated at 65,000 metric tons in 1953. A survey[12] of the bauxite industry described the operations of 10 producing firms in operation in India during the year.

The Geological Survey of India estimated[13] the reserves of all grades of bauxite at 250 million tons, the reserves of high-grade bauxite, presumably suitable for aluminum production, were estimated by the same authority at 25,322,000 tons.

Indonesia.—Production in 1953 by the Nederlands Indonesische Bauxite Exploitatie Mij., N. V. (Netherlands Indonesia Bauxite Exploration Co., Ltd.), with workings on Bintan Island, was 149,552 metric tons, or 56 percent less than the 1952 figure (343,754 tons). Exports were 169,455 tons in 1953, principally to West Germany and Japan. Exports in 1952 were 216,078 tons. Year-end stocks in 1953 were 154,893 metric tons compared with 174,806 tons at the end of 1952.

Ireland.—A study[14] of the origin and distribution of the laterites and bauxites of County Antrim, Ireland, was published, which recommended a drilling program to determine their economic values.

Italy.—The Societa per l'Industria Mineraria e Chimica of Milan opened a new bauxite mine near Caiazzo in Caserta Province. The Montecatini Co. had been exploring this area for some years.

A description[15] was published of the San Giovanni Rotondo bauxite deposit of Puglia Province. This was the largest known deposit in Italy.

Jamaica.—Development of the Jamaican bauxite reserves continued rapidly during 1953 by the Reynolds Jamaica Mines, Ltd. (subsidiary of the Reynolds Metals Co.), the Kaiser Bauxite Co. (subsidiary of the Kaiser Aluminum and Chemical Corp.), and the Alumina Jamaica, Ltd. (subsidiary of Aluminium, Ltd.). Exports during the year were reported as 1,068,925 long tons of bauxite (moisture free) to the Gulf coast of the United States by the first 2 firms and 28,731 long tons of alumina to Norway and Sweden by the last firm.

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[10] Kiss, J., [Mineralogy of the Bauxite of Nézsa]: Acta Geol. Acad. Sci. Hungary, 1952, vol. 1, pp. 113–132; Chem. Abs., vol. 47, July 25, 1953, pp. 6833–6834; Light Metals Bull., vol. 15, No. 20, Oct. 16, 1953, p. 719.

[11] Foldvari-Vogl., [Determination of the Mineral Composition of Hungarian Bauxites by Men as of Differential Thermal Analysis]: Acta Geol. Acad. Sci., Hungary, 1952, vol. 1, pp. 49–63; Chem. Abs., vol. 47, July 25, 1953, p. 6833; Light Metals Bull., vol. 15, No. 20, Oct. 16, 1953, p. 719.

[12] Journal du Four Electrique et des Industries Electrochimiques (France), Les Exploritants de bauxite aux indes: March–April 1953.

[13] Economic Commission for Asia and the Far East, Regional Conference on Mineral Resources Development, Aluminum Ore Deposits and Aluminum in the ECAFE Region: Annex B (A Note on the Scope of Increasing Aluminum Production in Indian Union), Apr. 21, 1953, 15 pp.

[14] Eyles, V. A., The Composition and Origin of the Antrim Laterites and Bauxites: H. M. Stationery Office, Belfast, 1953, 99 pp.; Min. Jour. (London), vol. 241, No. 6166, Oct. 23, 1953, p. 476.

[15] Cavinato, Antonio, Il deposito di bauxite di S. Giovanni Rotondo: l'Ind. Miner., vol. 4, No. 11, November 1953, pp. 497–503.

The principal operations of the Reynolds Jamaica Mines, Ltd., were at Belmont, St. Ann Parish, about 6 miles from a company shipping port on Ocho Rios Bay on the north coast, where the ore was partly dried. Shipments were to the La Quinta, Tex., alumina plant of the company. The first shipment was in June 1952.

The Kaiser Bauxite Co., with mining operations in St. Elizabeth Parish, began shipping to the alumina plant of the Kaiser Aluminum & Chemical Corp. at Baton Rouge, La., on February 10, 1953. The company planned a total investment of $12 million in Jamaica and expected to have an annual productive capacity of about 1 million tons. The reserves on 20,000 acres held by the company were reported as sufficient to supply its requirements for 50 years. Ore was transported from the mines over 12.5 miles of privately owned track for drying, storage, and shipment from a privately owned pier at Port Kaiser, on Little Pedro Point on the south coast. Moore [16] has described details of the operation.

Alumina Jamaica, Ltd. (formerly Jamaica Bauxites, Ltd.), shipped its first alumina from its Kirkvine plant at Shooter's Hill (near Mandeville) in January 1953 to Norway. Shipments during 1953 were from Kingston, but construction of a private port on Old Harbour Bay, known as Port Esquivel, on the south coast was nearing completion. This was 22 miles closer than Kingston and was to have storage capacity of 20,000 tons and to have a 600-foot pier. During 1953 the alumina plant was expanded to a productive capacity of 450 tons a day. The company anticipated a construction program which was expected to cost $40 million.

The Jamaican Government leased Government lands to producers and received a royalty of 1 shilling (14 cents) per ton for bauxite removed and in addition an income tax at a rate of 4 shillings (60 cents) per ton shipped. It was estimated that the Government would receive a total of $1 million in 1953 from royalties and income tax.

A report [17] was published on the origin and distribution of the bauxite deposits of Jamaica by the Geological Survey Department of Jamaica. The report contained a map of the known deposits and data as to the origin and quality of the ore.

The Jamaican Government Bureau of Statistics estimated that the gross creation of new capital in Jamaica by the 3 bauxite companies active there was £7.5 million [18] in 1948, £15.5 million in 1951, £17.4 million in 1952, and £16.8 million in 1953. The values of small houses and intangibles, such as land clearing, were omitted.

Japan.—Imports of bauxite in 1953 were 247,928 metric tons valued at ¥1,181,135,000.[19]

Malaya.—In 1953 Malaya production increased about sevenfold to 152,170 long tons from the 1952 production of 21,796 tons. All production was from the mine of the Ramunia Bauxite Co. in southern Johore State in the Bukit Bopeng area east of Singapore. During 1953, operations were begun at a new site, and a new washing plant was constructed. The ore was reported to average 58 percent alumina and 2.5 percent silica. The company mined at an average

[16] Moore, A. L., Kaiser's Jamaican Bauxite Operation: Min. Eng., AIME, New York, N. Y., vol. 6, No. 3, March 1954, pp. 284–286.

[17] Zans, V. A., Economic Geology and Mineral Resources of Jamaica: Jamaica Geol. Survey Dept., Bull. 1, 1951, 61 pp.

[18] 1 £ parity=$2.80 U. S.

[19] 1 yen=$0.00278 U. S.

rate of 15,000 tons per month and maintained a stockpile of 25,000 tons of ore. Exports were 120,374 tons to Japan and 15,787 to Formosa.

Nyasaland.—A bauxite deposit of 6 million tons was reported to be on Mlanje Mountain. It is said to have been derived from the weathering of syenite and to have a maximum thickness of 50 feet and an average of 20 feet. The following average analysis was reported: Al_2O_3 42.73, Fe_2O_3 13.93, TiO_2 1.57, loss on ignition 24.63, quartz 15.65, silicates 2.22.

Pakistan.—A deposit of bauxite was reported [20] in the Koti Tehsil area of Azad Kashmir, that is the part of Kashmir that was occupied by Pakistan. The alumina content in some instances exceeded 70 percent. The reserve estimate was about 2 million tons, but this was considered an inferred-reserve figure.

The Pakistan Government Department of Mineral Concessions, Ministry of Industries, has published a notice that applications for mineral-prospecting licenses or mining leases with respect to certain minerals, including aluminum ores, would be considered.

Surinam.—Exports from Surinam in 1953 were 3,158,275 long tons, 2 percent higher than the 1952 exports of 3,103,980 tons. Exports, by mining areas, were as follows:

Mining area	1953, long tons	1952, long tons	Change, percent
Moengo	1,909,879	1,660,797	+15
Paranam	559,521	865,943	−35
Billiton	688,875	577,240	+19
Total	3,158,275	3,103,980	+2

The 1953 value, calculated at the arbitrary value per ton set for tax purposes, was 40.1 million Surinam guilders.[21] The 1952 value figure was 39.4 million Surinam guilders.

Of the total 1953 ore production, 83,881 long tons or 2.6 percent was abrasive-grade and 43,680 tons or 1.4 percent chemical-grade. The remainder was metallurgical-grade ore. Nearly all of the abrasive- and chemical-grade ore was exported to the United States.

The Kennecott Copper Corp. received from the Surinam Government in May a bauxite exploration and mining concession of 45,000 hectars (about 174 sq. mi.) on the Marowijne River south of the Moengo concession of the Surinam Bauxite Co. However, investigation of this area was abandoned in favor of a second concession north and west of Moengo, and in October Kennecott established a local holding company which was to operate under the name of Guyana Exploratio Maatschappij N. V. (Guiana Exploration Co., Ltd.).

In October the Reynolds Metals Co. also organized a holding company in Surinam known as the Reynolds Surinaamse Mijnbouw Maatschappij N. V. (Reynolds Surinam Mining Co., Ltd.). It was reported that the company had requested a concession on property near the Billiton mine at Onverdacht.

[20] ECAFE Regional Conference on Mineral Resources Development held in Tokyo, Japan, Apr. 20–30, 1953.
[21] Surinam guilder, parity=$0.53 U. S.

A discovery was reported of a deposit of bauxite on Wintiwai Mountain between the Surinam and Marowijne Rivers, 72 miles south of the coast. Details on reserves and quality were not published.

Venezuela.—Analyses of bauxite deposits of unreported extent at Cerro el Chorro near Upata, Bolivar State, were as follows for 16 high-grade samples: Al_2O_3 47.4–70.5, average 60.1 percent; SiO_2 0.2–6.0, average 0.9 percent; Fe_2O_3 3.1–23.5, average 11.8 percent.

Yugoslavia.—Production in 1953 dropped to 462,309 metric tons, 20 percent below the 1952 production of 577,196 tons, which was the highest annual production recorded. The decrease was attributed to growing competition for foreign markets. Bauxite exports during 1953 totaled 465,530 tons valued at 905 million dinars [22] compared with the 1952 total of 612,716 tons valued at 1,457 million dinars. Most of the exports went to West Germany.

Domestic consumption of bauxite was about 29,000 tons in 1953 and was expected to increase very materially after completion of the Razine and Strnisce-Kidricevo aluminum plants in 1954.

To obtain as high a market price as possible for exported bauxite, an export agreement, which included all Yugoslav mines, was formed in June 1953. However, export prices declined during the second half of 1953, averaging 1,911 dinars per ton compared with 2,006 dinars during the first 6 months of the year. The internal market was maintained at 2,770 dinars per ton during the entire year.

[22] 1 dinar=$0.00333 U. S.

Beryllium

By Robert F. Griffith [1]

BERYLLIUM in 1953 followed the supply-demand pattern set in 1952 by many other small-tonnage "defense" metals; supplies of raw material and production of beryllium goods were more than ample to meet demands. The supply of beryl, the only commercial source-mineral of beryllium, was 39 percent higher than in the previous peak year 1952 and over 3 times as large as total domestic consumption. Resumption of commercial production by another primary producer resulted in an increased supply of basic material to fabricators and producers of end-use items. Since 1949 the beryl supply has substantially exceeded consumption, and in view of decreased defense demands in 1953 emphasis was placed on expanding commercial applications to maintain a healthy beryllium industry. Primary producers have succeeded in assuring themselves of a continuing supply of ore to satisfy foreseeable defense and commercial requirements.

Passage of H. R. 2824 extended the Government domestic beryl-purchase program for 2 years, through June 30, 1957. Beryl was retained on the list of minerals eligible for Government exploration assistance. Maximum Government participation was reduced on November 3 from 90 to 75 percent of approved costs. A basic survey of beryllium was compiled by the Bureau of Mines and published by the National Security Resources Board.[2]

TABLE 1.—Salient statistics on beryl [1] in the United States, 1944–48 (average) and 1949–53, in short tons

Year	Production [2]	Imports	Total supply	Exports		Consumption	Stocks		Average price per unit BeO	
				Beryl	Metal, alloys, and compounds [3]		Industry	Government	Domestic [4]	Foreign [5]
1944–48 (average)	154	1,598	1,752	2.3	63.5	1,726	506	2,938	18.45	12.28
1949	475	3,811	4,286	0.3	94.0	1,029	2,322	1,076	32.10	22.52
1950	559	4,860	5,419	0.1	110.5	3,007	2,621	(6)	30.51	25.43
1951	484	4,316	4,800	0.3	94.8	3,388	1,417	(6)	33.34	31.67
1952	515	5,978	6,493	1.9	[7] 196.6	3,476	2,492	(6)	38.55	38.55
1953	751	8,245	8,996	0.0	103.7	2,661	4,987	(6)	47.00	47.00

1 Estimated 10 percent BeO content.
2 Mine shipments.
3 Beryl equivalent.
4 F. o. b. mine.
5 C. i. f. United States ports.
6 Restricted.
7 Does not include an undisclosed quantity of secondary material exported to United Kingdom.

1 Commodity-industry analyst.
2 Bureau of Mines, Beryllium: Materials Survey, prepared for National Security Resources Board, September 1953, 178 pp.

TABLE 2.—Beryl shipped from mines in the United States, 1944–48 (average) and 1949–53, by States, in short tons

State	1944–48 (average)	1949	1950	1951	1952	1953
Colorado	(1)	144	97	97	54	75
New Hampshire	(1)	(1)	106	50	(1)	57
New Mexico	(1)	8	(1)	141	101	89
South Dakota	111	139	96	138	334	392
Other [2]	43	184	260	58	26	138
Total: Short tons	154	475	559	484	515	751
Value	$26,374	$152,485	$170,550	$161,361	$233,757	$354,487
Average value per ton	$171.26	$321.02	$305.10	$333.39	$453.90	$472.02

[1] Included with "Other" to avoid disclosure of individual company operations.
[2] Arizona (1949–51, 1953); Connecticut (1944, 1947, 1953); Georgia (1952–53); Idaho (1953); Maine (1944, 1947–53); Massachusetts (1944); North Carolina (1944, 1949, 1951); Virginia (1944); and States indicated by footnote 1.

DOMESTIC PRODUCTION

Mine Production.—Largely as a result of the Government domestic beryl-purchase program, mine shipments of beryl in the United States during 1953 were by far the largest on record. Of the 751 short tons sold over 500 tons was purchased by Government agencies. Although 195 tons contained only 8 percent BeO the weighted average grade of all beryl purchases was 10 percent BeO. The Custer-Pringle and Keystone districts in the Black Hills, S. Dak., supplied about 50 percent of the domestic production; increased production was reported from the New England States; and the Harding mine near Dixon, N. Mex., continued at a high level of output. In Colorado beryl was recovered from tailings of the Biggers mica mine, and Government reports describing beryl occurrences in the Mount Antero and Quartz Creek districts were published.[3] Shipments of beryl were purchased from Arizona and Georgia by private buyers; names of mines were not given. A small quantity of beryl was sold by Idaho Beryllium & Mica Corp., Deary, Idaho, to the Government Purchase Depot at Custer, S. Dak. In Washington a few tons of unsold beryl concentrates was recovered from the Merikay mine and stored at Chewelah, Wash.

Refinery Production.—Completion of a beryllium-copper master-alloy plant at Elmore, Ohio, by the Brush Beryllium Co. reportedly increased the Nation's production capacity of this alloy 54 percent;[4] the Brush fabrication unit is at Cleveland, Ohio. This expansion and increased beryllium-copper rolling-mill and foundry facilities resulted in a production capacity larger than required to meet current demands. During part of 1953 Brush Beryllium Co. operated a Government-owned beryllium plant at Luckey, Ohio, for the Atomic Energy Commission. This plant was shut down and placed on a standby status during the latter part of the year. The Beryllium Corp., Reading, Pa., the world's largest primary producer of beryllium products, appointed several additional warehouse distributors as an aid to marketing beryllium-copper wrought materials and mill products.

[3] Adams, J.W., Beryllum Deposits of the Mount Antero Region, Chaffee County, Colo.: Geol. Survey Bull. 982–D, 1953, 24 pp.
Wilson, S. R., and Young, W. A., Investigation of the New Anniversary-Bucky Pegmatite, Gunnison County, Colo.: Bureau of Mines Rept. of Investigations 4939, 1953, 7 pp.
[4] American Metal Market, vol. 60, No. 53, Mar. 19, 1953, p. 1.

Beryl Ores Co., Arvada, Colo., processed beryl ore for ceramic applications and in 1953 was the principal supplier of ground beryl and ceramic beryllium frit to manufacturers of end-use ceramic items. Penn Precision Products Co., Inc., Reading, Pa., was formed early in 1953 to operate a rolling mill specializing in close-tolerance beryllium-copper strip and thin-gage work.

Principal beryl consumers and manufacturers of beryllium products are:

Producer and plant location:	*Products*
Beryllium Corp., Reading, Pa.	Beryllium-copper master alloy; beryllium-copper casting ingots, sand castings, strip, rod, wire, bar, forgings, and safety tools; beryllium-aluminum master alloy; beryllium,magnesium-aluminum master alloy, ferroberyllium, beryllium-nickel casting ingots; beryllium metal and oxide.
Beryl Ores Co., Arvada, Colo.	Ground beryl; beryllium oxide; ceramic frit.
Brush Beryllium Co., Cleveland, Luckey, and Elmore, Ohio.	Beryllium-copper master alloy; beryllium-copper casting alloy ingots; beryllium-aluminum master alloy; beryllium metal and metal shapes; beryllium oxide, oxide crucibles, chemicals, and compounds.
Ampco Metal Co., Milwaukee, Wis.	Beryllium-copper foundry products.
P. R. Mallory & Co., Indianapolis, Ind.	Do.
Wilber B. Driver Co., Newark, N. J.	Beryllium-copper primary rolling-mill products.
Riverside Metal Co., Riverside, N. J.	Do.
American Silver Co., New York, N. Y.	Beryllium-copper reroll mill products.
General Plate Division, Attleboro, Mass.	Do.
Penn Precision Products Co., Inc., Reading, Pa.	Do.
Little Falls Alloys, Inc., Patterson, N. J.	Beryllium-copper wire.
Champion Spark Plug Co., Detroit, Mich.	Ceramics.
General Ceramic Corp., Keasbey, N. J.	Do.
Lapp Insulator Co., Inc., Le Roy, N. Y.	Do
A. O. Smith Co., Milwaukee, Wis.	Do.

CONSUMPTION AND USES

Beryl consumption in 1953 dropped over 800 tons below the peak year 1952, largely because of a sharp curtailment of production at the Luckey, Ohio plant operated by Brush Beryllium Co. for the Atomic Energy Commission. Reduced Government consumption was partly offset by increased commercial consumption. Distribution of the 2,661 tons of beryl consumed in 1953 was as follows, by class and percent: Beryllium-copper alloys, 83; beryllium metal, 9; ceramics, 5; other alloys and miscellaneous compounds, 3.

Beryllium-copper's extraordinary spring properties, resistance to fatigue, stability under load, and high electrical and thermal conductivity favor its use in electrical equipment and in parts subjected to severe wear conditions. High-strength alloys containing about

2 percent beryllium, 0.35 percent cobalt or nickel, and the balance copper find the widest use. In applications requiring maximum electrical conductivity rather than maximum strength or hardness, a beryllium content of less than 0.75 percent is usually preferred. A new beryllium-copper alloy with properties about midway between the high-strength and high-conductivity alloys was placed on the market the latter part of the year.[5] One of the earliest uses of beryllium-copper—the manufacture of nonsparking safety tools—is still an important application. These tools are used in industries where a spark might cause a disastrous explosion and in the chemical industry because of their resistance to corrosion.[6] The results of corrosion-resistance experiments indicate that beryllium-copper is a material to be considered in marine applications.[7]

Master alloys of beryllium with aluminum, iron, magnesium, and nickel, which are remelted and further alloyed to specific compositions by dilution, are available. Beryllium promotes fluidity and retards oxidation in aluminum and magnesium base alloys. Ferroberyllium is used in the stainless casting field and is under development in wrought stainless alloys. Applications for beryllium-nickel alloys include the matrix for diamond-drill bits, surgical instruments, watch and instrument springs, and precision-cast shapes. An alloy of beryllium, copper, and zinc (ZnCuBe) under investigation may be used as a replacement for brass and bronze in fabricating lamp and fuse sockets.

Beryllium is the only stable light metal with a high melting point and is also an excellent transmitter of sound. Its largest use is in the nuclear energy field because of its ability to moderate or slow neutrons produced in fission. Other nuclear energy applications include use as a reflector of neutrons, in radium- or polonium-beryllium neutron sources, and as a material of construction. Beryllium has the lowest thermal neutron absorption cross section of all the metals—about one-twentieth that of zirconium. The cost of beryllium metal has limited its use as a material of construction. The major commercial use of pure beryllium metal is as X-ray disk or "windows" because of its high permeability to X-rays.

Beryllium oxide, ceramic beryllium frits, and ground beryl are used in manufacturing high-grade dielectrics, specialized high-temperature ceramics, and as a protective coating for certain steels. The use of beryllium oxide is expanding rapidly because of its high electrical resistivity, exceptional thermal conductivity, high melting point, and resistance to thermal shock.

Uses of other beryllium compounds include the chloride in diagnosing tuberculosis, sodium beryllium fluoride in glasses having high ultraviolet permeability, beryllium nitrate in the manufacture of gas mantles, and beryllium stearate in printing inks and certain catalysts. Beryllium nitride is used as the starting point for the production of the C_{14} isotope.

STOCKS

Beryl stock in the hands of commercial consumers increased nearly 2,500 tons during 1953 and were by far the largest in history at the

[5] Materials and Methods, vol. 38, No. 6, December 1953, p. 149.
[6] American Metal Market, vol. 60, No. 184, Sept. 23, 1953, p. 1.
[7] Materials and Methods, vol. 38, No. 3, September 1953, pp. 192–194.

year end. Government stocks also increased substantially as a result of purchases by the Emergency Procurement Service for the National Stockpile. In addition, approximately 145 tons of beryl had been acquired under the Government's domestic beryl purchase program through December 1953.[8] Stocks of beryllium alloys and compounds held by primary producers remained at about the same level. Quantitative data on industry stocks of beryllium products or on stocks of beryl in the National Stockpile are not available for publication.

PRICES

The duration of the Government program for the purchase of beryl from small domestic producers was extended to June 30, 1957 by passage of H. R. 2824. General Services Administration Purchase Depots at Custer, S. Dak., Franklin, N. H., and Spruce Pine, N. C., are authorized to buy beryl under this program. Shipments up to 500 pounds of beryl, containing not less than 8 percent BeO, are purchased on a basis of visual inspection at a flat price of $400 per short dry ton. The beryl must be in the form of clean crystals, cobbed free of waste. Shipments of 500 pounds or more are analyzed at the producer's request and at his expense. Shipments accepted by sampling and chemical analysis are purchased on the basis of short-ton units (20 pounds) of contained BeO as follows: 8–8.9 percent, $40; 9–9.9 percent, $45; and 10 percent and over, $50. These prices may be converted to the price per ton by multiplying the value per unit of BeO by the percent BeO content. Purchases of more than 25 tons of beryl a year from individual producers must be negotiated with Emergency Procurement Service (EPS) of GSA. E&MJ Metal and Mineral Markets quoted domestic beryl in 1953, f. o. b. mine, Colorado, per unit BeO, 10–12 percent BeO, as follows: January $45–$48, depending on quantity; February through December, $46–$48. Prices quoted for imported ore, c. i. f. United States ports, were substantially the same.

In addition to the principal consumers of beryl listed under Refinery Production other markets include the following dealers and importers of beryl, all of New York, N. Y.: Alfred D. Brown, Associates, Ltd., 24 Stone Street; Continental Ore Corp., 500 5th Avenue; Derby & Co., Ltd., 285 Madison Avenue; Mercantile Import & Export Corp., 21 East 40th Street; Metallurg, Inc., 100 Park Avenue; Pan American Trading Co., 50 Broad Street; J. A. Samuel & Co., Inc., 220 Broadway; and C. Tennant, Sons & Co., 100 Park Avenue.

Beryllium products were among the last items to be freed when the Office of Price Stabilization abolished all price controls on March 12, 1953. Before price controls were abolished, OPS on February 13 established a ceiling price for beryllium-copper master alloy of $37.72 a pound of contained beryllium plus 29.3 cents a pound of contained copper. The price of 4-percent beryllium-copper master alloy was thus established at $1.79 per pound compared with $1.56 per pound allowed previously. On February 27 OPS authorized processors and manufacturers of beryllium-alloy products to increase their ceiling price to pass on to their customers the increased price of master alloy. From April through December beryllium-copper master alloy

[8] E&MJ Metal and Mineral Markets, vol. 25, No. 6, Feb. 11, 1954, p. 6.

was quoted in American Metal Market, f. o. b. Reading, Pa., or Elmore, Ohio, at $40 per pound of contained beryllium with balance as copper at market price on date of shipment. Beryllium-aluminum master alloy, in 5-pound ingots, f. o. b. Reading, Pa., was quoted at $72.75 per pound of contained beryllium plus aluminum at market price. Beryllium metal, 97 percent lump or beads, f. o. b. Reading, Pa., and Cleveland, Ohio, was quoted at $71.50 per pound. Beryllium oxide was offered at $9–$16 per pound, depending upon quality and quantity. Prices of other compounds and alloys were nominal.

FOREIGN TRADE [9]

Beryl shipments to the United States in 1953 exceeded those in the previous high year, 1952, by nearly 2,300 tons. Imports were divided about equally between Western and Eastern Hemisphere sources. Imports of beryl from Brazil were of the same magnitude as in the past 5 years, and Brazil continued to be the largest individual source country. In terms of percentage of total supply, however, Brazil contributed 33 percent in 1953 compared to 43 percent in 1952. Over 1,500 tons of beryl imported from Argentina offset the percentage decline in Brazilian imports in maintaining South American supply at the same percentage level. Shipments of 331 tons of beryl received from Madagascar—the first since 1945—reflected decreased beryl consumption in France and relaxation of export controls. Beryl imports from Mozambique, Portugal, Southern Rhodesia, and South Africa increased substantially. No imports of beryllium products by the United States were recorded in 1953.

Exports of beryllium metal, alloys (except beryllium-copper), scrap, and semifabricated forms from the United States in 1952 totaled 19,331 pounds valued at $89,547. The principal recipients were

TABLE 3.—Beryl imported for consumption in the United States, by countries, 1950–53, in short tons

[U. S. Department of Commerce]

Country	1950	1951	1952	1953	Total (short tons)	Percent of total
Argentina	----------	----------	550	1,513	2,063	8.8
Brazil	2,703	1,094	2,590	2,696	9,083	38.8
British East Africa (Uganda principally)	11	47	18	22	98	0.4
French Morocco	77	23	118	23	241	1.0
India	----------	449	196	200	845	3.6
Japan [1]	17	12	----------	----------	29	0.1
Madagascar	----------	----------	----------	331	331	1.4
Mozambique	130	174	308	410	1,022	4.4
Portugal	28	97	105	377	607	2.6
Southern Rhodesia	464	692	931	1,296	3,383	14.5
Union of South Africa (includes South West Africa)	1,401	1,722	1,156	1,369	5,648	24.2
Other countries [2]	29	6	6	8	49	0.2
Total: Short tons	4,860	4,316	5,978	8,245	23,399	100.00
Value	$1,235,639	$1,366,772	$2,548,423	$3,881,242	----------	----------

[1] Country of export only; ore produced principally in Brazil and Argentina before, or during World War II.
[2] 1950, Canada 29 tons; 1951, Finland 6 tons; 1952, Finland 3 tons; Republic of Korea 3 tons; 1953, Republic of Korea 8 tons.

[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.

Canada and United Kingdom. No beryllium ore and concentrates were exported. Beryllium-copper exports continued to be licensed through the fourth quarter of 1953; however, no quantitative limit was set. Nevertheless, exports were still controlled to safeguard the national security. In 1953, 115,000 pounds of beryllium-copper master alloy was licensed for export.

TECHNOLOGY

The ability of beryllium to produce precipitation hardening as an alloy with copper, nickel, iron, and certain other elements is responsible for its widest use. When such an alloy is heated into the range of higher than normal solubility for beryllium and quickly cooled the beryllium is retained in supersaturated solution (alpha phase), and the alloy is soft and workable at room temperature. Upon reheating to a relatively low temperature submicroscopic particles of beryllium compounds (gamma phase) precipitate throughout the metal and operate to harden it greatly. This process of reheating to produce precipitation hardening may be varied in practice so that a wide range of properties is obtainable, from the softest state with high formability to the hardest state with high strength.[10] A new low-content (1 percent Be) beryllium-copper alloy was developed in 1953 and is viewed as a potential rival of bronzes and brasses.[11]

A hardenable stainless steel alloy containing beryllium was developed.[12] After machining, the steel may be precipitation-hardened by low-temperature heat treatment. The alloy is reported to offer excellent corrosion resistance to certain acids and their salts. A ferroberyllium master alloy containing 5 percent Be was placed on the market. A magnesium-alloy ingot containing beryllium to reduce melt loss and patterned for the magnesium die-casting industry was developed.[13] Metallic beryllium flake (99.5 percent pure) was marketed in 1953. This product features high ductility and is particularly suited for hot-pressing shapes and forms.[14] Powder metallurgical techniques are normally employed in fabricating beryllium metal. Blocks up to 5 by 2½ feet and rounds up to 28 inches in diameter are available. An automatic processing unit for handling beryllium-copper coils up to 36 inches in diameter and bars 2½ inches in diameter by 20 feet in length was developed.[15] The results of a 2-year series of exposure tests on the corrosion resistance of beryllium-copper were reported at the annual meeting of the American Society for Testing Materials.[16] The electrolytic preparation of beryllium hydroxide was investigated using an aqueous solution of sodium beryllium fluoride as cathode liquor and graphite as electrode material.[17] A number of

[10] Bass, N. W., The Role of Beryllium in Industry: Brush Beryllium Co., Cleveland, Ohio, March 1954, 27 pp.

[11] Steel, vol. 133, No. 17, Oct. 26, 1953, p. 170.

[12] Mott, N. S. (assigned to Cooper Alloy Foundry Co.), Hardenable Stainless Steel Alloy: U. S. Patent 2,635,044, Apr. 14, 1953.

[13] Materials and Methods, Magnesium Die-Casting Ingot Offered: Vol. 38, No. 2, August 1953, pp. 144–146.

[14] Chemical Engineering, vol. 60, No. 12, December 1953, p. 342.

[15] Iron Age, New Equipment, Continuous Processing Line for Beryllium Coils: Vol. 172, No. 19, Nov. 5, 1953, p. 146.

[16] Work cited in footnote 7.

[17] Parikh, R. K., and Kammermeyer, Karl, Electrolytic Preparation of Beryllium Hydroxide: Ind. Eng. Chem., vol. 45, No. 7, July 1953, pp. 1583–1585.

patents relating to the processing and fabrication of beryllium compounds and alloys were granted in 1953.[18]

Three processes have been used commercially in recent years to convert beryl ore to beryllium oxide, which is used in the production of beryllium-copper master alloy and beryllium metal. In the fluoride process the ore is ground and fused with sodium silicofluoride or sodium ferric fluoride to form sodium-beryllium fluoride, which is leached with water. The solution is treated with caustic soda to precipitate beryllium hydroxide, which is heated and converted to beryllium oxide. The sulfate process employs fusion with lime and treatment with sulfuric acid at elevated temperatures to form soluble beryllium and aluminum sulfates, which are extracted with water. Aluminum is precipitated by adding ammonium sulfate. Beryllium sulfate crystals, obtained by evaporation of the mother solution, is heated and decomposes to beryllium oxide. Another sulfate process separates beryllium from aluminum in the sulfate solution by careful control of the hydrogen-ion concentration.[19]

Beryl is not recovered in large quantities comparable to ore minerals of more common metals because:

(1) Properties of elemental beryllium are such that it acts as a mineralizer during the solidification of rock bodies. That is, it tends to promote fluidity, and as a consequence, is concentrated only in late stages of rock solidification. Furthermore, beryllium ionic properties are not favorable for the replacement of common gangue minerals. For these reasons beryllium minerals are not found in large vein or replacement deposits as are lead, copper, and zinc.

(2) No successful commercial process has yet been developed for recovering beryl by mechancial methods. Commercial recovery of beryl is entirely by hand sorting and the percentage of recovery is low. The density of beryl is very near that of quartz, feldspar, and other common gangue minerals; therefore, beryl is not found concentrated in placer deposits, and gravity-concentration methods are not applicable to its recovery. Investigations have been conducted to recover beryl by flotation, agglomerate tabling, electrostatic separation, and a nucleonic device. The most favorable results have been obtained by flotation.[20] Bureau of Mines technologists at Rapid City, S. Dak., have developed a beryl flotation process employing petroleum sulfonate-type collectors. The process is being investigated on a pilot-plant scale aimed at recovering and separating all economic pegmatite minerals. A Bureau of Mines information circular describing the process has been published.[21] At Tuscaloosa, Ala., in work on the Kings Mountain, N. C., spodumene pegmatites the Bureau developed a reagent combination that retards beryl while permitting spodumene to float.[22] Pilot-plant tests have produced substantial quantities of beryl-bearing concentrates, on which studies are being conducted to upgrade them to meet commercial specifications.

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[18] Martin, D. C., Welding Beryllium and Beryllium Alloys: U. S. Patent 2,658,981, Nov. 10, 1953. Kawecki, H. C. (assigned to Beryllium Corp.), Method of Forming Alkaline Earth Metal-Beryllium Double Fluoride Compounds: U. S. Patent 2,647,817, Aug. 4, 1953. Process of Preparing Beryllium Fluoride: U. S. Patent 2,647,818, Aug. 4, 1953. Process of Preparing Beryllium Oxide: U. S. Patent 2,647,821, Aug. 4, 1953.

[19] Work cited in footnote 2, chap. 2, pp. 9–13.

[20] Clemmons, B. H., and Browning, J. S., Strategic Beryllium From Domestic Pegmatites; Min. Eng., vol. 5, No. 8, August 1953, pp. 786–788.

[21] Runke, S. M., Petroleum Sulfonate Flotation of Beryl: Bureau of Mines Inf. Circ. 5067, 1954, 19 pp.

[22] Work cited in footnote 20.

These studies include roasting and leaching, with smelting and fuming to extract the beryllium.

The application of the visual-arc spectroscopic method to the rapid qualitative determination of many elements including beryllium was described,[23] and a field test for differentiating between beryl and quartz was published.[24]

Studies conducted relative to possible beryllium health hazards have resulted in a new outlook on the health problems involved.[25] Investigations completed recently in the plant of a leading producer indicate that beryllium ore and commercial beryllium alloys involve no danger from the element itself. No medical cases have been identified with exposures to the ore mineral beryl or to alloys containing 2 percent or less beryllium. Finely divided beryllium and certain beryllium compounds are considered toxic to susceptible individuals. Standard safety practice, such as adequate exhaust systems and respirators used by other metal industries in dry grinding, shearing, and welding operations are considered adequate for the safe handling of commercial beryllium-copper alloys.

RESERVES

Beryl reserves in Brazil and elsewhere, based on a partial survey by the Beryllium Corp., were presented in a confidential report declassified in 1953.[26] Brazilian beryl reserves were reported as 40,000 tons proved, 100,000 tons probable, and possible reserve of 500,000 tons of beryl. In the areas of South-West Africa, Mozambique, Southern Rhodesia, and elsewhere it was reported that known explorations indicate a potential reserve of at least 50,000 tons of beryl. Studies concluded by the Geological Survey in 1953 increased the estimated reserves of beryl in the tin-spodumene belt, North Carolina, above a depth of 300 feet to a total of 823,000 tons. The beryl reserves in the minable spodumene ore contained in this belt were stated to be 46,000 tons.[27]

Additional data relative to domestic beryl reserves were presented in the 1952 Minerals Yearbook Beryllium chapter.

WORLD REVIEW

Argentina.—The control of purchase and export of domestic beryl by Argentine Trade Promotion Institute (IAPI) expired April 27, 1953, and was followed by decree 16,571 dated September 4, 1953. Under the new decree IAPI is obligated to purchase all offered domestic beryl of suitable grade from producers or cooperatives. Prices are fixed monthly by IAPI but until December 31, 1953, may not be less than 4.20 pesos per kilogram for beryl containing 10 percent BeO. Producers and cooperatives may use such beryl as is needed for in-

[23] Peterson, M. J., and Jaffe, H. W., Visual-Arc Spectroscopic Analysis: Bureau of Mines Bull. 524, 1953, 20 pp.

[24] Barlow, N. E., Simple Field Test for Differentiating Between Beryl and Quartz: Min. Rev. (London), vol. 18, No. 9, September 1953, pp. 43–44.

[25] Light Metal Age, Beryllium—Safety Factors Cited: Vol. 11, No. 7, 8, August 1953, p. 15.
Metal Progress, Note on Beryllium Poisoning: Vol. 63, No. 5, May 1953, p. 66.

[26] National Research Council, Division of Engineering and Industrial Research, Substitutes for Beryllium Alloys: Minerals and Metals Advisory Board, Library of Congress, Publications Board Project, September 1952, 35 pp.

[27] Griffits, W. R., Beryllium Resources of the Tin-Spodumene Belt, North Carolina: Geol. Survey Circ. 309, 1954, 12 pp.

dustrial purposes, and export quotas are fixed twice a year. The first price announced for beryl, retroactive to April 28, 1953, was 6 pesos per kilogram,[28] equivalent to about $40 per short-ton unit of BeO for 10-percent BeO beryl and based on the free value of a peso of 7.1982 cents.

TABLE 4.—World production of beryl, by countries [1], 1947-53, in metric tons [2]

[Compiled by Berenice B. Mitchell]

Country [1]	1947	1948	1949	1950	1951	1952	1953
Afghanistan				7	2		
Argentina	10	[3] 50				[3] 499	[3] 1,373
Australia	54	56	36	23	114	89	127
Belgian Congo							7
Brazil (exports)	1,027	1,783	3,078	2,625	1,533	2,523	2,160
Canada				[3] 26			
Chile		([3] [4])				([5])	([5])
France		2	2	3	([5])		([5])
French Morocco		51	211	56	84	129	33
India	([5])	([5])	([5])	([5])	215	[6] 550	([5])
Korea, Republic of	([5])				([5])	([4])	4
Madagascar	([4])	9	27	486	530	397	468
Mozambique	81	16	136	264	230	208	250
Northern Rhodesia				5	4	8	5
Norway			[3] 9				
Portugal		[6] 10	3	52	102	93	378
Southern Rhodesia			23	846	1,007	1,076	1,609
South-West Africa	52	90	239	659	753	537	535
Surinam							2
Tanganyika		2	1				
Uganda	18	44	34	71	2	3	50
Union of South Africa			223	844	593	375	482
United States (mine shipments)	132	90	431	507	439	467	681
Total (estimate)	1,430	2,470	4,587	6,651	5,720	6,850	8,500

[1] In addition to the countries listed, beryl has been produced in a number of countries for which no production data are available; except for U.S.S.R., their aggregate output is not significant.
[2] This table incorporates a number of revisions of data published in previous Beryllium chapters.
[3] United States imports.
[4] Less than 1 ton.
[5] Data not available; estimates by author of the chapter included in total.
[6] Estimate.

The large exports of beryl (1,513 short tons to the United States) in 1953 are believed to be a result of the uncertain IAPI beryl position between April and September. During this time producers who had held large stocks of beryl in anticipation of increased prices sold their beryl because of uncertain future markets.

A monthly output of about 4 tons of beryl was reported from a pegmatite mining operation in the Cordoba Province.[29]

Australia.—The British Ministry of Supply purchases all beryl ore produced in Australia; exportation of beryl ore is controlled. Beryl is produced in Western Australia from the Pilbara field.

Brazil.—A Government decree dated January 16, 1953, established a beryl export quota of 4,000 tons for 1953. A contract was executed in May between the Defense Materials Procurement Agency and Proberil, S. A., Rio de Janeiro, for developing beryl deposits in the State of Minas Gerais. DMPA has an option under the contract on $150,000 worth of beryl at a price of $50 per metric ton unit of BeO.[30] A partial survey by the Beryllium Corp. in the States of Minas Gerais and Bahía has shown a known beryl reserve of 40,000 tons. Other

[28] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 4, January 1954, p. 5.
[29] Mining World, vol. 15, No. 13, December 1953, p. 77.
[30] American Metal Market, vol. 60, No. 97, May 21, 1953, p. 1.

surveys and opinions indicate a possible reserve of 200,000 tons in the area and about 50 percent more in the northern and northeastern sections of the country.[31]

India.—Rajasthan is one of the principal beryl producing states in India. Beryl is mined in areas near Bhilwara, Amet, Kaunthal, Jahazpur, Sahara, Asind, Jaipur, Kishengarh, Sarwar, Malpura and Tonk.[32]

Madagascar.—The first large (331 short tons) shipment of beryl to the United States was made in 1953. Formerly, France was the principal recipient.

Portugal—Beryl production, which has increased steadily since 1950, assumed an important position with respect to total world production in 1953. Over 375 tons was exported to the United States.

Southern Rhodesia.—Beryl production was reported by 104 independent producers, of which 98 were operating in the Salisbury district in the Karoi and Fungwe areas.[33]

Surinam.—The Surinam Geological and Mining Service (GMD) sampled beryl deposits along the Surinam River near Rama. A preliminary examination of a beryl deposit near Herminadorp on the Marowisne River was encouraging.[34]

Union of South Africa (includes South-West Africa).—Beryl is produced by many small operators from scattered pegmatites in the Karabib-Usakos area.

U. S. S. R.—Chlorination of beryl to form $BeCl_3$ has reportedly replaced the fluoride method for processing beryl in Russia.[35] The most important beryl deposits are in the Ural Mountains at the emerald mines of Izumrudrye Kopi. Developed reserves are reported to be inadequate for industry.[36]

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[31] Mining World, vol. 15, No. 9, August 1953, p. 89.
[32] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 1, January 1954, pp. 5-6.
[33] Mining World, vol. 15, No. 12, November 1953, p. 77.
[34] Mining World, vol. 15, No. 6, May 1953, p. 73; No. 10, September 1953, p. 81.
[35] Nucleonics, vol. 11, No. 11, November 1953, p. 84.
[36] Thomson, A. G., The Production and Uses of Beryllium—I: Min. Jour. (London), vol. 241, No. 6172 Dec. 4, 1953, p. 661.

Bismuth

By Abbott Renick[1] and E. Virginia Wright[2]

ESTIMATED world production of 4,200,000 pounds of bismuth in 1953 was about 200,000 pounds higher than in 1952 and exceeded the 1944–48 average (2,900,000 pounds) by 46 percent. Production in the three leading bismuth-producing countries—the United States, Mexico and Peru—was reduced from 1952. Outside of the Western Hemisphere, the Republic of Korea was the most important single producer. Available reports place that country's production at 529, 000 pounds, an increase of 118 percent compared with 1952.

In 1953 domestic refinery production of bismuth declined 3 percent compared with 1952. The domestic supply[3] of bismuth metal decreased 10 percent from that in 1952. Imports of bismuth metal declined 9 percent, while exports of bismuth metal during 1953 declined 52 percent.

Consumption of bismuth in the United States totaled 1,600,000 pounds during 1953. This represented a decrease of about 200,000 pounds (12 percent) from the previous year and was accounted for principally by decreased demand for metal and fabricating alloys. Consumption of bismuth in pharmaceuticals was virtually unchanged from the previous year.

The quoted market price of metallic bismuth in New York 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 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 1953 output declined 3 percent compared with 1952.

Companies reporting output of refined bismuth metal in 1953 were American Smelting & Refining Co., at Omaha, Nebr., and Perth Amboy, N. J.; Anaconda Copper Mining Co., at Anaconda, Mont.; and United States Smelting Lead Refinery, Inc. (subsidiary of United States Smelting, Refining & Mining Co.), at East Chicago, Ind. The Cerro de Pasco Corp. continued in its role as the principal domestic producer of bismuth alloys at Brooklyn, N. Y. The bismuth metal used is obtained from the company smelting operation at La Oroya, Peru.

[1] Commodity-industry analyst.
[2] Statistical assistant.
[3] Opening stocks plus domestic refinery production plus imports minus exports minus year-end stocks.

CONSUMPTION AND USES

In 1953 domestic consumption of bismuth metal was 12 percent less than in 1952 and totaled 1,568,000 pounds. The bismuth content of pharmaceuticals was 414,200 pounds in 1953, virtually unchanged from the 406,800 pounds consumed in 1952, while the total quantity used by all other industries decreased 16 percent from the previous year.

Effective June 30, 1953, the National Production Authority revoked monthly mandatory reporting on Bureau of Mines Form 6-1028-M, in effect since February 1951. Statistical data are now being collected on a voluntary quarterly basis.

TABLE 1.—Bismuth metal consumed in the United States, 1951–53, by uses

Use	1951 [1]		1952		1953	
	Pounds	Percent of total	Pounds	Percent of total	Pounds	Percent of total
Fusible alloys	186,800	12	261,700	15	191,200	12
Solder	100,200	6	145,900	8	221,000	14
Other alloys	513,400	32	865,800	49	613,800	39
Selenium rectifiers	50,400	3	25,500	1	47,500	3
Pharmaceuticals	569,600	36	406,800	23	414,200	27
Other uses	171,600	11	69,300	4	80,300	5
Total consumption	1,592,000	100	1,775,000	100	1,568,000	100

[1] February through December only; compiled by National Production Authority, U. S. Department of Commerce.

STOCKS

Consumers' and dealers' stocks totaled 166,700 pounds at the end of 1953, a decrease of 21 percent from the 211,500 pounds on hand January 1, 1953. Producers' stocks increased during the year.

PRICES

The New York price for refined bismuth metal remained unchanged at $2.25 per pound, in ton lots, throughout 1953, according to E&MJ Metal and Mineral Markets. The Metal Bulletin (London) quotation for high-purity metal, per pound, 5 cwt. minimum, on January 2 was 17s. 6d. (equivalent to $2.45), subsequent fluctuations being recorded as follows: Per pound, 4 cwt. minimum, on June 5, 17s. ($2.38); per pound, 2 cwt. minimum, on December 24, 16s. ($2.24). Bismuth ore, per pound of contained metal c. i. f., was quoted on December 24, 1953, at 8s. 6d. ($1.19) for 65-percent minimum bismuth content, scaling downward to 1s. 3d. ($0.22) for ore containing less than 20 percent bismuth.

Prices of bismuth chemicals remained unchanged throughout the year. Prices per pound at the beginning and end of the year, as quoted by the Oil, Paint and Drug Reporter, were identical, as follows:

	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[4]

Imports.—During 1953 imports of refined metal totaled 641,400 pounds, a decrease of 9 percent from the 708,300 pounds imported in 1952. Of the total imports, Peru supplied 68 percent, Republic of Korea 14 percent, and Yugoslavia 8 percent; Mexico, Canada, Belgium-Luxembourg and the Netherlands supplied the remaining 10 percent.

Exports.—Exports of bismuth metal and alloys decreased 52 percent from the 244,800 pounds exported in 1952 and amounted to 117,300 pounds. The United Kingdom received 81,000 pounds, West Germany 23,400 pounds, Italy 4,600 pounds, and Japan 4,400 pounds. Smaller quantities were shipped to Brazil, Canada, Chile, Colombia, India, Israel, and the Philippines. Exports of bismuth salts and compounds totaled 51,600 pounds, valued at $247,200, compared with 233,200 pounds, valued at $741,300, in 1952.

Tariff.—Since October 1951 the duty on bismuth metal has been 1⅞ percent ad valorem. The duty on salts and compounds continued at 35 percent ad valorem. On bismuth alloys, the duty is 22½ percent ad valorem. Bismuth ore enters the United States duty-free.

TABLE 2.—Bismuth metal and alloys imported (for consumption) into and exported from the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Year	Imports of refined[1] metallic bismuth		Exports of metal and alloys	
	Pounds	Value	Pounds	Value
1944–48 (average)	345, 986	$414, 479	174, 324	$298, 910
1949	541, 852	833, 940	190, 882	356, 576
1950	781, 670	1, 287, 098	199, 253	387, 458
1951	514, 020	1, 003, 285	146, 998	376, 246
1952	708, 254	1, 451, 729	244, 797	635, 260
1953	641, 428	1, 273, 417	117, 322	237, 638

[1] Excludes imports of bismuth contained in bismuth-lead bars from Mexico and Peru; also excludes bismuth contained in concentrates.

TECHNOLOGY

The United States Naval Ordnance Laboratory reported[5] that:

Bismanol permanent magnets were evaluated for stability under various operating conditions. The magnets, after low-temperature stabilization, exhibited a magnetic flux constancy over a wide temperature range with some loss in original energy. The magnets were stable magnetically to shock, vibration, centrifugal force and stray magnetic fields. The application of a protective coating was recommended to prevent corrosion in atmospheres of high RH. The processing techniques for bismanol magnets were improved by eliminating magnetic separation. Excess Bi is separated from the melt by hot-pressing prior to pulverization. Bismanol magnets were made with maximum energy products up to 5.3×10^6 gauss-oersteds. Present maximum value for the coercive force is 3,650 oersteds and 4,800 gauss for the residual flux density. Various types of pulverizing

[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] United States Naval Ordnance Laboratory, Bismanol Permanent Magnets, Evaluation and Processing: Navord Rept. 2686, Jan. 5, 1953.

equipment were also evaluated with respect to the magnetic properties of the resulting compacts. Methods are discussed for determining percentage purity (Mn–Bi content), alignment, and effective particle size in bismanol magnets.

The dynamic corrosion of steel by liquid bismuth was a subject of a report. The report [6] states that:

> Bismuth offers desirable possibilities as a heat transfer medium for nuclear application because of its low melting point, high boiling point and nuclear properties. However, such an application presents certain corrosion-problems. The difficulties of containing Bi at elevated temperatures in a dynamic system prompted this investigation of the mass transfer corrosion of steel. Studies were made with thermal syphon loops, generally fabricated from the same material as the test strips, in which the test materials were subject at 1,290° F to Bi flowing at 0.1 f. p. s. under conditions defined by a Reynolds number between 3,000 and 4,000. The "cold spot" temperatures were maintained at 1,140° F to 1,165° F. The use of additives, the application of protective coatings and the corrosion resistance of some alloy steels were considered as possibilities for reducing penetration rates. * * *

The recovery of bismuth from refinery byproducts was discussed in an article.[7] It provides notes of various refining methods, and the author emphasizes that, to form a true criterion of bismuth recovery on a large scale, improved electrorefining methods must be studied.

A United States patent was issued in 1953 relative to indium-bismuth-tin alloys.[8]

WORLD REVIEW

Bolivia.—In 1953 Bolivia exported about 63 metric tons of bismuth contained in concentrates as compared with 16 tons in 1952.

Canada.—The principal source of bismuth in Canada is residues from electrolytic refining of lead bullion by the Consolidated Mining & Smelting Co. of Canada, Ltd., Trail, B. C. Bismuth also occurs in association with molybdenite in the ore of the La Corne mine in western Quebec.

Korea, Republic of.—Bismuth occurs as a mineral, bismuthinite, in the tungsten ores of the Sang Dong mine, South Korea. Bismuth production increased from 110 metric tons in 1952 to 240 tons in 1953.

Mexico.—Production of bismuth in Mexico totaled 365 metric tons in 1953 and exports 261 tons, of which 146 tons was shipped to the United Kingdom, 113 tons to the United States, and 2 tons to Belgium.

Cia Metalurgica Penoles, at Monterrey, initiated the production of refined-bismuth bars during the second quarter of 1953, the first such production in Mexico. Refined bars represented 44 tons of the total country output of 365 tons; the remainder was in the form of bismuth-lead bars.

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[6] Elgert, O. J., and Egan, C. J., Dynamic Corrosion of Steel by Liquid Bismuth: Nuclear Science Abs., vol. 7, No. 8, Apr. 30, 1953, p. 280.

[7] Downie, C. C., Recovery of Bismuth From Refinery Byproducts: Mining Jour. (London), vol. 240, No. 6136, Mar. 27, 1953, pp. 362–363.

[8] Smith, Albert A., Process Relates to Low-Melting Alloys Composed of 31–33 Percent Bismuth, 50–52 Percent Indium, and 16–18 Percent Tin: U. S. Patent 2,649,368, Aug. 18, 1953.

Peru.—One of the world's largest producers of bismuth is the Cerro de Pasco Corp. In 1953 the production of bismuth (metal content) in Peru totaled 287 metric tons compared with 324 in 1952. In 1953, 255 tons was shipped to the United States, 18 tons to the United Kingdom, and 6 tons to South and Central America.

United Kingdom.—Bismuth ores and residues were smelted and refined by Capper Pass & Son, Ltd., Bristol; Derby & Co., Ltd., Brimsdown, Middlesex; and Mining & Chemical Products, Ltd., London.

TABLE 3.—World production of bismuth, by countries,[1] 1944–48 (average) and 1949–53, in kilograms [2]

[Compiled by Pauline Roberts]

Country	1944–48 (average)	1949	1950	1951	1952	1953
North America:						
Canada (metal) [3]	97,867	46,680	86,917	104,461	73,651	44,824
Mexico (in impure bars)	163,949	309,344	263,000	338,000	406,069	[4] 365,367
United States	(5)	(5)	(5)	(5)	(5)	(5)
South America:						
Argentina:						
Metal	[6] 15,624	(7)	(7)	(7)	[6] 500	(7)
In ore	[6] 17,500	(7)	(7)	(7)	[6] 500	(7)
Bolivia (in ore and bullion exported) [8]	33,483	8,222	24,443	69,081	15,930	62,928
Peru:						
Metal	277,008	215,707	226,851	262,655	321,098	286,669
In lead-bismuth alloy	28,287	2,398	------	------	3,146	
Europe:						
France (in ore)	22,800	59,000	78,000	59,000	58,000	(7)
Spain (metal)	14,836	19,854	11,344	15,180	12,267	(7)
Sweden	4,688	------	------	------	(7)	(7)
Yugoslavia (metal)	[6][9] 36,947	38,100	60,531	87,760	98,700	98,452
Asia:						
China (in ore)	3,776	[6] 5,000	(7)	(7)	(7)	(7)
Japan (metal)	26,421	25,946	33,049	42,010	44,000	50,000
Korea, Republic of	[9] 34,667	173,420	(7)	12,500	110,000	240,000
Africa:						
Belgian Congo (in ore)	254	540	668	225	470	(7)
South-West Africa (in ore) [6]	------	500	7,200	100	------	------
Uganda	793	7,519	3,658	2,896	2,800	(7)
Union of South Africa (in ore)	515	5,045	7,649	3,184	1,538	[6] 1,000
Australia (in ore) [10]	3,272	660	914	1,168	1,422	500
World total (estimate)	1,300,000	1,500,000	1,400,000	1,700,000	1,800,000	1,900,000

[1] Bismuth is believed to be produced also in Brazil, Germany, Rumania, U. S. S. R., and United Kingdom. Production figures are not available for these countries, but estimates by 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] Includes 46,092 kilograms of refined bismuth and other.
[5] Production included in total: Bureau of Mines not at liberty to publish separately.
[6] Estimate.
[7] Data not available; estimate by senior author of chapter included in table.
[8] Excludes bismuth content of tin concentrates exported.
[9] Average for 1946–48.
[10] Partly estimated. Excludes content of some bismuth-tungsten concentrates.

Boron

By Joseph C. Arundale[1] and Flora B. Mentch[2]

THE BORON-COMPOUNDS industry in the United States originated nearly a century ago in California and Nevada. In the early years of its development it was burdened with difficulties, but after a varied history of failure and success it evolved as the world's principal source of boron.

Sales of boron minerals and compounds by producers in 1953 were greater than in any previous year except 1951.

TABLE 1.—Salient statistics of boron minerals and compounds in the United States, 1944–48 (average) and 1949–53

	1944–48 (average)	1949	1950	1951	1952	1953
Sold or used by producers:[1]						
Short tons:						
Gross weight	397, 415	467, 592	647, 735	862, 797	583, 828	715, 228
B_2O_3 content	121, 300	139, 200	191, 000	241, 000	169, 100	213, 300
Value[2]	$9, 356, 532	$11, 511, 893	$15, 890, 000	$20, 030, 000	$14, 105, 000	$17, 668, 000
Imports for consumption (refined):						
Pounds	21, 366	886	[3] 1, 224	1, 424	[4] 860	624
Value	$1, 357	$435	[3] $416	$497	[4] $306	$216
Exports:						
Short tons	57, 243	109, 491	142, 580	213, 445	103, 292	139, 317
Value	$3, 006, 395	$6, 862, 928	$8, 301, 081	$13, 322, 383	$6, 723, 925	$8, 971, 987
Apparent consumption: Short tons[5]	340, 183	358, 101	505, 167	649, 353	480, 536	575, 911

[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

Borax was being recovered from small lakes in Lake County, Calif., as long ago as 1864. A few years later both borax and ulexite were recovered from a number of saline marshes in California and Nevada. For several years before 1895 borax was produced from Borax Lake (now known as Searles Lake). The scene then shifted to Death Valley, where Pacific Coast Borax Co. began producing colemanite. Production from Searles Lake began again in 1908 and since 1916 has been continuous. Various materials, such as potash, salt cake, bromine, and lithium phosphate, are recovered as coproducts. Searles Lake is a playa from which the saline constituents are recovered by pumping from wells drilled into the porous salt body.

[1] Assistant chief, Construction and Chemical Materials Branch.
[2] Statistical assistant.

Discovery of the large bedded deposit of kernite and tincal in the Kramer district was reported in 1926, and since that time the deposit has developed into the world's principal source of boron compounds. This deposit is a 200- to 250-foot-thick series of beds of boron minerals interlayered with shale and covered by up to several hundred feet of alluvial sediments. The deposit is mined by shrinkage stoping and room-and-pillar methods.

Domestic production of boron minerals in 1953 was confined to California, as it has been for many years. The following firms reported production of boron compounds from natural sources: American Potash & Chemical Corp., 3030 West Sixth St., Los Angeles 54, Calif., recovered boron compounds from the brine of Searles Lake at Trona, Calif.; Pacific Coast Borax Co., 630 Shatto Pl., Los Angeles 5, Calif., mined kernite (hydrous sodium borate) from a bedded deposit 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.; West End Chemical Co., 608 Latham Square Building, Oakland 12, Calif., recovered boron compounds from the brine of Searles Lake; and Columbia-Southern Chemical Corp. produced borax in Inyo County, Calif.

The following firms produced boron alloys and related compositions:

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

It is estimated that about half of the boron compounds sold are consumed by the ceramics industry, about equally divided between glass and other ceramics. These compounds act as a flux in the manufacture of glass and other ceramics and also impart useful properties to the glass, such as lowering the coefficient of expansion and increasing the durability and index of refraction. The use of boron in agriculture is increasing as more soils are treated to correct a deficiency of this element.

Soaps and cleansing compounds long have had borax as an ingredient, and it is a constituent of some of the new synthetic detergents. Borax or boric acid is used in pharmaceuticals, starches, adhesives, and chemicals. They also find use in fireproofing, smelting, tanning, and hundreds of other applications.

In recent years there has been much interest in boron steels, wherein boron effects a saving of critical alloying metals, such as chromium, nickel, and molybdenum. However, the quantity of required boron in steel is comparatively small. Only a few thousandths of 1 percent by weight of such steel is boron.

TABLE 2.—Consumption of alloying metals in the manufacture of steel in the United States, 1950–53 [1]

	Pounds of named alloying metal contained			
	1950	1951	1952	1953
Boron	(2)	29,594	48,973	35,015
Chromium	247,649,084	305,289,694	278,085,534	322,134,071
Cobalt	[3] 2,040,118	2,581,689	2,633,413	2,546,384
Columbium	752,121	[3] 453,722	340,871	300,592
Manganese	(2)	(2)	930,541,611	1,165,345,307
Molybdenum	17,242,931	19,069,143	16,530,769	22,066,723
Nickel	79,135,137	75,914,210	84,854,360	79,202,666
Titanium	4,932,319	5,202,645	4,909,339	4,877,225
Tungsten	3,929,779	3,783,382	2,650,147	3,380,867
Vanadium	1,825,831	3,310,898	3,050,586	3,227,900
Zirconium	1,834,977	1,783,443	1,449,282	1,816,392

[1] American Iron and Steel Institute, Annual Statistical Report: New York, N. Y., 1953, p. 17.
[2] Data not available.
[3] Revised figure.

TABLE 3.—Production of alloy-steel ingots (other than stainless steel ingots) in the United States, net tons [1]

Grade	1952		1953	
	Without boron	With boron	Without boron	With boron
Carbon boron		(2)		21,269
Nickel	29,811		30,884	
Molybdenum	223,053	143,024	406,757	95,482
Manganese	281,193	26,010	331,230	29,967
Manganese-molybdenum	189,221	6,223	290,706	314
Chromium	1,329,789	99,503	1,621,496	100,177
Chromium-vanadium	101,154	10	62,038	
Nickel-chromium	88,565	25,857	164,824	390
Chromium-molybdenum	1,187,435	4,405	1,177,141	1,862
Nickel-molybdenum	146,092	13,085	189,286	6,085
Nickel-chromium-molybdenum	1,388,068	316,502	1,415,479	202,615
Silico-manganese	99,963		105,096	
All other	582,038	27,517	709,542	6,955
Subtotal	5,646,382	662,136	6,504,479	465,116
High-strength steels	796,758	40,739	986,139	32,099
Silicon sheet steels	940,666		1,220,404	
Total all grades	7,383,806	702,875	8,711,022	497,215

[1] American Iron and Steel Institute, Annual Statistical Report: New York, N. Y., 1953, p. 45.
[2] Data not available.

Promising new and potential applications of boron compounds have been listed as a coating material for wear-, corrosion-, and heat-resistant purposes, as a constituent of antiknock compounds, jet and rocket fuels, and certain alloy steels.[3]

PRICES

In May the price of most boron compounds was advanced, the first significant increase since 1951.

Borax, technical, anhydrous, bags, carlots, works was quoted at $74.50 per ton through May and $78 per ton for June through December; ton lots, ex-warehouse, New York or Chicago, was quoted at $120.25 per ton through May and $125.75 per ton from June through December. Granulated, 99½ percent, bags, carlots, works, was quoted at $37.75 per ton through May and $41.25 per ton from June through December; ton lots, ex-warehouse, New York or Chicago, was quoted ot $83.50 per ton through May and $89 per ton from June through December. Powder, bags, carlots, works, was quoted at $42.75 per ton through May and $46.25 per ton from June through December; ton lots, ex-warehouse, New York or Chicago, was quoted at $88.50 per ton through May and $94 per ton from June through December. Boric acid, 99½ percent, crystals, bags, carlots, works, was quoted at $120.75 per ton through May and $124.25 per ton from June through December; ton lots, ex-warehouse, New York or Chicago, was quoted at $166.50 per ton through May and $172 per ton from June through December. Granulated, bags, carlots, works, was quoted at $95.75 per ton through May and $99.25 per ton from June through December; ton lots, ex-warehouse, New York or Chicago, was quoted at $141.50 per ton through May and $147 per ton from June through December.

FOREIGN TRADE[4]

Boron compounds are exported from the United States to nearly all countries in the world. In 1953, 139,317 short tons was exported. Only a few hundred pounds of boron compounds was imported. Imports of boron carbide from Canada totaled 72,526 pounds.

TECHNOLOGY

During 1953 the Bureau of Mines continued its research on the production, fabrication, and testing of hard and refractory borides. The trade journals and scientific press reported extensively on the research on boron steels, borohydrides, and boron in agriculture.

Useful bibliographies on boron are published periodically by some boron-compounds producers and other organizations.[5]

A method developed by Cooper Metallurgical Associates, Cleveland, Ohio, for producing pure boron was described. The method consists of the electrolysis of a fused bath of potassium chloride or fluoride, potassium fluoborate, and boron oxide in an electrolytic cell consisting of an externally heated crucible of graphite, which serves as

[3] Williams, Clyde, New Uses for Boron: Monthly Business Review Federal Reserve Bank of Cleveland vol. 35, No. 6, June 1953, p. 8.

[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] American Potash Institute, List of References to Boron Literature: Washington, D. C.
Pacific Coast Borax Co., Boron-o-gram: New York, N. Y.

TABLE 4.—Exports of boric acid and borates, crude and refined from the United States in 1953, by countries of destination

[U. S. Department of Commerce]

Country	Pounds	Value
Argentina	20,900	$524
Australia	4,831,234	190,758
Austria	4,214,557	101,824
Belgian Congo	3,000	378
Belgium-Luxembourg	8,971,612	276,134
Bolivia	1,000	158
Brazil	4,181,074	146,194
British Western Pacific Islands	15,000	2,334
Canada	24,339,386	976,267
Canal Zone	17,150	1,809
Ceylon	12,320	543
Colombia	1,189,773	49,985
Costa Rica	179,060	7,246
Cuba	903,170	32,096
Denmark	988,281	23,474
Dominican Republic	34,048	2,940
Ecuador	7,100	651
Egypt	675,442	18,168
El Salvador	2,000	420
Finland	1,019,588	26,643
France	30,682,109	856,812
Germany, West	39,040,502	1,082,855
Greece	633,830	15,408
Guatemala	750	156
Haiti	4,204	485
Honduras	1,000	160
Hong Kong	3,288,838	97,654
India	905,500	49,025
Indonesia	122,426	7,911
Iran	692,017	18,657
Iraq	622	143
Ireland	1,780,960	53,513
Israel-Palestine	353,448	13,929
Italy	11,995,360	298,586
Japan	18,733,981	523,081
Korea	60,000	1,176
Mexico	4,890,909	228,521
Netherlands	22,573,550	721,194
Netherlands Antilles	1,250	211
New Zealand	1,537,786	60,359
Nicaragua	18,000	2,598
Norway	1,401,526	55,326
Pakistan	171,824	7,660
Panama, Republic of	3,300	370
Peru	621,219	20,834
Philippines	1,354,489	66,276
Portugal	625,751	22,152
Saudi Arabia	500	111
Southern Rhodesia	164,570	8,076
Spain	180,565	5,470
Sweden	3,373,809	109,150
Switzerland	6,855,844	281,025
Taiwan	670,446	20,644
Tangier	72,018	3,195
Thailand	19,845	1,342
Union of South Africa	1,803,622	83,723
United Kingdom	71,055,928	2,344,011
Uruguay	5,540	303
Venezuela	272,326	17,199
Yugoslavia	1,058,287	34,140
Total	278,634,146	8,971,987

the anode, and a low-carbon iron plate mounted for vertical movement into and out of the bath as the cathode.[6]

A report was published on a method for determining water soluble boron in fertilizers. The process is a modification of the official method of the Association of Official Agricultural Chemists.[7]

A series of alloys containing 18 and 20 percent chromium, with vari-

[6] Chemical and Engineering News, Electrolytic Process Gives Pure Boron in Commerical Quantities: Vol. 31, No. 28, July 13, 1953, pp. 2880, 2882.

[7] Berry, Rodney C., Report on Boron in Mixed Fertilizers· Jour. Assoc. Off. Agric. Chem., vol. 36, No. 3, Aug. 15, 1953, pp. 623–628.

ous balances between nickel, cobalt, iron and boron, were subjected to oxidation tests in air at 1,650°, 1,830°, and 2,012° F.—temperatures above those encountered in gas-turbine applications, to accelerate the oxidation.

Results of this investigation were said to indicate that iron and boron and, to a smaller extent, cobalt have an adverse effect on the oxidation resistance. Molybdenum strongly decreases the alloys' resistance to oxidation. Boron was found to promote the formation of complex spinel- and wolframite-type oxides.

It was concluded that, while boron has an adverse effect on the oxidation resistance of chromium-nickel-iron-cobalt alloys, boron-bearing alloys may be designed that have oxidation resistance comparable to those without boron by proper control of composition. This may be accomplished, primarily by keeping the iron content below 6 percent, using tungsten rather than molybdenum as a strengthening agent, and avoiding excessive cobalt contents, largely through replacement with nickel.[8]

It was reported that boron compounds had been used successfully as tracers in oil fields to detect channeling or bypassing of water injected into underground reservoirs. A good tracer material is said to be: (1) Susceptible to quantitative determination methods at very low concentrations; (2) absent or present only in trace quantities in natural waters; (3) unreactive with the input or connate waters to form a precipitate; (4) not absorbed by reservoir rocks; (5) reasonably water-soluble so that the required concentrations may be introduced at input wells; and (6) cheap and readily available.

These requirements are almost completely satisfied by boron in the forms of borax and boric acid.[9]

The Borolite Corp., with headquarters in Niagara Falls, N. Y., was organized by Firth-Sterling Inc., Carborundum Co., and American Electro Metal Corp. to conduct research on metal borides. Such borides as those of zirconium, chromium, and molybdenum may be used in crucibles for melting metals, protector tubes for thermocouples, nozzles for metal spraying equipment, and metal contacts because of their electrical conductivity, hardness, and erosion resistance.[10]

Results of tests were reported to have shown that the overheating characteristics of steel are affected by the type of boron ferroalloy used as the addition agent.[11]

The results of research during the past several years on methods of preparing diborane and borohydrides were summarized in several articles. These investigations led to preparation of borohydrides of sodium, potassium, and uranium and some of their derivatives, as well as new types of substances such as sodium trimethoxyborohydride formed by the addition of compounds of trivalent boron to alkali metal hydrides. Sodium borohydrides, as well as sodium trimethoxyborohydride, are of special interest because of their potential usefulness as reducing agents and sources for generating hydrogen. Uranium borohydride and its derivatives are of interest because they

[8] Binder, W. O., and Weisert, E. D., Some Notes on the Oxidation Resistance of Boron-Containing Chromium-Nickel-Cobalt-Iron Alloys: Corrosion (abs.), vol. 9, No. 9, September 1953, pp. 329–332.

[9] Carpenter, P. G., Morgan, T. D., and Parsons, E. D., Boron Compounds Used as Water-Flood Tracers: World Oil, vol. 136, No. 5, April 1953, pp. 214, 216, 218, 220.

[10] American Metal Market, vol. 60, No. 235, Dec. 8, 1953, p. 1.

[11] Field, J., Effect of Boron on the Overheating Temperature of Steel: Metal Progress, vol. 64, No. 2, August 1953, pp. 77–83.

are the most volatile compounds of uranium except the hexafluoride.[12]

The arc method for preparing diborane was described, and an improved procedure which reduces the quantity of liquid nitrogen and decreases greatly the time required for the generation of diborane was outlined. Pyridine was used in separating diborane from hydrogen halides and other impurities.[13]

The reaction between methyl borate and sodium hydride produces a product, $NaBH(OCH_3)$, which is useful in the preparation of diborane and is readily transformed to sodium borohydride. Research on these and related procedures and products was described.[14]

Boron fluoride ethyl etherate reacts with either sodium or lithium hydride to form diborane. The rate of reaction depends upon the physical state of the metal hydride. In most instances the yield based upon the metal hydrides was no better than 40 to 60 percent unless very finely divided hydrides were used or the reaction was run in equipment providing a grinding action on the solid hydride. However, sodium trimethoxyborohydride is far more reactive than the metal hydrides and yields of diborane approaching the theoretical were reported to have been obtained with short reaction times.[15]

In the presence of diethyl ether, lithium hydride reacts readily with diborane to form lithium borohydride. The latter is also formed by reaction of diborane with either lithium ethoxide or lithium tetramethoxyborohydride. Lithium borohydride is purified by recrystallization from ethyl ether; the etherate $LiBH_4 \cdot (C_2H_5)_2O$ is obtained, and the ether can be removed. Sodium borohydride may be prepared by the reaction of diborane with either sodium methoxide or sodium tetramethoxyborohydride. Potassium borohydride is obtained by the reaction of potassium tetramethoxyborohydride with diborane. These processes were described in detail.[16]

A simple method of preparing sodium borohydride is by rapid reaction at 225° to 275° of 1 mole of methyl borate with 4 moles of sodium hydride. Isopropylamine extracts the sodium borohydride from the reaction product, and nearly quantitive yields of essentially pure sodium borohydride are obtained.[17]

Aluminum borohydride is prepared by the reaction of either sodium or lithium borohydride with aluminum chloride or bromide. The aluminum borohydride, as the most volatile constituent of the reaction mixture, is readily distilled away from the less volatile products and reactants. Beryllium borohydride is prepared by the reaction of

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[12] Schlesinger, H. I., and Brown, Herbert C., in collaboration with Abraham, B., Bond, A. C., Davidson, Norman, Finholt, A. E., Gilbreath, James R., Hoekstra, Henry, Horvitz, Leo, Hyde, Earl K., Katz, J. J. Knight, J., Lad, R. A., Mayfield, Darwin L., Rapp, Louis, Ritter, D. M., Schwartz, Anthony M., Sheft, Irving, Tuck, L. D., and Walker, A. O., New Developments in the Chemistry of Diborane and the Borohydrides. I. General Summary: Jour. Am. Chem. Soc., vol. 75, No. 1, Jan. 5, 1953, p. 186.

[13] Schlesinger, H. I., Brown, Herbert C., Abraham, B., Davidson, Norman, Finholt, A. E., Lad, R. A., Knight, J., and Schwartz, Anthony M., Improved Arc Process for the Preparation of Diborane. Purification of Diborane: Jour. Am. Chem. Soc., vol. 75, No. 1, Jan. 5, 1953, p. 191.

[14] Brown, Herbert C., Schlesinger, H. I., Sheft, Irving, and Ritter, D. M., Addition Compounds of Alkali Metal Hydrides. Sodium Trimethoxyborohydride and Related Compounds: Jour. Am. Chem. Soc., vol. 75, No. 1, Jan. 5, 1953, p. 192.

[15] Schlesinger, H. I., Brown, Herbert C., Gilbreath, James R., and Katz, J. J., Reaction of the Boron Halides with the Alkali Metal Hydrides and With Their Addition Compounds; a New Synthesis of Diborane: Jour. Am. Chem. Soc., vol. 75, No. 1, Jan. 5, 1953, p. 195–199.

[16] Schlesinger, H. I., Brown, Herbert C., Hoekstra, Henry R., and Rapp, Louis R., Reactions of Diborane With Alkali Metal Hydrides and Their Addition Compounds. New Syntheses of Borohydrides. Sodium and Potassium Borohydrides: Jour. Am. Chem. Soc., vol. 75, No. 1, Jan. 5, 1953, p. 199.

[17] Schlesinger, H. I., Brown, Herbert C., and Finholt, A. E., The Preparation of Sodium Borohydride by the High-Temperature Reaction of Sodium Hydride With Borate Esters: Jour. Am. Chem. Soc., vol. 75, No. 1, Jan. 5, 1953, p. 205.

beryllium halides with lithium borohydride. Lithium borohydride may be prepared by metathesis between sodium borohydride and lithium chloride in isopropylamine solution.[18]

Simple procedures have been developed that permit conversion of boric oxide, boric acid, or borax into the methyl borate-methanol azeotrope. The properties of this azeotrope have been investigated. Methods have been examined for separating the ester from the azeotrope by procedures involving (1) washing the azeotrope with sulfuric acid, (2) azeotropic distillation with carbon disulfide, and (3) treatment with salts. These procedures permit methyl borate to be prepared in yields of 90 percent or better.[19]

Some borohydride reacts slowly with water to liberate hydrogen at room temperature. The reaction is accelerated by increasing the temperature or by the addition of acidic substances. For this purpose boric oxide is effective when the objective is generation of hydrogen. Certain metal salts, especially that of cobalt chloride, have a catalytic effect.[20]

Uranium borohydride was prepared by the reaction of uranium fluoride with excess aluminum borohydride.[21]

A monomethyl and a tetramethyl derivative of uranium borohydride have been prepared by treating uranium borohydride with trimethylboron.[22]

Research continued on the preparation of boron steels and their characteristics, properties, and performance. Results of tests on the machining characteristics of 6 standard alloy steels and 7 equivalent boron steels were said to have shown that the boron steels had better machinability than the equivalent standard steels. The difference was said to be more pronounced in cutting with high-speed steels than in machining with carbides.[23]

The performance of boron steels in process before heat treating was discussed in an article. The machinability, cold and hot forming, and welding of boron-treated steels in terms of performance in industry and of laboratory testing were reviewed. The author reached the conclusion that working of boron-treated steels in the shop should cause no more trouble than any alloy steel. In most instances it was claimed that boron-treated steels gave considerably better shop performance and economy than the higher alloy steels formerly used.[24]

Five low-alloy steels were made, each with 1 ingot treated with and 1 ingot without boron. Tensile and impact tests in the hardened and tempered condition were carried out, and the hardenability was investigated by Jominy end-quench tests and hardness traverses. From these data an attempt was made to assess the possibilities and

[18] Schlesinger, H. I., Brown, Herbert C., and Hyde, Earl K., The Preparation of Other Borohydrides by Metathetical Reactions Utilizing the Alkali Metal Borohydrides: Jour. Am. Chem. Soc., vol. 75, No. 1, Jan. 5, 1953, p. 209.

[19] Schlesinger, H. I., Brown, Herbert C., Mayfield, Darwin L., and Gilbreath, James R., Procedures for the Preparation of Methyl Borate: Jour. Am. Chem. Soc., vol. 75, No. 1, Jan. 5, 1953, p. 213.

[20] Schlesinger, H. I., Brown, Herbert C., Finholt, A. E., Gilbreath, James R., Hoekstra, Henry R., and Hyde, Earl K., Sodium Borohydride, Its Hydrolysis and Its Use as a Reducing Agent and in the Generation of Hydrogen: Jour. Am. Chem. Soc., vol. 75, No. 1, Jan. 5, 1953, p. 215.

[21] Schlesinger, H. I., and Brown, Herbert C., Uranium (IV) Borohydride: Jour. Am. Chem. Soc., vol. 75, No. 1, Jan. 5, 1953, pp. 219-221.

[22] Schlesinger, H. I., Brown, Herbert C., Horvitz, L., Bond, A. C., Tuck, L. D., and Walker, A. O., The Methyl Derivatives of Uranium (IV) Borohydride: Jour. Am. Chem. Soc., vol. 75, No. 1, Jan. 5, 1953, pp. 222-224.

[23] Zlatin, Norman, Kahles, J. F., and Friedlander, W. H., How Do Boron Steels Compare in Machinability? Iron Age, vol. 172, No. 18, Oct. 29, 1953, pp. 94-97.

[24] Raher, G. D., Processing of Boron Steels in the Shop: Metal Progress, vol. 63, No. 5, May 1953, pp. 85-89.

extent of alloy conservation that can be achieved by boron treatment. It was concluded that: [25]

1. In all the steels tested, boron increased the hardenability as shown by Jominy end-quench tests and hardness traverses.
2. With steels hardened and tempered between 500° and 600° C. the effect of boron on the mechanical properties varies with size at the time of heat-treatment. Each steel can be divided into three size groups, the limits of which vary from steel to steel.
   (a) In small sizes, in which both boron-free and boron-treated steels harden fully, boron has no effect.
   (b) In intermediate sizes, in which the boron-free steel does not harden fully but the boron-treated steel does, the boron-free steel has to be tempered at a lower temperature than the boron-treated steel to give equal mechanical properties.
   (c) In large sizes, in which neither the boron-free nor the boron-treated steels harden fully, tensile properties are similar, but the impact values obtainable on the boron steels are inferior—usually very much so—to those on the boron-free steels.
3. In certain sizes the addition of boron makes it possible to achieve a tensile strength unobtainable in the same steel without boron, except by tempering at temperatures lower than those usually considered suitable.
4. The possibility of conserving alloying metals, in the compositions studied, by the use of boron when tensile and impact tests are specified is confined to the intermediate size group.
5. On the basis of specifications En 15, En 16, and En 17, the Mo saved by the use of boron in 1½ percent Mn steels with Mo varied from nil to about 0.2 percent, depending on size.
6. In small sizes tempered at 400° C. or below, boron improves the impact values and, to a less extent, the ductility as indicated by elongation and reduction in area.
7. Both boron-free and boron-treated steels have higher yield ratios when fully hardened than when partially hardened. Boron imparts no advantage in this respect except that, by virtue of increased hardenability, good yield ratios are achieved in larger sizes than if boron were not present.

The carburized end-quenched test was used to evaluate the effect of boron on the case hardenability of 80B20, 94BV20, 94B20, and 47B20 steels over the range of carbon contents between 0.60 and 1.0 percent for several heat-treating conditions. Boron-free steels of substantially the same base analyses were procured and processed through all treatments with their boron-treated counterparts. Double quench treatments were simulated by gas carburizing the end-quench bars at 1,700° F. (925° C.), air cooling, reheating to quenching temperatures of 1,475°, 1,525°, 1,600°, and 1,700° F. (800°, 830°, 870°, and 925° C.) and end quenching. Two single-quench treatments were performed by pack carburizing the end-quench bars at 1,700° F. (925° C.), direct end-quenching one group and pot-cooling the other to 1,525° F. (830° C.) before end quenching.

It was concluded that:

1. For all heat treatments used, the effect of boron on the case hardenability of all four boron-treated steels investigated decreased with increase in carbon content.
2. In double-quench practice, the effect of boron is low to negligible at high carbon levels with a normal hardening temperature in the 1,475° to 1,525° F. (800° to 830° C.) range. In general, the boron effect increased with quenching temperature at a given carbon level.
3. Both single-quench treatments employed yielded much higher boron effects at the higher carbon levels than double-quench treatments at normal hardening temperatures. Both treatments yielded results about equal to that obtained on

[25] Wilcock, R., Effect of Boron on the Mechanical Properties of Low-Alloy Steels: Jour. Iron and Steel Institute, vol. 173, part 4, April 1953, pp. 406, 418.

reheating and quenching from 1,700° F. (925° C.). No evidence of serious fading of the boron effect as a result of direct quenching was noted in the carbon range investigated and pot-cooling to 1,525° F. (830° C.) before quenching did not increase the boron effect.

4. In the normal hardening range of 1,475° to 1,525° F. (800° to 830° C.) with double-quench practice, the single heat of 94BV20 (treated with Grainal No. 1) tested exhibited negligible boron hardenability effect at all carbon levels investigated. Higher hardening temperatures and single-quench treatments yielded as large boron effects as any obtained. In contrast, a heat of 94B20 (Grainal No. 79 treated) showed much higher boron effects at low hardening temperatures and underwent only the normal small increase in boron effect with increase in quenching temperature.

5. Within the limits of hardenability measurement, the steels treated with Grainal No. 79 appeared to show the same behavior over the full range of alloy content from 80B20 to 47B20.[26]

Fundamental data on the rate of diffusion of boron in austenite and solubility of boron in iron and steel were obtained and provide partial explanations for some of the phenomena observed in boron steels. The rate of diffusion of boron was said to be about the same as carbon in austenite. The solubility of boron in austenite at normal heat-treating temperatures is less than 0.001 percent. A partial tentative Fe–B phase diagram in the important low boron concentration ranges and an equation representing the diffusion of boron in austenite were prepared.[27]

On the basis of metallographic, X-ray diffraction, and melting-point data, a Ti-B phase diagram was prepared in composition up to 33 percent boron.[28]

Isothermal embrittlement curves were prepared for two manganese steels having an identical base composition, but differing in that one of the steels contains 0.0034 percent boron, while the other was free of boron.

Susceptibility to reversible temper embrittlement at temperatures between 850° and 1,050° F. was increased by the boron. For all other tempering treatments that avoid reversible temper embrittlement, the two steels were found to have reasonably identical notched-bar toughness.

Classification of various forms of embrittlement arising during tempering was discussed.[29]

WORLD REVIEW

Boracite production in Turkey in 1953 was 6,386 metric tons compared with 13,730 in the previous year.

Italy reported production of 4,208 metric tons of boric acid (sassolite) in 1953 compared with 4,352 in 1952.

[26] Jatczak, C. F., and Rowland, E. S., The Influence of Boron on Case Hardenability in Alloy Carburizing Steels: Trans. Am. Soc. Metals, vol. 45, 1953, pp. 771, 782–783.

[27] Busby, Paul E., Warga, Mary E., and Wells, Cyril, Diffusion and Solubility of Boron in Iron and Steel: Jour. Metals, vol. 5, No. 11, sec. 1, November 1953, p. 1463.

[28] Palty, A. E., Margolin, H., and Nielsen, J. P., Titanium-Nitrogen and Titanium-Boron Systems: Trans. Am. Soc. Metals, vol. 46, 1954, p. 312.

[29] Powers, A. E., and Carlson, R. G., The Effect of Boron on Notch Toughness and Temper Embrittlement: Trans. Am. Soc. Metals, vol. 46, 1954, p. 483.

Bromine

By Joseph C. Arundale[1] and Flora B. Mentch[2]

PRODUCTION of bromine and bromine compounds in the United States continued its steady growth. The 193 million pounds of bromine and its compounds sold by primary producers in 1953 was the largest volume of sales ever reported.

Bromine rarely occurs in mineral form but is found in numerous well brines and saline lake brines, and the sea is an inexhaustible source from which the bulk of current supply is recovered.

DOMESTIC PRODUCTION

Before the 1920's the domestic bromine industry was very small and supplied only minor quantities of bromine and its compounds to the pharmaceutical and photographic industries and for war gases. With introduction of a mixture of tetraethyl lead and ethylene dibromide as a gasoline antiknock compound the industry began an almost uninterrupted expansion. At the end of World War II sales dropped sharply but quickly recovered and began a greatly accelerated expansion to a new record high in sales of 192,629,000 pounds of bromine and bromine compounds in 1953.

Ethyl-Dow Chemical Co. recovers bromine from sea water at Freeport, Tex., and Westvaco Chemical Division of Food Machinery & Chemical Corp. operates a sea-water plant in the San Francisco Bay area. The following firms recover bromine from well brines in Michigan: The Dow Chemical Co., Midland and Ludington; Great Lakes Chemical Corp., Filer City; Michigan Chemical Corp., Eastlake and St. Louis; and Morton Salt Co., Manistee. Pomeroy Salt Co. at Minersville, Ohio, and Westvaco Chemical Division at South Charleston, W. Va., also treat well brines. American Potash & Chemical Corp. recovers bromine from the brine of Searles Lake in California.

TABLE 1.—Bromine and bromine in compounds sold by primary producers in the United States, 1944–48 (average) and 1949–53

Year	Pounds	Value	Year	Pounds	Value
1944–48 (average)	75,765,689	$14,546,411	1951	129,563,073	$26,179,556
1949	88,725,709	16,267,908	1952	156,201,577	30,639,292
1950	98,502,300	18,794,978	1953	164,143,348	35,372,386

[1] Assistant chief, Construction and Chemical Materials Branch.
[2] Statistical assistant.

TABLE 2.—Bromine and bromine compounds sold by primary producers in the United States, 1952–53

	Pounds		Value
	Gross weight	Bromine content[1]	
1952			
Elemental bromine	6,692,418	6,692,418	$1,273,659
Sodium bromide	909,637	706,333	261,582
Potassium bromide	2,663,940	1,788,836	708,424
Ammonium bromide	(2)	(2)	(2)
Other, including ethylene dibromide	173,452,068	147,013,990	28,395,627
Total	183,718,063	156,201,577	30,639,292
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

[1] Calculated as theoretical bromine content present in compound.
[2] Included with "Other, including ethylene dibromide."

CONSUMPTION AND USES

The largest single use for bromine is in ethylene dibromide, which is added to gasoline with tetraethyl lead as an antiknock compound. Not only is more gasoline being consumed but also better quality gasoline is required, as the compression ratios in modern automotive engines are continually increased. The mechanism of "preignition" and consequent engine knock is not thoroughly understood and intensive research is being conducted on this problem.[3]

Octane ratings can be raised by using more tetraethyl lead and ethylene dibromide. It has been reported that on the average, almost 40 percent more tetraethyl lead was being added per gallon of gasoline in 1953 than in 1946.[4]

Several commercial soil fumigants for controlling nematodes have bromine compounds as the active ingredient. These compounds are ethylene dibromide, methyl bromide, and chlorobromopropene. Of the three, ethylene dibromide is most widely used, only very small quantities of methyl bromide and chlorobromopropene being consumed.

For several years bromine compounds, such as methyl bromide, have been used in fumigating grains and seeds against infestation by insects.

Bromine compounds are used in photography and in water sterilization. They also are used in manufacturing dyes and colors, resins, and leather and rubber products, in permanent-wave kits, in pharmaceuticals, in flour and bread making, and in many organic synthesis processes.

In reclaiming used wool for reuse, dyes in the used material must be destroyed. The reducing agent used for this purpose would harm the

[3] National Bureau of Standards, Technical News Bulletin, New Data on Automotive Combustion: Vol. 37, No. 8, pp. 113–115.
Chemical and Engineering News, Preignition Puzzle: Vol. 32, No 21, May 24, 1954, pp. 2108–2110.
[4] Chemical and Engineering News, Gasoline Roundelay: Vol. 32, No. 19, May 10, 1954, pp. 1864–1866.

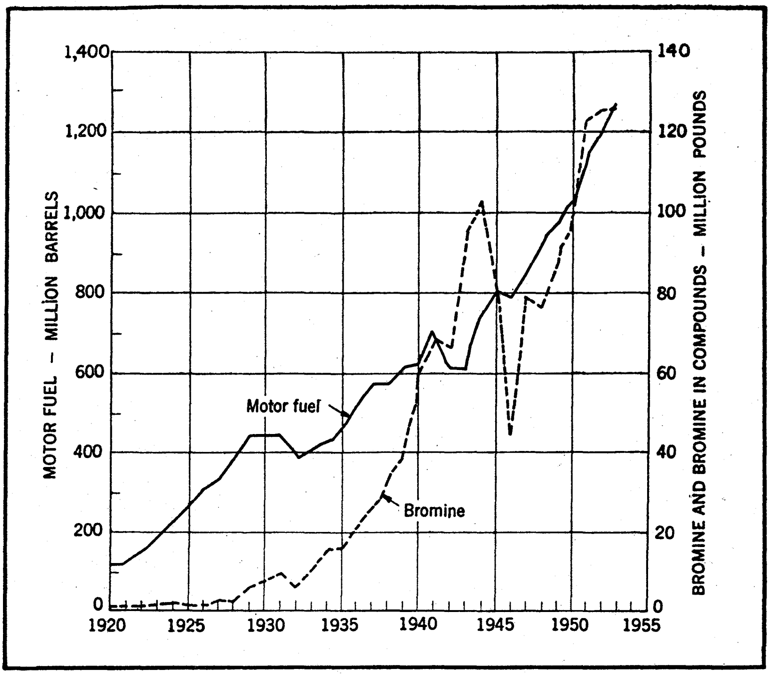

FIGURE 1.—Bromine and bromine in compounds sold or used and motor fuel produced, 1920–53.

fiber unless some additive agent, such as bromine, is employed. Bromine is considered to be more effective than chlorine at the high temperatures of the process.

PRICES

The price of bulk bromine was near the lowest quoted in its history, except for a brief period before the turn of the century when competition with Germany cut the price and for brief dips in times of depressed activity.

According to Oil, Paint and Drug Reporter the following prices were quoted for bromine and bromine compounds in 1953: Bromine, purified, cases, carlots, delivered east of the Rockies was quoted at 25 cents per pound for January through July, and 27 cents for August through December; less than carlots, up to 1,000 pound lots, same basis, was quoted at 27 cents per pound for January through July, and 29 cents per pound for August through December; drums, lead-lined, delivered, was quoted at 25 cents per pound for January through July, and 34 cents for August through December; potassium bromide, U. S. P., granular, barrels, kegs, was quoted at 34 cents per pound; potassium bromate, barrels, 1,000 pounds or more was quoted at 50 to 52 cents per pound; sodium bromide, U. S. P., barrels, kegs, works, was quoted at 34 to 35 cents. There was no change in price for potassium bromide, potassium bromate, or sodium bromide during 1953.

FOREIGN TRADE[5]

A total of 3,414,065 pounds of bromine, bromides, and bromates (not separately classified) valued at $1,865,427 was exported. Over 2¾ million pounds went to Brazil, nearly 350,000 pounds to Canada, and the remainder, in smaller lots, to about 38 other countries.

Only small quantities of bromine compounds have been imported into the United States in recent years. In 1953 only 575 pounds of unspecified bromine compounds were imported from United Kingdom, East Germany, and Australia.

TECHNOLOGY

A method for determining the bromine content of liquid hydrocarbons was outlined. It involved X-ray fluorescence of the sample, to which a known quantity of selenium is added. The ratio of bromine to selenium fluorescence is thereby determined as a function of bromine content. A series of calibration curves for hydrocarbons with known quantities of added bromine was prepared.[6]

The possibility of using ion-exchange methods for removing bromides and other dissolved inorganic impurities from organic liquids was investigated. Several anion-exchange resins were used to remove hydrobromic acid from various organic solvents. Good results were claimed in several experiments.[7]

A domestic firm advertised an unusually dry bromine. It was claimed that a typical analysis showed less than 30 parts per million of water and that the product was virtually harmless to nickel or monel, thereby eliminating the need for glass pipe and valves formerly needed in handling bromine in manufacturing processes.[8]

WORLD REVIEW

Australia.—The domestic demand for bromine and bromine derivatives reportedly is so limited that no attempt has been made to develop an industry dependent on the bromine content of sea water as a raw material. Before 1952 imports of bromine salts had shown a marked increase, owing to expansion of the photographic industry. As a result of the Commonwealth Government's import restrictions imposed in March 1952 imports of bromine salts were restricted, under Category A, to 40 percent of those in 1950–51. In 1952, 33,725 pounds of potassium bromate, 177,661 pounds of potassium bromide, and 92,600 pounds of other bromine compounds were imported.[9]

Japan.—Bromine is produced in Japan from bitterns as a byproduct of the sea-salt industry. Output in 1953 was reported to have been 758 metric tons.

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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.

[6] Chemical and Engineering News, vol. 31, No. 11, Mar. 16, 1953, p. 1082.

[7] Chance, F. S., Jr., Boyd, G. E., and Garber, H. J., Sodium and Bromide Removed from Solvents by Nonaqueous Ion Exchange: Ind. Eng. Chem., vol. 45, No. 8, August 1953, pp. 1671–1676.

[8] Chemical and Engineering News, vol. 31, No. 5, Feb. 2, 1953, p. 464.

[9] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 3, March 1954, pp. 42–43.

Cadmium

By Robert L. Mentch [1]

EXPANSION in many segments of the cadmium industry was the most significant development in that metal during 1953. Records were established in total supply, production, imports, consumption, and stocks. Total supply, consisting of output of metal and primary compounds at domestic plants and imports of metal, was 11,322,000 pounds or 1,276,000 pounds greater than the former high recorded in 1952. Primary production of 9,767,000 pounds and imports of 1,555,000 pounds were both new records, surpassing the previous high totals (production, 1950, and imports, 1952) by 6 and 5 percent, respectively. Apparent consumption of primary cadmium also attained a new peak—9,627,000 pounds, a 7-percent increase over the 1952 total and a slight gain over the former record established in 1950. Industrial consumption increased much more than the figures for apparent consumption indicate, inasmuch as the Government announced in February 1953 that cadmium purchases for the National Stockpile were no longer of the highest urgency and that completion of the later stages of stockpile inventories would be at a reduced rate. Nevertheless, stocks also advanced to record levels; metal producers', compound manufacturers', and distributors' inventories of metallic cadmium totaled 3,361,000 pounds on December 31 compared with ending stocks of 1,894,000 pounds in 1952. Metal producers' stocks increased over 1½ million pounds, owing largely to competition from imports, and accounted for the gain. The market price for commercial sticks of cadmium remained unchanged at $2.00 a pound throughout the year.

TABLE 1.—Salient statistics of the cadmium industry in the United States, 1944–48 (average) and 1949–53, in pounds of contained cadmium

	1944–48 (average)	1949	1950	1951	1952	1953
Production (primary)	7,983,695	8,226,617	9,190,394	8,311,337	8,567,159	9,767,197
Imports (metal)	28,573	157,204	630,109	90,065	1,478,770	1,555,140
Exports (metal)	409,940	566,135	352,927	606,233	[1] 300,918	[1] 65,866
Consumption, apparent	8,003,053	7,486,274	9,545,502	7,170,930	[2] 9,007,577	9,627,140

[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 flue dusts of zinc blende roasting furnaces and copper and

[1] Commodity-industry analyst.

lead blast furnaces, from zinc dust collected in the early stages of distillation in zinc retorts, from the high-cadmium precipitate obtained in purifying zinc electrolyte at electrolytic zinc plants, and from the zinc-cadmium sludge resulting from purification of zinc sulfate solutions used in manufacturing lithopone. A relatively small quantity of secondary metal is recovered from old bearings and other alloy scrap. United States production of primary cadmium is not wholly from domestic materials; a large portion of the output is obtained from foreign materials, notably imports of cadmium-bearing flue dust and zinc and lead ores and concentrates. In 1953, owing to unusually heavy imports of zinc concentrates, 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 are obtained from countries in the Western Hemisphere; Mexico is the chief source, followed by Canada and Peru.

The output of primary metallic cadmium at domestic plants increased 15 percent in 1953, while the production of primary compounds (cadmium content) decreased 53 percent. Recovery of cadmium in secondary metal and compounds declined 12 percent.

TABLE 2.—Cadmium produced and shipped in the United States, 1944–48 (average) and 1949–53, in pounds of contained cadmium

	1944–48 (average)	1949	1950	1951	1952	1953
Production:						
Primary:						
Metallic cadmium	7,635,339	8,023,616	8,849,690	8,114,238	8,387,824	9,682,197
Cadmium compounds [1]	348,356	203,001	340,704	197,099	179,335	85,000
Total primary production	7,983,695	8,226,617	9,190,394	8,311,337	8,567,159	9,767,197
Secondary (metal and compounds) [1,2]	152,070	384,398	427,052	167,957	80,000	70,000
Shipments by producers:						
Primary:						
Metallic cadmium	7,632,474	7,867,486	8,851,835	7,767,055	7,746,361	8,137,045
Cadmium compounds [1]	340,119	203,001	340,704	197,099	179,335	85,000
Total primary shipments	7,972,593	8,070,487	9,192,539	7,964,154	7,925,696	8,222,045
Secondary (metal and compounds) [1,2]	158,248	384,398	427,052	87,633	122,785	59,636
Value of primary shipments:						
Metallic cadmium	$8,734,957	$14,813,382	$17,925,482	$19,397,411	$17,130,966	$15,229,861
Cadmium compounds [3]	387,294	381,642	689,926	492,215	396,581	158,950
Total value	9,122,251	15,195,024	18,615,408	19,889,626	17,527,547	15,388,811

[1] Excludes compounds made from metal.
[2] Bureau of Mines not at liberty to publish figures separately for secondary cadmium compounds.
[3] Value of metal contained in compounds made directly from flue dust or other cadmium raw materials (except metal).

A list of plants producing cadmium metal in the United States in 1953 follows:

Primary metallic cadmium

Colorado: Denver—American Smelting & Refining Co.
Idaho:
  Bradley—Bunker Hill & Sullivan Mining & Concentrating Co.
  Kellogg—Sullivan Mining Co.
Illinois:
  Depue—New Jersey Zinc Co.
  East St. Louis—American Zinc Co. of Illinois.
Kansas: Coffeyville—Sherwin-Williams Co.
Missouri: Herculaneum—St. Joseph Lead Co.

Primary metallic cadmium—Continued

Montana: Great Falls—Anaconda Copper Mining Co.
Oklahoma: Bartlesville—National Zinc Co., Inc.
Henryetta—Eagle-Picher Co. (Mining & Smelting Div.)
Pennsylvania:
Donora—United States Steel Corp. (American Steel & Wire Div.)
Josephtown—St. Joseph Lead Co.
Texas: Corpus Christi—American Smelting & Refining Co.
Utah: International—International Smelting & Refining Co.

Secondary metallic cadmium

Arkansas: Jonesboro—Arkansas Metals Co.
New York: Whitestone, L. I.,—Neo-Smelting & Refining, Inc.

Output of cadmium oxide (cadmium content) increased 80 percent in 1953, and the cadmium content of sulfide pigments increased 37 percent. Data for the production of other cadmium compounds are not available.

TABLE 3.—Cadmium oxide and cadmium sulfide produced in the United States, 1944–48 (average) and 1949–53, in pounds

Year	Oxide		Sulfide [1]	
	Gross weight	Cd content	Gross weight	Cd content
1944–48 (average)	431,954	377,046	2,663,899	947,059
1949	570,993	497,876	2,631,888	999,386
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

[1] Includes cadmium lithopone and cadmium sulfoselenide.

CONSUMPTION AND USES

The apparent consumption of primary cadmium in all forms totaled 9,627,000 pounds in 1953, as computed by adding production and net imports of metal and adjusting for producers', distributors', and compound manufacturers' stock changes. This figure represented a gain of 7 percent over the quantity apparently consumed in 1952. In 1953, as in the preceding 5 years cadmium was purchased by the Federal Government for the National Stockpile, but at a reduced rate, owing to the favorable inventory position of cadmium in the Stockpile. The chief uses of cadmium are for electroplating, bearings, and pigments; these uses account for about 90 to 95 percent of the total consumption of cadmium, with electroplating by far the largest use. For the period 1940–44, 71 percent of the cadmium consumption of the United States was for electroplating, 11 percent for bearing alloys, 7 percent for pigments, and the remainder for solders, miscellaneous alloys, and various chemicals. More recent information on end uses is not available, but the current pattern is believed to be essentially the same as in 1940–44.

Electroplating.—Cadmium metal is used principally as a protective coating for iron and steel and, to a much smaller extent, for copper-base alloys and other metals and alloys. Its chief advantages as an electroplating medium in preference to zinc are as follows: (1) In thinner coatings or plating of equal thickness it provides superior protection in some applications, principally where the plated article is subjected to extended alkali or salt-water corrosion; (2) its rate of deposition for a given amperage of electric current is larger, hence electricity power costs are reduced; (3) on plated contacts its electrical resistance is lower; (4) it retains its metallic luster longer; (5) its plated parts are more easily soldered; (6) it is superior in throwing power, or ability to deposit uniformly on intricately shaped objects; (7) its electrodeposits are highly ductile; parts to be formed or stamped may be plated prior to these operations; (8) its cathode efficiency is considerably higher than that of zinc and therefore less difficulty is experienced with hydrogen embrittlement when plating on high-carbon steel; and (9) its plated parts have greater resistance to corrosion by galvanic action. The chief disadvantage of cadmium plating is its higher cost compared with zinc plating.

It was formerly thought that thinner coatings of cadmium provided protection equal to that of zinc in most atmospheres, but tests in recent years indicate that, for platings of equal thickness, zinc is actually superior to cadmium, particularly in industrial atmospheres.

Although data on the distribution of consumption are not available, it is believed that in 1953, as in 1952, zinc was used as a substitute for cadmium in many plating applications involving substantial quantities of metal. The use of zinc as a substitute for cadmium is attributed largely to its lower cost and more reliable supply.

Cadmium-Base Bearing Alloys.—A major use of cadmium is as a bearing alloy. Cadmium-base bearing alloys, which contain at least 97 percent cadmium, have low frictional properties, high strength and toughness at elevated temperatures, high melting points, temperature stability, and a wide range of hardness. These alloys have a much greater fatigue strength than the lead-base or tin-base alloys, have enough conformability to withstand shaft deflections without scoring or seizure, and are tough enough to prevent cracking at the edges. Cadmium-base bearing metals are used chiefly in internal-combustion engines for service under high pressures and temperatures and at high speeds. The most commonly used cadmium-base bearing alloys are the types containing approximately 1.3 percent nickel and 98.7 percent cadmium and the cadmium–silver–copper alloys containing 0.50 to 2.25 percent silver, 0.25 to 0.50 percent copper, and the remainder cadmium.

Cadmium Solders and Other Cadmium Alloys.—Relatively small quantities of cadmium are used in manufacturing low-melting-point alloys (chiefly tin–lead–cadmium, lead–tin–bismuth–cadmium, and zinc–lead–cadmium) for soldering and brazing and fusible alloys, composed largely of lead, bismuth, and cadmium, for sprinkler apparatus, fire-detector systems, and valve seats for high-pressure gas containers.

Cadmium alloys easily with copper and quantities up to 50 percent are contained in master alloys for addition to copper and bronze. Low-cadmium copper (0.7 to 1 percent cadmium) is very ductile and has found wide use in telegraphic, telephonic, and power-transmission wires, since cadmium imparts great durability and good tensile strength, hardness, and high annealing temperature and does not impair the conductivity of copper to any harmful extent. An alloy of copper–zirconium–cadmium, also used for power-transmission lines, is superior in strength and hardness to copper–cadmium alloys.

Cadmium Compounds.—The most important cadmium compounds are the sulfide and sulfoselenide, and their chief use is as paint pigments. These compounds are often extended with barium sulfate, in which case they are known as "lithopone." 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, and in atmospheres containing hydrogen sulfide which darkens paints containing lead owing to the formation of the black lead sulfide. Cadmium pigments are utilized principally where cheaper pigments cannot be used. Some of the more common uses of the pigments are in 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.

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, their physical properties, and uses can be found in the Cadmium chapter of Minerals Yearbook, 1949 (pp. 187–188).

STOCKS

Total domestic stocks of cadmium metal and cadmium contained in compounds, excluding consumers' stocks (other than compound manufacturers), for which data are not available, increased 75 percent during 1953. Details are given in table 4.

TABLE 4.—Cadmium stocks at end of year, 1952–53, in pounds of contained cadmium [1]

	1952 [2]			1953		
	Metallic cadmium	Cadmium compounds	Total cadmium	Metallic cadmium	Cadmium compounds	Total cadmium
Metal producers (primary)	1,502,593		1,502,593	3,047,745		3,047,745
Compound manufacturers	189,482	225,460	414,942	76,683	378,634	455,317
Distributors [3]	201,672	66,595	268,267	236,468	75,603	312,071
Total stocks [4]	1,893,747	292,055	2,185,802	3,360,896	454,237	3,815,133

[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 1,000,000 pounds at the end of 1944 (latest date for which figures were compiled).

PRICES

The quoted New York price of $2.00 a pound for commercial sticks of cadmium, established August 1, 1952, remained unchanged throughout 1953. One domestic producer opened the year at $1.75 a pound but returned to the $2.00 basis in January. Special platers' shapes were quoted at $2.15 a pound during the year.

In the London market, cadmium sticks and bars were quoted at 13s. 10d. (equivalent to $1.93 on the basis of $2.7975 per £) to 14s. 4d. ($2.00) during the year.

FOREIGN TRADE [2]

Total imports (for consumption) of metallic cadmium and cadmium contained in flue dust decreased 1 percent in weight and 16 percent in value in 1953. Exports of cadmium metal, alloys, dross, flue dust, residues, and scrap decreased 78 percent in weight and 94 percent in value from 1952.

Imports.—United States imports of metallic cadmium established a new high in 1953, 5 percent above the former peak recorded in 1952. Of the 1,555,000 pounds imported, Belgium-Luxembourg supplied 34 percent, Canada 33 percent, Japan 14 percent, Australia-New Zealand 10 percent, Italy and Norway 4 percent each, and Peru, West Germany, and the Netherlands small quantities. Imports of flue dust (cadmium content), entirely from Mexico, were 6 percent lower than in 1952.

Exports.—United States exports of cadmium (metal, alloys, dross, flue dust, residues, and scrap) declined from 301,000 pounds in 1952 to 66,000 in 1953. Of the quantity exported, West Germany received 36 percent, Canada 33 percent, the Netherlands 8 percent, Yugoslavia 6 percent, Israel and Mexico 5 percent each, Chile 4 percent, and 5 other countries the remaining 3 percent.

TABLE 5.—Cadmium metal and flue dust imported for consumption in the United States, 1951–53, by countries

[U. S. Department of Commerce]

Country	1951		1952		1953	
	Pounds	Value	Pounds	Value	Pounds	Value
METALLIC CADMIUM						
Australia	9,627	$30,962			123,289	$204,732
Belgium-Luxembourg	52,870	209,246	1,195,186	$2,152,950	536,523	933,860
Canada	3,336	11,684	10,080	13,104	508,946	901,300
Germany, West			6,083	10,666	4,079	7,341
Italy					66,142	120,800
Japan	18,808	70,813	267,421	449,806	211,175	337,867
Netherlands	5,402	21,466			3,000	5,700
New Zealand					24,923	36,507
Norway					66,138	103,896
Peru					10,925	21,850
Sweden	22	111				
Total metallic cadmium	90,065	344,282	1,478,770	2,626,526	1,555,140	2,673,853
FLUE DUST (CD CONTENT)						
Canada			2,506	6,645		
Mexico	1,606,775	2,261,390	1,984,831	2,429,495	1,863,538	1,586,895
Peru			4,212	10,742		
Total flue dust	1,606,775	2,261,390	1,991,549	2,446,882	1,863,538	1,586,895
Grand total	1,696,840	2,605,672	3,470,319	5,073,408	3,418,678	4,260,748

[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.

TABLE 6.—Cadmium exported from the United States, 1950–53, by kinds, in gross weight

[U. S. Department of Commerce]

Kind	1950		1951		1952		1953	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
Dross, flue dust, residues, and scrap			200,579	$10,029	} 300,918	$1,005,370	65,866	$60,256
Metal	352,927	$794,540	606,233	2,198,311				
Alloys	9,106	11,575	5,639	9,311				
Total		806,115		2,217,651		1,005,370		60,256

Tariff.—Action taken at the Geneva Trade Conference of 1947 reduced, as of January 1, 1948, the import duty on cadmium metal from 7½ cents per pound as established in the Canadian Trade Agreement of 1939 to 3¾ cents per pound. Cadmium contained in flue dust remained duty free in 1953.

TECHNOLOGY

Metallurgy.—The Hudson Bay Mining & Smelting Co., Ltd., a Canadian producer of zinc, copper, and cadmium, has developed a method for producing refined cadmium of the exceptionally high purity required for use as an analytical standard in spectrographic work.[3]

Uses.—The use of cadmium in atomic energy development was disclosed in a report [4] published in 1953. One of the plans advanced for converting nuclear energy into power called for spraying the entire outer surface of the reactor sphere with a 70-percent-silver, 30-percent-cadmium alloy to reduce the neutron-flux leakage, with similar treatment applied to the piping outside the sphere. The reactor is of the "conventional" type, gas-cooled and graphite-moderated. Utilization of cadmium as a neutron absorber for controlling the fissionable elements in similar reactors is described in the Cadmium chapter of Minerals Yearbook, 1952.

WORLD REVIEW

Industry Operations.—The makeup of the cadmium industry in foreign countries is similar to that in the United States. The primary producers are, for the most part, large producers of zinc and, to a lesser extent, lead. Plants are established at zinc smelters, electrolytic zinc plants, and lead smelters. A list of the principal foreign producers follows:[5]

Country:	*Company*	*Location of plant*
Australia	Electrolytic Zinc Co. of Australasia, Ltd.	Risdon (Tasmania).
	Broken Hill Associated Smelters Pty., Ltd.	Port Pirie (South Australia).

[3] Isherwood, E. I., A Method for Production of Spectrographically Pure Cadmium Metal: The Precambrian, vol. 26, No. 4, April 1953, p. 24.

[4] Reports to the United States Atomic Energy Commission on Nuclear Power Technology, May 1953, 80 pp.

[5] Source: Principally from Minerais et Métaux, Société Anonyme, Statistiques, July 1953, p. 100.

Country:	*Company*	*Location of plant*
Belgian Congo	Sté. Générale Industrielle & Chimique du Katanga "Sogechim" (Union Minière du Haut Katanga).	Jadotville.
Belgium	S. A. Métallurgique de Prayon.	Prayon-les-Trooz.
	Produits Chimiques de Tessenderloo S. A.	
	S. A. des Mines et de Zinc de la Vieille-Montagne.	Balen Wezel.
	Cie des Métaux d'Overpelt-Lommel & de Corphalie.	Overpelt.
Canada	Hudson Bay Mining & Smelting Co., Ltd.	Flin Flon (Manitoba).
	Consolidated Mining & Smelting Co. of Canada, Ltd.	Trail (British Columbia).
France	S. A. des Mines et Fonderies de Zinc de la Vieille-Montagne.	Viviez (Aveyron).
Italy	Sta Mineraria e Metallurgica di Pertusola.	Crotone (Calabria).
	Sta di Monteponi	Monteponi (Sardinia).
	Sta Montevecchio, Italiana e dello Zinco.	Porto Marghera (Venice).
Japan	Mitsubishi Metal Mining Co., Ltd.	Hosokura (Miyagi). Naoshima (Kagawa, Shikoku I.).
	Mitsui Mining & Smelting Co., Ltd.	Hikoshima (Yamaguchi). Kamioka (Gifu). Miike (Fukuoka, Kyūshū I.).
	Nippon Soda Co., Ltd	Aizu (Fukushima).
	Toho Zinc Co., Ltd	Annaka (Gumma).
Mexico	American Smelting & Refining Co.[6]	San Luis Potosi (San Luis Potosi). Rosita (Coahuila). Chihuahua (Chihuahua).
	American Metal Co., Ltd.[6]	Monterrey (Nuevo Leon). Torreon (Coahuila).
Norway	Det Norske Zinkkompani A/S	Eitrheim (Odda).
Peru	Cerro de Pasco Copper Corp	Oroya.
Spain	Cie Royale Asturienne des Mines.	Arnao.
United Kingdom.	Imperial Smelting Corp	Avonmouth (Bristol).

Netherlands.—It was reported[7] that the Maastrichtse Zinkwit Maatschappij had applied for a permit to manufacture cadmium, a metal previously not produced in the Netherlands, at Limmen in the Province of Limburg. A tentative annual production goal of 50 tons was planned. The report states that the Zinkwit company plans to produce cadmium oxide from zinc concentrates and ship the oxide to the Kempensche Zink Maatschappij, Budel, for electrolytic processing into metal. The Kempensche company also expects to extract cadmium from the residues of zinc ore which it processes. Production was scheduled to begin late in 1953. An annual output of 50 tons of cadmium would cover Netherlands domestic requirements adequately, as present consumption is at an estimated rate of 40 tons a year.

[6] Production is cadmium flue dust, which is shipped to the United States for recovery of the metal.
[7] State Department Despatch No. 10, American Consul General, Amsterdam, Netherlands, July 10 1953; and Mining World, vol. 15, No. 8, July 1953, p. 75.

U. S. S. R.—The cadmium resources of the U. S. S. R. were described and evaluated in a recent textbook.[8] Production, capacity, and imports of cadmium are given, as well as the location of zinc deposits containing cadmium, the ratio of cadmium to zinc, recovery factors, and estimated reserves.

United Kingdom.—The British Bureau of Non-Ferrous Metal Statistics reported consumption of 696 short tons of cadmium in the United Kingdom in 1953 compared with 646 tons in 1952. The quantities used for various purposes were as follows: Plating anodes, 297 tons; plating salts, 50 tons; cadmium-copper alloys, 57 tons; other alloys, 21 tons; alkaline batteries, 76 tons; dry batteries, 6 tons; solder, 27 tons; colors, 146 tons; and miscellaneous uses, 16 tons. Domestic production and imports totaled 190 and 469 tons, respectively, in 1953 compared with 174 and 696 tons, respectively, in 1952. In 1953 imports were obtained from Australia (142 tons), Belgium (148 tons), and Canada (179 tons).

Yugoslavia.—A new electrolytic zinc plant with an annual capacity of 12,000 tons was under construction at Sabac, Serbia, in 1953. The plant also will produce sulfuric acid and approximately 40 tons of cadmium annually.[9]

World production of cadmium in recent years, insofar as data are available, is shown in table 7.

TABLE 7.—World production of cadmium, by countries, 1944–48 (average) and 1949–53, in kilograms [1]

[Compiled by Berenice B. Mitchell]

Country	1944–48 (average)	1949	1950	1951	1952	1953
Australia	250,372	263,767	299,125	234,708	292,978	298,668
Belgian Congo	20,085	24,635	29,668	24,316	20,506	[2] 32,000
Belgium [2]	67,238	148,000	365,000	450,000	550,000	600,000
Canada	313,912	383,983	384,828	601,878	430,270	596,919
France	30,463	58,123	71,591	84,997	88,318	[2] 100,000
Germany, West	[3] 1,902	5,000	----------	70,000	64,000	103,000
Italy	38,611	74,000	75,000	204,000	133,000	182,000
Japan	28,419	52,484	90,348	117,687	166,297	[2] 180,000
Mexico [4]	827,012	820,000	689,000	893,000	734,000	959,000
Norway	32,720	71,400	78,747	100,257	73,880	[2] 75,000
Peru	3,069	800	1,365	----------	17,071	[2] 20,000
Poland	127,839	[5] 240,000	[2] 240,000	[2] 240,000	[2] 240,000	[2] 240,000
South-West Africa [6]	103,419	753,867	609,625	650,448	504,392	541,586
Spain	1,074	5,116	4,348	3,900	5,476	[2] 5,500
U. S. S. R.[2]	53,000	58,000	70,000	80,000	90,000	90,000
United Kingdom	154,687	102,620	118,899	147,996	157,283	172,525
United States:						
Metallic cadmium	3,463,313	3,639,432	4,021,254	3,680,537	3,804,633	4,391,748
Cadmium compounds (Cd content)	158,011	92,079	154,540	89,402	81,345	38,555
Total (estimate)	4,786,000	5,219,000	6,005,000	6,130,000	6,215,000	7,126,000

[1] This table incorporates a number of revisions of data published in previous Cadmium chapters.
[2] Estimate.
[3] Average for 1946–48.
[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] Planned production.
[6] Cadmium content of concentrates exported for treatment elsewhere. To avoid duplication of figures, data are not included in the total.

[8] Shimkin, Demitri B., Minerals—A Key to Soviet Power: Harvard University Press, Cambridge, Mass., 1953, chap. 4, pp. 158–161.
[9] Mining World, vol. 15, No. 1, January 1953, p. 72.

Calcium

By Joseph C. Arundale[1] and Flora B. Mentch[2]

SALES of calcium chloride decreased slightly in 1953 but were exceeded only in 1951 and 1952. Imports of calcium metal continued to increase and again reached a new high.

DOMESTIC PRODUCTION

Calcium chloride (and calcium-magnesium chloride) is produced both from natural brines and as a byproduct in the manufacture of soda ash by the ammonia-soda process. Shipments by producers in 1953 totaled 412,034 short tons of solid and flake calcium chloride (77–80 percent $CaCl_2$) and 144,588 short tons of liquid calcium chloride (40–45 percent $CaCl_2$).

The following firms produced calcium chloride (and calcium-magnesium chloride) from natural brines in 1953: California Salt Co., 2436 Hunter St., Los Angeles 21, Calif., plant at Amboy, Calif.; Hill Bros. Chemical Co., 2159 Bay St., Los Angeles, Calif., plant at Saltus, Calif.; National Chloride Co. of America, 354 South Spring St., Los Angeles 13, Calif., plant at Amboy Calif.; Michigan Chemical Corp., 500 North Bankson St., St. Louis, Mich., plant at St. Louis, Mich.; Wilkinson Chemical Co., Mayville, Mich.; The Dow Chemical Co., Midland, Mich., plants at Midland and Ludington, Mich.; Pomeroy Salt Corp., Pomeroy, Ohio, plant at Minersville, Ohio; Westvaco Chemical Division, Food Machinery & Chemical Corp., South Charleston 3, W. Va.

The production in California is from the brine of Bristol Lake. In Michigan, Ohio, and West Virginia calcium chloride is recovered from well brines, with bromine and magnesia as coproducts.

Calcium-metal production was begun in the United States in 1939 by Electro Metallurgical Division, Union Carbide & Carbon Corp., Sault Ste. Marie, Mich. This firm produces the metal by electrolysis of calcium chloride. A second firm, Nelco Metals Inc., Canaan, Conn., produces calcium by vacuum reduction of lime with aluminum. Ethyl Corp. suspended production of "crystalline calcium" at Baton Rouge, La.

TABLE 1.—Calcium chloride and calcium-magnesium chloride from natural brines sold by producers in the United States, 1944–48 (average) and 1949–53

[In terms of 75 percent (Ca, Mg) Cl_2]

Year	Short tons	Value	Year	Short tons	Value
1944-48 (average)	252,459	$2,455,093	1951	328,042	$4,756,242
1949	255,797	3,260,675	1952	(1)	(1)
1950	299,821	3,801,508	1953	(1)	(1)

[1] Figure withheld to avoid disclosure of individual company operations.

[1] Assistant chief, Construction and Chemical Materials Branch.
[2] Statistical assistant.

CONSUMPTION AND USES

The Calcium Chloride Institute News, published periodically by the Calcium Chloride Institute, Washington, D. C., contained detailed information on the numerous calcium chloride uses, methods of application, results of various tests, and technological problems and developments. Uses discussed in these publications included control of ice and snow on streets and sidewalks and "freezeproofing" of coal, iron ore, and other materials during stockpiling or bulk shipment. Calcium chloride is used in solution as a liquid ballast in tires on tractors, motor graders, loaders, and other heavy equipment running on rubber tires. Such 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. It is commonly used in refrigeration brines in icemaking. It is claimed that calcium chloride in concrete accelerates the set, promotes high early strength, increases ultimate strength, increases workability, and provides increased resistance to surface wear.

Calcium metal has a number of important applications in the metallurgical industries. It can be used to reduce metal oxides to their metals, such as chromium, thorium, titanium, uranium, and zirconium. As a degasifier it can be used in treating steel and nonferrous alloys. In certain steels it may be used to control grain size and inhibit carbide formation. Because of its easy combination with water, calcium may be used to dehydrate alcohol and other organic liquids.

PRICES

E&MJ Metal and Mineral Markets quoted calcium metal, cast in slabs and small pieces, in ton lots, at $2.05 per pound throughout the year.

According to Oil, Paint and Drug Reporter calcium chloride, crystalline, purified, drums, jars, was quoted at 28 to 30 cents per pound for January through May, 28 cents per pound for June through October, and 27 cents per pound for November through December; flake, 77–80 percent, paper bags, carlots, works, freight equaled, was quoted at $25 per ton for January through August and $27 per ton for September through December; liquor, 40 percent, tank cars, works, freight allowed, was quoted at $10.50 per ton for January through August and $11.50 per ton for September through December; pellets, bags, carlots, works, was quoted at $31.25 per ton for January through August and $33 for September through December; powder, bags, carlots, works, was quoted at $35.65 per ton for January through August and $37.65 for September through December; solid, 73–75 percent, drums, carlots, freight equaled, was quoted at $23.50 per ton for January through August and $25.50 for September through December; less than carlots, works, same basis, was quoted at $32 to $69 for January through August and $34 to $71 for September through December; U. S. P., granulated, drums, was quoted at 30 cents per pound for January through July and 40 cents per pound for August through December.

FOREIGN TRADE [3]

Imports of calcium metal from Canada reached an alltime high. No other imports were reported.

TABLE 2.—Calcium metal and calcium-silicon imported for consumption in the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Year	Calcium metal		Calcium-silicon	
	Pounds	Value	Pounds	Value
1944–48 (average)	3,647	$3,801	218,170	$28,000
1949	3,510	4,736	112,000	14,977
1950	75,756	66,407	491,646	11,479
1951	574,636	602,226		
1952	751,215	807,997		
1953	990,017	1,009,934		

In 1953 calcium chloride was imported from Canada, United Kingdom, West Germany, and Belgium-Luxembourg.

TABLE 3.—Calcium chloride imported for consumption in and exported from the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Year	Imports		Exports	
	Short tons	Value	Short tons	Value
1944–48 (average)	1,674	$21,377	9,778	$346,209
1949	(1)	20	21,094	507,845
1950	1,881	54,170	15,624	403,230
1951	813	37,451	18,637	559,284
1952	1,333	45,888	19,193	594,904
1953	2,671	84,594	11,572	370,799

[1] Less than 1 ton.

TECHNOLOGY

The technical panel of the Calcium Chloride Institute held its third annual meeting in 1953. Special technical committees considered the broad fields of applications of calcium chloride and the technical needs of users and made several recommendations on changes in procedures for certain uses, continuing research studies, and broader distribution of technical information. Recommended research included projects on calcium chloride in concrete to be conducted by National Bureau of Standards; several road stabilization projects, and weighting of tires.[4]

The design and operation of a new-type ice-cube machine was described. The procedure involves the use of calcium chloride brine as the refrigerant.[5]

[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] Calcium Chloride Institute News, vol. 3, No. 5, October 1953, p. 5.
[5] Calcium Chloride Institute News, New Ice-Cube Maker Cuts Costs: Vol. 3, No. 6, December 1953, p. 8.

A method for producing calcium chloride pellets was patented.[6] The method involved spraying a calcium chloride solution over semi-anhydrous particles of calcium chloride while tumbling and rolling under drying conditions.

Calcium chloride is a commonly used accelerator in concrete mixed in cold weather. The technology of such use was described in a pamphlet.[7]

WORLD REVIEW

Canada.—Calcium metal has been produced in Canada since 1945 by Dominion Magnesium, Ltd., Haley, Ontario. The method employed by that firm is reduction of lime with aluminum powder in vacuum retorts. Calcium distills and is condensed on a removable condenser. The purity of the metal depends on the purity of the raw material. The product contains less than 2 percent magnesium; redistilled grades contain less than 0.5 percent magnesium. Overall recovery by this method is said to be about 75 percent.[8] Figures on production of calcium metal in Canada have not been available since 1949, when 520,069 pounds of output was reported.

[6] Bennett, W. R., and Carmouche, L. N. (assigned to the Dow Chemical Co., Midland, Mich.), Method of Producing Calcium Chloride Pellets: U. S. Patent 2,646,343, July 21, 1953, Official Gazette, vol. 672, No. 3, p. 827.

[7] National Ready Mixed Concrete Association, Cold-Weather Ready-Mixed Concrete: August 1953, 15 pp.

[8] Graves, H. A., Calcium in Canada: Department of Mines and Technical Surveys, Ottawa, 1953 (preliminary), 2 pp.

Cement

By Oliver S. North[1] and Esther V. Balser[2]

THE PORTLAND-CEMENT INDUSTRY in 1953, as in each year since 1947, set new records, with production of 264,181,000 barrels and shipments totaling 260,879,000 barrels[3] valued at $697,263,000.

The combined production of the other hydraulic cements—natural, masonry (natural), and pozzolan—and the output and shipment of prepared masonry cements also increased.

The portland-cement industry operated at 90.5 percent of capacity in 1953 compared with 87.8 percent in 1952. The estimated annual capacity of all portland-cement-producing facilities in the United States and Puerto Rico at the end of 1953 was almost 292 million barrels—3 percent higher than at the end of 1952.

The average net mill realization per barrel of portland cement increased from $2.54 in 1952 to $2.67 in 1953. The average value of the other hydraulic cements, as a group, increased 16 cents per barrel to $2.99, and prepared masonry cements were 18 cents per barrel higher at $3.27.

The moving 12-month total for production of finished portland cement in the Bureau of Mines Monthly Cement Reports increased steadily until the period ended with October; in the last 2 months it declined moderately.

As indicated in figure 1, regional consumption trends of portland cement in 1953 continued essentially upward.

States in the regions shown in figure 1 are as follows: Northeastern—Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont; Southern—Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia; Middle—Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin; Rocky Mountain—Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming; and Pacific—California, Oregon, and Washington.

[1] Commodity-industry analyst.
[2] Statistical clerk.
[3] Barrel as used in this chapter, unless otherwise indicated, refers to a 376-pound barrel.

TABLE 1.—Salient statistics of the cement industry in the United States, 1944–48 (average) and 1949–53[1]

	1944–48 (average)	1949	1950	1951	1952	1953
Production:						
Portland ... barrels	149,948,476	209,727,417	226,025,849	246,022,476	249,256,154	264,180,522
Masonry, natural, and pozzolan (slag-lime) ... do	2,319,297	3,185,229	4,246,299	3,449,463	3,401,684	3,488,102
Total ... do	152,267,773	212,912,646	230,272,148	249,471,939	252,657,838	267,668,624
Capacity used at portland-cement mills ... percent	61.1	81.0	84.3	87.4	87.8	90.5
Shipments from mills:						
Total ... barrels	154,725,103	209,313,850	231,975,216	244,628,695	254,815,893	264,337,896
Value of shipments [2]	$287,873,951	$481,183,393	$545,950,709	$623,003,439	$648,264,065	$707,603,575
Average value per barrel	$1.86	$2.30	$2.35	$2.55	$2.54	$2.68
Stocks at mills, Dec. 31 ... barrels	13,857,418	14,920,104	13,308,190	18,223,906	[3] 16,045,980	19,376,708
Imports ... do	58,317	109,821	1,409,974	921,953	475,986	386,051
Exports ... do	5,674,380	4,561,899	2,418,435	2,932,787	[3] 3,174,405	2,535,549
Apparent consumption [4] ... do	149,109,040	204,861,772	230,966,755	242,617,861	[3] 252,117,474	262,188,398
World production (estimated) ... do	427,616,000	674,279,000	[3] 779,819,000	[3] 873,631,000	[3] 943,991,000	1,043,667,000

[1] Includes Puerto Rico and Hawaii, 1946; Puerto Rico only, 1947–53. There has been no production in Hawaii since 1946.
[2] Value received f. o. b. mill, excluding cost of containers.
[3] Revised figure.
[4] Shipments from domestic mills minus net exports.

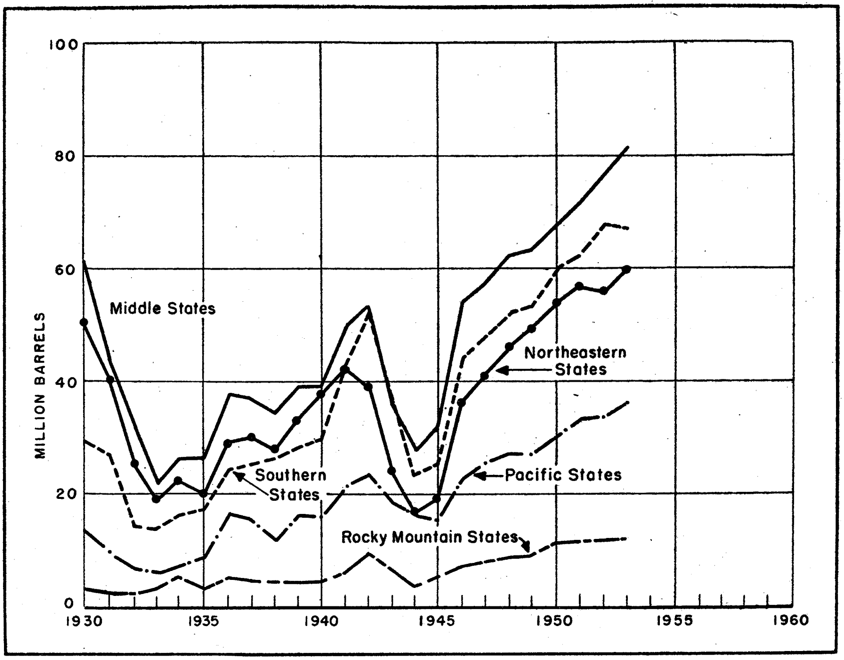

FIGURE 1.—Indicated consumption of portland cement in continental United States, 1930–53, by regions.

PORTLAND CEMENT

PRODUCTION AND SHIPMENTS

Portland cement, which constituted almost 99 percent of the hydraulic cement (exclusive of masonry cements) produced in 1953, was manufactured in 156 plants in 37 States and Puerto Rico. No new plants were put into production during the year, but Southern Cement Co. was building a portland-cement plant at Roberta, Ala., and facilities were being improved and expanded at several plants.

Table 2 contains a district breakdown of production, shipments, and stocks in 1952–53. Table 3 shows similar information on a monthly basis. Data in the latter table were compiled from monthly reports—many of which were preliminary estimates by producers—in which totals were rounded to thousands of barrels. No attempt has been made to adjust the data in table 3 to the final annual figures shown in table 2. In all instances the discrepancy is extremely small percentagewise.

Output in 1953 was greater in 17 districts and lower in 3 districts compared with 1952. Changes ranged from an 11-percent decrease in Puerto Rico to an 18-percent increase in the Virginia-Georgia-Florida-Louisiana-South Carolina-Mississippi district. Twelve districts reported outputs over 10 million barrels.

386902—56——19

TABLE 2.—Finished portland cement produced, shipped, and in stock in the United States, 1952–53, by districts

District	Active plants 1952	Active plants 1953	Production, Barrels 1952	Production, Barrels 1953	Production, Change from 1952 (percent)	Shipments 1952, Barrels	Shipments 1952, Value Total	Shipments 1952, Value Average	Shipments 1953, Barrels	Shipments 1953, Value Total	Shipments 1953, Value Average	Shipments 1953, Change from 1952 (percent) in— Barrels	Shipments 1953, Change from 1952 (percent) in— Average value	Stocks at mills on Dec. 31, Barrels 1952	Stocks at mills on Dec. 31, Barrels 1953	Stocks, Change from 1952 (percent)
Eastern Pennsylvania, Maryland	21	21	34, 204, 438	36, 775, 219	+7. 5	34, 971, 324	$90,148,570	$2. 58	36, 304, 071	$98, 208, 892	$2. 71	+3. 8	+5. 0	[1] 1,771,196	2, 242, 344	+26. 6
New York, Maine	11	11	15, 995, 631	17, 022, 581	+6. 4	16, 081, 524	40, 429, 862	2. 51	16, 966, 628	44, 810, 455	2. 64	+5. 5	+5. 2	[1] 950, 406	1, 006, 359	+5. 9
Ohio	9	9	11, 270, 431	12, 539, 132	+11. 3	11, 377, 806	28, 488, 500	2. 50	12, 532, 437	32, 957, 308	2. 63	+10. 1	+5. 2	[1] 748, 541	755, 236	+. 9
Western Pennsylvania, West Virginia	7	7	10, 554, 119	11, 533, 669	+9. 3	10, 471, 497	26, 156, 314	2. 50	11, 234, 723	29, 404, 837	2. 62	+7. 3	+4. 8	873, 224	1, 172, 170	+34. 2
Michigan	7	7	14, 790, 587	15, 532, 853	+5. 0	14, 760, 783	36, 819, 042	2. 49	15, 853, 096	41, 860, 464	2. 64	+7. 4	+6. 0	1, 627, 909	1, 307, 666	−19. 7
Illinois	4	4	8, 514, 443	8, 869, 342	+4. 2	8, 710, 621	20, 600, 347	2. 36	8, 651, 385	21, 961, 761	2. 54	−. 7	+7. 6	605, 708	823, 665	+36. 0
Indiana, Kentucky, Wisconsin	6	6	13, 899, 522	16, 162, 378	+16. 3	14, 170, 654	34, 992, 989	2. 47	15, 940, 923	41, 385, 260	2. 60	+12. 5	+5. 3	[1] 866, 058	1, 087, 513	+25. 6
Alabama	7	7	10, 609, 234	10, 682, 579	+. 7	10, 642, 409	25, 084, 379	2. 36	10, 427, 542	25, 701, 421	2. 46	−2. 0	+4. 2	551, 641	806, 678	+46. 2
Tennessee	6	6	7, 439, 873	7, 474, 604	+. 5	7, 428, 604	17, 834, 060	2. 40	7, 276, 964	18, 283, 366	2. 51	−2. 0	+4. 6	388, 290	585, 930	+50. 9
Virginia, Georgia, Florida, Louisiana, South Carolina, Mississippi	11	11	14, 513, 923	17, 110, 360	+17. 9	14, 390, 516	37, 257, 041	2. 59	16, 951, 199	46, 114, 623	2. 72	+17. 8	+5. 0	[1] 722, 893	882, 054	+22. 0
Iowa	5	5	9, 028, 350	9, 341, 422	+3. 5	9, 336, 727	22, 849, 597	2. 45	9, 111, 358	23, 330, 177	2. 56	−2. 4	+4. 5	868, 596	1, 098, 660	+26. 5
Eastern Missouri, Minnesota, South Dakota	6	6	11, 406, 529	12, 128, 396	+6. 3	11, 528, 582	29, 416, 600	2. 55	11, 551, 967	30, 949, 811	2. 68	+. 2	+5. 1	906, 314	1, 482, 743	+63. 6
Kansas	6	6	8, 672, 883	8, 766, 206	+1. 1	8, 811, 762	20, 956, 886	2. 38	8, 546, 250	21, 428, 536	2. 51	−3. 0	+5. 5	524, 860	744, 816	+41. 9
Western Missouri, Nebraska, Oklahoma, Arkansas	6	6	8, 890, 216	9, 351, 805	+5. 2	9, 265, 497	22, 981, 413	2. 48	9, 173, 478	23, 703, 624	2. 58	−1. 0	+4. 0	548, 437	726, 764	+32. 5
Texas	13	13	19, 997, 983	19, 253, 677	−3. 7	19, 849, 455	48, 042, 901	2. 42	19, 140, 193	48, 497, 762	2. 53	−3. 6	+4. 5	[1] 1, 134, 826	1, 248, 310	+10. 0
Colorado, Arizona, Wyoming, Montana, Utah, Idaho	9	9	8, 226, 211	8, 737, 196	+6. 2	8, 303, 467	24, 007, 382	2. 89	8, 534, 313	26, 577, 933	3. 11	+2. 8	+7. 6	[1] 572, 722	775, 605	+35. 4
Northern California	5	5	13, 676, 126	15, 125, 072	+10. 6	13, 714, 018	36, 958, 815	2. 69	15, 166, 928	43, 930, 333	2. 90	+10. 6	+7. 8	976, 524	934, 668	−4. 3
Southern California	6	6	15, 908, 779	17, 020, 375	+7. 0	16, 072, 227	42, 498, 930	2. 64	16, 835, 389	46, 942, 408	2. 79	+4. 7	+5. 7	[1] 587, 614	772, 600	+31. 5
Oregon, Washington	9	9	7, 568, 677	7, 098, 042	−6. 2	7, 486, 547	22, 470, 706	3. 00	7, 038, 556	21, 878, 416	3. 11	−6. 0	+3. 7	596, 390	655, 876	+10. 0
Puerto Rico	2	2	4, 088, 199	3, 655, 614	−10. 6	3, 994, 483	10, 517, 894	2. 63	3, 641, 135	9, 335, 421	2. 56	−8. 8	−2. 7	[1] 110, 054	124, 533	+13. 2
Total	156	156	249,256,154	264,180,522	+6. 0	251,368,503	638,512,228	2. 54	260, 878, 535	697, 262, 808	2. 67	+3. 8	+5. 1	[1] 15,932,203	19, 234, 190	+20. 7
Pennsylvania	24	24	39, 437, 971	42, 799, 409	+8. 5	40, 037, 761	103,388,586	2. 58	42, 093, 765	114, 002, 846	2. 71	+5. 1	+5. 0	[1] 2, 390, 588	3, 096, 232	+29. 5
Missouri	5	5	10, 007, 609	10, 281, 230	+2. 7	10, 086, 850	25, 523, 038	2. 53	9, 860, 179	26, 238, 460	2. 66	−2. 2	+5. 1	663, 938	1, 084, 989	+63. 4

[1] Revised figure.

TABLE 3.—Production, shipments from mills, and stocks at mills of finished portland cement in the United States in 1953, by months and districts, in thousand barrels

District	January	February	March	April	May	June	July	August	September	October	November	December
PRODUCTION												
Eastern Pennsylvania, Maryland	2,720	2,665	2,934	2,598	3,133	3,056	3,288	3,318	3,328	3,432	3,252	3,052
New York, Maine	1,021	1,042	1,205	1,381	1,488	1,482	1,645	1,629	1,626	1,695	1,430	1,375
Ohio	936	760	911	1,063	1,024	1,004	1,124	1,187	1,193	1,221	1,079	1,038
Western Pennsylvania, West Virginia	847	740	858	1,031	1,009	1,002	1,076	999	1,041	1,038	974	918
Michigan	796	408	724	1,403	1,502	1,405	1,665	1,627	1,617	1,664	1,436	1,284
Illinois	671	468	708	741	755	792	816	787	841	828	727	727
Indiana, Kentucky, Wisconsin	1,141	1,011	1,145	1,436	1,432	1,516	1,503	1,557	1,397	1,502	1,367	1,151
Alabama	880	798	849	819	955	870	982	989	907	999	895	741
Tennessee	535	524	599	625	708	659	682	656	630	666	662	529
Virginia, Georgia, Florida, Louisiana, South Carolina, Mississippi	1,341	1,290	1,474	1,372	1,452	1,437	1,417	1,479	1,441	1,587	1,481	1,345
Iowa	722	650	648	555	839	817	886	901	933	882	716	749
Eastern Missouri, Minnesota, South Dakota	777	809	884	1,103	1,056	875	1,041	1,140	1,191	1,258	1,086	901
Kansas	634	631	695	629	748	795	795	777	787	776	779	718
Western Missouri, Nebraska, Oklahoma, Arkansas	698	523	657	798	883	839	894	886	904	931	784	567
Texas	1,558	1,496	1,741	1,748	1,710	1,657	1,686	1,673	1,528	1,634	1,577	1,251
Colorado, Arizona, Wyoming, Montana, Utah, Idaho	514	488	687	777	823	802	757	879	763	862	706	570
Northern California	997	1,147	1,196	1,333	1,402	1,305	1,301	1,350	1,292	1,381	1,323	1,093
Southern California	1,432	1,208	1,440	1,436	1,449	1,430	1,478	1,433	1,400	1,445	1,442	1,426
Oregon, Washington	364	423	565	596	709	657	740	689	672	663	518	503
Puerto Rico	272	244	295	358	322	298	358	333	304	274	295	305
Total: 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
1952	17,039	16,545	18,095	19,817	21,829	20,748	21,342	23,573	23,010	24,164	22,048	20,881
SHIPMENTS												
Eastern Pennsylvania, Maryland	1,940	2,054	2,787	2,852	3,238	3,765	3,285	3,524	3,864	3,982	2,780	2,231
New York, Maine	612	649	1,187	1,354	1,612	1,891	1,838	1,792	1,830	1,984	1,288	931
Ohio	472	542	880	903	1,000	1,411	1,455	1,459	1,352	1,406	1,035	616
Western Pennsylvania, West Virginia	431	514	810	854	968	1,341	1,303	1,185	1,244	1,298	832	456
Michigan	428	460	739	1,113	1,519	1,800	1,952	1,956	1,954	1,958	1,279	693
Illinois	232	291	655	599	850	1,019	1,063	1,106	1,031	1,006	547	251
Indiana, Kentucky, Wisconsin	633	699	1,174	1,247	1,442	1,769	1,745	1,772	1,732	1,823	1,249	655
Alabama	739	697	927	790	883	982	947	1,030	976	1,023	823	610
Tennessee	442	464	733	677	593	669	686	688	676	735	572	341
Virginia, Georgia, Florida, Louisiana, South Carolina, Mississippi	1,328	1,172	1,457	1,429	1,423	1,544	1,513	1,469	1,519	1,635	1,361	1,095
Iowa	194	217	728	543	933	1,151	1,193	1,218	1,223	1,017	485	209
Eastern Missouri, Minnesota, South Dakota	407	495	988	872	926	1,034	1,109	1,435	1,553	1,480	794	459
Kansas	401	499	736	645	671	788	956	1,034	906	849	642	420

TABLE 3.—Production, shipments from mills, and stocks at mills of finished portland cement in the United States in 1953, by months and districts, in thousand barrels—Continued

District	January	February	March	April	May	June	July	August	September	October	November	December
SHIPMENTS—continued												
Western Missouri, Nebraska, Oklahoma, Arkansas	447	436	651	751	840	915	991	1,072	1,081	940	630	426
Texas	1,580	1,386	1,966	1,788	1,596	1,763	1,672	1,521	1,623	1,632	1,394	1,229
Colorado, Arizona, Wyoming, Montana, Utah, Idaho	452	447	687	765	777	857	822	925	882	888	598	436
Northern California	853	1,072	1,299	1,405	1,341	1,221	1,386	1,480	1,520	1,496	1,099	995
Southern California	1,386	1,409	1,475	1,359	1,404	1,435	1,408	1,417	1,419	1,450	1,309	1,365
Oregon, Washington	292	381	594	607	640	726	802	676	717	688	481	437
Puerto Rico	251	271	340	338	268	319	354	333	331	266	296	275
Total: 1953	13,520	14,155	20,813	20,891	24	26,400	26,480	27,092	27,433	27,556	19,494	14,130
1952	12,696	14,362	15,993	21,764	23,282	25,067	25,084	25,915	26,240	27,223	19,771	13,740
STOCKS (END OF MONTH)												
Eastern Pennsylvania, Maryland	2,546	3,160	3,309	3,055	2,950	2,240	2,243	2,036	1,500	950	1,422	2,243
New York, Maine	1,389	1,780	1,795	1,819	1,691	1,278	1,081	916	710	422	562	1,006
Ohio	1,213	1,431	1,461	1,620	1,644	1,237	906	634	475	289	334	755
Western Pennsylvania, West Virginia	1,292	1,518	1,567	1,744	1,785	1,447	1,219	1,033	830	570	711	1,173
Michigan	1,996	1,944	1,929	2,218	2,201	1,806	1,520	1,191	855	561	718	1,308
Illinois	1,045	1,222	1,274	1,416	1,321	1,094	848	528	338	168	348	824
Indiana, Kentucky, Wisconsin	1,363	1,674	1,644	1,833	1,826	1,575	1,336	1,126	792	471	591	1,086
Alabama	692	792	714	743	815	703	738	697	628	603	675	807
Tennessee	480	540	406	355	469	459	456	423	377	307	398	586
Virginia, Georgia, Florida, Louisiana, South Carolina, Mississippi	736	854	871	815	843	736	640	651	560	512	632	882
Iowa	1,396	1,829	1,749	1,761	1,667	1,333	1,026	708	419	283	514	1,055
Eastern Missouri, Minnesota, South Dakota	1,276	1,590	1,486	1,717	1,847	1,688	1,619	1,324	970	749	1,040	1,482
Kansas	757	889	849	833	911	918	757	501	382	310	447	745
Western Missouri, Nebraska, Oklahoma, Arkansas	800	887	892	939	982	906	809	623	446	437	591	732
Texas	1,129	1,239	1,015	973	1,087	981	995	1,148	1,053	1,056	1,238	1,261
Colorado, Arizona, Wyoming, Montana, Utah, Idaho	635	676	676	689	735	681	624	621	560	533	641	776
Northern California	1,121	1,196	1,093	1,021	1,083	1,166	1,082	951	723	607	831	929
Southern California	634	434	399	477	522	516	586	603	583	578	712	773
Oregon, Washington	663	705	677	666	735	666	603	615	570	546	583	649
Puerto Rico	131	104	59	79	133	112	116	116	88	97	95	124
Total: 1953	21,294	24,464	23,865	24,773	25,247	21,542	19,204	16,445	12,859	10,049	13,083	19,196
1952	22,336	24,519	26,622	24,672	23,220	18,896	15,158	12,819	9,602	6,546	8,823	[1] 15,957

[1] Revised figure.

TYPES OF CEMENT

A breakdown of total production of portland cement by various types for the 1944–53 period is shown in table 4. The output of all types except high-early-strength (type III), low-heat (type IV), sulfate-resisting (type V), and miscellaneous cements, as a group, was higher in 1953 than in 1952. Percentagewise, the largest gains were in output of air-entrained and portland-pozzolan cements.

TABLE 4.—Portland cement produced and shipped in the United States,[1] 1944–48 (average) and 1949–53, by types

Type and year	Active plants	Production (barrels)	Shipments		
			Barrels	Value	
				Total	Average
General use and moderate heat (types I and II):					
1944–48 [2] (average)	150	129,021,777	131,270,814	$240,094,577	$1.83
1949	150	177,597,585	174,569,746	396,817,234	2.27
1950	150	191,994,091	193,693,533	449,842,513	2.32
1951	155	207,702,941	203,279,206	510,975,002	2.51
1952	156	210,720,294	212,589,258	534,252,252	2.51
1953	156	217,555,091	215,103,044	569,217,300	2.65
High-early-strength (type III):					
1944–48 (average)	95	5,773,702	5,898,380	12,808,858	2.17
1949	87	5,979,435	5,649,482	15,047,036	2.66
1950	90	6,667,974	6,607,172	18,094,386	2.74
1951	96	7,455,107	7,294,686	21,494,894	2.95
1952	95	8,014,918	7,982,072	23,377,812	2.93
1953	99	7,949,035	7,794,606	23,743,313	3.05
Low-heat (type IV):					
1944–48 (average)	4	175,613	171,968	282,556	1.64
1949	6	159,739	129,411	329,284	2.54
1950	5	328,879	271,559	682,008	2.51
1951	6	900,624	790,819	2,647,460	3.35
1952	2	252,122	272,062	767,571	2.82
1953	2	192,889	171,717	507,290	2.95
Sulfate-resisting (type V):					
1944–48 (average)	5	68,022	64,819	174,734	2.70
1949	5	95,023	113,370	472,016	4.16
1950	4	4,070	49,152	141,888	2.89
1951	3	9,908	87,635	342,689	3.91
1952	4	99,229	78,276	240,129	3.07
1953	4	79,244	89,631	317,792	3.55
Oil-well:					
1944–48 (average)	16	1,440,104	1,496,264	3,195,505	2.14
1949	17	1,714,938	1,745,908	4,554,603	2.61
1950	17	1,829,651	1,830,167	4,735,423	2.59
1951	15	1,508,252	1,630,305	4,581,109	2.80
1952	18	1,841,470	1,787,786	5,099,335	2.85
1953	17	1,861,603	1,822,887	5,463,901	3.00
White:					
1944–48 (average)	5	678,376	683,738	2,946,859	4.31
1949	4	1,071,100	1,031,408	4,985,107	4.83
1950	5	1,175,490	1,187,202	5,637,101	4.75
1951	4	1,139,500	1,109,088	5,631,518	5.08
1952	4	1,081,122	1,094,276	5,900,986	5.39
1953	4	1,114,374	1,091,016	6,087,641	5.58
Portland-pozzolan:					
1944–48 (average)	5	932,064	962,083	1,825,591	1.90
1949	4	1,080,848	1,147,694	2,602,853	2.27
1950	5	1,369,764	1,321,223	3,232,282	2.45
1951	6	2,279,023	2,250,280	5,602,288	2.49
1952	6	1,861,991	1,856,656	4,646,078	2.50
1953	6	2,406,314	2,448,861	6,440,686	2.63
Air-entrained:					
1945–48 [3] (average)	67	14,028,123	13,993,927	25,907,389	1.85
1949	78	21,266,590	20,940,562	46,091,687	2.20
1950	80	21,717,585	21,860,316	50,107,196	2.29
1951	79	24,201,376	23,885,423	59,247,898	2.48
1952	81	24,484,689	24,796,917	61,432,052	2.48
1953	95	32,130,866	31,474,609	82,593,723	2.62

See footnotes at end of table.

TABLE 4.—Portland cement produced and shipped in the United States,[1] 1944–48 (average) and 1949–53, by types—Continued

Type and year	Active plants	Production (barrels)	Shipments		
			Barrels	Value	
				Total	Average
Miscellaneous:[4]					
1944–48 (average)	19	636, 320	654, 712	$1, 542, 039	$2. 36
1949	24	762, 159	752, 744	2, 277, 212	3. 03
1950	24	938, 345	936, 312	2, 848, 326	3. 04
1951	23	825, 745	825, 830	2, 647, 625	3. 21
1952	22	900, 319	911, 200	2, 796, 013	3. 07
1953	21	891, 706	882, 764	2, 891, 162	3. 28
Grand total:					
1944–48 (average)	150	149, 948, 476	152, 397, 920	283, 596, 631	1. 86
1949	150	209, 727, 417	206, 080, 325	473, 177, 032	2. 30
1950	150	226, 025, 849	227, 756, 636	535, 321, 123	2. 35
1951	155	246, 022, 476	241, 153, 272	613, 170, 483	2. 54
1952	156	249, 256, 154	251, 368, 503	638, 512, 228	2. 54
1953	156	264, 180, 522	260, 878, 535	697, 262, 808	2. 67

[1] Includes Puerto Rico and Hawaii, 1946; Puerto Rico only, 1947–53. There has been no production in Hawaii since 1946.
[2] Includes air-entrained and Vinsol resin cements, classed as modified cements by producers in 1944.
[3] Figures reported separately for the first time in 1945.
[4] Includes hydroplastic, plastic, and waterproofed cements.

Prepared Masonry Cements.—Prepared masonry cements are those special cements that are not true portlands but employ portland-cement clinker or finished portland cement as a base. To this base are added limestone and small quantities of other constituents. These specially compounded masonry cements usually are sold under proprietary names.

Production of prepared masonry cements was reported by 110 plants in 1953 and totaled 11,101,000 barrels. Shipments were 10,813,000 barrels valued at $35,331,000 an average mill value of $3.27 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 cement are 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 total estimated annual capacity of all portland-cement plants in 1953, as reported to the Bureau of Mines by producers, increased 3 percent over that reported in 1952. The overall rate of operation in 1953 was almost 3 percent of total capacity higher than in 1952.

Although no new plants began operation during the year, increased installed capacity at older plants raised the productive capacity of the cement industry in the United States almost 8 million barrels. Capacity was higher in 17 districts, lower in 2 districts, and unchanged in 1 district compared with 1952. Increases of over 1 million barrels occurred in the Michigan and Indiana-Kentucky-Wisconsin districts, while the increase in Texas approached 1 million

TABLE 5.—Portland-cement-manufacturing capacity of the United States, 1952–53, by districts

District	Estimated (barrels)		Percent utilized	
	1952	1953	1952	1953
Eastern Pennsylvania, Maryland	38, 895, 393	39, 872, 977	87. 9	92. 2
New York, Maine	17, 692, 491	18, 426, 414	90. 4	92. 4
Ohio	13, 244, 125	13, 510, 125	85. 1	92. 8
Western Pennsylvania, West Virginia	13, 132, 300	12, 195, 300	80. 4	94. 6
Michigan	16, 366, 360	17, 988, 816	90. 4	86. 3
Illinois	9, 549, 290	9, 552, 230	89. 2	92. 9
Indiana, Kentucky, Wisconsin	16, 098, 147	17, 201, 097	86. 3	94. 0
Alabama	11, 443, 150	11, 586, 450	92. 7	92. 2
Tennessee	8, 030, 000	8, 174, 197	92. 7	91. 4
Virginia, Georgia, Florida, Louisiana, South Carolina, Mississippi	18, 556, 940	19, 324, 415	78. 2	88. 5
Iowa	9, 396, 280	10, 210, 298	96. 1	91. 5
Eastern Missouri, Minnesota, South Dakota	13, 064, 400	13, 181, 255	87. 3	92. 0
Kansas	9, 552, 608	9, 544, 609	90. 8	91. 8
Western Missouri, Nebraska, Oklahoma, Arkansas	9, 200, 781	9, 735, 987	96. 6	96. 1
Texas	21, 856, 000	22, 855, 000	91. 5	84. 2
Colorado, Arizona, Wyoming, Montana, Utah, Idaho	10, 465, 000	10, 665, 000	78. 6	81. 9
Northern California	15, 900, 000	15, 900, 000	86. 0	95. 1
Southern California	19, 220, 000	19, 320, 000	82. 8	88. 1
Oregon, Washington	8, 251, 151	8, 254, 300	91. 7	86. 0
Puerto Rico	4, 100, 000	4, 300, 000	99. 7	85. 0
Total	284, 014, 416	291, 798, 470	87. 8	90. 5

barrels. The only district in which a large capacity decrease was noted was Western Pennsylvania-West Virginia. Most portland-cement plants listed kiln departments as the factor-limiting capacity, while a few reported that their capacities were limited by raw- or finish-grinding facilities.

As indicated in table 5, the percentage of capacity utilized was higher in 12 and lower in 8 districts compared with 1952. In the continental United States the changes ranged from a 7.3-percent decrease in Texas to a 14.2-percent increase in the Western Pennsylvania-West Virginia district. Other marked increases in capacity utilization were in the Virginia-Georgia-Florida-Louisiana-South Carolina-Mississippi, Northern California, Ohio, and Indiana Kentucky-Wisconsin districts.

Table 6 shows the percentage of estimated monthly production capacity utilized in each month of 1952 and 1953, and the percentage of capacity utilized in the 12-month period ended the last day of each month of those 2 years.

TABLE 6.—Percentage of capacity used in the finished portland-cement industry in the United States, 1952–53

Month	Monthly		12 months ended—		Month	Monthly		12 months ended—	
	1952	1953	1952	1953		1952	1953	1952	1953
January	73	79	90	89	July	90	100	87	93
February	76	80	90	89	August	99	101	87	93
March	78	84	90	90	September	99	102	87	93
April	86	94	88	90	October	101	103	88	93
May	92	97	88	91	November	95	97	88	93
June	90	98	87	92	December	87	84	88	93

The capacity of plants utilizing the wet process for manufacturing portland cement was 3 percent higher than in 1952 but constituted only a slightly higher percentage of the total productive capacity than in 1952. Capacity of the dry-process plants in operation increased 2 percent and constituted 43.5 percent of the total capacity. Table 7 shows capacity, capacity utilization, and percentage of total output produced for each of these processes.

TABLE 7.—Capacity of portland-cement plants in the United States,[1] Dec. 31, 1951–53, by processes

Process	Capacity, Dec. 31: Thousands of barrels			Capacity, Dec. 31: Percent of total			Percent of capacity utilized			Percent of total finished cement produced		
	1951	1952	1953	1951	1952	1953	1951	1952	1953	1951	1952	1953
Wet	155,430	159,812	164,726	55.2	56.3	56.5	89.3	88.7	90.9	56.4	56.9	56.7
Dry	126,102	124,202	127,072	44.8	43.7	43.5	85.0	86.5	90.1	43.6	43.1	43.3
Total	281,532	284,014	291,798	100.0	100.0	100.0	87.4	87.8	90.5	100.0	100.0	100.0

[1] Includes Puerto Rico.

A grouping of the cement plants based on their annual capacities is shown below. The less-than-1,000,000-barrel-capacity, 1,000,000–2,000,000-barrel-capacity, and 3,000,000–10,000,000-barrel-capacity groups were each smaller in 1953 than in 1952, while the number of plants in the 2,000,000–3,000,000-barrel-capacity group increased from 33 in 1952 to 39 in 1953.

Number of portland-cement plants in the United States (including Puerto Rico) in 1953, by size groups

Estimated annual capacity, Dec. 31, barrels:	*Number of plants*
Less than 1,000,000	20
1,000,000 to 2,000,000	85
2,000,000 to 3,000,000	39
3,000,000 to 10,000,000	12
Total	156

CLINKER PRODUCTION

Output of clinker—the product intermediate between raw materials and the finished cement—was 6 percent higher in 1953 than in 1952. As in the preceding several years, peak production was attained in October, while stocks reached their greatest accumulation in March. Lower stocks of clinker were on hand at the end of the spring months in 1953 than in 1952 but in the other months of 1953 varied little from the corresponding month of the previous year. Stocks of clinker on December 31, 1953, were 1 percent lower than those reported at the end of 1952. Tables 8 and 9 show pertinent data on the production and stocks of clinker during 1953.

TABLE 8.—Production and stocks of portland-cement clinker at mills in the United States in 1953, by months and districts, in thousand barrels

District	January	February	March	April	May	June	July	August	September	October	November	December
PRODUCTION												
Eastern Pennsylvania, Maryland	2,896	2,667	2,874	2,696	3,074	3,111	3,277	3,326	3,201	3,407	3,228	3,147
New York, Maine	1,277	1,216	1,334	1,357	1,462	1,357	1,499	1,470	1,403	1,498	1,454	1,484
Ohio	955	848	1,023	1,060	1,138	1,049	1,077	1,067	1,075	1,169	1,100	1,084
Western Pennsylvania, West Virginia	868	814	897	907	942	904	969	943	952	931	929	952
Michigan	1,190	973	1,027	1,336	1,432	1,307	1,435	1,522	1,306	1,481	1,415	1,426
Illinois	738	664	757	711	673	765	745	750	763	810	748	755
Indiana, Kentucky, Wisconsin	1,338	1,137	1,332	1,359	1,403	1,411	1,426	1,367	1,393	1,469	1,389	1,233
Alabama	906	798	862	904	953	902	976	977	931	946	864	799
Tennessee	588	557	634	597	711	656	672	715	685	700	663	583
Virginia, Georgia, Florida, Louisiana, South Carolina, Mississippi	1,441	1,328	1,462	1,465	1,572	1,529	1,406	1,434	1,415	1,580	1,447	1,465
Iowa	761	723	700	719	762	756	855	869	777	861	723	789
Eastern Missouri, Minnesota, South Dakota	795	862	1,049	1,041	1,055	932	975	1,055	1,071	1,141	1,065	1,010
Kansas	744	600	709	634	742	746	790	762	744	793	774	756
Western Missouri, Nebraska, Oklahoma, Arkansas	732	700	661	762	792	776	893	831	829	912	851	648
Texas	1,627	1,503	1,659	1,731	1,775	1,647	1,781	1,763	1,470	1,703	1,605	1,375
Colorado, Arizona, Wyoming, Montana, Utah, Idaho	753	670	620	755	822	796	785	755	655	748	700	693
Northern California	1,185	1,072	1,237	1,223	1,290	1,302	1,261	1,303	1,242	1,386	1,336	1,232
Southern California	1,384	1,047	1,430	1,437	1,447	1,433	1,460	1,444	1,444	1,438	1,487	1,473
Oregon, Washington	608	535	607	693	684	609	569	650	559	619	468	502
Puerto Rico	343	203	305	322	345	244	334	367	320	282	243	260
Total: 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
1952	19,569	18,541	19,959	19,596	20,975	19,950	20,542	22,233	22,135	23,241	22,039	22,020

TABLE 8.—Production and stocks of portland-cement clinker at mills in the United States in 1953, by months and districts, in thousand barrels—Continued

District	January	February	March	April	May	June	July	August	September	October	November	December
STOCKS (END OF MONTH)												
Eastern Pennsylvania, Maryland	662	677	627	646	562	579	573	546	418	363	303	331
New York, Maine	553	738	891	893	902	806	693	563	356	240	289	432
Ohio	233	302	393	380	480	509	450	317	197	138	147	188
Western Pennsylvania, West Virginia	263	345	422	367	359	296	247	239	174	135	135	203
Michigan	921	1,449	1,799	1,713	1,646	1,452	1,125	809	440	222	159	294
Illinois	161	354	392	354	267	233	156	112	29	6	22	43
Indiana, Kentucky, Wisconsin	506	581	768	678	645	540	458	263	234	202	213	270
Alabama	195	188	192	265	264	288	273	261	274	205	171	220
Tennessee	106	131	157	116	108	95	73	120	169	182	176	218
Virginia, Georgia, Florida, Louisiana, South Carolina, Mississippi	257	268	239	299	391	451	385	281	231	187	127	190
Iowa	221	291	346	497	425	359	319	276	126	112	115	146
Eastern Missouri, Minnesota, South Dakota	282	325	475	440	465	536	504	442	343	256	254	386
Kansas	174	153	163	173	159	106	90	80	41	59	54	88
Western Missouri, Nebraska, Oklahoma, Arkansas	204	380	376	345	255	197	191	135	82	74	134	219
Texas	307	305	209	165	220	208	307	393	320	365	386	488
Colorado, Arizona, Wyoming, Montana, Utah, Idaho	625	799	734	710	702	692	709	578	423	240	242	364
Northern California	415	347	396	294	188	191	161	124	82	97	119	263
Southern California	593	406	409	392	356	363	356	338	364	347	374	392
Oregon, Washington	596	704	751	852	833	798	634	601	495	457	419	421
Puerto Rico	171	156	156	136	174	133	125	174	203	222	183	153
Total: 1953	7,445	8,899	9,895	9,715	9,401	8,832	7,829	6,652	5,001	4,109	4,022	5,309
1952	7,085	9,021	10,833	10,520	9,513	8,578	7,548	6,262	5,352	4,360	4,329	[1] 5,385

[1] Revised figure.

TABLE 9.—Portland-cement clinker produced and in stock at mills in the United States,[1] 1952–53, by processes, in barrels [2]

Process	Plants		Production		Stocks on Dec. 31—	
	1952	1953	1952	1953	1952 [3]	1953 [4]
Wet	92	93	141,840,287	150,225,452	2,573,662	3,337,564
Dry	64	63	108,959,477	114,833,577	2,811,223	1,970,800
Total	156	156	250,799,764	265,059,029	5,384,885	5,308,364

[1] Includes Puerto Rico.
[2] Compiled from monthly estimates of producers.
[3] Revised figures.
[4] Preliminary figures.

RAW MATERIALS

In table 10 production is classified according to the kinds of raw materials from which the cement was manufactured.

Cement produced from argillaceous limestone ("cement rock") or from a mixture of cement rock with pure limestone is shown under the first heading. This is the combination of materials used in all cement plants in Lehigh and Northampton Counties, Pa. (the so-called "Lehigh district"), and at a few plants in other States.

Cement manufactured from a mixture of comparatively pure limestone with clay or shale and from mixtures of oyster-shells (or other marine shells, such as coquina) and clay or shale are shown under the

TABLE 10.—Production and percentage of total output of portland cement in the United States,[1] 1905–14, 1926, 1929, 1933, 1935, and 1941–53, 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
1905	18,454,902	52.4	11,172,389	31.7	3,884,178	11.0	1,735,343	4.9
1906	23,896,951	51.4	16,532,212	35.6	3,958,201	8.5	2,076,000	4.5
1907	25,859,095	53.0	17,190,697	35.2	3,606,598	7.4	2,129,000	4.4
1908	20,678,693	40.6	23,047,707	45.0	2,811,212	5.5	4,535,300	8.9
1909	24,274,047	37.3	32,219,365	49.6	2,711,219	4.2	5,786,800	8.9
1910	26,520,911	34.6	39,720,320	51.9	3,307,220	4.3	7,001,500	9.2
1911	26,812,129	34.1	40,665,332	51.8	3,314,176	4.2	7,737,000	9.9
1912	24,712,780	30.0	44,607,776	54.1	2,467,368	3.0	10,650,172	12.9
1913	29,333,490	31.8	47,831,863	51.9	3,734,778	4.1	11,197,000	12.2
1914	24,907,047	28.2	50,168,813	56.9	4,038,310	4.6	9,116,000	10.3
1926	44,090,657	26.8	101,637,866	61.8	3,324,408	2.0	15,477,239	9.4
1929	51,077,034	29.9	97,623,502	57.2	4,832,700	2.9	17,112,800	10.0
1933	14,135,171	22.3	43,638,023	68.7	1,402,744	2.2	4,297,251	6.8
1935	23,811,687	31.0	45,073,144	58.8	1,478,569	1.9	6,378,170	8.3
1941	46,534,193	28.4	102,285,699	62.3	3,142,021	1.9	12,068,646	7.4
1942	49,479,304	27.0	115,948,373	63.4	3,009,562	1.7	14,343,945	7.9
1943	29,915,157	22.4	92,310,018	69.2	2,300,636	1.7	8,897,977	6.7
1944	17,609,055	19.4	65,478,178	72.0	2,078,530	2.3	5,739,933	6.3
1945	20,383,505	19.8	73,409,831	71.4	2,035,236	2.0	6,976,312	6.8
1946	39,070,643	23.8	112,142,154	68.3	2,720,500	1.7	10,130,891	6.2
1947	43,428,201	23.3	129,338,247	69.3	2,408,845	1.3	11,344,054	6.1
1948	47,559,783	23.1	144,855,487	70.5	2,620,060	1.3	10,412,933	5.1
1949	45,655,516	21.8	150,435,948	71.7	3,310,270	1.6	10,325,683	4.9
1950	47,120,142	20.8	164,811,547	73.0	2,596,962	1.1	11,497,198	5.1
1951	50,328,000	20.4	169,204,269	68.8	2,653,211	1.1	23,836,996	9.7
1952	48,563,411	19.5	177,900,477	71.4	4,037,749	1.6	18,754,417	7.5
1953	54,028,856	20.5	184,181,[illegible]	69.7	5,097,256	1.9	20,872,709	7.9

[1] Includes Puerto Rico, 1941–53; 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 1952–53 (includes 1 plant that used coquina shells).

TABLE 11.—Raw materials used in producing portland cement in the United States,[1] 1951–53

Raw material	1951	1952	1953
	Short tons	*Short tons*	*Short tons*
Cement rock	13,927,428	13,404,234	14,579,919
Limestone (including oystershells)	53,564,633	[2] 54,229,475	55,619,940
Marl	627,013	1,065,164	1,291,726
Clay and shale [3]	7,857,584	7,939,326	8,606,483
Blast-furnace slag	1,071,749	1,017,976	1,408,486
Gypsum	1,863,018	1,855,274	1,956,093
Sand and sandstone (including silica and quartz)	920,183	893,682	888,359
Iron materials [4]	379,818	375,852	410,420
Miscellaneous [5]	173,902	[2] 168,901	176,173
Total	80,385,328	[2] 80,949,884	84,937,599
Average total weight required per barrel (376 pounds) of finished cement	*Pounds* 653	*Pounds* 646	*Pounds* 643

[1] Includes 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.

second heading. The former mixture was used at the majority of plants in the United States in 1953, while eight plants utilized marine shells.

Cement manufactured from a mixture of marl and clay is listed under the heading "Marl and clay." This type of mixture was used at only four plants in 1953; these were in Mississippi, Ohio, South Carolina, and Virginia.

Portland cement made from a mixture of limestone and blast-furnace slag is shown under the last heading. This mixture was used at cement plants in the Buffalo, Pittsburgh, and Birmingham 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 material (exclusive of fuels and explosives) required to produce portland cement in recent years are given in table 11.

TABLE 12.—Finished portland cement produced and fuel consumed by the portland-cement industry in the United States,[1] 1952–53, 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)
1952						
Wet	92	141,821,019	56.9	3,789,690	4,859,406	77,583,713
Dry	64	107,435,135	43.1	4,283,519	1,646,990	[3] 34,128,323
Total	156	249,256,154	100.0	[4] 8,073,209	6,506,396	[3] 111,712,036
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	[5] 8,361,935	6,781,922	[3] 117,142,445

[1] Includes Puerto Rico.
[2] Figures compiled from monthly estimates of producers.
[3] Includes byproduct gas: 1952—233,200 M cubic feet; 1953—71,112 M cubic feet and 2,032,228 M cubic feet of coke-oven gas.
[4] Comprises 170,150 tons of anthracite and 7,903,059 tons of bituminous coal.
[5] Comprises 194,781 tons of anthracite and 8,167,154 tons of bituminous coal.

FUEL AND POWER

All of the major types of fuel consumed in the portland-cement industry were used in greater quantity in 1953 than 1952. Percentage increases were as follows: Coal, 4; fuel oil, 4; and gas (including natural, byproduct, and coke-oven), 5. Stocks of coal and oil rarely were large enough to maintain operations for more than 2 months at the average monthly consumption rate. Tables 12 and 13 show pertinent data on the fuel consumption and the quantities of cement produced from each type of fuel in 1952 and 1953.

TABLE 13.—Portland cement produced in the United States,[1] 1952–53, by kinds of fuel

Fue	Finished cement produced			Fuel consumed [2]		
	Plants	Barrels	Percent of total	Coal (short tons)	Oil (barrels of 42 gallons)	Natural gas (M cubic feet)
1952						
Coal	74	[3] 116, 074, 806	46. 6	6, 550, 779		
Oil	15	[3] 22, 854, 174	9. 2		4, 653, 767	
Natural gas	16	[3] 25, 445, 073	10. 2			35, 752, 525
Coal and oil	12	17, 913, 815	7. 2	860, 852	615, 302	
Coal and natural gas	20	31, 222, 710	12. 5	551, 284		[4] 33, 484, 592
Oil and natural gas	11	24, 993, 566	10. 0		1, 043, 834	27, 962, 394
Coal, oil, and natural gas	8	10, 752, 010	4. 3	110, 294	193, 493	14, 512, 525
Total	156	249, 256, 154	100. 0	[5] 8, 073, 209	6, 506, 396	111, 712, 036
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		[6] 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	[7] 8, 361, 935	6, 781, 922	117, 142, 445

[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: 1952—Coal, 112.9 pounds; oil, 0.2036 barrel; natural gas, 1,405 cubic feet. 1953—Coal, 111.5 pounds; oil, 0.2044 barrel; natural gas, 1,408 cubic feet.
[4] Includes 233,200 M cubic feet of byproduct gas.
[5] Comprises 170,150 tons of anthracite and 7,903,059 tons of bituminous coal.
[6] Includes 71,112 M cubic feet of byproduct gas and 2,032,228 M cubic feet of coke-oven gas.
[7] Comprises 194,781 tons of anthracite and 8,167,154 tons of bituminous coal.

Data on electric energy used in the production of portland cement are shown in table 14. In 1953 a larger percentage of the total electric energy used was purchased, compared to earlier years.

TRANSPORTATION

The quantity and proportion of portland cement shipped in 1951–53 by each method of transportation and mode of packing or packaging are shown in table 15. The most important 1953 changes were a continuing increase in the percentage shipped in bulk and a corresponding decrease in the percentage shipped in bags. An accelerated trend to truck transportation was noted. Study of producers' reports shows that the principal 1953 percentage gains in bulk shipments, as compared with percentages shipped in containers, were made in the

TABLE 14.—Electric energy used at portland-cement-producing plants in the United States,[1] 1952–53, 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)
1952								
Wet	30	751,718,142	86	2,262,480,825	3,014,198,967	54.7	141,821,019	21.3
Dry	35	1,373,153,231	54	1,120,823,116	2,493,976,347	45.3	107,435,135	23.2
Total	65	2,124,871,373	140	3,383,303,941	5,508,175,314	100.0	249,256,154	22.1
Percent of total electric energy used		38.6		61.4	100.0			
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			

[1] Includes Puerto Rico.

TABLE 15.—Shipments of portland cement from mills in the United States,[1] 1951–53, 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
1951								
Truck	[3]42,899,170	29.2	22,366,199	186,924		22,553,123	65,452,293	27.2
Railroad	102,233,611	69.5	70,327,861	673,634	8,558	71,010,053	173,243,664	71.8
Boat	1,940,483	1.3	496,895	18,416	1,521	516,832	2,457,315	1.0
Total	147,073,264	100.0	93,190,955	878,974	10,079	94,080,008	241,153,272	100.0
Percent of total	61.0		38.6	0.4	(4)	39.0	100.0	
1952								
Truck	[3]45,690,842	28.8	22,948,530	138,702		23,087,232	68,778,074	27.3
Railroad	109,566,554	69.1	68,891,460	446,361	8,218	69,346,039	178,912,593	71.2
Boat	3,248,587	2.1	392,025	36,340	884	429,249	3,677,836	1.5
Total	158,505,983	100.0	92,232,015	621,403	9,102	92,862,520	251,368,503	100.0
Percent of total	63.1		36.7	0.2	(4)	36.9	100.0	
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	

[1] Includes Puerto Rico.
[2] Includes steel drums and iron and wood barrels.
[3] Includes cement used at mills by producers as follows—1951: 1,368,117 barrels; 1952: 1,212,495 barrels; 1953: 1,306,411 barrels.
[4] Less than 0.05 percent.

Puerto Rico, Western Missouri-Nebraska-Oklahoma-Arkansas, Iowa, Colorado-Arizona-Wyoming-Montana-Utah-Idaho, and Ohio districts.

Shipments shown in table 15 represent the movement of the portland cement as it leaves the manufacturer's possession. Intracompany movements—for example, by boat from the Huron Portland Cement Co. Alphena, Mich., plant to that company's various distribution centers—are not considered shipments.

CONSUMPTION

Quantities shown in table 16 are the total number of barrels of portland cement reported by domestic producers (including those in Puerto Rico) to have been shipped to destinations in the respective States and the District of Columbia. They represent shipments both from plants in the State in question and from all other States. These data 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 certain instances much of the cement shipped to a distributing point near a State line is subsequently used in a State other than that listed as its "destination." Some coastal and border States receive cement from foreign countries, and the quantities are not included here. Although shipments to destinations in a State do not equal its consumption during that period of time, shipments over a long period afford a fair index of consumption.

As shown in table 16, indicated consumption of portland cement in 1953 increased 4 percent and was higher in 31 States and the District of Columbia and lower in 17 States, compared with 1952.

Table 17 shows a monthly breakdown of apparent consumption in each State.

STOCKS

Shipments in 1953 were considerably lower than production, and stocks of finished cement on hand at the end of the year were, therefore, well over those on hand at the end of 1952. Four districts reported stocks more than 40 percent higher on December 31, 1953, than on December 31, 1952.

In the early months of 1953 stocks of cement were lower than in the same months of 1952, but during the last 8 months of the year, stock levels were 2 to 4 million barrels higher than in the previous year.

TABLE 16.—Destination of shipments of finished portland cement from mills in the United States, 1951–53, by States

Destination	1951 (barrels)	1952 (barrels)	1953	
			Barrels	Change from 1952 (percent)
Continental United States:				
Alabama	3,736,413	3,920,511	4,260,020	+8.7
Arizona	1,681,846	2,121,492	2,422,223	+14.2
Arkansas	1,854,107	1,941,519	1,772,135	−8.7
California	25,191,516	25,361,032	27,732,814	+9.4
Colorado	2,858,840	2,824,978	2,940,615	+4.1
Connecticut [1]	2,770,756	2,977,458	3,188,752	+7.1
Delaware [1]	783,892	906,245	891,978	−1.6
District of Columbia [1]	1,457,896	1,155,923	1,248,696	+8.0
Florida	6,051,603	6,680,385	7,487,563	+12.1
Georgia	3,513,978	4,116,620	4,643,993	+12.8
Idaho	1,154,434	1,110,295	985,580	−11.2
Illinois	12,286,321	13,324,065	13,515,338	+1.4
Indiana	6,354,398	6,222,861	6,430,278	+3.3
Iowa	4,948,586	4,976,010	5,025,264	+1.0
Kansas	4,477,884	5,852,155	5,791,950	−1.0
Kentucky	2,925,136	3,621,414	3,319,505	−8.3
Louisiana	5,282,319	5,868,630	5,759,267	−1.9
Maine	711,192	692,055	907,788	+31.2
Maryland	4,398,730	4,362,945	4,672,721	+7.1
Massachusetts [1]	4,153,399	4,346,378	4,351,196	+.1
Michigan	10,693,060	11,310,322	12,716,532	+12.4
Minnesota	4,520,518	4,748,175	4,968,121	+4.6
Mississippi	1,670,933	1,704,719	1,696,176	−.5
Missouri	5,663,459	6,319,588	6,797,881	+7.6
Montana	1,576,885	1,358,350	948,293	−30.2
Nebraska	2,356,433	2,626,741	3,384,652	+28.9
Nevada [1]	389,815	618,392	623,133	+.8
New Hampshire [1]	442,168	456,691	548,692	+20.1
New Jersey [1]	8,231,613	8,084,668	8,574,407	+6.1
New Mexico [1]	1,745,162	1,645,426	1,876,499	+14.0
New York	16,248,279	16,898,736	19,101,250	+13.0
North Carolina [1]	3,683,471	3,885,629	3,746,417	−3.6
North Dakota [1]	1,004,990	1,071,422	1,120,297	+4.6
Ohio	12,967,938	13,095,380	14,292,284	+9.1
Oklahoma	3,781,008	4,651,344	4,158,026	−10.6
Oregon	3,349,725	2,927,040	2,445,679	−16.4
Pennsylvania	16,133,233	15,132,930	15,229,467	+.6
Rhode Island [1]	956,077	923,860	859,500	−7.0
South Carolina	2,313,122	2,961,293	2,260,545	−23.7
South Dakota	1,012,080	1,108,810	1,188,758	+7.2
Tennessee	4,792,334	4,701,963	4,867,836	+3.5
Texas	16,518,808	17,257,467	16,153,989	−6.4
Utah	1,191,237	1,342,998	1,342,755	−.02
Vermont [1]	330,400	316,066	296,159	−6.3
Virginia	4,719,467	4,649,768	4,705,831	+1.2
Washington	4,518,034	4,954,171	5,399,200	+9.0
West Virginia	1,802,919	1,804,409	1,922,820	+6.6
Wisconsin	5,226,527	5,667,282	6,138,721	+8.3
Wyoming	606,912	561,486	537,625	−4.2
Unspecified	7,536	8,840	14,250	+61.2
Total continental United States	235,047,389	245,176,937	255,263,471	+4.1
Outside continental United States [2]	6,105,883	6,191,566	5,615,064	−9.3
Total shipped from cement plants	241,153,272	251,368,503	260,878,535	+3.8

[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.

TABLE 17.—Destination of shipments of finished portland cement from mills in the United States in 1953, by months, in barrels

Destination	January	February	March	April	May	June	July	August	September	October	November	December
Alabama	290, 120	263, 860	379, 220	313, 236	352, 171	421, 033	391, 750	438, 750	433, 879	437, 994	324, 771	212, 747
Arizona	217, 339	200, 944	221, 302	246, 794	199, 142	179, 450	147, 950	184, 557	202, 767	233, 699	198, 387	200, 436
Arkansas	114, 720	100, 180	139, 812	163, 226	155, 253	203, 766	210, 506	200, 011	165, 383	123, 129	108, 965	76, 603
California	1, 942, 522	2, 148, 912	2, 387, 215	2, 384, 031	2, 361, 190	2, 289, 615	2, 399, 830	2, 519, 809	2, 537, 220	2, 586, 079	2, 091, 611	2, 088, 658
Colorado	158, 824	148, 505	242, 807	246, 468	288, 738	311, 569	294, 656	327, 347	302, 903	297, 919	191, 044	129, 747
Connecticut	134, 545	136, 975	219, 871	214, 666	279, 452	352, 784	364, 961	362, 256	321, 275	357, 029	267, 779	182, 067
Delaware	38, 084	49, 275	57, 835	97, 574	61, 970	83, 406	103, 615	102, 573	107, 442	114, 619	44, 205	41, 099
District of Columbia	87, 873	84, 636	89, 544	103, 596	97, 970	114, 651	119, 135	116, 352	122, 511	123, 327	100, 761	88, 302
Florida	632, 642	621, 015	705, 186	593, 836	590, 837	619, 506	703, 952	596, 075	579, 566	614, 527	657, 477	572, 748
Georgia	319, 780	299, 380	428, 969	368, 790	408, 723	431, 691	400, 789	440, 814	438, 846	479, 018	385, 013	242, 414
Idaho	46, 816	51, 784	92, 552	92, 745	89, 438	98, 326	97, 666	108, 489	106, 965	90, 901	70, 333	39, 539
Illinois	428, 904	504, 680	1, 008, 027	964, 095	1, 253, 403	1, 440, 371	1, 537, 108	1, 666, 265	1, 503, 790	1, 606, 827	1, 014, 530	511, 489
Indiana	222, 496	272, 419	568, 461	501, 905	607, 613	712, 241	694, 821	718, 482	771, 781	729, 945	503, 515	264, 594
Iowa	74, 828	92, 203	299, 925	233, 078	460, 630	567, 589	626, 609	714, 343	835, 356	648, 260	293, 020	95, 331
Kansas	249, 358	310, 991	473, 180	386, 268	424, 090	555, 193	644, 638	734, 555	658, 605	675, 412	424, 738	264, 127
Kentucky	174, 321	218, 307	331, 510	267, 665	274, 255	323, 413	334, 787	327, 264	340, 967	366, 801	257, 102	137, 390
Louisiana	443, 410	335, 896	483, 057	498, 762	463, 117	552, 895	508, 519	539, 958	549, 149	583, 030	415, 587	354, 647
Maine	21, 668	20, 928	36, 206	46, 584	82, 867	95, 376	125, 137	112, 581	122, 662	121, 936	62, 700	45, 815
Maryland	248, 915	291, 520	340, 157	404, 376	445, 086	510, 845	470, 622	459, 189	447, 056	478, 496	321, 825	258, 013
Massachusetts	196, 364	179, 474	362, 385	306, 110	420, 168	471, 660	494, 282	452, 477	398, 976	447, 304	334, 008	287, 948
Michigan	362, 749	415, 963	691, 581	1, 059, 415	1, 226, 567	1, 435, 665	1, 402, 293	1, 487, 808	1, 505, 768	1, 540, 977	1, 042, 483	544, 945
Minnesota	104, 384	109, 182	359, 431	297, 213	488, 130	639, 447	648, 886	651, 213	686, 704	609, 361	244, 927	129, 289
Mississippi	147, 423	104, 587	166, 834	124, 264	114, 187	137, 050	139, 296	176, 103	185, 983	164, 961	150, 830	84, 358
Missouri	269, 049	345, 212	558, 844	604, 891	586, 873	429, 794	536, 040	878, 551	941, 980	768, 157	538, 609	337, 846
Montana	28, 268	25, 376	60, 314	75, 220	82, 205	92, 007	107, 094	110, 120	105, 367	137, 173	77, 297	48, 207
Nebraska	54, 189	70, 079	205, 765	256, 921	366, 509	447, 232	525, 514	434, 720	400, 851	378, 017	165, 947	78, 419
Nevada	50, 538	43, 042	55, 113	67, 482	47, 521	43, 708	45, 367	44, 746	54, 677	56, 316	54, 416	55, 271
New Hampshire	14, 114	17, 892	41, 583	38, 350	52, 950	53, 175	62, 958	59, 276	64, 287	65, 661	45, 600	32, 831
New Jersey	436, 595	476, 553	643, 774	693, 425	760, 142	851, 639	829, 268	859, 801	822, 802	912, 637	684, 543	609, 510
New Mexico	126, 992	149, 478	198, 559	166, 661	174, 320	202, 817	173, 246	142, 815	164, 473	142, 252	128, 770	89, 212
New York	803, 264	861, 498	1, 338, 756	1, 498, 824	1, 858, 380	2, 256, 312	1, 607, 462	1, 685, 939	2, 342, 489	2, 311, 880	1, 503, 205	1, 066, 439
North Carolina	257, 917	246, 142	325, 131	377, 807	329, 289	343, 032	370, 047	349, 040	296, 629	331, 537	289, 900	198, 112
North Dakota	15, 927	21, 427	82, 256	56, 231	77, 230	146, 788	196, 658	201, 829	150, 605	140, 454	41, 447	17, 564
Ohio	520, 101	588, 256	942, 568	1, 008, 058	1, 110, 677	1, 579, 069	1, 635, 393	1, 652, 362	1, 603, 640	1, 696, 757	1, 238, 894	710, 573
Oklahoma	325, 554	335, 574	356, 315	360, 754	371, 108	355, 327	317, 294	379, 527	358, 386	329, 695	353, 209	315, 366
Oregon	119, 670	166, 482	228, 709	213, 363	198, 719	226, 901	256, 754	248, 253	248, 836	225, 508	159, 812	152, 432
Pennsylvania	723, 811	788, 699	1, 153, 417	1, 158, 786	1, 263, 542	1, 632, 375	1, 709, 689	1, 707, 904	1, 618, 221	1, 682, 354	1, 045, 185	749, 860

TABLE 17.—Destination of shipments of finished portland cement from mills in the United States in 1953, by months, in barrels—Con.

Destination	January	February	March	April	May	June	July	August	September	October	November	December
Rhode Island	33,763	33,401	66,234	90,926	97,230	103,641	85,626	84,898	88,288	80,589	53,360	38,814
South Carolina	203,776	166,945	226,934	200,447	197,686	201,109	188,907	185,020	175,924	183,387	158,355	128,903
South Dakota	19,438	45,079	84,131	76,339	84,279	146,493	152,852	166,391	208,788	176,112	62,500	24,035
Tennessee	340,397	331,837	525,844	391,062	348,208	446,210	433,558	443,620	498,692	506,833	355,907	234,055
Texas	1,371,693	1,166,070	1,692,531	1,555,851	1,361,413	1,509,412	1,385,757	1,240,645	1,338,440	1,344,313	1,162,246	1,029,635
Utah	56,717	63,190	106,175	121,038	135,377	127,810	148,478	162,297	155,891	133,070	89,162	43,512
Vermont	4,153	5,105	24,813	25,060	31,467	38,298	36,498	37,711	30,288	30,870	24,029	11,461
Virginia	278,173	322,556	384,744	420,906	408,457	444,551	481,297	424,645	441,055	466,862	349,951	277,694
Washington	216,877	301,440	469,801	498,480	519,321	534,949	631,535	498,917	539,880	488,658	384,852	328,564
West Virginia	75,286	90,159	139,036	129,167	162,724	189,773	200,920	215,206	225,370	241,207	158,239	94,134
Wisconsin	163,069	131,782	333,015	406,430	631,855	862,344	878,968	761,197	658,673	711,100	404,389	184,477
Wyoming	25,156	21,047	38,410	40,355	46,822	52,256	58,969	65,550	62,894	59,079	39,504	27,569
Unspecified	150	9,929	6,472	2,378	162	6,708	4,094	1,111	971	11,498	1,106	562
Continental United States	13,192,722	13,785,866	20,374,311	20,449,909	22,449,463	25,871,527	25,922,051	26,479,362	26,923,951	27,043,527	19,076,045	13,737,363
Outside continental United States [1]	327,278	369,134	438,689	441,091	474,537	528,473	557,949	612,638	509,049	512,473	417,955	392,637
Total	13,520,000	14,155,000	20,813,000	20,891,000	22,924,000	26,400,000	26,480,000	27,092,000	27,433,000	27,556,000	19,494,000	14,130,000

[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.

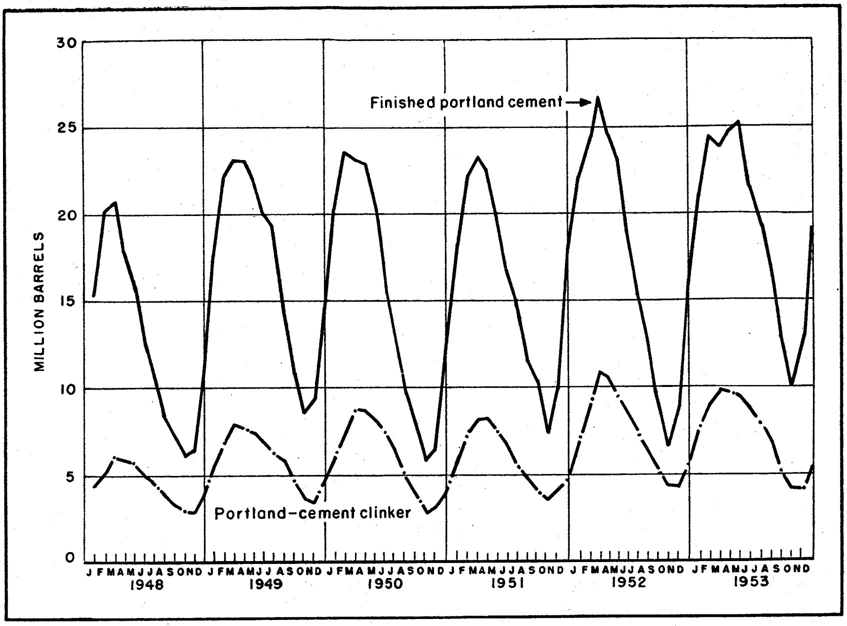

FIGURE 2.—End-of-month stocks of finished portland cement and portland-cement clinker, 1948–53.

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, 1949–53

		Dec. 31 (barrels)	Range			
			Low		High	
			Month	Barrels	Month	Barrels
1949	Cement	14, 758, 499	October	8, 569, 000	March	23, 104, 000
	Clinker	4, 586, 746	November	3, 387, 000	do	7, 764, 000
1950	Cement	13, 118, 867	October	5, 945, 000	February	23, 583, 000
	Clinker	3, 924, 801	do	2, 852, 000	March	8, 821, 000
1951	Cement	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	[2] 15, 932, 203	do	6, 546, 000	March	26, 622, 000
	Clinker	[2] 5, 384, 885	November	4, 329, 000	do	10, 833, 000
1953	Cement	19, 234, 190	October	10, 049, 000	May	25, 247, 000
	Clinker	5, 308, 364	November	4, 022, 000	March	9, 895, 000

[1] Includes Puerto Rico.
[2] Revised figure.

PRICES

The average net mill realization of all portland cement shipped from mills in 1953 was $2.67 compared with $2.54 in each of the 2 preceding years. The average value in the first quarter of 1953 was $2.57 per barrel, but spring price increases raised the average value to $2.70, where it remained during the rest of the year.

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 122.2 in 1953 compared with 116.4 in 1952 and 1951.

Average mill value per barrel, in bulk, of portland cement in the United States,[1] 1944–48 (average) and 1949–53

1944–48 (average)	$1.86	1951	$2.54
1949	2.30	1952	2.54
1950	2.35	1953	2.67

[1] Includes Puerto Rico and Hawaii, 1946; Puerto Rico only, 1947–53.

NATURAL, MASONRY (NATURAL) AND POZZOLAN CEMENTS

Natural, masonry (natural), and pozzolan cements were produced in eight plants in 1953, the same number as in 1952. Output, shipments, and stocks during the year were, respectively, 3, 0.3, and 25 percent higher than in 1952. Producers in this group reported consumption of 37,136 short tons of coal and 138,841,000 cubic feet of gas (equivalent to approximately 3,000 short tons of coal).

The eight producing plants reported a total estimated annual capacity on December 31, 1953, of 3,649,000 equivalent barrels of 376 pounds. Raw materials used during 1953 in producing these cements were 337,000 short tons of cement rock, 166,000 short tons of slag, and 113,000 short tons of other materials, principally shale, lime, and limestone.

Quantities in table 19 are shown in equivalent barrels of 376 pounds to maintain uniformity with other data in this chapter.

TABLE 19.—Natural, masonry (natural), and pozzolan (slag-lime) cements produced, shipped, and in stocks at mills in the United States, 1944–48 (average) and 1949–53

Year	Production		Shipments		Stocks on Dec. 31, (barrels)
	Active plants	Barrels	Barrels	Value	
1944–48 (average)	9	2,319,297	2,327,183	$4,277,320	160,911
1949	9	3,185,229	3,233,525	8,006,361	161,605
1950	9	4,246,299	4,218,580	10,629,586	189,323
1951	9	3,449,463	3,475,423	9,832,956	159,485
1952	8	3,401,684	3,447,390	9,751,837	[1] 113,777
1953	8	3,488,102	3,459,361	10,340,767	142,518

[1] Revised figure.

FOREIGN TRADE [4]

Imports.—Imports of hydraulic cement totaled 386,100 barrels in 1953, 19 percent less than the quantity imported in 1952. Most of this cement came from Belgium-Luxembourg and West Germany, while imports exceeding 10,000 barrels each also came from Sweden, Canada, United Kingdom, and Yugoslavia.

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

TABLE 20.—Hydraulic cement imported for consumption in the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Year	Barrels	Value	Year	Barrels	Value
1944–48 (average)	58,317	$166,087	1951	921,953	$3,162,960
1949	109,821	329,969	1952	475,986	1,397,239
1950	1,409,974	3,610,056	1953	386,051	1,265,821

Imports of all hydraulic cement, except white, nonstaining, and other special cements for 1951–53 are listed by country of origin in table 21. Imports of white nonstaining cement in 1953 totaled 45,700 barrels and of hydraulic cement clinker from Canada and United Kingdom 3,300 barrels in 1953.

TABLE 21.—Roman, portland, and other hydraulic cement imported for consumption in the United States, 1951–53, by countries [1]

[U. S. Department of Commerce]

Country	1951		1952		1953	
	Barrels	Value	Barrels	Value	Barrels	Value
Belgium-Luxembourg	10,856	$26,187	194,350	$518,617	187,245	$524,552
Canada	929	4,176	1,731	11,246	11,548	51,105
Colombia	12,449	26,632	------	------	------	------
Denmark	53	231	3,963	18,617	750	1,559
France	------	------	------	------	152	1,281
Germany	722,478	2,494,679	[2] 132,710	[2] 328,141	[2] 98,678	[2] 275,888
Japan	84	285	1	6	------	------
Mexico	2,567	5,326	------	------	------	------
Sweden	------	------	33,146	105,375	17,573	35,854
United Kingdom	159,314	536,269	103,289	379,222	10,578	61,958
Yugoslavia	1,085	7,845	879	4,371	10,554	52,411
Total	909,815	3,101,630	470,069	1,365,595	337,078	1,004,608

[1] Excludes "white, nonstaining, and other special cements."
[2] West Germany.

Exports.—Exports of hydraulic cement in 1953 were 20 percent lower than in 1952 and represented only 1 percent of the total shipments of domestically produced cement. About one-half of the exports went to Canada. Other countries receiving over 100,000 barrels were Cuba, Mexico, and Venezuela.

TABLE 22.—Hydraulic cement exported from the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Year	Barrels	Value	Percent of total shipments from miles
1944–48 (average)	5,674,380	$16,368,231	3.7
1949	4,561,899	15,960,954	2.2
1950	2,418,435	7,274,564	1.0
1951	2,932,787	9,963,721	1.2
1952	[1] 3,174,405	[1] 11,148,535	1.2
1953	2,535,549	9,260,924	1.0

[1] Revised figure.

TABLE 23.—Hydraulic cement exported from the United States, 1951–53, by countries of destination

[U. S. Department of Commerce]

Country	1951		1952		1953	
	Barrels	Value	Barrels	Value	Barrels	Value
North America:						
Bermuda	1,324	$5,861	1,250	$5,021	7,425	$27,450
Canada	971,824	3,767,895	1,407,735	5,163,635	1,207,296	4,519,410
Central America:						
British Honduras	325	1,219	2,049	9,418	3,900	13,692
Canal Zone	514	2,501	396	2,318	710	4,211
Costa Rica	38,604	144,031	8,893	35,451	9,577	36,046
El Salvador	25,574	99,490	8,716	37,918	2,508	19,655
Guatemala	4,905	30,436	1,888	14,459	1,326	8,878
Honduras	74,866	267,561	58,437	198,674	32,973	89,627
Nicaragua	5,558	21,432	6,692	26,359	8,064	30,808
Panama	674	4,601	1,388	10,091	1,452	10,204
Mexico	218,845	878,481	285,277	1,128,373	278,368	1,152,740
West Indies:						
British:						
Bahamas	7,282	37,760	15,147	68,306	12,252	54,790
Barbados	----------	----------	375	1,754	500	2,480
Jamaica	18,493	58,141	1,985	7,464	2,055	6,214
Leeward and Windward Islands	1,880	6,576	1,936	7,146	2,634	9,367
Trinidad and Tobago	3,050	11,260	1,232	9,989	4,133	20,133
Cuba	611,360	1,632,358	[1] 656,735	[1] 2,006,866	447,584	1,254,473
Dominican Republic	33,993	124,642	10,403	31,240	2,214	12,256
French West Indies	6,625	21,945	8,550	27,917	8,601	26,420
Haiti	102,220	266,691	118,848	269,695	73,628	193,655
Netherland Antilles	99,036	249,297	99,647	280,014	76,710	195,650
Total North America	2,226,952	7,632,178	[1] 2,697,579	[1] 9,342,108	2,183,910	7,688,159
South America:						
Argentina	518	4,997	780	2,942	800	5,488
Bolivia	462	2,777	704	4,103	2,916	13,723
Brazil	10,558	85,763	3,156	15,090	7,270	29,944
Chile	2,695	21,082	2,937	21,793	2,533	23,840
Colombia	9,103	72,857	17,473	107,285	11,663	76,875
Ecuador	3,157	14,883	3,000	13,260	4	104
Paraguay	250	3,000	----------	----------	382	2,815
Peru	1,335	10,527	13,629	52,895	10,063	47,322
Surinam	1,368	5,007	6,325	18,355	32,638	78,995
Uruguay	50	693	----------	----------	----------	----------
Venezuela	558,721	1,597,675	375,880	1,285,239	225,012	964,213
Total South America	588,217	1,819,261	423,884	1,520,962	293,281	1,243,319
Europe:						
Belgium-Luxembourg	396	3,888	795	6,333	528	4,279
France	1,507	6,446	1,766	13,233	137	2,491
Italy	339	2,705	149	1,999	13	153
Norway	68	214	135	11,013	82	5,359
Spain	----------	----------	25	365	864	5,012
Turkey	59,532	206,830	4,238	21,870	45	152
Other Europe	859	9,064	614	9,999	520	6,195
Total Europe	62,701	229,147	7,722	64,812	2,189	23,641
Asia:						
Bahrein	1,372	7,276	3,231	12,998	----------	----------
India	9	230	1,160	4,873	22	400
Indonesia	6,249	30,043	2,750	12,092	5,424	27,014
Iran	2,980	13,000	----------	----------	----------	----------
Iraq	3,992	19,128	9,781	45,659	11,327	53,195
Israel and Palestine	7,035	43,147	109	2,019	596	4,357
Japan	----------	----------	243	9,667	1,382	22,247
Kuwait	----------	----------	38	188	2,000	7,570
Philippines	6,171	62,838	314	3,147	4,271	42,059
Saudi Arabia	18,323	72,451	22,095	104,087	18,341	88,548
Other Asia	----------	----------	175	957	1,380	11,082
Total Asia	46,131	248,113	39,896	195,687	44,743	256,472

[1] Revised figure.

TABLE 23.—Hydraulic cement exported from the United States, 1951–53, by countries of destination—Continued

[U. S. Department of Commerce]

Country	1951		1952		1953	
	Barrels	Value	Barrels	Value	Barrels	Value
Africa:						
Ethiopia			1,250	$5,455		
Liberia	362	$1,910	313	1,995	450	$1,562
Northern Rhodesia					750	3,809
Tunisia			625	3,325	502	2,414
Other Africa	333	2,827	276	1,125	820	6,594
Total Africa	695	4,737	2,464	11,900	2,522	14,379
Oceania:						
French Pacific Islands	3,693	13,582				
New Zealand	3,499	12,460	2,530	9,845	8,113	29,814
Other Oceania	899	4,243	330	3,221	791	5,140
Total Oceania	8,091	30,285	2,860	13,066	8,904	34,954
Grand total	2,932,787	9,963,721	[1] 3,174,405	[1] 11,148,535	2,535,549	9,260,924

[1] Revised figure.

TECHNOLOGY

A new specification for portland-pozzolan cement has been written in Mexico. Minimum permissible content of portland-cement clinker is 70 percent. Fifteen percent of the cement now used in Mexico is of the portland-pozzolan type, and some areas depend solely on that type for all concrete work.[5] The American Society for Testing Materials is preparing a proposed specification for portland-pozzolan cement in the United States.

Hydrophobic cement developed in Russia is made by grinding ordinary portland-cement clinker with a water-repellant admixture.[6]

A published report summarized results of investigations of volume-change characteristics of portland-cement pastes. These studies indicated the primary causes of unsoundness in portland cement.[7]

Laboratory tests indicated that the admixture of a certain type of fly ash in concrete improved its strength. No difference in resistance to frost was noted between air-entrained concretes with and without fly ash.[8]

The new research center of Ideal Cement Co., near the Boettcher, Colo., plant, will serve the company's 13 plants with research studies on cement production and uses.[9]

Methods for transporting cement by truck in light-metal pressure tanks have been developed in Sweden. A pneumatic device permits quick, dustless unloading. Advantages in labor savings and overall convenience also were noted.[10]

The causes of ring formation in cement kilns and methods of removing them were reviewed. An advantage of shooting the rings

[5] de la O, F. B., Puzzolan Cements Gaining Favor in Mexico: Rock Products, vol. 56, No. 8, August 1953 pp. 124–127, 192.
[6] Nurse, R. W., Hydrophobic Cement: Cement and Lime Manufacture (London), vol. 26, No. 4, July 1953, pp. 47–51.
[7] Gonnerman, H. F., Lerch, W., and Whiteside, T. M., Investigations of Hydration Expansion Characteristics of Portland Cements: Portland Cement Assoc. Research Laboratories, Bull. 45, June 1953, 168 pp.
[8] Wash, G. W., and Withey, N. H., Strength and Durability of Concrete Containing Chicago Fly Ash: Am. Concrete Inst. Jour., vol. 24, No. 8, April 1953, pp. 701–712.
[9] Wilsnack, G. C., Ideal Cement Co.'s Research Center: Rock Products, vol. 56, No. 12, December 1953, pp. 98–101, 124.
[10] Grindrod, J., Pneumatic Tanks for Bulk Cement: Rock Products, vol. 56, No. 3, March 1953, p. 118. Concrete, Pneumatic Tanks Transport Swedish Cement: Vol. 61, No. 3, March 1953, p. 36.

with industrial guns and shells is the fact that no extended kiln downtime is required.[11]

A Japanese cement technologist investigated the burning mechanism of cement kilns, using both dry- and wet-process kilns. In his report suggestions were given relative to planning and handling cement rotary kilns.[12]

The Third International Symposium on the Chemistry of Cement was held in London. Representatives of the cement industries of many countries attended to discuss latest developments in cement chemistry and concrete design and construction. Abstracts of several of the more important papers presented at the meeting appeared in a trade publication.[13]

Articles of interest to cement process technologists included: Methods for calculating raw mixes;[14] a study of the mechanics of slurry flow;[15] a series dealing with cement and lime rotary-kiln loading problems;[16] and a description of the use of strain gages to aline kilns accurately.[17]

Spectrographic methods can be used to estimate the cement content of soil-cement and pozzolan-cement mixtures,[18] magnesium oxide in portland cement,[19] and the components of calcium silicates and cement clinkers.[20]

A comprehensive report described in detail the various common types of mechanical equipment used for handling cement.[21]

A series of articles on the theoretical chemistry of cement and concrete, begun in 1952, continued in several of the 1953 issues of the sponsoring publication.[22]

Methods of dry-grinding both raw materials and clinker in short ball mills, as contrasted with multiple-compartment mills, were said to be attracting increased interest in the cement industry. By far the bulk of the clinker was ground in compartment mills, but short ball mills were in commercial usage.[23]

The new Lehigh Portland Cement Co. 1,400,000 barrel-per-year portland-cement plant at Bunnell, Fla., was the first to use coquina shell as a source of calcium carbonate and staurolite residue as a source

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[11] Davis, W. G., What Causes Kiln Rings?: Rock Products, vol. 56, No. 7, July 1953, pp. 67, 94.
Davis, W. G., Removal of Rotary-Kiln Rings: Pit and Quarry, vol. 46, No. 1, July 1953, pp. 140–143.

[12] Yoshii, T., Research on Burning Mechanism in Rotary Kiln: Rock Products, vol. 56, No. 3, March 1953, pp. 106–108, 129.

[13] Hansen, W. C., Symposium on the Chemistry of Cement: Rock Products, vol. 56, No. 1, January 1953, pp. 161–162, 164.

[14] Pucar, Z., Calculation of Raw Mixes in the Manufacture of Portland Cement: Rock Products, vol. 56, No. 12, December 1953, pp. 126, 128.

[15] van Wazer, J. R., Facts for the Cement Industry on Flow of Slurries: Rock Products, vol. 56, No. 12, December 1953, pp. 104–107.

[16] Warner, I., Rotary-Kiln Loading: Rock Products, vol. 56, No. 5, May 1953, pp. 72–73; vol. 56, No. 8, August 1953, pp. 128–129, 216; vol. 56, No. 11, November 1953, pp. 79–80, 122.

[17] Sale, J., Use Strain Gauges to Accurately Align Kilns: Rock Products, vol. 56, No. 6, June 1953, p. 122.

[18] Streed, E. R., and Stoll, U. W., Flame Method for Estimating Cement Content of Soil-Cement and Pozzolan-Cement Mixtures: ASTM Bull. 189, April 1953, pp. 58-60.

[19] Wilson, T. C., and Grotinger, N. J., The Photometric Determination of Magnesium Oxide in Portland Cement: ASTM Bull. 189, April 1953, pp. 56–58.

[20] Tromel, G., and Moller, H., High-Temperature X-Ray Spectrograms of Calcium Silicates and Cement Clinkers: Rock Products, vol. 55, No. 11, November 1952, pp. 72–75, 110.

[21] Orchard, D. F., Handling of Cement: Proc. Inst. Civil Eng. (London), vol. 2, pt. 1, No. 5, September 1953, pp. 616–642.

[22] Rockwood, N. C., Prospective Chemistry of Cement and Concrete: Rock Products, vol. 56, No. 1, January 1953, pp. 154–157; vol. 56, No. 3, March 1953, pp. 110, 112, 117; vol. 56, No. 6, June 1953, pp. 101–103; vol. 56, No. 8, August 1953, pp. 174, 176, 208, 210, 212.

[23] Wolfe, J. M., Short Ball Mills for Dry-Raw and Clinker Grinding: Pit and Quarry, vol. 46, No. 4, October 1953, pp. 99–101, 122.

of alumina and iron. The plant will help to relieve shortages that have developed in Florida and other Southeastern States.[24]

Cement rock from a quarry of the Universal Atlas Cement Co., Northampton, Pa., has a relatively low calcium carbonate content. It is upgraded by removing carbonaceous matter and mica, using flotation beneficiation. The mechanics and technology of that operation were described in detail.[25]

Characteristics and uses of the various types of portland cement were discussed.[26]

Preliminary investigations show that polyvinyl acetate imparts useful properties to portland-cement mortars. Specimens containing the chemical showed maximum improvement in properties when cured in air at ordinary temperatures and humidities. This is in contrast to plain cement mortars, which require a water or damp curing to achieve optimum properties.[27]

Equipment and methods used at the following cement plants were described in articles: Penn-Dixie Cement Corp., West Winfield, Pa.;[28] Alpha Portland Cement Co., Jamesville, N. Y.;[29] Carolina Giant Cement Co., Harleyville, S. C.;[30] Superior Cement Div. of the New York Coal Sales Co., Superior, Ohio;[31] Southwestern Portland Cement Co., Victorville, Calif.;[32] and Dragon Cement Co., Thomaston, Maine.[33]

The National Bureau of Standards tested 17 brands of masonry cement for soundness, strength, consistency, fineness, time of setting, shrinkage, water repellency, water retention, autoclave expansion, air entrainment, and resistance to freezing and thawing.[34]

A patent was granted on a method of preparing cement by intergrinding diatomaceous earth and portland-cement clinker. The materials are intermixed while the clinker is hot, then cooled and milled. Concrete made with this product is said to have high strength and other use advantages.[35]

Sodium tripolyphosphate was used by a Missouri cement producer to disperse a thick raw slurry and virtually eliminate plugged lines and pump failures. Addition of a small percentage of that chemical to the shale slurry permitted a cut in slurry-water content.[36]

24 Nordberg, B., Lehigh Manufactures Cement From Coquina and Staurolite Residue: Rock Products, vol. 56, No. 8, August 1953, pp. 130–149, 202, 204.
Avery, W. M., Lehigh's Florida Mill Now in Full-Scale Production: Pit and Quarry, vol. 46, No. 1, July 1953, pp. 98–113.

25 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.

26 Lerch, W., Types of Portland Cement—Their Characteristics and Uses: Pit and Quarry, vol. 46, No. 5, November 1953, pp. 202–204, 211.

27 Geist, J. M., Amagna, S. V., and Mellor, B. B., Improved Portland-Cement Mortars With Polyvinyl Acetate Emulsion: Ind. Eng. Chem., vol. 45, No. 4, April 1953, pp. 759–767.

28 Nordberg, B., Batching Bulk Cement for Truck Delivery: Rock Products, vol. 56, No. 8, August 1953, pp. 110–123.

29 Nordberg, B., Single-Kiln Cement Plant With New Ideas in Design: Rock Products, vol. 56, No. 8, August 1953, pp. 150–161, 164, 166, 168, 170.
Trauffer, W. E., Alpha's New Wet-Process Plant Replaces Old Dry-Process Operation at Jamesville, N. Y.: Pit and Quarry, vol. 46, No. 1, July 1953, pp. 114–121, 124–125, 128.

30 Ponzer, H. S., Carolina Giant Cement Co. Adds 1 Million Barrels to Capacity: Pit and Quarry, vol. 45, No. 8, February 1953, pp. 78–85, 98.

31 Nordberg, B., Diversify (Superior Cement Division): Rock Products, vol. 56, No. 2, February 1953, pp. 79–83.

32 Rock Products, From Open- to Closed-Circuit Grinding With Liquid Cyclones: Vol. 56, No. 7, July 1953, pp. 62–65.

33 Trauffer, W. E., Capacity of Maine Plant Increased to Meet Swelling Demand: Pit and Quarry, vol. 46, No. 1, July 1953, pp. 95–97.

34 Evans, D. N., Litvin, A., Figlia, A. C., and Blaine, R. L., Properties of Some Masonry Cements: Nat. Bureau of Standards, Jour. Research, vol. 51, No. 1, July 1953 (RP2427), pp. 11–16.

35 Frankenhoff, C. A., Diatomaceous Earth and Portland Cement Compositions: U. S. Patent 2,654,674, Oct. 6, 1953.

36 Romig, J., and Kester, B., Control Slurry Viscosity With Additive: Rock Products, vol. 56, No. 5, May 1953, pp. 64–67.

WORLD REVIEW

Statistics on world production of cement in 1949–53 are shown in table 24.

TABLE 24.—World production of hydraulic cement, by countries, 1944–48 (average) and 1949–53, in thousand metric tons [1]

[Compiled by Helen L. Hunt]

Country	1944–48 (average)	1949	1950	1951	1952	1953
North America:						
Canada (sold or used by producers)	1,692	2,527	2,658	2,700	2,940	3,584
Cuba	244	312	316	382	420	407
Dominican Republic	12	54	70	104	137	130
Guatemala	28	36	42	57	60	67
Jamaica	---	---	---	---	75	[2] 100
Mexico	833	1,228	1,528	1,615	1,640	1,672
Nicaragua	14	16	17	20	19	24
Panama	[3] 8	54	51	75	93	80
Salvador	---	---	---	---	---	36
United States	25,970	36,313	39,273	42,548	43,091	45,651
South America:						
Argentina	1,185	1,452	1,572	1,560	1,548	1,644
Bolivia	33	42	38	39	37	34
Brazil	887	1,281	1,386	1,456	1,616	2,041
Chile	499	495	513	698	818	762
Colombia	325	475	580	648	707	873
Ecuador	37	52	58	79	89	91
Paraguay	---	---	---	---	4	3
Peru	263	289	331	367	370	449
Uruguay	249	293	305	301	300	297
Venezuela	145	285	501	621	840	982
Europe:						
Albania	(4)	(4)	15	(4)	(4)	(4)
Austria	398	1,098	1,289	1,475	1,390	1,394
Belgium	1,815	2,925	3,557	4,395	4,111	4,626
Bulgaria	[2] 257	(4)	(4)	(4)	674	[2] 650
Czechoslovakia	979	1,738	[5] 1,875	[5] 2,000	[5] 2,520	[2] 2,620
Denmark	558	834	873	985	1,212	1,260
Finland	356	656	743	829	778	937
France	3,376	6,443	7,208	8,125	8,645	9,050
Germany:						
East	[2] [6] 4,188	1,000	(4)	(4)	[2] 1,900	[2] 2,300
West		8,460	10,877	12,204	12,886	15,377
Greece	133	330	399	433	596	702
Hungary [2]	173	550	800	949	1,080	1,100
Ireland	285	431	444	426	460	(4)
Italy	2,167	4,037	5,004	5,578	6,652	7,554
Luxembourg	78	121	125	132	114	147
Netherlands	391	552	593	702	813	861
Norway	380	593	582	720	725	767
Poland	1,269	2,342	2,512	2,688	2,660	3,320
Portugal	352	521	573	642	727	769
Rumania	353	560	650	733	1,500	2,100
Saar	[7] 94	206	208	234	238	305
Spain	2,086	2,248	2,522	2,742	2,962	3,256
Sweden	1,355	1,698	1,936	2,035	2,116	2,316
Switzerland	711	977	1,078	1,315	1,384	1,582
U. S. S. R. [2]	3,620	8,000	10,500	12,400	14,100	16,000
United Kingdom	6,233	9,364	9,913	10,388	11,314	11,397
Yugoslavia	768	1,288	1,219	1,159	1,313	1,281
Asia:						
Burma	---	---	---	---	---	41
Ceylon	---	---	---	63	61	64
China [2]	(4)	450	800	1,300	2,000	2,300
Hong Kong	[2] 30	59	67	71	68	64
India	[8] 1,921	2,136	2,652	3,252	3,594	3,840
Indochina	36	154	144	212	235	291
Indonesia	14	(4)	(4)	[2] 100	137	148
Iran	[9] 43	[9] 59	[9] 64	[9] 65	65	70
Iraq	---	7	66	[10] 75	104	177
Israel	215	241	380	439	446	465
Japan	1,631	3,277	4,463	6,548	7,117	8,768
Korea:						
North Korea	315	(4)	(4)	(4)	(4)	(4)
Republic	13	24	12	7	36	44
Lebanon	161	233	263	303	285	305
Malaya	---	---	---	---	---	26

See footnotes at end of table.

TABLE 24.—World production of hydraulic cement, by countries, 1944–48 (average) and 1949–53, in thousand metric tons [1]—Continued

Country	1944–48 (average)	1949	1950	1951	1952	1953
Asia—Continued						
Pakistan	(8)	429	421	507	539	606
Philippines	73	201	292	309	310	291
Syria	43	58	68	64	151	224
Taiwan (Formosa)	182	291	332	389	446	520
Thailand (Siam)	50	127	166	312	247	288
Turkey	319	375	388	396	459	530
Africa:						
Algeria	115	128	324	448	470	482
Angola	--------	--------	--------	--------	--------	29
Belgian Congo	97	144	174	205	240	[2] 279
Egypt	572	889	1,022	1,130	947	1,097
Eritrea	[2] 32	--------	--------	--------	--------	--------
Ethiopia [2]	6	8	6	6	6	10
French Morocco	168	264	321	377	435	610
French West Africa	--------	44	60	55	80	60
Madagascar	5	7	5	5	(4)	(4)
Mozambique	32	46	50	78	83	(4)
Northern Rhodesia	--------	--------	--------	55	55	[2] 70
Southern Rhodesia	69	83	156	163	[2] 216	(4)
Tunisia	96	168	169	187	208	227
Union of South Africa	1,181	1,363	1,847	1,954	2,027	2,340
Oceania:						
Australia	761	1,076	1,278	1,236	1,357	1,598
New Zealand	233	254	256	163	263	280
Total (estimate)	73,000	115,000	133,000	149,000	161,000	178,000

[1] This table incorporates a number of revisions of data published in previous Cement chapters.
[2] Estimate.
[3] Average for 1 year only, as 1948 was first year of production.
[4] Data not available; estimate by senior author of chapter included in total.
[5] Planned production.
[6] Includes Saar 1944–45.
[7] Average for 1946–48.
[8] Pakistan included with India.
[9] Year ended Mar. 20 of year following that stated.
[10] Year ended Mar. 31 of year following that stated.

NORTH AMERICA

Canada.—Output of cement at the 10 producing plants was 22,577,000 barrels (valued at C$59,840,000) in 1953 compared with 18,521,000 barrels (valued at C$48,059,000) in 1952. Imports totaled 2,483,000 barrels in 1953 compared with 2,914,000 barrels in 1952. The bulk of the imports came from the United States and the United Kingdom. Construction of a 1,500,000-barrel-per-year cement plant was reported to be underway in Villeneuve, near Quebec, but it was not expected to begin production until 1955. Three Canadian cement plants were described in articles,[37] and two reviews of the Canadian cement industry appeared.[38]

Cuba.—Production of cement at Cuba's only plant—at Mariel—was slightly lower in 1953 than in 1952 and totaled 2,385,000 barrels. Demand for cement continued strong, and 732,000 barrels was imported, largely from Puerto Rico, Germany, and England. A new plant, to have a daily capacity of 2,400 barrels, reportedly was under construction at Giabara, in eastern Cuba, and there were reports that another plant, to be built at Santiago, was in the planning stage.

[37] Pit and Quarry, British Columbia Cement Company Expands Bamberton Plant: Vol. 46, No. 5, November 1953, pp. 84–89, 120.
Leja, E. A., Newfoundland's New Cement Plant: Pit and Quarry, vol. 46, No. 9, March 1954, pp. 91–97.
Trauffer, W. E., Ciment Quebec—Canada's Newest Cement Plant: Pit and Quarry, vol. 45, No. 6, December 1952, pp. 98–100.
[38] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 6, June 1953, pp. 37–41.
Trauffer, W. E., Canada (Review and Forecast): Pit and Quarry, vol. 46, No. 7, January 1954, pp. 118, 156.

Dominican Republic.—The cement plant at Ciudad Trujillo produced 130,100 metric tons in 1953 compared with 137,300 in 1952. Capacity of the plant was being increased by installation of a third kiln.

El Salvador.—El Salvador's only cement plant—at Playa Las Flores, Acajutla—produced 36,400 metric tons in 1953. This wet-process plant used marine shells, sand, and pumice as raw materials.

Guatemala.—Guatemala's only cement plant, at La Pedrera, supplied the country's entire requirements.

Haiti.—Haiti's first cement plant was being constructed at Source Matelas, about 15 miles north of Port-au-Prince. Production was expected to begin in mid-1954.[39]

Jamaica.—The new plant of the Caribbean Cement Co., Ltd., at Kingston, operated at a high rate of capacity almost from its start in February 1952.[40]

Mexico.—Production of cement in 1953 at Mexico's 18 plants totaled 1,672,000 metric tons compared with 1,640,000 tons in 1952. New plants were scheduled for construction at Orizaba, Veracruz, and Torreon, Coahuila, and expansion programs were planned at many old plants. It was expected that much of the increased output will be exported, because of favorable economic factors.[41] Several reviews of the Mexican cement industry were published.[42]

Nicaragua.—The cement plant in Nicaragua did not fill domestic requirements, and the country relied on Panama to make up the deficit.

Panama.—The cement plant in Panama supplied local demand and exported moderate quantities.

SOUTH AMERICA

The cement industry in South America was comprehensively reviewed, and many plants were described.[43] Industrialization and a rising standard of living in these countries in the last decade have resulted in widespread expansion of cement facilities.

Argentina.—Twelve portland-cement plants and one white-cement plant were in operation in Argentina. As the domestic demand for cement has remained nearly static for some time, capacity has not been notably expanded in recent years. However, improved credit facilities granted by the National Mortgage Bank for residential construction are expected to increase the demand. Annual imports normally had been between 400,000 and 500,000 metric tons, but Government restrictions reduced imports to virtually nothing in 1953.

Brazil.—A list of Brazilian cement plants producing or under construction, with pertinent data on each, was published.[44] A translation of a bulletin issued by the Brazilian Portland Cement Association also appeared; the industry was reviewed, and the locations of

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[39] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 5, November 1953, pp. 42–43.

[40] Pit and Quarry, First Year's Production at Caribbean Cement Co. Hits 600,000-bbl. Mark: Vol. 45, No. 8, February 1953, p. 60.

[41] Pit and Quarry, Mexican Cement Industry Planning Big Expansion to Produce for Export: Vol. 46, No. 2, August 1953, p. 61.

[42] Cement and Lime Manufacture (London), Extension of Cement Works in Mexico: Vol. 26, No. 5, September 1953, pp. 61–70.

Elek, L., The Cement Industry of Mexico: Min. Eng., vol. 4, No. 10, October 1952, pp. 960, 961.

Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 5, November 1953, pp. 45–47: Vol. 38, No. 4, April 1954, pp. 32–36.

[43] Pit and Quarry, A Review of the Cement Industry of Latin America: Vol. 46, No. 3, September 1953, pp. 100–106, 108–115.

[44] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 2, February 1953, pp. 39–41.

all plants operating or under construction were shown on a map.[45] To encourage the installation of new cement-manufacturing facilities, the Brazilian Government enacted a law permitting certain exemptions from taxes and duties. A new plant began operation in June at Aratu, 12 miles north of Salvador, and another plant reportedly was planned for Bela Horizonte, Minas Gerais. When most or all of the new facilities have been built, it is expected that Brazil not only will be self-sufficient in cement but also will be able to export sizable quantities.

Chile.—Industrial development in Chile has increased the demand for portland cement. The domestic shortage has been lessened by erection of a plant near Polpaico, about 30 miles north of Santiago. This factory uses flotation to correct the composition of its raw materials.[46]

Colombia.—Owing to increased domestic demand and larger exports, the cement industry in the Baranquilla area reported better sales in 1953 than in any previous year. Most of Colombia's output of 750,000 metric tons was consumed locally, but small quantities were exported to Costa Rica, Haiti, and Netherland West Indies.

Ecuador.—A West German firm was reportedly building a cement plant in Ecuador; production was expected to start by the end of 1954.

Paraguay.—The Valle Mi cement plant received a large Government loan in November and was placed under Government control in December.

Peru.—The industrialization of Peru has been causing a greater demand for cement than can be met by the only plant now in operation. Another mill was being built at Chilca, and a further project was reported to be contemplated at Pacasmayo.

Uruguay.—At the end of 1953 ANCAP, the Government petroleum, alcohol, and cement monopoly, awarded a contract for erecting a cement plant, to be completed early in 1955. ANCAP has never actually manufactured cement and has exercised its monopoly only with regard to cement imports. The privately owned cement plants at Sayago and Pan de Azucar have been unable to supply local demand.

Venezuela.—The Venezuela Cement Co. planned to expand the capacity of its Pertigalete plant to 480,000 metric tons per year. It was announced that a new 10,000-bag-per-day cement plant would be built at Chichiriviche Bay to supply the market in western Venezuela and possibly Netherland West Indies.

EUROPE

Belgium.—There were 21 producers of portland cement in Belgium, with an annual capacity of 4.5 million metric tons, and 8 producers of metallurgical cement, with an estimated yearly capacity of 800,000 metric tons. Large quantities of cement were exported to the Netherlands, Belgian Congo, Indonesia, and other countries.[47]

Denmark.—The four Danish cement plants produced for domestic consumption and export. The industry was dominated by 1 firm that produced 80 percent of the total output.

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[45] Bureau of Mines, Mineral Trade Notes: Vol 38, No. 2, February 1954, pp. 41–50.
[46] Pit and Quarry, Chilean Cement Concern Uses Flotation to Cut High-Silica Content of Raw Material: Vol. 46, No. 1, July 1953, pp. 129–133.
[47] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 4, October 1953, pp. 38–45.

Germany, West.—West Germany was an important producer and exporter of cement. Over 50 countries throughout the world normally import West German cement.

Greece.—Addition of two new kilns plus auxiliary equipment increased the capacity of the Eleusis plant of Société Anonyme de Ciments "Titan" from 400 metric tons per day to 1,000. Cement was transported from the plant by truck, railroad, and boat. Considerable quantities were exported from Greece to Turkey.[48]

Iceland.—There was no cement plant in Iceland, but construction of a cement mill was under way at Akranes.

Ireland.—There was one cement plant in Ireland, at Drogheda.[49] There was no protective tariff on cement; but the Government restricted imports when the local output was presumed to be adequate to meet the country's needs.

Italy.—Production of portland cement in 1953 totaled 7,683,000 metric tons. Imports, principally from France, Belgium-Luxembourg, and West Germany totaled 330,200 tons, and 22,900 tons was exported. A large portland-cement plant, with a planned annual capacity of 420,000 tons, was reportedly under construction at Coroglio, Naples. A description [50] of the Italian cement industry was published.

Netherlands.—The Netherlands produced less than half of its cement requirements. Large quantities were imported from Belgium-Luxembourg and West Germany. An article described the history, present facilities, and production methods at the E. N. C. I. cement plant at Maastricht.[51]

Norway.—There were three cement mills in Norway—at Oslo and Dalen in south Norway and Kjopsvik in north Norway. Facilities at the latter plant were being doubled while those at the other two were being gradually expanded.[52] The wet-process plant of A/S Christiana Portland Cementfabrik near Oslo has been modernized and the annual capacity increased to 2,200,000 barrels; the mine and plant equipment and practices were described.[53]

Portugal.—The cement industry in Portugal supplied the needs of the country and exported almost 200,000 metric tons. Over half of the exported cement in 1952 went to Angola, but that market will disappear when the new Lobito, Angola, cement plant is in full production.

Spain.—Sales of portland cement from Spanish plants in 1953 totaled 2,659,000 metric tons, and an additional 231,900 tons of special cements (mainly of the natural type) was sold. A table showing a breakdown of Spanish cement production in 1952, by Provinces, was published.[54] Portland cement was produced in 37 plants and natural cement in 124. Expansion plans in 1953 will, when completed, increase annual capacity by 770,000 tons. Development

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[48] Tsountas, C., Largest Greek Cement Plant Increases Capacity 150 Percent: Rock Products, vol. 56, No. 10, October 1953, pp. 90–92.
[49] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 2, February 1954, pp. 48–50.
[50] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 1, January 1953, pp. 26–31.
[51] Van Biers, P., and Rey, F., E. N. C. I. Operates Cement Plant in Historic Holland Setting: Pit and Quarry, vol. 46, No. 8- February 1954, pp. 70–75, 92.
[52] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 6, December 1953, pp. 39–40.
[53] Rutle, Johs, A/S Christiana Portland Cementfabrik: Pit and Quarry, vol. 46, No. 4, October 1953, pp. 92–98.
[54] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 3, March 1954, pp. 45–48.

of the Spanish cement industry during the past 50 years was discussed, and some plants were described in an article.[55]

Sweden.—Exports of portland cement from Sweden in 1953 totaled 342,500 metric tons, about half of which went to Brazil. The annual capacity of Sweden's 8 plants was over 2 million tons. Addition of a new-type Lepol kiln, which has good fuel efficiency, increased the daily capacity of the Hellekis plant of Skanska Cement AB to 6,800 barrels.[56]

Switzerland.—There were 15 cement plants, owned by 13 companies, in Switzerland, with an annual capacity of 1.5 million metric tons.

United Kingdom.—Operations of the Associated Portland Cement Manufacturers, Ltd., were described.[57] This company operated 26 plants in Britain and had interests in many mills in other countries.

Yugoslavia.—The cement industry was one of the more important sectors of the Yugoslav economy in 1953.[58] Most of the 23 plants were along the Dalmatian coast, especially in the area around the port of Split and in the Istrian Peninsula. Although published data were not available, it was estimated that the total annual productive capacity exceeded 1,500,000 metric tons. The country imported an additional 300,000 tons. Five new plants have been proposed for the purposes of making the nation self-sufficient and supplying at least a moderate quantity for export.

ASIA

Ceylon.—The Government-owned cement plant at Kankesanturai, which in 1953 produced 62,600 long tons of cement, was described in two articles.[59] This plant began production in 1950. Because of plant difficulties and sharply increased local demand, imports of cement into Ceylon were at a peak.

India.—The cement industry, one of the major industries in India, has made significant progress in the last decade. There were 23 cement factories in 1953—12 controlled by Associated Cement Cos., Ltd. The Mysore plant was Government owned, and there were 10 other independent units. The total annual capacity of all plants was estimated at 3,880,000 metric tons, and the Planning Commission of the Government of India expected that by the end of 1956 expansion programs and erection of 4 new plants would increase the annual capacity to 5,310,000 tons. Imports were negligible.

Iraq.—To meet sharply increased demand, two new cement plants, at Mosul and Kirkuk, were proposed.

Israel.—The Nesher Cement Co. planned construction of new plants near Tel Aviv and Jerusalem to enable the firm to meet local demand and export moderate quantities.

Japan.—Japan was the fifth largest exporter of cement in the world; 9.5 million metric tons were shipped to other countries in 1952. The

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[55] Cement and Lime Manufacture (London), Portland-Cement Industry in Spain: Vol. 26, No. 2, March 1953, pp. 27–32.

[56] Tham, H. S., and Sylvan, P., Producing Clinker at Less Than 700,000 B. t. u. per Barrel: Rock Products, vol. 56, No. 9, September 1953, pp. 78–87, 124–126.

[57] Updale, E., They Circle the Globe with Blue Circle Cement: Excavating Eng., vol.47, No. 2, February 1953, pp. 30–38.

[58] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 3, September 1953, pp. 47–53.

[59] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 2, August 1953, pp. 42–45.
Ridge, D. J., Government Cement Works, Kankesanturai, Ceylon: Cement and Lime Manufacture (London), vol. 26, No. 3, May 1953, pp. 33–44.

economic aspects of the Japanese cement industry were reviewed.[60]

Jordan.—Jordan's first cement plant was nearing completion at the end of the year. Its projected annual production capacity was about 72,000 metric tons, approximately 75 percent more than the country normally consumes. The company expected that lower cost would encourage increased local consumption, which, with proposed dams and irrigation projects, would provide a domestic market for the entire output.[61]

Malaya Federation.—A new cement plant, the first in the country, began production in July at Rawang. It was estimated that the new mill would have capacity to supply one-quarter of Malaya's annual cement requirements, which were over 400,000 long tons. Imports have been principally from England and Japan.[62]

Pakistan.—A Canadian group reportedly was planning to build a new $5 million cement plant in northern Pakistan. The establishment of two new cement plants, one at Hyderabad and the other at Dadukhel, and expansion of the five existing plants were expected to make Pakistan self-sufficient in cement by 1955.

Philippines.—Cement constitutes about 65 percent of the total value of Philippine nonmetallics. Three Philippine cement plants produced 1,740,000 barrels in 1953, a decrease of 6 percent from the previous year. A new cement plant was reported being built at Bacnotan, Province of La Union, Island of Luzon. Its output was expected to relieve the critical cement shortage and lessen the country's cement imports.[63]

Taiwan (Formosa).—Production in the 3 plants of the Government-owned Taiwan Cement Corp. increased from 445,600 metric tons in 1952 to 519,700 in 1953. Exports from Taiwan in 1953 totaled 49,200 tons.

Thailand.—Installation of a new 300-ton-a-day kiln increased the daily capacity of the Thai Cement Co. plant to 900 metric tons. Unofficial estimates placed 1953 output at 285,000 tons. Proposals were made for constructing a Government-owned cement factory, but no definite decision had been made by the end of the year.

Turkey.—Turkish cement output from the 6 plants totaled approximately 400,000 metric tons, and an additional 250,000 tons were imported. A review of the Turkish cement industry showed the need for greater capacity and described the economic factors concerning fuel, power, transportation, labor supply, etc.[64] A new plant was in construction at Ankara, and several others were in the planning stage.

AFRICA

Belgian Congo.—Cement plants at Lukulu, Bas Congo, and Lubudi, Katanga, each produced over 100,000 metric tons of cement, but their production supplied only about half of the domestic requirements. Construction [65] of a plant at Albertville continued throughout the year, and the new cement plant at Katontwe was opened formally

[60] Pit and Quarry, The Japanese Cement Industry: Vol. 46, No. 7, January 1954, pp. 96, 98.
[61] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 4, October 1953, pp. 45–46.
[62] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 5, November 1953, pp. 44–45.
[63] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 2, August 1953, pp. 45–47.
[64] Carman, C. Mac A., Turkey's Expanding Cement Industry: Rock Products, vol. 55, No. 9, September 1952, pp. 96, 98, 100.
[65] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 5, November 1953, pp. 40–42.

in April. The latter operation, which will utilize cobalt furnace slag as a basic raw material, had a yearly capacity of 25,000 tons.

Ethiopia.—Cement was produced at the rate of 20,000 metric tons a year at the Dire Dawa plant. Output from this plant has been adequate for local needs.

French Morocco.—About half of French Morocco's annual cement requirements of 800,000 metric tons was met by local production.

Tangier.—The first cement plant in Tangier began production in June. The mill, Spanish owned and controlled, had an annual capacity of 50,000 metric tons. The bulk of the output was used locally.[66]

Tunisia.—In August a cement plant with an annual capacity of 200,000 metric tons began production at Bizerte. It was expected that the new plant, second cement producer in Tunisia, would depend on foreign markets.

Uganda.—The cement plant at Tororo began producing early in 1953. Annual capacity at this plant was estimated at 55,000 tons.

Union of South Africa.—A balance between cement supply and demand was reached in 1952. To sell a surplus from expanded capacity at Pretoria and Port Elizabeth, producers asked the Government for authority to export, and they were permitted to ship a small quantity to the Republic of Korea. However, complications developed, and the Government suspended export permits in August.

OCEANIA

Australia.—Portland cement was manufactured at 11 plants. The vertical kiln plant at Traralgon, Victoria, was nearing completion at the end of the year. It was estimated that the annual output of this unique installation will be 35,000 to 40,000 metric tons.

[66] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 4, October 1953, pp. 46–47.

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Chromium

By Charles Katlin[1] and Hilda V. Heidrich[2]

MANY RECORDS in supply and demand were established in the chromium industry during 1953, despite a generally sluggish market the latter part of the year. Domestic production of chromite was at the highest point since World War II and almost three times the previous year's output. Consumption, imports, and stocks of chromite were record-breaking, and world production continued to rise.

To stimulate United States production of chromite, the termination date of the Government's Purchase Program for Domestic Chrome Ore and Concentrates was extended 2 years, and the limit on the quantity of ore to be purchased from any 1 producer was canceled. As further inducement to domestic chromite mining the Government granted a loan and purchase contract for development and production of ore from the Red Mountain chrome deposit in Alaska. Financially assisted by a similar agreement signed last year, the Mouat mine initiated its first production since World War II the latter part of 1953 and notably increased the country's total output. California and Oregon were the only other producers of domestic chromite and shipped all but a small quantity sold for refractory purposes to the Government Purchase Depot at Grants Pass, Oreg.

Uses of all grades of chrome ore increased, but stocks climbed disproportionately during the final quarter as metallurgical consumption lagged behind record imports. A decline in the use of chromium ferroalloys and metal began at midyear but was not paralleled by decreased production of those chromium products until the final quarter, with the result that producers' stocks of chromium ferroalloys and metal more than tripled the December 1952 level by the end of 1953.

Turkey and Union of South Africa made extensive gains in chromite production during 1953 and together mined 43 percent of the world total.

TABLE 1.—Salient statistics of chromite in the United States, 1944–48 (average) and 1949–53, in short tons

	1944–48 (average)	1949	1950	1951	1952	1953
Domestic production (shipments)	[1] 13,655	433	404	7,056	21,304	58,817
Imports for consumption	1,035,995	1,203,852	1,303,713	1,429,020	[2] 1,708,969	2,226,610
Total new supply	1,049,650	1,204,285	1,304,117	1,436,076	[2] 1,730,273	2,285,427
Exports	4,374	2,382	2,044	2,030	[2] 1,531	1,166
Consumption	819,943	672,773	980,369	1,212,480	1,185,460	1,335,755
Stocks Dec. 31 (consumers')	381,912	756,995	606,271	637,453	754,299	1,015,878
World production	1,700,000	2,300,000	2,600,000	3,100,000	3,700,000	4,300,000

[1] Average of annual totals as widely divergent as 45,629 tons in 1944 and 948 tons in 1947.
[2] Revised figure.

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

DOMESTIC PRODUCTION

Largely through resumption of active mining in Montana after 8 years, domestic production of chromite during 1953 increased 176 percent compared with the previous year. By the year end, the Mouat chrome mine in Stillwater County, Mont., operated by the American Chrome Co., which began operations in August, had produced 80 percent as much chromite as the other 145 producing mines. California had 96 producing mines and Oregon 49. Purchases by the Government at the Grants Pass, Oreg., Purchase Depot during 1953 increased 46 percent as more mines were put into production.

Concentrates and fines composed 62 percent of the California chromite production, and the average grade of all California chromite on a natural weight basis was 43.5 percent Cr_2O_3. All Montana production was converted to concentrates averaging 37.4 percent Cr_2O_3. Chromite shipments from Oregon averaged 47 percent Cr_2O_3, and at least 61 percent was in concentrate form.

Alaska reentered the chromite industry for the first time since 1944 when the Kenai Chrome Co. began to develop the Red Mountain chrome deposit on the Kenai Peninsula with the help of a United States Government loan and purchase contract granted in March.

Government actions during the year included a 2-year extension by Congress of the termination date of the Purchase Program for Domestic Chrome Ore and Concentrates to June 30, 1957 (Public Law 206, 83d Cong.), and cancellation by administrative order effective April

TABLE 2.—Chromite production (shipments) in the United States, 1949–53, by States, in short tons

State	1949	1950	1951	1952		1953	
				Shipments	Value	Shipments	Value
California	433	404	6,302	14,713	[1]$1,269,000	26,512	$2,078,461
Montana						26,089	869,958
Oregon			754	6,591	507,981	6,216	484,453
Total	433	404	7,056	21,304	[1]1,777,000	58,817	3,432,872

[1] Partly estimated.

TABLE 3.—Chromite shipped from mines in the United States, from before 1880 through 1953

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	1939	4,048	1948	3,619
1914	662	1940	2,982	1949	433
1915	3,675	1941	14,259	1950	404
1916	52,679	1942	112,876	1951	7,056
1917	48,972	1943	160,120	1952	21,304
1918	92,322	1944	45,629	1953	58,817
1919	5,688	1945	13,973	Grand total	935,733
1920	2,802	1946	4,107		
Total 1914–20	206,800	Total 1939–46	357,994		

[1] Annual totals published separately in Minerals Yearbooks, 1947–50.

10, 1953, of a limit on the quantity of chromite to be purchased from any 1 producer under the program. The quantity of chromite the Government was committed to purchase remained at 200,000 long dry tons, and the minimum shipment of ore accepted was still 5 tons. Regulations governing the program, as well as a table of prices offered by grade, appeared in the Chromium chapter of Minerals Yearbook, 1951.

Defense Minerals Exploration Administration.—As in the previous year, only three applications for loans to explore chromite properties were received during 1953 by DMEA. Two applications were denied, and the third was withdrawn at the applicant's request. The DMEA will finance up to 50 percent of a sound domestic chromite exploration project but is not empowered to grant development loans. Financial assistance for purposes other than exploration and of a nonspeculative nature may be obtained from the Small Business Administration, United States Department of Commerce.

CONSUMPTION AND USES

In 1953 chromite was consumed at the highest recorded rate in United States history, notwithstanding a sharp drop in the final quarter of the year. Consumption of chromite for all uses rose 13 percent over 1952 and 10 percent over 1951, the former peak year. Compared with 1952 metallurgical uses increased 10, refractory 14, and chemical 25 percent.

The metallurgical industry consumed 56 percent of all chromite in producing 285,000 short tons of chromium alloys, such as ferrochromium and ferrochrome-silicon. Chrome brick, cement, and other chrome refractories consumed 33 percent. The remaining 11 percent went into the manufacture of 108,000 short tons of chromium chemicals (sodium bichromate equivalent), an average of 1.4 tons of chrome ore per ton of sodium bichromate produced.

The average chromic oxide content of all chromite consumed during 1953 in the United States declined to 42.7 percent from 42.9 percent in 1952 (see table 4). Chromite consumption centered in six adjoining States—Maryland, New Jersey, New York, Ohio, Pennsylvania, and West Virginia.

United States consumption of chromium alloys and metal during 1953 increased 10 percent over 1952 to reach a total of 284,000 short tons. Proportionately, there were no significant changes in the consumption of individual alloys during 1953 compared with the 1952 usage. Ferrochromium composed the major portion of the total; about twice as much low-carbon ferrochromium (carbon content up to 2 percent) was consumed as high-carbon (4 percent carbon and up). Low-carbon ferrochrome-silicon, chrome silicide, exothermic ferrochromium, other alloys, and chromium metal comprised the remainder. Stainless steels (steels containing over 10 percent chromium) consumed 63.2 percent of all chromium alloys and metal. Of the remainder, 0.4 percent went into high-speed steels and 31.0 percent into other alloy steels. High-temperature alloys utilized 3.7 percent, and 1.7 percent was used for other purposes.

TABLE 4.—Consumption of chromite and tenor of ore used by primary consumer groups in the United States, 1944–48 (average) and 1949–53, 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)
1944–48 (average)	408, 813	48. 5	276, 783	34. 3	134, 348	45. 2	819, 944	43. 0
1949	288, 518	47. 6	268, 925	33. 5	115, 330	44. 1	672, 773	41. 3
1950	491, 685	47. 8	353, 642	34. 0	135, 042	44. 6	980, 369	42. 4
1951	573, 075	48. 1	440, 771	34. 7	198, 634	44. 3	1, 212, 480	42. 6
1952	676, 624	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

Specifications.—Chromite, the only chromium mineral currently found in sufficient quantity and concentration to be classified as an ore mineral, is composed by definition of oxides of iron and chromium ($FeO \cdot Cr_2O_3$). As found in nature, however, the mineral also contains oxides of magnesium, aluminum, and silicon (MgO, Al_2O_3, and SiO_2). Pure chromite contains 68 percent Cr_2O_3, but usable ores may contain 30 to 72 percent Cr_2O_3, depending on the extent and manner of substitution of the other oxides for the chromium and iron oxides.

Traditionally, desirable chromite to be used directly for metallurgical purposes in making ferrochromium has been hard lump ore with at least 48 percent chromic oxide, a 3 : 1 chromium-iron ratio, a silica content of no more than about 5 percent, and a combined magnesia and alumina content of no more than about 25 percent. In current practice, however, chromites of all types are being blended and used; one plant producing standard high-carbon ferrochromium used ores during 1952 and 1953 with a chromic oxide content ranging from 31 to 52 percent and averaging 44 percent. One ferrochromium producer used only high-grade chrome ore (49 percent Cr_2O_3 average), but about 40 percent of the material was in concentrate form rather than lump. Standard submerged-arc electric-furnace smelting requires lump ore preferably 2 to 5 inches in size, whereas tilting furnaces require ore particles of ¼-inch diameter or finer. Since fines and concentrates in a standard furnace may be caught in the slag and cause high losses, such material may be sintered or otherwise agglomerated to insure maximum entry into the melt through the slag cover.

For the making of refractory brick, cement, and plastic mixes, the hard lump chromite used ordinarily has a combined chromic oxide and alumina content of over 60 percent, the chromic oxide content being 31 to 33 percent, and contains about 5 percent silica and 10 percent iron. Friable ores are used, also, ranging up to 45 percent Cr_2O_3, with correspondingly lower alumina values and silica and iron proportions up to 11 and 19 percent, respectively. Hard lump ore is preferred because grain size is important in refractory-brick manufacture to obtain proper qualities of density, and the manufacturers grind the ore to their particular specifications. For certain purposes, however, such as making refractory cements and ramming mixtures, friable ores are used.

TABLE 5.—Chromite purchase specifications for National Stockpile in 1953

[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 fort he manufacture of commercial ferrochromium and special chromium alloys. Lumpy ore shall be hard, dense, nonfriable material, of which not more than 25 percent shall pass a 1-inch Tyler Standard screen. Material of friable nature, regardless of an initially lumpy appearance, will be classified as fines. No size restrictions apply to fines or concentrates.

[2] Guaranteed analyses superior to that stated are desired, and no offers will be considered unless the chemical analyses are at least within the stated limits in all respects. The right is reserved to reject any proposal for which the proposed guaranteed analysis is inferior to that shown for high grade chromite.

[3] Specification P-12-R, May 28, 1953, covers refractory-grade chromium ore that is suitable for the production of all chromium-type refractories. Based on ore originating in Philippine Islands and Cuba, although material from other sources of the same chemical composition may be purchased. Material shall consist of lump ore, of which not more than 20 percent (by weight) shall pass a U. S. Standard Sieve No. 12 (Tyler Standard Sieve mesh No. 10).

[4] Specification P-65, June 1, 1949, covers chromium ore intended for the manufacture of chromium chemicals.

Chromium chemicals are made by roasting finely ground chrome ore with soda ash (sodium carbonate) or a mixture of soda ash and some limestone or dolomite and by means of acid leaching and precipitation, creating sodium bichromate from which all other chromium chemicals are derived. For this purpose high-iron content in the ore is not detrimental, but a low silica content (5 percent maximum) is desirable to minimize soda-ash loss. Transvaal chemical-grade ores (Grade B Friable, etc.), therefore, containing 43–45 percent chromic oxide (average 44.5), about 2.5 to 3.5 percent silica, and too high in iron content (Cr–Fe ratio about 1.6 : 1) for standard metallurgical use are currently the sole source of chromium for chemical manufacture. This selection of Transvaal chemical-grade ore is based on its price—it is the cheapest available chrome ore—and its tremendous reserves, estimated in hundred million tons, which provide a steady source of relatively uniform material.

Federal specifications for the purchase of chrome ores for the National Stockpile are listed in table 5. Specifications under the Domestic Purchase Program call for minima of 42 percent Cr_2O_3 and a 2 : 1 chromium-iron ratio and a maximum of 10 percent SiO_2.

Metallurgical Uses.—Chromium is one of the basic alloying elements. Most chromium finds its way into the metallurgical industry, either directly in the making of various alloys or indirectly through the use of chromium refractory bricks and cements in steel furnaces or the use of chromium chemicals for chromium-metal manufacture and the cleaning, protection, and treatment of metal surfaces.

Direct metallurgical applications of chromium include the conversion of chrome ore to various ferrochromium alloys and the use of these primary alloys in making stainless steels, high-speed steels, high-temperature alloys, and various other special purpose alloys. Some steels are made by direct addition of chrome ore to the furnace. Stainless steels are used wherever corrosive conditions or high temperature are to be considered, such as in chemical manufacturing and food-processing equipment, petroleum production and refining, and architectural trim where the corrosive effects of exposure to the elements must be considered. A prime use for chromium metal is in the manufacture of high-temperature alloys for jet engines and gas turbines. 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 utilize 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, and construction and mining equipment and wherever else high tensile and creep strength and hardness are required.

Refractory Uses.—Most chromium refractory products are used in steel mills for lining basic open-hearth and stainless-steel electric furnaces. One method of lining the basic open-hearth furnace requires several elements in the hearth; a 3-inch layer of cement is overlain by chrome brick blanketed by 6 inches of plastic chrome and topped by 10 inches of magnesite brick. Plastic chrome is slightly plastic at furnace temperatures and keeps the melt from leaking through cracks in the brick. Chrome brick also is used along the sides of the furnace and wherever very high heat is encountered. In furnaces that have basic hearths and acid roofs chrome brick is used at the juncture between the two because of its neutral qualities. Chrome cements are used for patching furnaces. Chrome refractories are also used in lining naval boilers, in nonferrous metal smelting furnaces, and in the ceramics industry.

Chemical Uses.—Chromium chemicals are used by the metallurgical industry in electroplating, in surface-treating and cleaning metals, and in making chromium metal by the aluminothermic process. The largest use of chromium chemicals is in the manufacture of pigments, such as lead chromate (which imparts brilliance and high covering power to paints and printing inks), zinc chromate (used in corrosion-inhibiting paints), and chrome oxide green (which resists chemicals, heat, water, and sunlight). Leather tanning consumes substantial quantities of sodium bichromate, which does in hours what it takes vegetable tannins days to accomplish. Chromium metal made by the aluminothermic process utilizes chromic oxide as the source of chromium. Chromium plating is effected by means of chromic acid 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 in thickness are applied compared with 0.00002-inch coatings used for decorative purposes. Pyrotechnics, matches, photographic supplies, wood preservatives, and corrosion-inhibiting muds for oil-well drilling are other end uses of chromium chemicals.

STOCKS

Although chromite was imported and consumed at record rates during 1953, import gains were by far the greater; in consequence, total stocks of chromite in the hands of industry at the end of 1953 rose 35 percent above those at the beginning of the 12-month period. Stocks held by metallurgical and chemical users climbed 67 and 23 percent, respectively, while refractory stocks dropped 4 percent. Based on the respective annual consumption rates, a 9.1-month supply of all chromite was available at the end of 1953 compared with a 7.6-month supply in 1952.

Reflecting the lower operating rate of the steel industry in particular and business in general during the latter part of 1953, producers' stocks of ferrochromium alloys and metal rose sharply toward year end to a point over three and a quarter times those at the beginning of the year. Consumers' stocks ended the year virtually the same as they began.

TABLE 6.—Stocks of chromite at consumers' plants, December 31, 1949–53, in short tons

Grade	1949	1950	1951	1952	1953
Metallurgical	325, 881	248, 872	305, 134	364, 013	607, 724
Refractory	303, 110	251, 663	247, 673	269, 933	259, 896
Chemical	128, 004	105, 736	84, 646	120, 353	148, 258
Total	756, 995	606, 271	637, 453	754, 299	1, 015, 878

PRICES

Prices quoted for some foreign chromites dropped $2 to $4 toward the close of 1953, according to E&MJ Metal and Mineral Markets (see table 7). According to other sources, however, chromite prices as a whole were stable throughout the year. Analysis of values at foreign ports as derived from monthly import tables reveals no significant trends. Lowered shipping rates during the year undoubtedly caused prices to drop. A nominal price of $26 was reported by American Metal Market for refractory ore containing 34 percent chromic oxide.

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. Offgrade Montana ores 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).

Although all price controls were removed in early 1953, the price of high-carbon ferrochromium (65 to 69 percent Cr, 4 to 9 percent C) remained at 24.75 cents per pound of contained chromium, f. o. b. destination, continental United States, according to E&MJ Metal and Mineral Markets; low-carbon ferrochromium remained at 34.5 cents per pound of contained chromium. Chromium-metal prices experienced no change, the 97-percent grade being quoted at $1.23 per pound spot and $1.18 on a contract basis, and electrolytic chromium, 99 percent minimum, at $3–$4.50 per pound, f. o. b. Niagara Falls, depending on mesh size. Basic chrome-brick quoted prices began the year at $73–$78 per short ton for burned brick and $77–$82 for chemical-bonded brick, f. o. b. shipping point, but rose during the second quarter to $80 and $86, respectively, where they remained.

TABLE 7.—Price quotations for various grades of foreign chromite in 1953

[E&MJ Metal and Mineral Markets]

Source	Cr_2O_3 (percent)	Cr-Fe ratio	Price per long ton [1] Jan. 1	Price per long ton [1] Dec. 31
Pakistan	48	[2] 3:1	$53-$54	$51-$52
Rhodesian	48	[2] 3:1	44- 46	44- 46
Do	48	2.8:1	40- 42	40- 42
Do	48		32- 33	32- 34
South African (Transvaal)	48		34- 35	33- 34
Do	44		27- 28	23- 24
Turkish	48	[2] 3:1	55- 56	53- 54

[1] Quotations are on a dry basis, subject to penalties if guarantees are not met, f. o. b. cars, east coast ports.
[2] Lump ore.

FOREIGN TRADE[3]

Imports.—A peak import level of 2¼ million short tons of chromite was attained by the United States during 1953, exceeding the 1952 level by 30 percent. Ore destined for metallurgical use comprised 63 percent of the total, refractory 28 percent, and chemical 9 percent. The Philippines continued to be the largest supplier of United States imports, shipping 28 percent of the total. Turkey and Union of South Africa again were next largest, with 25 and 19 percent, respectively.

Of the 13 countries exporting chromite to the United States for metallurgical use, Turkey was by far the largest single source, supplying 41 percent of the total; Southern Rhodesia and Union of South Africa shipped 38 percent of the remainder. Refractory ore originated chiefly in the Philippines (87 percent) and Cuba (9 percent), and Union of South Africa was the source of all chemical ore. The value of all imports at foreign ports averaged $25.17 a short ton as opposed to $22.58 in 1952.

The average chromic oxide content of all chromite imported was 42.3 percent, metallurgical averaging 46.2 percent, refractory 33.1 percent, and chemical 44.4 percent. All averages increased slightly, except for refractory, which was 1.6 percent less than the 1952 figure.

Ferrochromium imports increased 56 percent over 1952 to 33,282 short tons containing 20,604 tons of chromium valued at $10,397,933. High-carbon ferrochromium comprised 18,094 tons of the total and was valued at $3,656,204; it contained an average of 56 percent chromium. Canada supplied 86 percent of the high-carbon ferrochromium; the rest came from West Germany, Sweden, Union of South Africa, and Yugoslavia. Low-carbon ferrochromium imports totaled 15,188 tons valued at $6,741,729; it had an average chromium content of 69 percent. Sources of the material were Canada (61 percent), France (21 percent), Sweden, West Germany, and Norway.

Chromium-metal imports totaled 177 tons of which 169 tons came from United Kingdom and the rest from France.

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:

[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.

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 that number chromium and at least 1 of the following elements among their constitutents 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 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.

TABLE 8.—Chromite imported for consumption in the United States, 1952–53 [1] by countries, and by grades

[U. S. Department of Commerce]

Country	Chemical grade			Metallurgical grade			Refractory grade			Total		
	Short tons		Value	Short tons		Value	Short tons		Value	Short tons		Value
	Gross weight	Cr_2O_3 content		Gross weight	Cr_2O_3 content		Gross weight	Cr_2O_3 content		Gross weight	Cr_2O_3 content	
1952												
Afghanistan				1,006	464	$25,875				1,006	464	$25,875
Cuba				[2] 37,879	[2] 14,921	[2] 1,114,602	[2] 58,875	[2] 21,396	[2] $1,028,127	96,754	[2] 36,317	[2] 2,142,729
Greece				246	118	7,920				246	118	7,920
Guatemala				1,458	846	51,050				1,458	846	51,050
India				6,581	2,931	205,748				6,581	2,931	205,748
New Caledonia [3]				58,776	29,778	2,072,175				58,776	29,778	2,072,175
Pakistan				3,372	1,577	132,355				3,372	1,577	132,355
Philippines				41,175	19,490	1,117,833	502,527	170,662	6,790,447	543,702	190,152	7,908,280
Sierra Leone [4]				26,846	10,769	850,810				26,846	10,769	850,810
Southern Rhodesia				172,515	82,514	4,813,553	11,057	4,784	214,831	183,572	87,298	5,028,384
Turkey				[2] 460,236	[2] 211,301	[2] 16,166,896	3,343	1,313	33,441	[2] 463,579	[2] 212,614	[2] 16,200,337
Union of South Africa	[2] 190,816	[2] 84,502	[2] 1,749,838	[2] 87,990	[2] 40,253	[2] 1,125,828	22,610	9,355	217,147	[2] 301,416	[2] 134,110	[2] 3,092,813
Yugoslavia				21,661	9,511	[2] 876,599				21,661	9,511	[2] 876,599
Total	[2] 190,816	[2] 84,502	[2] 1,749,838	[2] 919,741	[2] 424,473	[2] 28,561,244	[2] 598,412	[2] 207,510	[2] 8,283,993	[2] 1,708,969	[2] 716,485	[2] 38,595,075
1953												
Afghanistan				47	28	1,987				47	28	1,987
Cuba				29,656	11,721	822,057	57,630	19,644	1,086,518	87,286	31,365	1,908,575
Greece				375	164	12,920	1,003	401	27,300	1,378	565	40,220
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
New Caledonia [3]				98,877	48,737	3,667,256				98,877	48,737	3,667,256
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
Sierra Leone [4]				15,008	6,425	490,424				15,008	6,425	490,424
Southern Rhodesia				325,836	152,947	10,169,223	2,530	1,045	41,699	328,366	153,992	10,210,922
Turkey				565,120	259,718	21,739,645				565,120	259,718	21,739,645
Union of South Africa	204,968	91,087	2,033,620	198,114	90,551	3,253,126	14,835	6,069	164,831	417,917	187,707	5,451,577
Yugoslavia				48,675	22,099	1,769,168				48,675	22,099	1,769,168
Total	204,968	91,087	2,033,620	1,393,279	643,625	45,318,692	628,363	207,913	8,688,407	2,226,610	942,625	56,040,719

[1] Changes for table in Minerals Yearbook, 1952, are as follows for 1951: Imported from Republic of the Philippines—Refractory grade, 316,845 tons (gross weight), 106,895 tons (Cr_2O_3 content), $3,372,131; all grades, 318,861 tons (gross weight), 107,863 tons (Cr_2O_3 content), $3,409,512. Total: Refractory grade, 433,833 tons (gross weight), 151,785 tons (Cr_2O_3 content), $4,980,414; all grades—1,429,020 tons (gross weight), 610,737 tons (Cr_2O_3 content), $25,505,809.

[2] Revised figure.

[3] Assumed source; classified in import statistics under "French Pacific Islands."

[4] Assumed source; classified in import statistics under "British West Africa."

Exports.—Most of the chromite exported from the United States during 1953 (table 9) went to Canada, as did the 607 short tons of ferrochromium valued at $285,900.

Chromic acid exports of 624,095 pounds valued at $170,667 also were directed mainly to Canada.

Exports of chromite, chromium alloys and metal, chromium chemicals, and chrome refractory brick during 1953 were subject to United States export-licensing control.

TABLE 9.—Chromite ore and concentrates exported from the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Year	Domestic [1]		Foreign [2]	
	Short tons	Value	Short tons	Value
1944–48 (average)	4,374	$132,365	8,356	$302,283
1949	2,382	74,034	9,700	223,543
1950	2,044	63,409	2,543	100,382
1951	2,030	144,248	15,199	569,670
1952	[3] 1,531	[3] 73,137	21,265	1,152,941
1953	1,166	56,393	6,071	251,525

[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.
[3] Revised figure.

TECHNOLOGIC DEVELOPMENTS

Research leading toward the fullest utilization of Western Hemisphere resources of chromium raw materials was conducted by the Bureau of Mines in 1953 as part of a continuing program toward that end. Blast furnace and electric furnace tests on the smelting of Cuban lateritic iron ore and serpentine, both of which have a chromium content of less than 3 percent, were designed to recover chromium and nickel in an alloy pig iron. Roasting and leaching tests also were conducted on Cuban laterites and serpentines to recover those metals. Additional experiments on a three-stage pyrometallurgical process for selectively reducing Cuban laterites to recover chromium and nickel resulted in the production of low-carbon 17-percent chromium iron containing 1 to 2 percent manganese and 1 percent silicon. The feasibility of utilizing the chromium in laterites in making sodium chromate was the subject of further experimental study. High-iron domestic chrome ores, such as those from the Mouat mine in Montana, were subjected to pyrometallurgical tests to raise the chrome-iron ratio for subsequent use in making standard ferrochromium. The agglomeration of domestic chrome ores was studied in an effort to produce briquets with a high melting point for use in making ferrochromium with a minimum of chromium loss in the slag. Various ferrochromium alloys were made from domestic chromites, and two types of chrome-silicide were submitted to industry for testing under conditions of commercial use.

Experiments conducted by the Bureau of Mines on the making of high-purity chromium metal culminated in the creation of metal sheet, rod, and wire characterized by full ductility at room temperatures. Investigators at the Battelle Memorial Institute studying ductile chromium-metal crystals made by the iodide process on a test-tube scale were led to the conclusion that there "is strong evidence that chromium is inherently ductile." [4] Full ductility in this material, formerly considered to be almost completely brittle at room temperatures, was achieved by removing the surface coating of arc-melted, hydrogen-reduced, electrolytic chromium to a depth of 0.003 to 0.005 inch by electrolytic, chemical, or mechanical means. Research by the Bureau to extract high-purity chromium metal from refined chromium chemicals was viewed with interest by the chemical industry.

The Bureau of Mines made and tested refractory chrome brick and chrome-magnesite brick from Pacific Northwest ores; a 60-percent chromite, 40-percent magnesia brick, similar in composition to a widely-used commercial product, proved successful in laboratory tests and was shipped to industry for use tests. Studies were also undertaken on the economics of utilizing Montana chromites in the manufacture of chemicals and ferrochromium.

A new process for making an extra-low-carbon ferrochromium alloy was put into commercial operation during the year at the Marietta, Ohio, plant of the Electro Metallurgical Co.[5] This process involves pelletizing in a roll-briquetting press standard arc-furnace-produced ferrochromium which has been ball-milled to fine powder and mixed with silica sand; a flat car is covered with a foot-thick bed of pellets and placed in a horizontal, cylindrical, high-vacuum furnace about 150 feet in length and 12 in diameter. Carbon resistors in the upper portion of the furnace heat the pellets to about 2,000° F., causing the silica to react with the carbon in the ferrochromium, converting the carbon to carbon monoxide. The resulting pelletized alloy contains 0.025 to 0.01 percent carbon, about 6 percent silicon, and 65 percent chromium. Vanadium Corp. of America is also producing a new-type extra-low-carbon ferrochromium at its Graham, W. Va., plant.[6] The new alloy has high-density, low silicon content, and a carbon content of 0.025 percent.

A recent paper reported that chromium in slags can be recovered by tapping slag and metal into a ladle and then repouring them into the furnace, maintaining as much agitation as possible to mix the two effectively and create a more complete and faster reaction.[7]

A chromium cermet composed of 77-percent chromium and 23-percent aluminum oxide by weight was used successfully as a superior protecting tube for thermocouples in checking temperatures of open-hearth checker bricks and molten brass. High thermal conductivity and shock resistance are supplied by the chromium metal, while a high melting point and resistance to deformation, oxidation, and solution attack are supplied by the aluminum oxide ceramic.[8]

Articles published on advances in chromium plating described: (1) Investigations regarding the efficacy of certain self-regulating chromic-acid-type solutions in making a crack-free chromium-plated finish [9] and (2) research on chromium-base electroplating to effect a

[4] Goodwin, H. B., Gilbert, R. A., Schwartz, C. M., and Greenidge, C. T., A Preliminary Study of the Ductility of Chromium: Jour. Electrochem. Soc., April 1953, vol. 100, p. 152.
[5] Chemical-Engineering, vol. 60, No. 7, July 1953, p. 102.
[6] E&MJ Metal and Mineral Markets, vol. 24, No. 47, Nov. 19, 1953, p. 7.
[7] Merrill, T. W., and St. Vincent, F., Slag Treatment for Conservation of Chromium: Paper pres. at Electric Furnace Steel Conference, Cincinnati, Ohio, Dec. 2-4, 1953, and pub. as preprint by AIME.
[8] McSherry, P. B., Metal-Ceramic Wall Lengthens Thermocouple Life: Iron Age, vol. 72, No. 18, Oct. 29, 1953, pp. 100-101.
[9] Dow, R., and Stareck, J. E., Crack-Free Chromium: Metal Industry (London), vol. 83, No. 17, Oct. 23, 1953, pp. 342-344.

uniform black coating that would withstand heating in a high vacuum (as in electron tubes) and have a low vapor pressure. Three methods by which satisfactory coatings may be obtained were indicated.[10]

In a recent article [11] measurement of specific gravity was suggested as a reliable, speedy, and inexpensive method for use at chrome mine sites as a qualitative check on production of ore and concentrates from a specific deposit. Basing his study on the relationship of the specific gravity of an ore to its chromic oxide content, the writer found that chromic oxide content derived from a determination of specific gravity, when plotted against a line graph based on ores of known chemical analyses and specific-gravity determinations from a given area, seldom differs from chemical analysis determinations of chromic oxide content by more than 0.5 percent and never by more than 1.0 percent.

During the early part of the year the United States Public Health Service published the results of an industry-requested study on the health of workers in the chromate-producing industry. In addition to the complete medical survey, brief descriptions of the processes involved in making chromium chemicals are presented.[12]

WORLD REVIEW

All major chromite-producing countries increased their output during 1953, as did most minor producers, raising the total world production to a record 4.2 million short tons. With a reported gain of 13 percent over the previous year's high, Turkey retained its position as the principal world chromite producer. Union of South Africa followed, with a 25-percent increase.

Pakistan.—A chromite find was reported in the Upper Punjab Valley of Kharan in the Baluchistan States Union at Punjab Nala, Javi Nala, and the Ban area. The Geological Survey of Pakistan, which had geologists investigating the area, announced the discovery. Ore ranging from 49 percent Cr_2O_3 down to 35 percent was reported.[13]

Philippines.—A review of the chromite-mining industry in the Philippines, briefly covering history, geology, prices, specifications, production, reserves, etc., was published.[14] Although chromite was first discovered during the early years of the present century, it is related, mining did not begin until 1934 at the Florannie mines, northwest of Lagonoy, Camarines Sur. Four years later production of refractory chromite was initiated at the Consolidated Mines property east of Masinloc, Zambales Province, Luzon; this is still the largest known deposit of refractory chromite in the world, with a current reserve of over 10 million short tons. At the same time the first shipments of metallurgical ore were made from the Acoje deposits near Lucapon, Santa Cruz, Zambales Province, mining operations having begun the year before. Several other deposits were also developed during 1938. By 1941 a peak production of 300,000 metric tons had been attained. During the subsequent Japanese occupation

[10] Quaely, M. F., Black Chromium-Base Electroplating: Metal Industry (London), vol. 83, No. 15, Oct. 9, 1953, pp. 299–300.

[11] Hamilton, G. N. G., A Simple Method of Assessing the Grade of Chrome Ores and Concentrates: South African Min. & Eng. Jour., vol. 66, part II, Oct. 24, 1953, pp. 263–264.

[12] Public Health Service, Health of Workers in Chromate-Producing Industry: Public Health Service Pub. 192, 1953, 131 pp.

[13] Mining World, vol. 15, No. 10, September 1953, p. 78.

[14] Roa, Consorcio G., Chromite in the Philippines: Philippine Bureau of Mines Inf. Circ. 15, May 1953, 19 pp.

TABLE 10.—World production of chromite, by countries,[1] 1944–48 (average) and 1949–53, in metric tons [2]

[Compiled by Berenice B. Mitchell]

Country [1]	1944–48 (average)	1949	1950	1951	1952	1953
North America:						
Canada	7,220	327	----------	----------	----------	----------
Cuba	166,514	97,368	65,820	79,065	61,808	70,039
Guatemala	444	300	289	1,138	105	400
United States	12,388	393	367	6,401	19,327	53,358
South America: Brazil	[3] 1,602	[3] 3	3,227	2,416	2,649	[6] 3,500
Europe:						
Albania	[4] 16,500	(5)	[6] 52,000	(5)	(5)	(5)
Greece	6,782	3,381	12,631	25,333	32,162	36,759
Portugal	756	88	45	33	108	(5)
U. S. S. R.[6] [7]	400,000	350,000	500,000	600,000	600,000	600,000
Yugoslavia	50,106	109,120	114,736	99,639	107,222	126,961
Asia: [7]						
Afghanistan	----------	1,000	550	75	----------	----------
Cyprus (exports)	2,976	14,875	18,441	12,653	13,487	8,269
India	[8] 43,147	19,728	16,998	16,970	[9] 36,768	65,810
Iran	----------	----------	----------	(5)	8,825	20,000
Japan	23,700	27,108	32,964	40,944	47,151	37,632
Pakistan	(8)	17,194	18,416	18,006	17,706	23,818
Philippines	----------	246,744	250,511	334,571	543,514	557,090
Turkey	175,113	451,566	422,529	619,420	806,911	912,523
Africa:						
Egypt	151	50	36	----------	----------	210
Sierra Leone	9,077	22,101	7,518	16,455	23,870	24,745
Southern Rhodesia	200,131	243,506	291,525	300,267	322,667	420,052
Union of South Africa	237,226	404,351	496,324	545,306	580,024	724,444
Oceania:						
Australia	326	642	905	1,402	1,420	2,785
New Caledonia	53,111	88,992	84,801	88,792	107,653	121,060
Total (estimate)	1,500,000	2,100,000	2,400,000	2,800,000	3,400,000	3,900,000

[1] In addition to countries listed, Argentina, 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] Exports.
[4] Planned production as reported for 1948.
[5] Data not available; estimate by senior author of chapter included in total.
[6] Estimate.
[7] Output from U. S. S. R. in Asia included with U. S. S. R. in Europe.
[8] Pakistan included with India.
[9] Does not include 21,603 tons of low-grade ore accumulated from production from 1943 through 1948.

the output dropped to a maximum of 70,000 tons (1944), mainly from the Acoje deposits, which contain the largest reserves of metallurgical ore in the Islands, estimated at well over 1 million tons.

Both the Acoje and the Masinloc chromite deposits, as well as a few others, are in the Zambales Mountains, western Luzon. Other deposits of chrome ore occur on many islands in the archipelago, the major ones being in the Surigao and Misamis Oriental regions of Mindanao, on Dinagat Island, and one on Ambil Island, northwest of Mindoro. The Zambales ores are enclosed in serpentinized peridotite; the chromite and serpentine ore dissected by dikes of the gabbro and diorite country rock at the Masinloc deposit.

Chromite occurs at the Acoje Mining Co. deposits in lenses and as sandy disseminations in the top soil. The sandy material comprises 15 to 20 percent of the soil and, after washing, contains up to 51 percent Cr_2O_3, is low in silica (about 3 percent), and has a Cr-Fe ratio of 2.8 : 1; this material is recovered by sluicing, particularly during the rainy season. Production of metallurgical concentrates from milling-grade ore was started at the beginning of 1953, and recovery was reported to average 73.5 percent; this milling ore is estimated to comprise 40 percent of the Acoje reserves with an average chromic oxide content of 45 percent and a 2.2 : 1 chrome-iron ratio. The mill utilizes Humphreys spirals, as well as tables, vibrating screens, and thickeners. The production of chromite from the Acoje mine in 1952 was 46,967 short tons.

At the Masinloc deposit (operated by Benguet Consolidated Mining Co. for Consolidated Mines, Inc.) the chrome ore is in one massive body near the surface of a hill about 500 feet high and 1,000 feet wide at the base. The ore mineral is a massive high-alumina chrome-spinel with a chromic oxide content of 32 percent. About one-third of the ore produced is shipped directly from the pits, and the remainder is run through a sink-float plant. Production from the mine in 1952 totaled 541,400 short tons.

Sierra Leone.—Belt conveyors are reportedly being used to transport overburden to the dumps by Sierra Leone Chrome Mines Co., Ltd., at its mines near Hangha, 180 miles from Freetown. Mined mainly by opencut methods, the chromite occurs as lenses in serpentine and talc schist associated with hornblende schist and is overlain by at least 150 feet of decomposed rock, boulders, and partly laterized deposits.[15]

Southern Rhodesia.—Production of ferrochromium was initiated at Gwelo during 1953. Trial shipments were made by Rhodesian Alloys, Ltd., from its pilot plant to various steel companies in Great Britain and the United States. Annual plant capacity is rated at 5,000 to 7,000 tons of low-carbon ferrochrome containing 70 percent chromium. Rhodesia Chrome Mines, Ltd., is supplying most of the chrome ore from its new heavy-medium separation plant at Selukwe and the remainder from the Windsor mine at Que Que.[16]

Turkey.—Chromite was reportedly mined from new deposits in the Tokat area near the Black Sea.[17] Most other chrome areas are in southern and western Turkey. Toward the close of the year, some mines were reported to be ceasing operations because of slackened demand for the high-priced Turkish chromites.

TABLE 11.—Exports of chromite from Turkey, by destination, 1944–48 (average) and 1949–53, in metric tons [1]

Destination	1944–48 (average)	1949	1950	1951	1952	1953
Austria	5,171	37,325	29,233	35,472	39,708	38,687
Belgium	----	390	----	----	50	----
Canada	525	----	6,696	----	2,032	----
Czechoslovakia	188	----	----	----	----	----
France	12,852	17,676	10,729	27,288	39,382	19,452
Germany, West	11,930	8,196	8,743	38,828	49,771	27,591
Hungary	----	3,452	58	100	----	----
Italy	2,390	5,750	3,702	6,140	7,025	2,666
Netherlands	----	----	----	276	7,529	4,264
Norway	7,903	500	12,900	7,774	14,357	21,618
Spain	----	----	----	1,110	----	2,802
Sweden	11,805	16,280	23,128	12,821	16,166	22,147
Switzerland	----	50	----	2,595	16,115	8,219
United Kingdom	2,167	11,017	16,556	15,959	8,790	15,834
United States	92,380	252,610	241,415	356,246	424,983	514,177
Other	406	----	[2] 1,016	----	[3] 500	[4] 1,000
Total	147,717	353,246	354,176	504,609	626,408	678,457

[1] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 6, December 1954, p. 10.
[2] Greece.
[3] Lebanon.
[4] Australia.

[15] Mines and Quarry Engineering, vol. 19, No. 8, August 1953, pp. 281–283.
[16] Chemical and Engineering News, vol. 31, No. 42, Oct. 19, 1953, p. 4356.
[17] Mining World, vol. 15, No. 6, May 1953, p. 69.

United Kingdom.—Unst, most northerly of the Shetland Islands, has produced about 50,000 tons of chromite since 1820, according to a recent article.[18] Until World War I the entire output was consumed in making chemicals; but in subsequent years it was used in manufacturing chrome-magnesite refractory brick. Shipments ceased in 1944 because of the virtual exhaustion of surface deposits. Recent investigations aimed at evaluating the underground chromite resources of the area included diamond drilling of inclined holes and subsequent trenching but did not reveal any sizable new deposit. The chromite occurs as bands of disseminated grains with a chromic oxide content of 10 to 40 percent; dump samples indicate, however, that the larger deposits had more massive ore centers containing over 40 percent chromic oxide.

Yugoslavia.—It was reported that a plant capable of producing chrome-magnesia brick had been erected, and construction was underway on a chemical plant for producing sodium bichromate. Local ores and concentrates are to be used.[19]

[18] Riverton, J. B., Recent Chromite Exploration in Shetland: Mining Mag. (London), vol. 89, No. 6, December 1953, pp. 329–337.
[19] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 3, September 1953, p. 10.

Clays

By Brooke L. Gunsallus [1] and Eleanor V. Blankenbaker [2]

TOTAL clay sold or used by producers in 1953 increased 2 percent in tonnage compared with 1952. Of the six major classifications of clay—china clay or kaolin, ball clay, fire clay, bentonite, fuller's earth, and miscellaneous clays—the output of kaolin, fuller's earth and miscellaneous clays increased and of the others decreased in 1953 from 1952.

TABLE 1.—Salient statistics of clays in the United States, 1952–53

	1952		1953	
	Short tons	Value	Short tons	Value
Domestic clay sold or used by producers:				
Kaolin or china clay	1, 829, 102	$25, 205, 836	1, 883, 974	$27, 092, 181
Ball clay	305, 083	3, 955, 958	300, 762	3, 388, 667
Fire clay, including stoneware clay	11, 285, 173	48, 383, 470	10, 267, 113	37, 802, 989
Bentonite	[1] 1, 317, 979	[1] 14,790, 948	1, 269, 971	16, 180, 242
Fuller's earth	422, 853	6, 875, 483	435, 837	7, 614, 759
Miscellaneous clays	[1] 26,507, 910	[1] 31,179, 891	28, 278, 307	32, 424, 198
Total sold or used by producers	[1] 41,668, 100	[1]130,391,586	42, 435, 964	124, 503, 036
Imports:				
Kaolin or china clay	103, 937	1, 526, 920	118, 775	1, 854, 248
Common blue and Gross Almerode	28, 666	299, 597	24, 274	262, 139
Fuller's earth	157	3, 698	222	2, 573
Other clay	10, 296	86, 941	5, 840	76, 259
Total imports	143, 056	1, 917, 156	149, 111	2, 195, 219
Exports:				
Kaolin or china clay	40, 303	706, 111	43, 590	795, 043
Fire clay	88, 025	916, 425	90, 897	919, 928
Other clay (including fuller's earth)	175, 663	5, 391, 956	167, 901	5, 315, 867
Total exports	303, 991	7, 014, 492	302, 388	7, 030, 838

[1] Revised figure.

Kaolin output increased 3 percent in tonnage and 7 percent in value; fuller's earth increased 3 percent in tonnage and 11 percent in value; and miscellaneous clays sold or used by producers increased 7 percent in tonnage and 6 percent in value. Increases in kaolin consumption were as follows: Pottery, 13 percent; high-grade tile, 7 percent; paper coating, 13 percent; portland and other hydraulic cements, 7 percent; fertilizers, 104 percent; filler (other than paper or paint), 64 percent; and insecticides, 14 percent. Decreases in consumption in 1953 compared with 1952 included: Paper filler, 5 percent; linoleum, 3 percent; paints, 5 percent; refractories, 11 percent; chemicals, 75 percent; and plaster products, 22 percent.

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

Although bentonite output decreased 4 percent in tonnage in 1953 compared with the alltime high record of 1952, it increased 9 percent in value—the highest on record. The petroleum and foundry industries consumed 93 percent of the total tonnage in 1953. Bentonite used for foundry-sand bond increased, but rotary-drilling mud and filtering and decolorizing-oil uses decreased.

Fuller's earth sold or used by producers increased 3 percent in tonnage in 1953 compared with 1952 and was the second largest output in the history of the industry.

In 1953 absorbent uses consumed 30 percent of the total, followed by mineral-oil refining, 29 percent; insecticides, 17 percent; rotary-drilling mud, 12 percent; and vegetable-oil refining, 4 percent.

Fire clay sold or used by producers decreased 9 percent in 1953 compared with 1952, although the output was the third largest in the history of the industry.

Price quotations for most clay and clay products in 1953, as shown in trade papers, remained steady.

Imports of kaolin for 1953 increased 14 percent from 1952 and represented a little more than 6 percent of the total domestic consumption of kaolin.

Imports of ball clay (including common blue and Gross Almerode clays) in 1953 decreased 15 percent in tonnage and 13 percent in value compared with 1952.

Exports of kaolin or china clay in 1953 increased 8 percent over 1952; 88 percent was shipped to Canada. Exports of fire clay in 1953 increased 3 percent in tonnage, but the value increased less than 1 percent. Canada received 67 percent and Mexico 10 percent of the total exports.

CONSUMPTION AND USES

Heavy clay products (building brick, structural tile, sewer pipe, etc.) in 1953 consumed 3 percent more clay than in 1952 and comprised 54 percent of the total clay output compared with 53 percent in 1952 and 55 percent in 1951. Clays used in portland and other hydraulic cements in 1953 consumed 20 percent of the total clay output; refractories, 14 percent; rotary-drilling mud, 2 percent; paper filler, paper coating, filtering and decolorizing oils, and pottery, 1 percent each. The tonnage of clay and shale used in producing lightweight aggregate for use in concrete products was compiled for the first time in 1953. This tonnage represented 3 percent of the total clay output. The remainder was consumed for a large number of miscellaneous purposes.

Although the total tonnage of clay consumed in 1953 increased 2 percent above 1952 many uses showed decreases. The increases for some of the more important classifications were as follows: Pottery, 6 percent; architectural terra cotta, 25 percent; paper coating, 14 percent; rubber, 4 percent; cement (1952 revised tonnage, 7,820,491 short tons), 10 percent; heavy clay products, 3 percent; absorbent uses, 28 percent; chemicals, 2 percent; fertilizers, 112 percent; and insecticides and fungicides, 4 percent. The following uses decreased: High-grade tile, 11 percent; kiln furniture, 24 percent; paper filler, 5 percent; linoleum, 2 percent; paint, 9 percent; refractories, 16 percent; and rotary-drilling mud, 2 percent.

TABLE 2.—Clays sold or used by producers in the United States in 1953, by kinds and uses, in short tons

Use	Kaolin	Ball clay	Fire clay and stoneware clay	Bentonite	Fuller's earth	Miscellaneous clays, including slip clay	Total
Pottery and stoneware:							
Whiteware, etc	125,065	209,825	482				335,372
Stoneware, including chemical stoneware	12,227	475	56,430	99		947	70,178
Art pottery and flower pots	4,209	9,416	10,716			43,403	67,744
Slip for glazing	400	500		41			941
Total	141,901	220,216	67,628	140		44,350	474,235
Tile, high-grade	26,896	40,438	103,854			59,059	230,247
Kiln furniture:							
Saggers, pins, and stilts	6,788	4,916	11,857				23,561
Wads						1,650	1,650
Total	6,788	4,916	11,857			1,650	25,211
Architectural terra cotta			39,150				39,150
Paper:							
Filler	437,151						437,151
Coating	558,194			2,314			560,508
Total	995,345			2,314			997,659
Rubber	241,052		18,475	103			259,630
Linoleum	38,510		10,427	120			49,057
Paints:							
Filler or extender	28,782		432	101		543	29,858
Calcimine	1,400			68			1,468
Total	30,182		432	169		543	31,326
Portland and other hydraulic cements	46,128		17,041	185		8,539,981	8,603,335
Refractories:							
Firebrick and block	149,386	16,118	3,817,595	1,180		3,359	3,987,638
Bauxite, high-alumina brick			61,661				61,661
Fire-clay mortar, including clay processed for laying firebrick	25,072	2,500	490,292			2,557	520,421
Clay crucibles	208	50					258
Glass refractories	1,015		77,736				78,751
Zinc retorts and condensers			51,900	7,524			59,424
Foundries and steelwork	1,160	500	733,019	347,056		14,670	1,096,405
Other refractories	2,401		137,406			2,184	141,991
Total	179,242	19,168	5,369,609	355,760		22,770	5,946,549
Heavy clay products: Building brick, paving brick, drain tile, sewer pipe, and kindred products		2,615	4,534,069			18,243,673	22,780,357
Miscellaneous:							
Rotary-drilling mud				583,373	52,429	167,978	803,780
Filtering and decolorizing oils (raw and activated earths)	66,554			251,107	[1]145,666		463,327
Other filtering and clarifying				5,628	7,709		13,337
Artificial abrasives	150		885				1,035
Absorbent uses (oily floors, etc.)	1,185			40	130,108		131,333
Asbestos products	2,350		291				2,641
Chemicals	4,382		91,891	13,819			110,092
Enameling		2,074		129			2,203
Fertilizers	11,106			40	1,800	188	13,134
Filler (other than paper or paint)	15,304	11,335		9,862	13,423	6,097	56,021
Insecticides and fungicides	31,810			4,621	75,695	187	112,313
Plaster and plaster products	3,702			21			3,723
Lightweight aggregate						1,166,553	1,166,553
Other uses	41,387		1,504	42,540	9,007	25,278	119,716
Total	177,930	13,409	94,571	911,180	435,837	1,366,281	2,999,208
Grand total:							
1953	1,883,974	300,762	10,267,113	1,269,971	435,837	28,278,307	42,435,964
1952	1,829,102	305,083	11,285,173	[2]1,317,979	422,853	[2]26,507,910	[2]41,668,100

[1] Comprises the following: Mineral oils, 127,687 tons; vegetable oils, 17,979 tons.
[2] Revised figures.

CHINA CLAY OR KAOLIN

The upward trend in kaolin production that began in 1945 was broken only in 1952. A 3-percent increase in tonnage of kaolin sold or used by producers was reported in 1953. The value increase was 7 percent.

As has been the pattern for the past 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, 9 percent; and pottery, 8 percent. The remaining 17 percent was consumed for a wide variety of purposes, including cement, high-grade tile, fertilizers, chemicals, insecticides, paint filler or extender, calcimine, and linoleum. The following users reported increases: Pottery, 13 percent; high-grade tile, 7 percent; paper coating, 13 percent; portland and other hydraulic cements, 7 percent; fertilizers, 104 percent; filler (other than paper or paint), 64 percent; and insecticides, 14 percent. Rubber increased less than 1 percent. Decreases in consumption were reported for paper filler, 5 percent; linoleum, 3 percent; paint, 5 percent; refractories, 11 percent; chemicals, 75 percent; and plaster products, 22 percent.

TABLE 3.—Kaolin sold or used by producers in the United States, 1952–53, by States

State	Sold by producers		Used by producers		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1952						
Alabama, Florida, and North Carolina	58,579	$1,067,883			58,579	$1,067,883
California	(1)	(1)	(1)	(1)	21,589	256,906
Georgia	1,189,457	17,921,448	138,798	$880,745	1,328,255	18,802,193
South Carolina	(1)	(1)	(1)	(1)	322,778	4,079,112
Other States [2]	428,938	5,281,903	13,330	53,857	97,901	999,742
Total	1,676,974	24,271,234	152,128	934,602	1,829,102	25,205,836
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

[1] Included with "Other States."
[2] Includes States indicated by footnote 1 and Illinois (1952 only), Pennsylvania, South Carolina (1952 only), Utah, and Virginia.

Nine States shipped kaolin in 1953 compared with 10 States in 1952. Illinois did not report shipments in 1953. Georgia remained the principal producing State in 1953, with 71 percent of the total United States output; South Carolina was second, with 17 percent. The Alabama, Florida, and North Carolina group reported a 42-percent increase; California 36 percent; and Georgia and South Carolina registered small increases compared with 1952.

No quotations were reported by E&MJ Metal and Mineral Markets on domestic kaolin in 1953. The last quotations, given in June 1951, were as follows: Georgia kaolin, for filler and ceramic grades, $8.50 to $9.50 per ton, depending upon grade for crushed material, and $13 to $17 for pulverized, in paper bags. North Carolina china clays, ceramic grades, in bulk, carlots, were quoted at $20.25 to $22.25 per ton. Florida kaolins were quoted by the same source at $18.75 per ton for purified and crushed; $24.75 for washed and air-floated clays; and $38.50 for air-floated enamel grade. Crude Pennsylvania kaolin was quoted at $5 to $7.50 per ton and "purified" kaolin at $21 to $24. These prices were the same as those quoted in December 1950 and are substantially the same as those for 1949.

TABLE 4.—Georgia kaolin sold or used by producers, 1944–48 (average) and 1949–53, 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
1944–48 (average)	780,855	$9,365,296	$11.99	111,543	$550,251	$4.93	892,398	$9,915,547	$11.11
1949	902,433	13,229,888	14.66	100,958	576,448	5.71	1,003,391	13,806,336	13.76
1950	1,087,174	16,533,582	15.21	133,481	806,946	6.05	1,220,655	17,340,528	14.21
1951	1,147,865	17,615,634	15.35	175,945	1,084,101	6.16	1,323,810	18,699,735	14.13
1952	[1] 1,145,063	[1] 17,635,838	[1] 15.40	[1] 183,192	[1] 1,166,355	[1] 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

[1] Revised figure.

Prices for imported china clay in December 1953 were quoted by the Oil, Paint and Drug Reporter as follows: White lump, carlots, ex dock (Philadelphia, Pa., and Portland, Maine), $20 to $40 per long ton; powdered, ex dock, in bags, $50 per net ton; and powdered, l. c. l., ex warehouse, $60. The average value of domestic kaolin sold or used as reported to the Bureau of Mines in 1953 was $14.38 per short ton compared with $13.78 in 1952, $13.57 in 1951, and $13.68 in 1950.

Imports of kaolin for 1953 increased 14 percent compared with 1952 and represented a little more than 6 percent of the total domestic consumption. Imports represented a like quantity in 1952 and 1951 and 7 percent in 1950. Over 99 percent of the 1953 imports came from the United Kingdom and the remainder from Canada.

Exports of kaolin or china clay in 1953 increased 8 percent over 1952; 88 percent was shipped to Canada, 5 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 1953 decreased 1 percent in tonnage and 14 percent in value compared with 1952.

Beginning with 1943 Tennessee has been the largest producer. In 1953 Tennessee production was 55 percent of the United States total; and Kentucky was second, with 33 percent. Following the two

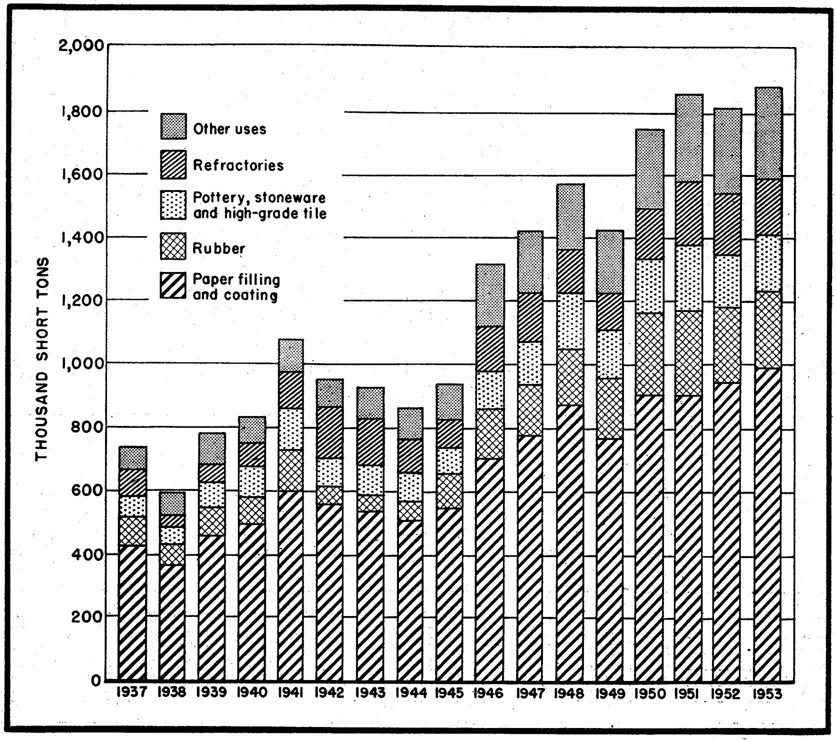

FIGURE 1.—Kaolin sold or used by domestic producers for specified uses, 1937–53.

principal producers were Maryland, Mississippi, and California, in decreasing order of tonnage. Compared with 1952 ball-clay production in 1953 in Tennessee increased 1 percent and in Kentucky decreased 6 percent.

The pottery industry consumed 73 percent of the ball clay produced in the United States in 1953, the same percentage as in 1952, compared with 78 percent in 1951. Ball clay used in making whiteware decreased 1 percent. Other decreases were: Art pottery, 7 percent; refractories, 15 percent; and saggers, pins, and stilts, 38 percent. The quantity of ball clay used in high-grade tile increased 12 percent and in fillers 10 percent. In 1953 high-grade tile consumed 13 percent (12 percent in 1952 and 1951), refractories 6 percent (7 percent in 1952 and 6 percent in 1951), and enamels, fillers, and miscellaneous uses 8 percent (8 percent in 1952 and 4 percent in 1951) of the total national output.

Quotations on ball clay did not appear in E&MJ Metal and Mineral Markets in 1953 or 1952. Quotations in 1951 were unchanged from 1950 and 1949 and were as follows: Tennessee—crude ball clay, $10 per short ton, and air-floated and pulverized, $19.50 per ton; and Maryland—shredded, in bulk, $7 to $9, and air-floated, in bags, $14 to $17.50 per ton. No quotations on Kentucky ball clay have been published since 1949. In 1953 the average value per short ton for ball clay as reported by producers was $11.27 compared with $12.97

in 1952, $10.80 in 1951, and $12.27 in 1950. In 1953 the average value for ball clay in Tennessee was $12.52 compared with $12.98 in 1952 and $9.18 in 1951. In Kentucky the average value in 1953 was $9.70 compared with $12.80 in 1952 and $12.69 in 1951. The average value in 1953 for California was $5, for Maryland, $6.21, and for Mississippi, $14.57.

Imports of common blue and ball clay and Gross Almerode clays in 1953 decreased 15 percent in tonnage and 13 percent in value compared with 1952. Unmanufactured blue and ball clays represented the major share of imports; the United Kingdom supplied 99 percent of this classification and virtually all of 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 from West Germany in 1953 totaled only 16 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, 1951–53, by States

State	Sold by producers		Used by producers		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1951						
Kentucky	111,215	$1,411,175			111,215	$1,411,175
Maryland, Mississippi, and New Jersey	39,575	532,113			39,575	532,113
Tennessee	194,191	1,782,642			194,191	1,782,642
Total	344,981	3,725,930			344,981	3,725,930
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

FIRE CLAY

Although fire clay sold or used in 1953 decreased 9 percent compared with 1952 it was the third largest output in the history of the industry. The use of refractories from inventories built up in 1951 and 1952 by the steel and foundry industries helped to lessen the demand for refractories direct from refractory producers in 1953.

The principal uses of fire clay in 1953 were for refractories manufacture, which consumed 52 percent of the national output, and heavy clay products, which consumed 44 percent. These two uses absorbed 96 percent of the 1953 tonnage, the same as in 1952, compared with 97 percent in 1951. In 1953 fire clay consumed for refractories decreased

17 percent while that consumed by the heavy clay products industry increased 2 percent compared with 1952. About 1 percent was consumed in the manufacture of high-grade tile, a little less than 1 percent in chemicals, and the remainder in a wide variety of uses. The principal refractory use of fire clay was for firebrick and block manufacture. This division of the fire-clay industry used 30 percent less fire clay in 1953 than in 1952. In 1952 use of fire clay as a rubber filler was reported for the first time. In 1953 the consumption was 18,475 short tons, nearly double that in 1952. Of the less important uses high-grade tile decreased and architectural terra cotta increased compared with 1952.

TABLE 6.—Fire clay, including stoneware clay, sold or used by producers in the United States, 1952–53, by States [1]

State	Sold by producers		Used by producers		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1952						
Alabama	145,567	$292,788	74,442	$464,663	220,009	$757,451
Arkansas	(2)	(2)	(2)	(2)	386,111	1,337,542
California	196,954	631,351	365,181	1,086,613	562,135	1,717,964
Colorado	159,972	377,635	140,902	410,979	300,874	788,614
Illinois	193,076	962,605	257,368	582,063	450,444	1,544,668
Indiana	280,629	440,010	116,707	292,015	397,336	732,025
Kentucky	96,308	418,111	429,930	3,031,935	526,238	3,450,046
Maryland	9,937	45,319	165,465	503,539	175,402	548,858
Missouri [3]	585,691	1,776,186	1,265,111	8,683,401	1,850,802	10,459,587
New Jersey	80,225	721,960	199,538	877,789	279,763	1,599,749
Ohio	792,894	2,814,155	2,074,563	8,124,919	2,867,457	10,939,074
Pennsylvania	245,062	972,854	1,718,173	9,594,840	1,963,235	10,567,694
South Carolina	(2)	(2)	(2)	(2)	7,547	18,250
Tennessee	(2)	(2)	(2)	(2)	21,290	203,845
Texas	15,716	168,242	342,750	895,763	358,466	1,064,005
Utah	5,215	28,682	29,254	78,689	34,469	107,371
Washington	8,300	12,338	71,671	143,317	79,971	155,655
West Virginia	(2)	(2)	(2)	(2)	621,996	2,072,688
Other States [4]	147,452	599,078	1,071,120	3,351,631	181,628	318,384
Total	2,962,998	10,261,314	8,322,175	38,122,156	11,285,173	48,383,470
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	496,717	103,375	221,526	318,507	718,243
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	145,655	389,633	153,804	416,026
Mississippi	(2)	(2)	(2)	(2)	43,850	74,209
Missouri [3]	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	1,422,751	6,879,398	1,670,588	7,821,326
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	7,937,787	7,531,123	29,865,202	10,267,113	37,802,989

[1] Includes stoneware clay as follows: 1952—80,651 tons, $326,408; 1953—67,628 tons, $175,574.
[2] Included with "Other States."
[3] Includes diaspore and burley clay as follows: 1952—diaspore, 44,757 tons, $705,269; burley, 71,433 tons, $664,358; 1953—diaspore, 50,144 tons, $962,384; burley, 53,971 tons, $563,043.
[4] Includes States indicated by footnote 2 above and Georgia, Idaho, Iowa, Kansas, Michigan (1952 only), Minnesota, Mississippi (1952 only), Montana (1952 only), Nebraska (1952 only), Nevada, New Mexico (1952 only), New York (1953 only), Oregon, and Tennessee (1953 only).

In 1953 Ohio ranked first in fire-clay output, followed by Pennsylvania, Missouri, West Virginia, Indiana, California, Colorado, Texas, and Kentucky. These States supplied 85 percent of the total quantity. The remainder was produced in 21 States. Of the 18 principal producing States listed in table 6, Alabama, Colorado, Indiana, South Carolina, Utah, and West Virginia reported increases and the other 11 decreases. Price quotations on fire clay do not appear in trade journals. However, the average value per short ton of fire clay sold by producers, as reported to the Bureau of Mines in 1953, was $2.90 compared with $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 $3.68 in 1953 compared with $4.29 in 1952, $4.11 in 1951, and $3.04 in 1950. Quotations on brick manufactured from fire clay were reported in 1953 in E&MJ Metal and Mineral Markets (comparable 1952 prices in parentheses) as follows: Missouri, Kentucky, and Pennsylvania, superquality, $99.30 per thousand ($116.50); high-heat quality, $92.40 ($94.60); Ohio fire brick, intermediate grade, $92.40 ($88.00); second grade, $83.15 ($79.20) per thousand.

Imports of fire clay are not shown separately in foreign trade statistics. Exports of fire clay in 1953 increased 3 percent in tonnage and less than 1 percent in value compared with 1952. Canada received 82 percent and Mexico 13 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

Bentonite sold or used by producers in 1953 was exceeded only in the record year 1952. Although the tonnage for 1953 decreased 4 percent compared with 1952 the value increased 9 percent to set an alltime high.

The foundry and petroleum industries consumed 93 percent of the total tonnage in 1953 compared with 94 percent each for 1952 and 1951. Rotary-drilling mud consumed 46 percent in 1953 compared with 50 percent in 1952 and 38 percent in 1951; filtering and decolorizing oils, 20 percent (21 percent in 1952 and 33 percent in 1951); and foundry-sand bond, 27 percent (23 percent each for 1952 and 1951). The remaining 7 percent of the national output was used for a wide variety of purposes. Bentonite tonnage used as foundry-sand bond increased 8 percent; but for rotary-drilling mud the demand decreased 17 percent, and the quantity used for filtering and decolorizing oils decreased 18 percent compared with 1952.

Eleven States reported bentonite production in 1953, the same number as in 1952. Although 1 new State (Alabama) was added, 1 State (Montana) was dropped from the list of producing States in 1953. Of the States that reported in 1953 and 1952 tonnage increased in Louisiana, Oklahoma, and Texas and decreased in Arizona, California, Mississippi, South Dakota, Utah, and Wyoming.

The Wyoming-South Dakota district supplied 69 percent of the total bentonite sold or used by producers in 1953 (Wyoming 53 percent and South Dakota 16 percent) compared with 68 percent in 1952 (Wyoming 52 percent and South Dakota 16 percent) and

58 percent in 1951 (Wyoming 38 percent and South Dakota 20 percent). Mississippi furnished 15 percent in 1953 but was included in "Other States" in 1952 and 1951. Texas contributed 4 percent in 1953 compared with 2 percent in 1952 and 3 percent in 1951. Trends in sales for principal uses are shown in figure 2.

TABLE 7.—Bentonite sold or used by producers in the United States, 1951–53, by States

State	1951		1952		1953	
	Short tons	Value	Short tons	Value	Short tons	Value
Arizona	(1)	(1)	(1)	(1)	134,850	$651,752
Mississippi	(1)	(1)	(1)	(1)	189,211	2,028,040
Montana			2,000	$24,000		
South Dakota	246,585	$2,926,756	205,934	2,553,783	205,303	2,700,394
Texas	38,425	212,670	31,386	584,938	47,887	670,300
Utah	(1)	(1)	(1)	(1)	1,738	20,396
Wyoming	465,254	5,981,655	692,853	9,168,708	670,756	9,861,321
Other States [2]	468,604	3,885,564	[3] 385,806	[3] 2,459,519	20,226	248,039
Total	1,218,868	13,006,645	[3] 1,317,979	[3] 14,790,948	1,269,971	16,180,242

[1] Included with "Other States."
[2] Includes Alabama (1953 only), California, Colorado (1951 and 1953 only), Idaho (1951 only), Louisiana (1952–53 only), Nevada (1952 only), Oklahoma (1952–53 only), and States indicated by footnote 1.
[3] Revised figure.

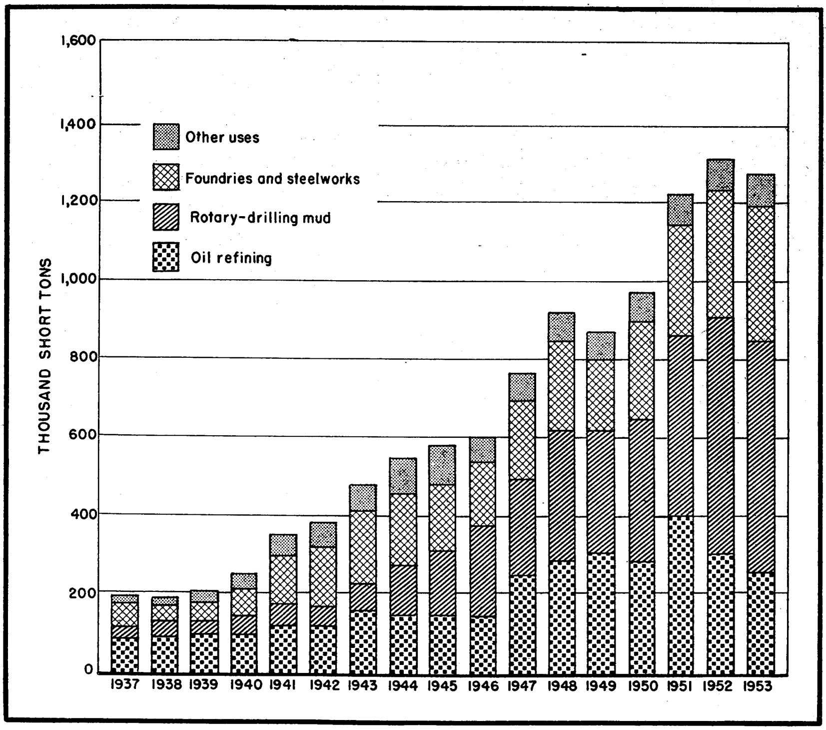

FIGURE 2.—Bentonite sold or used by domestic producers for specified uses, 1937–53.

In 1953 and 1952 bentonite was not quoted in E&MJ Metal and Mineral Markets. The following quotations were given for 1951 on Wyoming bentonite: Dried, crushed, in bulk, $9 per short ton; and 200-mesh, pulverized, in 100-pound bags, $12.50. Oil-well grade was quoted at $14 per short ton. The average value per short ton, as reported by the producers to the Bureau of Mines in 1953, increased to $12.74 compared with $11.22 in 1952, $10.67 in 1951, and $8.79 in 1950.

Bentonite imported in 1953 comprised 150 short tons from Canada and 100 tons from Italy.

Exports of bentonite are not shown separately in foreign trade statistics but are included under the blanket classification of "Other clays or earths, not especially provided for." It is understood, however, that some domestic producers export part of their production to destinations throughout the world.

The United Products Co., Rock River, Wyo., a bentonite producer since 1948, ceased operations. The plant was sold in March 1953 and dismantled.

FULLER'S EARTH

Fuller's earth sold or used in 1953 increased 3 percent in tonnage compared with 1952.

Absorbent uses composed 30 percent of the national consumption in 1953 compared with 24 percent in 1952, 20 percent in 1951, and 21 percent in 1950. Mineral-oil refining was the second largest consumer in 1953, with 29 percent compared with 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 1953 insecticides composed 17 percent of the national output compared with 18 percent in 1952, 1951, and 1950; rotary-drilling mud 12 percent compared with 15 percent in 1952, 16 percent in 1951, and 10 percent in 1950; and vegetable-oil refining 4 percent compared with 4 percent in 1952 and 1951 and 5 percent in 1950. The remainder was used in other filtering and clarifying, binders, and other unspecified uses.

All reporting districts showed increases in tonnage in 1953 compared with 1952. The Florida-Georgia area supplied 62 percent of the total tonnage produced in 1953 compared with 64 percent in 1952 and 62 percent in 1951. Production in Texas represented 24 percent of the total United States production in 1953 compared with 25 percent in 1952 and 29 percent in 1951.

Quotations on fuller's earth were not listed in E&MJ Metal and Mineral Markets in 1953 or 1952. Prices, which had not changed since 1949, were quoted in 1951 as follows: 14- to 30-mesh, $14 per short ton; 30- to 60-mesh, $14.50; 100-mesh up, $7; and 200-mesh up, $10. The average value per short ton of fuller's earth sold or used in the United States in 1953 was $17.47 compared with $16.26 in 1952, $16.81 in 1951, and $16.42 in 1950.

Imports of fuller's earth in 1953 totaled 222 short tons—188 from Canada and 34 from the United Kingdom. Exports are not given separately in official foreign trade statistics. Reports from the producers to the Bureau of Mines, however, indicate exports of approximately 18,000 short tons in 1953 compared with 26,000 short tons in 1952, 35,000 short tons in 1951, and 16,400 short tons in 1950. Destinations reported included North America, Central and South America, West Indies, Europe, Asia, and the Philippines.

TABLE 8.—Fuller's earth sold or used by producers in the United States, 1951–53, by States

State	1951		1952		1953	
	Short tons	Value	Short tons	Value	Short tons	Value
California and Nevada	(1)	(1)	(1)	(1)	10,286	$240,587
Florida and Georgia	299,071	$5,258,330	270,261	$4,829,552	271,187	5,093,501
Mississippi	(1)	(1)	(1)	(1)	12,472	523,044
Tennessee	(1)	(1)	25,974	358,752	30,961	427,933
Texas	142,273	1,952,304	105,565	1,030,005	106,437	1,277,670
Utah	(1)	(1)	(1)	(1)	4,494	52,024
Other States	42,279	921,127	21,053	657,174		
Total	483,623	8,131,761	422,853	6,875,483	435,837	7,614,759

1 Included with "Other States."

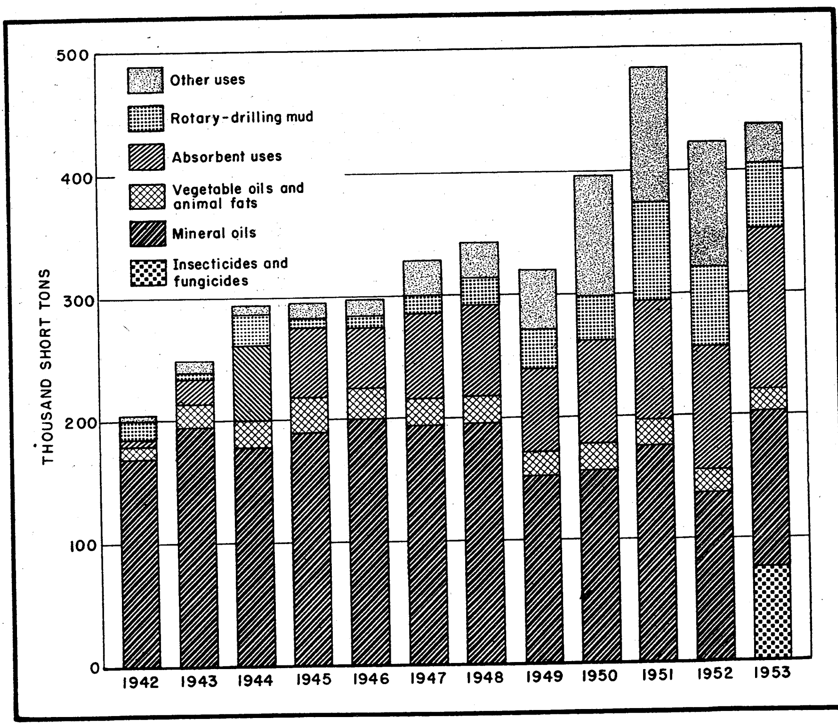

FIGURE 3.—Fuller's earth sold or used by producers for specified uses, 1942–53

MISCELLANEOUS CLAYS

This section presents statistics for the large-tonnage clays and shales—other than those discussed in the preceding pages—that are used in manufacturing heavy clay products and portland cement. With these clays are grouped small tonnages of slip clay, oil-well drilling mud, pottery clay, and clays that cannot clearly be identified with one of the types discussed separately in this chapter.

Miscellaneous clays sold or used by producers increased 7 percent compared with 1952. The tonnage of clay used in the production of cement in 1953 increased 10 percent over 1952. As cement output reached an alltime high in 1953, so clay used in cement production reached a corresponding high, exceeded only by clay used for that purpose in 1952. Miscellaneous clays consumed in the manufacture of heavy clay products increased 3 percent in 1953 compared with 1952. The value of shipments of clay construction products during 1953 was 7 percent greater than in 1952. In 1953, 65 percent of the total miscellaneous clays were used in manufacturing heavy clay products and 31 percent in cement. Both the percentages were the same as in 1952. Captive tonnage—clay produced by the mine operators for their own use in manufacturing brick, tile, cement, and lightweight aggregate and marketed for the first time as such—amounted to 99 percent of the miscellaneous clays sold or used in 1953. The quantity of miscellaneous clays used in producing lightweight aggregate for concrete mixtures was shown for the first time in 1953 and composed 4 percent of the total. The average value of miscellaneous clays sold as crude or prepared clay in 1953 was $1.91 compared with $2.31 (revised) in 1952 and $2.05 in 1951.

TABLE 9.—Miscellaneous clays, including shale and slip clay sold or used by producers in the United States, 1952–53, by States

State	Sold by producers [1]		Used by producers [2]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1952						
Arkansas			166,465	$176,392	166,465	$176,392
California	[3] 229,751	[3] $757,781	[3] 1,917,139	[3] 1,827,593	[3] 2,146,890	[3] 2,585,374
Colorado	(4)	(4)	(4)	(4)	267,856	298,540
Connecticut			157,500	157,500	157,500	157,500
Georgia			1,050,792	1,020,132	1,050,792	1,020,132
Illinois	(4)	(4)	(4)	(4)	1,886,299	2,324,583
Indiana	[3] 46,086	[3] 43,528	[3] 858,259	[3] 895,039	[3] 904,345	[3] 938,567
Iowa	62,943	658,751	772,177	1,984,104	835,120	2,642,855
Kansas			642,250	738,481	642,250	738,481
Kentucky			247,425	278,525	247,425	278,525
Louisiana	(4)	(4)	(4)	(4)	380,218	384,218
Maine			26,050	26,050	26,050	26,050
Maryland	(4)	(4)	(4)	(4)	578,051	651,622
Massachusetts	73	1,453	140,075	158,918	140,148	160,371
Michigan	(4)	(4)	(4)	(4)	[3] 1,599,990	[3] 1,633,293
Minnesota	(4)	(4)	(4)	(4)	96,203	104,297
Missouri	(4)	(4)	(4)	(4)	[3] 755,698	[3] 1,232,710
Montana			44,205	41,205	44,205	41,205
New Hampshire			30,135	30,135	30,135	30,135
New Jersey	1,910	3,820	315,707	339,925	317,617	343,745
New Mexico	(4)	(4)	(4)	(4)	38,048	71,615
New York	(4)	(4)	(4)	(4)	1,218,850	1,291,736
North Carolina			1,332,051	1,546,949	1,332,051	1,546,949
Ohio	281,338	293,644	2,345,035	2,411,024	2,626,373	2,704,668
Oklahoma	(4)	(4)	(4)	(4)	516,705	527,245
Oregon	(4)	(4)	(4)	(4)	256,692	548,934
Pennsylvania	[3] 19,523	[3] 28,590	[3] 1,691,049	[3] 1,856,730	[3] 1,710,572	[3] 1,885,320
South Carolina			616,953	577,899	616,953	577,899
Texas	16,000	288,000	1,557,603	1,503,234	1,573,603	1,791,234
Utah			84,943	171,369	84,943	171,369
Virginia			937,156	947,359	937,156	947,359
Washington	(4)	(4)	(4)	(4)	211,163	196,921
West Virginia			360,034	348,981	360,034	348,981
Wisconsin	48,632	48,672	85,821	85,821	134,453	134,493
Wyoming			13,895	7,799	13,895	7,799
Undistributed [5]	898,595	1,589,176	9,510,340	10,335,312	2,603,162	2,658,774
Total	[3] 1,604,851	[3] 3,713,415	[3] 24,903,059	[3] 27,466,476	[3] 26,507,910	[3] 31,179,891

See footnotes at end of table.

TABLE 9.—Miscellaneous clays, including shale and slip clay sold or used by producers in the United States, 1952–53, by States—Continued

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	(4)	(4)	(4)	(4)	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	895,237	884,283	947,190
Kansas			606,583	621,357	606,583	621,357
Kentucky	(4)	(4)	(4)	(4)	262,368	333,727
Louisiana	(4)	(4)	(4)	(4)	614,427	901,612
Maine			29,661	27,476	29,661	27,476
Maryland	(4)	(4)	(4)	(4)	498,143	600,899
Massachusetts	(4)	(4)	(4)	(4)	152,117	195,809
Michigan	422,017	462,326	1,223,787	1,223,787	1,645,804	1,686,113
Minnesota	(4)	(4)	(4)	(4)	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	(4)	(4)	(4)	(4)	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	(4)	(4)	(4)	(4)	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	89,240	210,718	89,992	213,726
Virginia			949,266	881,571	949,266	881,571
Washington	(4)	(4)	(4)	(4)	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	3,235,141	297,232	285,256
Total	1,504,946	2,872,664	26,773,361	29,551,534	28,278,307	32,424,198

[1] Purchases by portland-cement companies of common clay and shale: 1952—790,531 tons, estimated at $813,301 (revised figures); 1953—734,706 tons, estimated at $733,725.

[2] Includes the following: Common clay and shale used by portland-cement companies: 1952—6,986,573 tons, estimated at $7,004,018 (revised figures); 1953—7,805,275 tons, estimated at $7,659,662.

[3] Revised figure.

[4] Included with "Undistributed."

[5] Figures include (1952 only) Alabama, Arizona, Idaho, Mississippi, Nebraska, Tennessee; (1953 total only) North Dakota and South Dakota; (1952 and 1953) Delaware, District of Columbia, Florida, Nevada, and States indicated by footnote 4.

Some special types of clays 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.

Miscellaneous clays, including shales and the so-called common or surface clays, occur widely, and production was reported from all States except Vermont and Rhode Island in 1953 and 1952. Only Ohio reported tonnage exceeding 2 million short tons. States reporting more than 1 million and less than 2 million tons sold or used by producers were, in decreasing order of output: Illinois, California, Pennsylvania, Texas, Michigan, North Carolina, Georgia, and Indiana. Of the States for which data are shown in table 9 for both 1952 and 1953, 26 reported increases and 9 decreases in output in 1953.

HEAVY CLAY PRODUCTS

In 1953 structural clay products increased 7 percent in value of shipments compared with 1952, 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. Clay consumed in producing structural clay products increased 3 percent in 1953. The largest percentage of increase was in hollow facing tile, with a value of shipments 19 percent more than in 1952. The value of shipments of glazed and unglazed floor and wall tile increased 12 percent, over 1952. Shipments of the principal clay-construction product unglazed brick, increased 5 percent over 1952. Vitrified-clay sewer-pipe shipments increased 3 percent in value in 1953 compared with 1952. Drain tile decreased 3 percent in shipments.

TABLE 10.—Shipments of principal structural clay products in the United States, 1951–53 [1]

Product and unit quantity	1951		1952		1953	
	Quantity	Value (thousand dollars)	Quantity	Value (thousand dollars)	Quantity	Value (thousand dollars)
Unglazed brick (building) M stand. brick..	6,306,561	170,743	[2] 5,642,239	[2] 154,881	5,771,211	162,752
Unglazed structural tile..short tons..	1,166,879	14,098	[2] 993,910	[2] 11,435	921,985	11,524
Vitrified clay sewer pipe......do....	1,554,711	58,238	[2] 1,548,109	[2] 59,161	1,562,986	61,117
Drain tile..................do....	655,757	11,387	815,490	14,073	793,785	14,223
Hollow facing tile, glazed and unglazed..........M brick equiv..	467,767	25,984	389,376	22,104	444,294	26,304
Glazed and unglazed floor and wall tile and accessories, including quarry tile........M square feet..	141,322	71,277	[2] 123,267	[2] 64,146	134,375	71,569

[1] Compiled from information furnished by the Bureau of the Census, U. S. Department of Commerce.
[2] Revised figure.

The value of clay refractories shipment in 1953 was about the same as in 1952. The value of fire-clay brick shipments (except superduty) represented 42 percent of the total value of fire-clay shipments in 1953; ladle brick, 11 percent; superduty fire-clay brick, 8 percent; and insulating firebrick, 6 percent. A number of classifications composed the remaining 33 percent, as shown in table 11.

The growth of the United States refractories industry since the mid-19th century and its relationship to industrial growth in the United States was discussed.[3]

[3] Brick and Clay Record, vol. 122, No. 1, January 1953, pp. 56–57, 60–61.

TABLE 11.—Production and shipments of refractories in the United States, by kinds, 1952–53

[Bureau of the Census]

Product	Unit of quantity	1952			1953		
		Production (quantity)	Shipments		Production (quantity)	Shipments	
			Quantity	Value (thousand dollars)		Quantity	Value (thousand dollars)
Clay refractories:							
Fire-clay brick, standard and special shapes except superduty.	1,000 9-in. equiv.	628,262	610,254	70,849	541,040	542,568	67,051
Superduty fire-clay brick, standard and special shapes.	do	[1] 91,772	[1] 88,647	[1] 15,261	72,219	69,184	12,754
High-alumina brick, standard and special shapes (50 percent Al_2O_3 and over, except fused alumina and mullite).	do	22,251	21,655	6,655	17,694	16,230	5,337
Insulating firebrick, standard and special shapes.	do	60,343	60,127	11,510	53,781	48,740	9,925
Ladle brick	do	209,511	199,913	13,490	240,385	236,230	16,995
Hot-top refractories	do	49,148	48,892	5,042	61,262	60,133	6,368
Sleeves, nozzles, runner brick, and tuyères.	do	55,085	54,231	7,789	58,580	56,946	8,565
Glass-house pots, tank blocks, upper structure, and floaters.	Short tons	20,513	19,404	3,373	14,207	16,299	3,262
High-temperature bonding mortars.	do	71,402	72,427	6,272	77,017	76,229	6,727
Plastic refractories (including wet and dry ramming mixtures).	do	101,856	101,893	5,624	110,265	109,243	5,868
Cast and castables (hydraulic setting).	do	83,111	82,387	6,807	87,639	87,060	7,309
Ground crude fire-clay and high-alumina clay material.	do	[1] 379,935	[1] 380,651	[1] 4,590	376,601	376,386	4,952
Other clay refractories	do			[1] 3,830			4,550
Total clay refractories				161,092			159,663
Nonclay refractories:							
Silica brick, standard and special shapes.	1,000 9-in. equiv.	336,579	327,997	46,797	343,827	338,043	54,033
Magnesite and magnesite-chrome (magnesite predominating) brick, standard and special shapes.	do	38,420	38,150	[1] 21,948	41,809	41,288	25,019
Chrome and chrome-magnesite (chrome predominating) brick, standard and special shapes.	do	48,708	48,187	23,658	55,966	54,709	28,638
Graphite and other carbon crucibles and retorts.	Short tons	9,810	9,844	5,573	12,214	12,130	7,691
Other graphite and carbon refractories.	do	1,358	1,329	593	1,639	1,618	905
Silicon carbide				[1] 7,691			9,034
Mullite and kyanite				[1] 4,622			4,220
Sillimanite				268			(2)
Fused alumina and bauxite				2,560			3,463
Zirconia, forsterite, fused magnesia, pyrophyllite, and other nonclay shapes.				[1] 4,612			5,351
High-temperature bonding mortars.	Short tons	45,802	44,990	5,283	50,852	50,522	6,536
Plastic refractories (including wet and dry ramming mixtures).	do	141,779	141,836	11,245	166,640	164,872	12,991
Other nonclay refractory materials, sold in lump or ground forms (including ground silica and nonclay cast and castables).				4,572			6,823
Total nonclay refractories [3]				139,422			164,704
Grand total refractories [3]				300,514			324,367

[1] Revised figure.
[2] Included with mullite and kyanite.
[3] Data for dead-burned magnesia or magnesite excluded to avoid duplication in other refractory products covered in this table (such as magnesite brick and shapes). Quantity and value of shipment of dead-burned magnesia or magnesite totaled 353,000 tons valued at $16,818,000 (revised figures) in 1952, and 353,000 tons valued at $17,177,000 in 1953.

TECHNOLOGY

During 1953 the Expanded Shale Institute, Washington, D. C., sponsored a comprehensive research program at the University of Toledo, Toledo, Ohio, to correlate the structural properties of concrete using lightweight aggregate produced from expanded shale and clay. The study will extend over a period of several years. Planning also was initiated for programs to study the fire resistance of reinforced concrete in which lightweight aggregate produced from expanded clay and shale is used.[4]

In June 1953 The Expanded Shale Institute began publication of its official bulletin, Concrete Facts.[5] The purpose and functions of the organization were described.[6]

Development of both the rotary-kiln and sintering-machine methods of producing lightweight aggregate from clays and shales continued in 1953. The Expanded Shale Institute represented the users of the rotary-kiln method and the Expanded Shale and Clay Association producers of the sintering-machine method. The proper method allows the use of almost all types of clay or shale to produce lightweight aggregate. The use of the drum pelletizer in developing lightweight aggregate from clay or shale is extremely important when a sintering machine is employed.[7] Only 2 men were required to process 140 cubic yards of shale per 8-hour shift in a rotary kiln in South Dakota's first lightweight aggregate plant.[8] An expanded-shale aggregate was produced at Fort Smith, Ark., and a lightweight aggregate plant to expand clay and shale was being built at Mandan, N. Dak.[9] A detailed description of the operation of a modern plant producing lightweight aggregate from shale by the rotary-kiln method was given.[10] An example of the integration of a brick plant and lightweight aggregate plant under one management was described.[11] A new light weight aggregate plant was built in Oklahoma City, Okla., by Texas Industries, Inc. This company operates plants in Texas and Louisiana.[12]

An all-ceramic building block with advantages over the common cement block was developed by Armour Research Foundation. The block is composed largely (90 percent) of lightweight clay aggregate and a bond; it contains no cement.[13] A claylike mineral consisting principally of clay and volcanic ash suitable for producing a lightweight aggregate was found in western Louisiana. Samples taken nearly 1 mile apart showed little difference in behavior. A similar deposit was found a few miles across the border in the Houston, Tex., area.[14]

Miscellaneous clays found in Los Angeles County, Calif., were discussed.[15]

New techniques in building brick packaging and transporting were discussed.[16]

[4] Expanded Shale Institute, Letter to Bureau of Mines: Nov. 5, 1954.
[5] Pit and Quarry, vol. 46, No. 3, September 1953, p. 228.
[6] Work cited in footnote 5, p. 216.
[7] Brick and Clay Record, vol. 122, No. 7, July 1953, p. 55.
[8] Brick and Clay Record, vol. 122, No. 3, March 1953, pp. 48–50.
[9] Brick and Clay Record, vol. 123, No. 3, September 1953, pp. 30, 34.
[10] Rock Products, vol. 56, No. 9, September 1953, pp. 70–74.
[11] Pit and Quarry, vol. 46, No. 6, December 1953, pp. 108–110.
[12] Pit and Quarry, vol. 45, No. 9, March 1953, p. 87.
[13] Chemical and Engineering News, vol. 31, No. 52, Dec. 28, 1953, p. 5370.
[14] Cox, P. E., Two New Materials for Making Lightweight-Concrete Aggregate: Ceram. Age, vol. 62, No. 1, July 1953, p. 24.
[15] Mineral Information Service, Dept. of Natural Resources, Division of Mines, California, vol. 6, No. 10, October 1953, pp. 1–4.
[16] Work cited in footnote 7, pp. 44–47.

During 1953 the National Clay Pipe Manufacturers, Inc., continued active research in developing longer clay-pipe sections and stronger pipe. New jointing techniques include "tubular joints" which employ the hydraulic principle for use on 8-inch and larger diameter pipe; and the development of new jointing techniques of clay-pipe house-connection drains, including the use of new plastic polyesters and plastisols. All these joints use the mechanical compression principle and are claimed to be rootproof. During 1953 hydraulic research was continued to develop additional data on fluid-flow characteristics.[17] The method of horizontal extrusion in the production of small sizes of clay sewer pipe was discussed.[18] It was said that 6 men could produce 300 to 350 lengths of 8-inch pipe per hour. Mechanized equipment and automatic controls have aided in the continued growth of a clay-sewer-pipe plant in California.[19]

The Pacific Clay Products was constructing a $100,000 research laboratory at Los Nietos, Calif., in which to consolidate all research activities on vitrified-clay sewer pipe and other clay products.[20]

Laclede-Christy Co., with heavy clay product plants in several States, purchased the facilities of the White Hall Sewer Pipe & Stoneware Co., which had been operating more than 75 years at White Hall, Ill.[21]

The silica brick plant of the Harbison-Walker Refractories Co., at Windham, Ohio, completed in 1952, was described. In its construction the latest laboratory and pilot-plant developments were translated into commercial practice and full advantage was taken of new concepts and machine design improvements. Mechanical and electrical controls at every stage of manufacture assure a uniform product.

The plant manufactures conventional and superduty type silica refractories. Direct setting from power presses to tunnel-kiln cars was an innovation at this plant. A silica conglomerate quarried near Windham, Ohio, is used to produce the brick.[22]

There has been a trend toward increased plant modernization and improved manufacturing methods since 1951 in the structural clay products industry.[23]

The Structural Clay Products Research Foundation, Chicago, Ill., in 1953 concentrated on developing improved job-site techniques and more convenient unit sizes and shapes for the structural clay products industry. With the original research fund of $1,250,000 spent, manufacturers voted to renew research contracts on a permanent basis for further reduction of in-the-wall costs of clay masonry construction.[24]

A new high-temperature laboratory was built by the Ceramics and Minerals Department of the Armour Research Foundation, Illinois Institute of Technology, Chicago. The new laboratory was established to study refractory materials, metal-ceramic combinations, and special nonmetallic inorganic bodies.[25]

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[17] National Clay Pipe Manufacturers, Inc., letter to Bureau of Mines: Dec. 20, 1954.
[18] Brick and Clay Record, vol. 122, No. 6, June 1953, p. 57.
[19] Work cited in footnote 7, pp. 52–53.
[20] Western Industry, vol. 18, No. 11, November 1953, p. 130.
[21] Work cited in footnote 18, p. 28.
[22] Work cited in footnote 9, pp. 69–74. Metal Progress, vol. 64, No. 4, October 1953, pp. 161–166.
[23] Brick and Clay Record, vol. 122, No. 1, January 1953, pp. 40–41, 44; No. 2, February 1953, pp. 40–43, 46–47; No. 3, March 1953, pp. 52–53, 55, 61–69; No. 4, April 1953, pp. 59–63, 66, 68, 84.
[24] Western Industry, vol. 18, No. 2, February 1953, p. 81.
[25] Brick and Clay Record, vol. 61, No. 2, August 1953, p. 3. Chemical and Engineering News, vol. 31, No. 23, June 8, 1953, p. 2408.

The new Binns-Merrill ceramic building at New York College of Ceramics, Alfred University, was dedicated. The experimental and research equipment alone amounted to over $100,000.[26]

The Olir Foundation made a grant of $445,000 to Clemson College, South Carolina, for constructing a building and furthering research in ceramics.[27]

A successful method of applying a ceramic coating to commercial nickel was announced by Oak Ridge National Laboratory, Oak Ridge, Tenn. The new coating process may permit the use of nickel in jet engines, gas turbines, guided missiles, and other products subjected to high temperatures.[28]

To meet the ever-growing demand for protective coatings for many metals used in military, industrial, and civilian applications, the General Ceramics & Steatite Corp. established a new ceramic coating department in its chemical equipment division at Keasbey, N. J.[29]
A color test based on the absorption and oxidation of p-amino phenol on clay mineral surfaces was developed for routine identification of the principal clay-mineral groups. This test was found to be most sensitive for the montmorillonoid group, and kaolin minerals are identified with ease when kaolin is the principal constituent.[30]

An investigation was made to correlate particle size distribution with firing shrinkage, using classified fractions of previtrified ceramic whiteware material.[31]

The control of bentonitic drilling muds by quebrachotannin extract and its application were surveyed.[32]

A new method of pneumatic conveying, applicable to finely divided solids, uses a fluidized bed as a feeder. The development of this method was undertaken to determine the feasibility of applying it to air-floated clays and other finely divided raw materials. The efficiency of this method for blending materials of widely different particle sizes and materials of widely different densities was studied.[33]

Drying problems and the installation of new equipment to solve these problems were discussed. Drying systems for sanitary-ware molds, electrical porcelain, and refractory porcelain are described, including a section on jet drying.[34]

The quantity of titania that a fire clay may contain without appreciably lowering its refractoriness was determined. The most rapid increase in the development of glassy material occurred when 3 to 4.5 percent titania was added to the clay.[35]

A chemically bonded, high-strength, refractory brick was developed, consisting essentially of a refractory aggregate, including clay bonded with a minor proportion of acid aluminum sulfate and acid aluminum phosphate.

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[26] Ceramic Age, vol. 61, No. 1, July 1953, p. 87.
[27] Work cited in footnote 3, p. 89.
[28] Ceramic Age, vol. 62, No. 2, August 1953, p. 22.
Steel, vol. 133, No. 3, July 20, 1953, pp. 146–148; No. 6, Aug. 10, 1953, p. 95.
Materials and Methods, vol. 38, No. 4, October 1953, p. 240.
[29] Ceramic Industry, vol. 61, No. 4, October 1953, p. 37.
[30] Hambleton, W. W., and Dodd C. G., A Qualitative Color Test for Rapid Identification of the Clay-Mineral Groups: Econ. Geol., vol. 48, No. 2, March-April 1953, pp. 139–146.
[31] Contardi, W. A., and Hund, G. J., Correlation of Particle Size Distribution With Firing Shrinkage in a Ceramic Whiteware Composition: Ceram. Age, vol. 62, No. 5, November 1953, pp. 13–15.
[32] White, T., Effect of Quebracho Extract on Clays: Ceram. Age, vol. 62, No. 4, October 1953, pp. 31–34.
[33] Koble, R. A., Jones, P. R., and Koehler, W. A., Blending and Conveying of Ceramic Raw Materials by Fluidization: Bull., Am. Ceram. Soc., vol. 32, No. 11, November 1953, pp. 367–372.
[34] Henderson, J. L., Jr., Recent Examples of Improved Drying in the Whiteware Industry: Bull., Am. Ceram. Soc., vol. 32, No. 11, November 1953, pp. 373–375.
[35] Wilder, D. R., and Dodd, C. M., Some Effects of Titania on Refractory Clays: Jour. Am. Ceram. Soc., vol. 36, No. 12, Dec. 1, 1953, pp. 400–403.

Tests to determine the quantity of barium carbonate necessary to precipitate soluble sulfates in clay as barium sulfate were discussed. A simple and accurate turbidity measurement was described for the control of dry-house scum and efflorescence on fired clay products.[36]

A comparison of ceramic and plastic dinnerware was presented, showing how each meets the various tests of good dinnerware.[37]

A comprehensive book on clay mineralogy was published. Available data were summarized on the structure, composition, properties, occurrence, and mode of origin of the various clay minerals whose identities have been reasonably well established. The distribution of the clay minerals in rocks of various lithologic types, geologic age, and condition of formation was discussed.[38]

The properties and uses of semisilica brick were discussed, and the methods of manufacture and potential uses given in detail.[39]

Flatwise, edgewise, and endwise, permeabilities, bulk densities, moduli of elasticity, and porosities were determined for many types of brick submitted by manufacturers.[40]

The elimination of green efflorescence on products made from buff-burning fire clay was discussed.[41]

A book was published on reinforced-brick masonry and lateral force design. The book presents data on the performance of reinforced and unreinforced masonry, recommended design and construction procedures based upon these data, and a review of the currently accepted design criteria, particularly those relating to lateral forces resulting from wind, earthquake, or blast.[42]

WORLD REVIEW

Africa.—Deposits of fuller's earth were found in an area of 54 square miles in the Immerpan district of the Springbox Flats. The overburden ranges from 5 to 30 feet.[43]

Argentina.—Geologists completed a preliminary survey of Barker, an important clay area in the Province of Buenos Aires, and recommended a complete investigation.[44]

Australia.—Three known bentonite deposits in Australia were considered to be worth developing, according to the States Mines Department. In 1953 most of the bentonite used was imported.[45]

Canada.—All of the production of bentonite in Canada in 1953 continued to come from Manitoba and Alberta. The output was valued at C$416,558 in 1953 compared with C$388,542 in 1952. Shipments consisted of natural and activated swelling bentonites.[46]

[36] Tubbs, L. G., Determination of Soluble Sulphates in Clay: Bull. Am. Ceram. Soc., vol. 32, No. 5, 1953, pp. 181–182.
[37] Cline, R. W., and Schramm, E. A., Comparison of Plastic and Ceramic Dinnerware: Bull. Am. Ceram. Soc., vol. 32, No. 10, 1953, pp. 349–353.
[38] Grim, R. E., Clay Mineralogy, McGraw-Hill Series in Geology: McGraw-Hill Book Co., Inc., New York, N. Y., 1953, 384 pp.
[39] Remmy, G. B., Properties and Uses of Semisilica Brick: Iron and Steel Eng., vol. 30, No. 5, May 1953, pp. 94–100.
[40] Massengale, G. B., Mong, L. E., and Heindl, R. A., Permeability and Some Other Properties of a Variety of Refractory Materials: Jour. Am. Ceram. Soc., vol. 36, No. 7, July 1, 1953, pp. 222–229.
[41] Work cited in footnote 9, pp. 37–39, 85.
[42] Plummer, H. C., Reinforced Brick Masonry, Lateral Force Design: Structural Clay Products Institute, Washington, D. C., 1953, 271 pp.
[43] Refractories Journal (London), vol. 29, No. 11, November 1953, p. 500.
[44] Mining World, vol. 15, No. 9, August 1953, p. 89.
[45] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 5, May 1953, p. 30.
[46] Canada Department of Mines and Technical Surveys, Bentonite in Canada, 1953 (Preliminary); Ottawa, Canada, 1954, 4 pp.

A new use for bentonite that has developed with the utilization of taconite or iron ore promises to be important in developing western Canadian bentonite deposits.[47]

India.—Two samples of fuller's earth found in the State of Hyderabad were reported to be comparable to imports of this mineral.[48]

Japan.—Fire clay found in the Komatsuyama area, Ogawa village, Iwate prefecture, was examined by chemical, thermal, X-ray, optical, and electron-microscope methods and found to be mainly kaolinite.[49]

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[47] Canadian Mining and Metallurgical Bulletin, vol. 46, No. 499, November 1953, p. 725.
[48] Chemical Age (London), vol. 49, No. 1791, Nov. 7, 1953, p. 956.
[49] Yamauchi, Toshiyoshi and Ueda, Suzuo, [Fundamental Studies on Iwate Hard Fire Clay]: Jour. Ceram. Assoc., Japan, vol. 61, No. 681, March 1953, pp. 104–107.

Cobalt

By Hubert W. Davis [1] and Charlotte R. Buck [2]

WORLD production of cobalt continued its upward trend to establish a new high of 12,000 metric tons in 1953, a 20-percent gain over 1952, itself a record year. In recent years much progress has been made in metallurgical research on extractive methods for cobalt, and as a result world production has increased to such an extent that it now exceeds civilian needs. It is estimated that the world (exclusive of U. S. S. R.) potential annual production capacity of refineries completed, under construction, and planned is about 23,000 short tons. Consequently, barring full mobilization or large expansion in use, the industry will have much surplus production on its hands when the Government stockpile objective is fulfilled. As the bulk of the world production of cobalt will be a byproduct or coproduct of copper and nickel mining, output will be governed by the prosperity in these industries. Nevertheless, to absorb the surplus production vigorous research will be required to find new uses and expanded applications for present uses. The high cost of recovering cobalt by present processes restricts its use and forces employment of less desirable substitutes. For example, cobalt is superior to nickel for certain uses, but because it costs four times more per pound of metal, efforts are directed toward maximum use of nickel. Also, the high cost of cobalt has made it commercially feasible to recover cobalt from scrap. In 1953, for example, 1,651,000 pounds of cobalt in purchased scrap was consumed in the United States.

As a result of the improved supply position, allocation and end-use restrictions on cobalt were discontinued by the National Production Authority on June 30. Despite the removal of end-use limitations, less cobalt was consumed in the United States during the last 6 months of 1953 than during the first 6 months. As a consequence, consumption reversed a 3-year upward trend in 1953 and was 1 percent less than in 1952. The 39-percent increase in the consumption of cobalt in magnet alloys in 1953 was noteworthy. More cobalt was also consumed in low-cobalt alloy steels, alloy hard-facing rods, ground-coat frit for porcelain enamel, and pigments. These gains, however, were offset by smaller consumption of cobalt in high-temperature alloys, high-speed steel, and cemented carbides.

Production of cobalt metal in the United States in 1953 was the largest since 1945 and 39 percent more than in 1952; but imports, which again established a new record, were 20 percent greater. Sales of cobalt metal to consumers declined 3 percent, but deliveries to the National Stockpile were 93 percent larger.

Cobalt oxide production in the United States in 1953 was 23 percent less than in 1952, but imports were 58 percent more; sales declined

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

2 percent. Production of salts and driers exceeded that in 1952 by 21 and 18 percent, respectively, and output of hydrate increased 12 percent. Imports of sulfate and other compounds increased to 273,286 pounds (gross weight) in 1953 from 12,759 pounds in 1952.

Prices of cobalt metal and oxide were advanced 20 and 14 cents a pound, respectively, in 1953.

Northfield Mines and Montana Coal & Iron Co. continued to explore for cobalt at the 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. In 1953 the Administration also provided financial assistance to Calera Mining Co. to explore its Blackbird property, also in Idaho.

DOMESTIC PRODUCTION

Mine Production.—Despite the fact that the United States is the largest consumer of cobalt in the world, only a small part of its requirements has been furnished from domestic ore. However, more commercial cobalt products were made from domestic ore in 1953 than in any other year. Moreover, with full production as planned by Calera Mining Co. and Cobalt-Nickel Reduction Co., there will be far less dependence on foreign sources for cobalt.

Production of cobalt ore or concentrates in the United States in 1953 was 8 percent less than in 1952, but shipments were 112 percent larger.

The Calera Mining Co., a wholly owned subsidiary of Howe Sound Co., was again the chief producer of cobalt ore in the United States. Its production, however, was 23 percent less than in 1952. Output was curtailed because of technical problems in getting its refinery into capacity production. The company operates the Blackbird mine at Cobalt, Idaho, and the ore carries about 0.6 to 0.8 percent cobalt, about twice as much copper, and a little nickel and gold. The concentrate produced averaged 17.93 percent cobalt in 1953. The concentrate is shipped to the company refinery at Garfield, Utah, which made its first output of cobalt granules in March 1953. The granules average about 95.5 percent cobalt and 4 percent nickel.

Bethlehem Steel Co. produced 21 percent more cobalt in 1953 than in 1952. The cobalt-bearing material (averaging 1.42 percent in 1953)

TABLE 1.—Cobalt ore produced and shipped in the United States, 1944–48 (average) and 1949–53 [1]

Year	Produced		Shipped from mines	
	Gross weight (short tons)	Cobalt content (pounds)	Gross weight (short tons)	Cobalt content (pounds)
1944–48 (average)	20,373	755,861	19,245	720,513
1949	19,599	521,656	25,175	673,773
1950	28,660	809,328	23,662	660,025
1951	28,485	902,629	26,564	755,631
1952	21,159	1,363,251	24,551	836,372
1953	22,524	1,258,924	24,026	1,775,489

[1] Figures, by years, for 1933–48 are given in chapter on Cobalt in Minerals Yearbook, 1952.

is obtained as a flotation sulfide concentrate from the magnetite mined at Cornwall, Pa. The concentrate is shipped to the Pyrites Co., Wilmington, Del., where it is processed into metal and other cobalt products.

The Sullivan Mining Co., Kellogg, Idaho, continued to recover cobalt at its electrolytic zinc plant but, as in previous years, made no shipments. In 1953 it recovered 76 short tons of residues containing 5,737 pounds of cobalt.

The St. Louis Smelting & Refining Division of National Lead Co. continued to produce an iron concentrate carrying cobalt, nickel, and copper at its property near Fredericktown, Madison County, Mo. The cobalt content of the reject concentrate produced averaged 3.37 percent in 1953. Construction of a 50-ton plant (head feed) to treat the reject concentrate was nearing completion at the year end. The plant will be operated by Cobalt-Nickel Reduction Co., a subsidiary of National Lead Co.

Refinery Production.—Although 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 was 39 percent larger than in 1952, but output of oxide was 23 percent smaller. The metal was produced chiefly from white alloy from the Belgian Congo and concentrates from Idaho and Pennsylvania. The oxide was produced chiefly from white alloy from Belgian Congo, metal from Belgium, concentrates from Pennsylvania and Canada, and scrap. Consumption of cobalt contained in white alloy and concentrates by refiners exceeded that of 1952 by 35 percent. Production of salts and driers was 21 and 18 percent, respectively, more than in 1952. The salts and driers were made chiefly from cobalt fines, metal, hydrate, sulfate, and scrap.

TABLE 2.—Cobalt products produced and shipped in the United States, 1952–53, in pounds

Product	Production		Shipments	
	Gross weight	Cobalt content	Gross weight	Cobalt content
1952				
Metal	2,065,447	2,028,964	1,932,608	1,898,871
Oxide	745,934	539,467	708,674	512,581
Hydrate	244,656	96,326	244,914	98,046
Salts:				
Acetate	109,541	25,612	104,913	24,572
Carbonate	127,844	58,694	111,408	51,103
Sulfate	609,274	128,000	574,038	118,120
Other	197,443	43,917	179,893	39,997
Driers	7,924,714	480,616	7,409,610	449,269
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	255,386	107,444	238,271	99,858
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	250,092	56,553	238,352	53,777
Driers	9,140,138	567,756	8,995,651	554,297

TABLE 3.—Cobalt consumed by refiners or processors in the United States, 1949–53, in pounds of contained cobalt

Cobalt material [1]	1949	1950	1951	1952	1953
Alloy and ore	2,607,281	2,526,755	2,857,328	3,002,087	4,059,287
Metal	518,252	993,864	717,636	643,108	801,192
Hydrate	129,444	80,497	81,710	79,733	74,504
Carbonate	2,664	13,944	6,841	292	108
Other	17,565	48,261	48,549	53,081	117,744

[1] Total consumption is not shown, since the metal, hydrate, and carbonate originated from alloy and ore; combining alloy and ore with these materials would result in duplication.

CONSUMPTION

Consumption of cobalt by industrial consumers reversed a 3-year uptrend in 1953 and was 1 percent less than in 1952, the record year. For the third consecutive year, the largest single use for cobalt was for cobalt–chromium–tungsten–molybdenum alloys, which represented half of the total quantity consumed in 1953 but utilized 17 percent less than in 1952.

As in 1951 and 1952, magnet alloys were the second largest user of cobalt and consumed 22 percent of the total in 1953; moreover, consumption for this purpose was 39 percent greater than in 1952.

TABLE 4.—Cobalt consumed in the United States, 1949–53, by uses, in pounds of contained cobalt

Use	1949	1950	1951	1952	1953
Metallic:					
High-speed steel	283,496	235,227	316,064	223,203	217,652
Other steel	162,638	252,885	79,885	115,761	162,185
Permanent-magnet alloys	1,194,920	2,834,040	2,052,042	1,664,842	2,336,889
Soft-magnetic alloys	42,965	37,552	58,652	18,727	11,559
Cobalt–chromium–tungsten–molybdenum alloys	1,238,083	2,226,199	4,899,591	6,408,537	5,321,689
Alloy hard-facing rods and materials	82,965	260,371	575,268	505,367	591,909
Cemented carbides	118,522	136,935	297,751	610,750	359,125
Other metallic	116,344	208,574	276,222	132,917	233,428
Total metallic	3,239,933	6,191,783	8,555,475	9,680,104	9,234,436
Nonmetallic (exclusive of salts and driers):					
Ground-coat frit	424,051	683,358	448,983	309,167	374,158
Pigments	188,606	262,441	50,073	85,262	102,612
Other nonmetallic	84,336	43,826	60,462	42,960	84,293
Total nonmetallic	696,993	989,625	559,518	437,389	561,063
Salts and driers: Lacquers, varnishes, paints, inks, pigments, enamels, glazes, feed, electroplating, etc. (estimate)	765,000	1,102,000	818,000	701,000	953,000
Grand total	4,701,926	8,283,408	9,932,993	10,818,493	10,748,499

TABLE 5.—Cobalt consumed in the United States, 1949–53, by forms in which used, in pounds of contained cobalt

Form	1949	1950	1951	1952	1953
Metal	3,311,229	6,087,048	7,534,864	8,328,552	7,727,210
Oxide	606,510	964,055	680,452	418,211	524,401
Cobalt-nickel compound	4,315	3,434	1,786		
Ore and alloy		436	3,438	2,736	2,451
Purchased scrap	14,872	126,435	894,453	1,367,994	1,541,437
Salts and driers	765,000	1,102,000	818,000	701,000	953,000
Total	4,701,926	8,283,408	9,932,993	10,818,493	10,748,499

More cobalt was also used in low-cobalt alloy steels, alloy hard-facing rods, ground-coat frit for porcelain enamel, and pigments, but less was used in high-speed steel and cemented carbides. Cobalt salts and driers were utilized at a rate about 36 percent greater than in 1952.

PRICES

The price of cobalt metal rondelles (97–99 percent, in containers of 500 pounds) and metal granules (in containers of 2,152 pounds) was advanced to $2.60 a pound f. o. b. Niagara Falls or New York, N. Y., on November 1, 1953. The former price of $2.40 a pound had been in effect since October 1, 1951. On November 1 the price of ceramic-grade oxide (72½–73½ percent, in 350-pound containers) was increased to $1.96 a pound (gross weight) east of the Mississippi River. The former price of $1.82 a pound had been in effect since November 8, 1951.

FOREIGN TRADE [3]

Imports.—For the fourth successive year, imports of cobalt into the United States increased to establish a new high of 17,237,000 pounds (cobalt content) in 1953 and were 15 percent larger than in

TABLE 6.—Cobalt imported for consumption in the United States, 1944–48 (average) and 1949–53, by classes

[U. S. Department of Commerce]

Year	Alloy [1] (pounds)		Ore		
	Gross weight	Cobalt content	Pounds		Value
			Gross weight	Cobalt content	
1944–48 (average)	5,435,424	2,378,152	[2] 2,144,956	[2] 232,791	[2] $177,703
1949	3,691,051	1,657,788	109,009	11,965	9,344
1950	3,979,088	1,792,348	164,188	18,838	16,003
1951	4,083,541	1,904,429	[3] 537,309	40,303	[3] 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

Year	Metal		Oxide		Salts and other compounds	
	Pounds	Value	Pounds (gross weight)	Value	Pounds (gross weight)	Value
1944–48 (average)	2,851,364	$4,034,469	592,672	$729,748	519	$1,640
1949	5,588,327	9,025,595	360,318	384,879	359	1,167
1950	[4] 6,706,875	[4] 11,210,872	[4] 904,650	[4] 1,009,431	4,649	5,927
1951	[4] 8,119,326	16,302,356	436,517	603,855	3,157	4,048
1952	[4] 12,014,920	[4] 27,291,006	386,935	620,955	12,759	11,328
1953	[4] 14,431,894	[4] 33,203,094	610,054	979,541	273,286	172,986

[1] Reported by importer to Bureau of Mines; not separately classified by U. S. Department of Commerce. Value not available.
[2] Excludes imports of ore from French Morocco in 1944 totaling 185,460 pounds containing 28,413 pounds of cobalt, valued at $22,256; see footnote 2, table 8.
[3] Includes 146 pounds of zaffer, valued at $215.
[4] Adjusted by Bureau of Mines.

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

1952, itself a record year. Belgian Congo continued to be the chief source; in 1953 it supplied 67 percent of the total imports. Belgium supplied 23 percent; however, 86 percent of the metal and oxide was produced from Belgian Congo alloy. The first imports of cobalt were received from Norway, and Germany exported cobalt to this country for the first time since 1939. Noteworthy also was the receipt of 204,120, and 52,800 pounds (gross weight), respectively, of cobalt sulfate and other compounds from United Kingdom and West Germany.

TABLE 7.—Cobalt alloy, ore, metal, and oxide imported for consumption in the United States, 1952–53, by countries, in pounds

[U. S. Department of Commerce]

Country	White alloy (crude) and ore				Metal		Oxide (gross weight)	
	1952		1953					
	Gross weight	Cobalt content	Gross weight	Cobalt content	1952	1953	1952	1953
Belgian Congo	[1] 6,113,102	[1] 2,841,210	[1] 5,249,781	[1] 2,412,804	8,120,195	9,290,972		
Belgium					3,539,210	[2] 3,615,146	385,220	590,800
Canada			445,063	51,323	[2] 354,325	[2] 727,373	100	9,500
France							827	
Germany, West						589,818	500	2,200
Mexico	214,402	17,284					185	1,554
Morocco, French	1,170	100						
Netherlands							100	
Norway						208,450		
Switzerland					1,190			
United Kingdom						135	3	6,000
Total	6,328,674	2,858,594	5,694,844	2,464,127	[2] 12,014,920	[2] 14,431,894	386,935	610,054

[1] Reported by importer to Bureau of Mines.
[2] Adjusted by Bureau of Mines.

Historical table 8 shows imports of cobalt for 1923–53, by classes. Corresponding figures for earlier years are not available.

During the 31 years 1923–53, receipts of metal comprised nearly 59 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, Norway, Sweden, and United Kingdom. Imports of alloy represented the second largest quantity (31 percent); virtually all was from Belgian Congo. About 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 Germany and Canada, and smaller quantities from other countries, principally Australia, Finland, and France. Cobalt ore has been about 2 percent of total imports; Canada has been the largest source, and most of the remainder came from Australia. A substantial quantity of ore was imported from French Morocco in 1943–44; it was exported to Belgium in 1952–53 for refining to metal. As the quantity is included in the imports of metal, the figures for ore have been excluded to avoid duplication. Cobalt sulfate and other compounds have been only 0.2 percent of total imports.

Exports.—Exports of cobalt from the United States are small; 382,630 pounds of metal, alloys, and cobalt-bearing scrap valued at $360,654 was exported in 1953. The bulk of the exports was cobalt-

TABLE 8.—Cobalt imported for consumption in the United States, 1923–53, in pounds

Year	Gross weight					Total	
	Alloy	Ore	Metal	Oxide	Sulfate and other compounds	Gross weight	Cobalt content (estimated)
1923	------------	58,719	225,639	258,574	45,644	588,576	426,000
1924	------------	28,786	118,952	226,703	797	375,238	283,000
1925	------------	34,782	198,669	287,265	13,256	533,972	408,000
1926	------------	154,468	387,076	333,132	37,342	912,018	642,000
1927	------------	60,382	407,198	369,747	55,127	892,454	680,000
1928	------------	107,[illegible]98	535,817	364,154	68,281	1,075,750	819,000
1929	------------	434,443	806,640	475,928	64,782	1,781,793	1,212,000
1930	------------	199,642	460,251	425,881	55,303	1,141,077	794,000
1931	------------	83,895	164,967	321,891	46,317	617,070	410,000
1932	------------	27,193	123,112	225,896	92,098	468,299	303,000
1933	------------	556,119	281,713	568,057	99,231	1,505,120	769,000
1934	439,476	748,513	506,119	328,730	43,787	2,066,625	1,000,000
1935	378,848	419,110	563,866	557,083	80,554	1,999,461	1,167,000
1936	------------	1,039,760	883,377	813,642	46,658	2,783,437	1,580,000
1937	------------	587,499	1,073,129	842,847	56,585	2,560,060	1,734,000
1938	------------	449,984	938,476	373,215	41,867	1,803,542	1,249,000
1939	------------	611,083	2,130,296	680,644	76,664	3,498,687	2,665,000
1940	7,843,828	2,653,891	130,321	756,759	11,468	11,396,267	4,200,000
1941 [1]	9,970,589	2,443,725	554,030	38,002	4,980	[1] 13,011,326	[1] 4,328,000
1942	10,313,867	834,797	148,304	------------	200	11,297,168	4,280,000
1943	10,110,879	[2] 1,682,886	266,670	58,928	56	[2] 12,119,419	[2] 4,528,000
1944	8,500,516	[2] 288,069	73,088	225,609	115	[2] 9,087,397	[2] 3,769,000
1945	8,397,145	859,940	946,475	120,672	224	10,324,456	4,615,000
1946	1,648,595	657,787	1,935,582	1,074,630	350	5,316,944	3,451,000
1947	3,751,452	751,438	6,035,153	752,150	530	11,290,723	8,206,000
1948	4,879,413	8,167,545	5,266,521	790,300	1,374	19,105,153	8,821,000
1949	3,691,051	109,009	5,588,327	360,318	359	9,749,064	7,458,000
1950	3,979,088	164,188	6,706,875	904,650	4,649	11,759,450	9,095,000
1951	4,083,541	[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	12,759	18,743,288	15,031,000
1953	5,249,781	445,063	14,431,894	610,054	273,286	21,010,078	17,237,000

[1] In addition to classes shown, 4,796,000 pounds of Burmese speiss containing 335,721 pounds of cobalt was imported.
[2] Excludes imports of ore from French Morocco totaling 8,873,156 pounds containing 1,098,228 pounds of cobalt in 1943 and 185,460 pounds containing 28,413 pounds of cobalt in 1944. This ore was exported to Belgium for refining in 1952 and 1953. The metal produced from the ore is included in the import figures for 1952 and 1953.
[3] Includes 146 pounds of zaffer

bearing scrap. Some oxide, salts, and driers are also exported, but the figures are not separately recorded by the United States Department of Commerce.

Tariff.—Since June 7, 1951, the duty on cobalt oxide has been 5 cents a pound, sulfate 2½ cents a pound, and linoleate 5 cents a pound. The duty on salts and compounds continued at 30 percent ad valorem. Cobalt metal and ore enter the United States duty-free.

TECHNOLOGY

Methods developed by the Bureau of Mines Mississippi Valley Experiment Station (Rolla, Mo.) for recovering cobalt and nickel from pyrite and copper concentrates from the National Lead Co. mill at Fredericktown, Mo., and from smelter matte produced by the St. Joseph Lead Co. at Herculaneum, Mo., have been described.[4] The investigations on recovery of cobalt and nickel from the complex sulfide concentrates were continued. The concentrates were chlorinated at low temperatures, ferric chloride converted to ferric oxide,

[4] Kenworthy, H., and Kershner, K. K., Metallurgical Investigations of Southeastern Missouri Cobalt-Nickel Resources: Bureau of Mines Rept. of Investigations 4999, 1953, 37 pp.

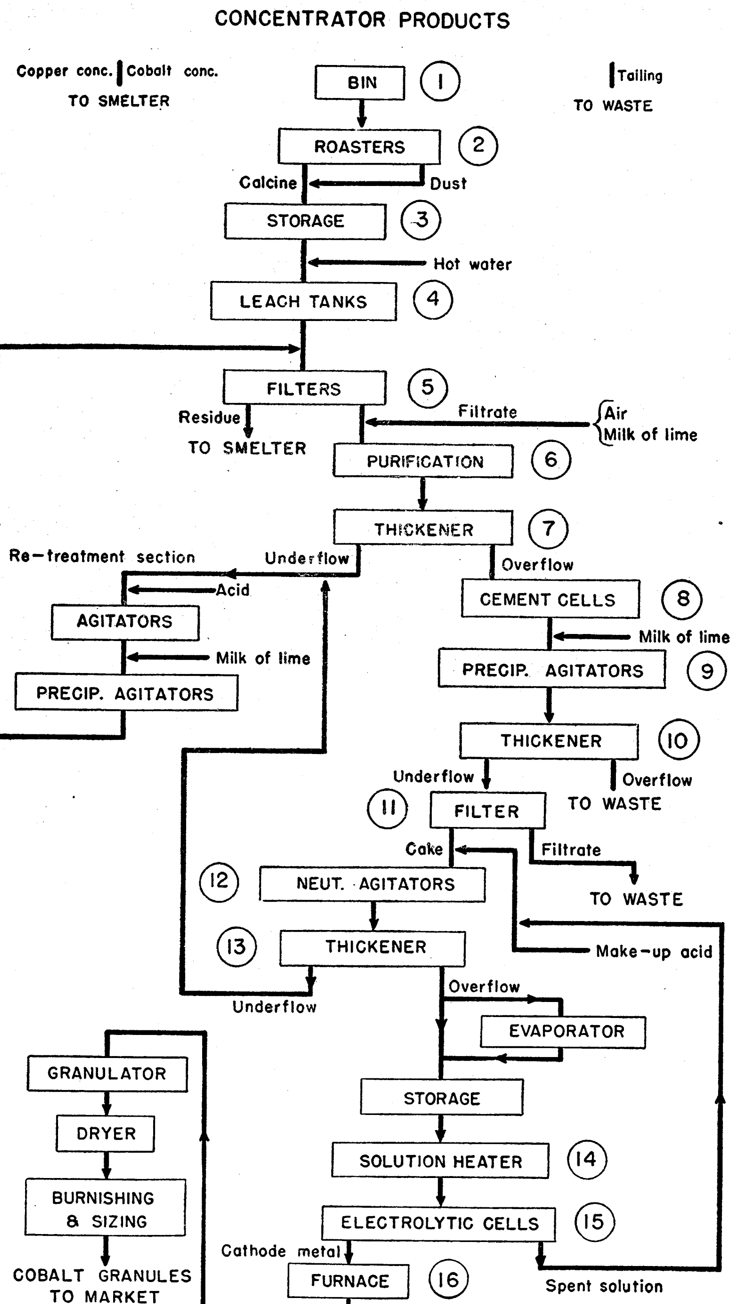

FIGURE 1.—Electrolytic cobalt production by Rhokana Corp., Nkana, Northern Rhodesia.

LEGEND

1. Cobalt concentrate assays about 3.5 percent cobalt, 25 percent copper, and 17 percent iron.
2. Stage sulphatizing roast in six 8-hearth Nichols furnaces, down-draft.
3. Electrostatic precipitator for dust recovery.
4. Continuous leaching with hot water.
5. Two-stage filtration on stainless steel Eimco filters. Cake carries over 20 percent copper.
6. Agitators for purifying solutions by aeration with milk of lime.
7. Thickener, 40-ft.
8. Cascades of cementation cells, final traces copper removed by passing over cobalt granules.
9. Cobalt completely precipitated as hydroxide by agitation with milk of lime.
10. Thickener, 40-ft.
11. Eimco filters.
12. Mechanically-agitated tanks, careful pH control.
13. Thickener, 50-ft.
14. Stainless steel heat exchangers, temperature to 60° C.
15. Two units, each 32 cells, 12 mild steel cathodes, 13 antimonial lead anodes.
16. Lectromelt furnace, 3-ton.

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and metal chlorides leached from the residue. Cobalt, nickel, and copper were fractionally precipitated from the leach liquor, and the separated cobalt was purified and electrolytes prepared for deposition of high-purity metal.

A comprehensive report on appraisal of research and development of permanent magnets, prepared by a panel of the Minerals and Metals Advisory Board, was made available.[5]

The refining process of Rhokana Corp., Nkana, Northern Rhodesia, has been described.[6] A flowsheet illustrating the process is shown in Figure 1.

Concerning the cobalt refinery of Calera Mining Co. at Garfield, Utah, Howe Sound Co. reports as follows:[7]

> During the year progress was made in solving the difficulties which had made a continuous operation impossible. These difficulties were largely due to the failure of parts and equipment to withstand the corrosive and abrasive conditions to which they were subject. Although the operation was intermittent the production of some metal was possible and during the year a total of 591,500 pounds of cobalt was recovered. Of this amount, approximately 500,000 pounds had been shipped, or was ready to ship, under Government contracts, and has fully met all Government specifications. It is to be expected that with the installation of additional equipment by Chemico, production will be materially accelerated.

Patents were issued for the separation of nickel from cobalt-containing solutions;[8] copper, cobalt, and ammonium sulfate recovery from mineral leach liquors;[9] and process for recovering nickel and/or cobalt ammonium sulfate from solutions containing nickel and/or cobalt values.[10]

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[5] National Research Council, An Appraisal of Research and Development of Permanent Magnet Materials: National Academy of Sciences, Report MMAB-34-M, Washington, D. C., June 15, 1953, 211 pp. Available from Library of Congress, Publication Board Project, Washington 25, D. C., microfilm $7.75, photostat $27.50 (PB 109913).

[6] Talbot, H. L., and Chapman, F. H., How Northern Rhodesia Meets Rising Base-Metal Demands: Eng. and Min. Jour., vol. 154, No. 8, August 1953, pp. 83-85.

[7] Howe Sound Co., Annual Report, 1953, p. 6.

[8] De Merre, Marcel (assigned to Société Générale Métallurgique de Hoboken), Separation of Nickel from Cobalt Containing Solutions: U. S. Patent 2,624,702, Jan. 6, 1953.

[9] McCauley, P. J. (assigned to Chemical Construction Corp.), Copper, Cobalt, and Ammonium Sulfate Recovery from Mineral Leach Liquors: U. S. Patent 2,647,819, Aug. 4, 1953.

[10] Forward, F. A. (assigned to Sherritt Gordon Mines, Ltd.), Process for Recovering Nickel and/or Cobalt Ammonium Sulfate from Solutions Containing Nickel and/or Cobalt Values: U. S. Patent 2,647,820, Aug. 4, 1953.

In an attempt to meet a growing need for a collected account of some of the more important recent developments in the analysis of cobalt, a series of articles was made available.[11] Qualitative, gravimetric, volumetric, colorimetric, and miscellaneous methods are discussed.

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 Northern Rhodesia, 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 in recent years. Some cobalt production is derived from pyrites residues, but a complete record of such output is lacking.

TABLE 9.—World mine production of cobalt, by countries,[1] 1944–48 (average) and 1949–53, in metric tons of contained cobalt

[Compiled by Berenice B. Mitchell]

Country [1]	1944–48 (average)	1949	1950	1951	1952	1953
Australia (recoverable cobalt)	9	9	10	8	11	11
Belgian Congo (recoverable cobalt)	2,963	4,403	5,148	5,715	6,831	8,278
Canada [2]	212	281	265	432	[3] 645	796
Chile	1					
Finland (recoverable cobalt)	[4] 95	([5])	([5])	([5])	([5])	([5])
Italy (content of ore)	3	([6])			([6])	([6])
Japan (content of concentrates)	8					
Mexico (content of ore)				[7] 2	[7] 8	
Morocco, French (content of concentrates)	192	209	420	680	1,000	600
Northern Rhodesia [8] (content of white alloy, cathode metal, and ferrocobalt)	638	402	670	678	585	677
Sweden	2					
United States (shipments) (content of concentrates)	327	306	299	343	379	805
Total (estimate) [1]	4,700	5,900	7,200	8,300	10,000	12,000

[1] In addition to Finland's output, the world total also includes an estimate of cobalt recovered from iron pyrites produced in other European countries.
[2] Figures comprise Canadian ore processed in Canada and exported (irrespective of year when mined) plus the cobalt content of concentrates made at Port Colborne from nickel-copper ore; however, figures exclude the cobalt recovered at Clydach, Wales, and Kristiansand, Norway, from Canadian nickel-copper ores, for which estimate by author of chapter has been included in world total.
[3] Revised figure.
[4] Partly estimated.
[5] Data not available. Estimate by author of chapter included in total.
[6] Less than 0.5 ton.
[7] Imports into United States.
[8] Year ended June 30 of year stated.

Belgian Congo.—The world's premier source of cobalt continues to be Belgian Congo, where the Union Minière du Haut-Katanga is the sole producer. For 7 consecutive years output has established new records; in 1953 it was 8,278 metric tons, a 21-percent gain over 1952. Union Minière completed enlargement of its cobalt refinery at Jadotville; annual capacity is now 4,400 tons.

[11] Chemical Age (London), The Analysis of Cobalt: Vol. 69, No. 1774, July 11, 1953, pp. 77–80; No. 1775, July 18, 1953, pp. 125–128; No. 1787, Oct. 10, 1953, pp. 751–752, 758; No. 1789, Oct. 24, 1953, pp. 869–871; No. 1790, Oct. 31, 1953, pp. 909–912; No. 1791, Nov. 7, 1953, pp. 971–972.

The mines, concentrators, and smelter of Union Minière in Belgian Congo have been briefly described.[12]

Canada.—In Canada cobalt is found associated chiefly with the silver ore in the Cobalt area of northern Ontario; with the nickel-copper ores of the Sudbury district, Ontario, and Lynn Lake area, Manitoba; and with pitchblende in Northwest Territory. Production in northern Ontario was begun in 1904 and commercial recovery of cobalt from the nickel-copper ores of the Sudbury district in 1947. Recovery of cobalt from the nickel-copper ores of the Lynn Lake area was scheduled for 1954.

According to the Dominion Bureau of Statistics, production of cobalt (content) was 1,754,300 pounds in 1953 compared with 1,421,900 pounds (revised figure) in 1952. These figures, however, do not include the cobalt recovered by Mond Nickel Co. at its Clydach (Wales) nickel refinery from the nickel-copper ores of the Sudbury district or by Falconbridge Nickel Mines, Ltd., at its Kristiansand (Norway) refinery from nickel-copper matte produced from Sudbury ores.

The International Nickel Co. of Canada, Ltd., continued to produce cobalt concentrate at its Port Colborne refinery. The cobalt is contained in the Sudbury nickel-copper ores. According to the company, its deliveries of cobalt salts and oxides were the largest in its history.

Falconbridge Nickel Mines, Ltd., continued to recover cobalt from its nickel-copper ores of the Sudbury district.

The refinery of Sherritt Gordon Mines, Ltd., at Fort Saskatchewan, Alberta, was scheduled for completion about April 1954.

Cobalt Chemicals, Ltd., completed its smelter at Cobalt, Ontario, for producing cobalt metal. It will treat locally mined arsenical ores.

The Deloro Smelting & Refining Co., Ltd., completed its expansion and modernization program. The capacity of its refinery was increased 50 percent. The company, which operates no mines, treats ores from northern Ontario, Northwest Territory, and French Morocco. The ore from French Morocco is refined for the account of the United States Government.

The Eldorado Mining & Refining (1944), Ltd., continued to produce cobalt-nickel speiss at its Port Hope refinery from pitchblende mined at Port Radium, Northwest Territories. The speiss averages about 14 percent cobalt.

Chile.—Cia. Minera Merceditas reported that high-grade cobalt had been found in its El Colcan copper mine not far from Santiago, and at the end of 1952 a group was attempting to develop a cobalt deposit near La Serena.[13]

Cuba.—The Nicaro Nickel Co., a subsidiary of Freeport Sulphur Co., has developed 40 million tons of ore averaging 1.35 percent nickel and 0.14 percent cobalt in the Moa Bay district, Oriente. The company proposed to treat the ore with a sulfuric acid leaching process and to recover nickel and cobalt metal from the acid leaching solutions. Upon completion of a pilot-plant program, facilities will be constructed in Cuba and the United States to produce about 30 million pounds of nickel and 3 million pounds of cobalt metal annually.

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[12] Mining World, From Africa Comes Cobalt: Vol. 15, No. 12, November 1953, pp. 48–52.
[13] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 3, September 1953, p. 13.

Finland.—The cupriferous pyrite of the Outokumpu mine in eastern Finland contains 0.1 to 0.2 percent cobalt, 4 to 4.45 percent copper, 27 percent iron, 1 percent zinc, and 26 percent sulfur.[14] The sulfur contained in the pyrite concentrate produced is extracted by roasting in Finland. After the roasting process the remaining pyrite sinter, which contains 0.4 to 0.5 percent cobalt, is shipped to Duisburg, Germany, for recovery of the cobalt, iron, zinc, and copper. Shipments of pyrite sinter to West Germany were 124,179 metric tons, containing about 0.5 percent cobalt, in 1953.

French Morocco.—Production of cobalt concentrate in French Morocco was 6,019 metric tons containing 600 tons of cobalt in 1953 compared with 9,136 tons containing 1,000 tons of cobalt in 1952. La Société Minière de Bou-Azzer et du Graara, Casablanca, is the sole producer. The cobalt concentrate contains 10 to 12 percent cobalt. During 1953 a substantial quantity of French Morocco concentrate was refined to metal by Deloro Smelting & Refining Co. at Deloro, Ontario, Canada, and Société Générale Métallurgique de Hoboken at Oolen, Belgium, for the United States Government. Most of the concentrates, however, are exported to France.

Germany, West.—Production of cobalt, chiefly metal, in West Germany was about 581 metric tons in 1953 compared with 454 tons in 1952 and 445 tons in 1951. The refinery of Duisburger Kupferhütte at Duisburg recovers cobalt from pyrite sinter obtained from Finland, Cyprus, Spain, Norway, and Sweden. The refinery of Gebrüder Borchers at Goslar recovers cobalt chiefly from scrap.

Northern Rhodesia.—Output of cobalt in 1953 by Rhokana Corp., the sole producer in Northern Rhodesia, was 16 percent more than in 1952. In the year ended June 30, 1953, production comprised 1,259 short tons of alloy containing 472 tons of cobalt, 259 tons of cathode metal, and 20 tons of ferrocobalt alloy containing 15 tons of cobalt. Thus, total production of cobalt in various forms was 746 tons compared with 645 tons (all alloy) in 1952. Production of alloy from smelter converter slag continued but was curtailed by a power shortage and the necessity for suspending alloy operations whenever cobalt metal refining was in progress.

The grade of ore treated was 0.150 percent cobalt in 1953 compared with 0.156 percent in 1952. Concentrates produced contained 1.51 percent in 1953 compared with 1.59 percent in 1952.

The company achieved continuous operation at its electrolytic cobalt plant beginning February 1953. Production of metal during the 5 months ended June 30 was 186 short tons compared with 73 tons during the preceding 7 months, when plant operations were frequently interrupted by mechanical troubles. An increase in future production was contemplated from modifications in progress and from further experience of steady operation. However, before full production can be attained, it will be necessary to have additional roasters, which had been ordered. Construction of a plant to produce cobalt carbonate was virtually completed.

Chibuluma Mines, Ltd., which is reported to have proved ore reserves of 7,300,000 tons averaging 5.23 percent copper and 0.25 percent cobalt, plans to begin production of cobalt at an annual rate of 500,000 pounds late in 1955.

[14] Young, R. S., Cobalt: Reinhold Publishing Corp., New York, 1948, p. 19.

Norway.—The electrolytic cobalt unit of Falconbridge Nickel Mines, Ltd., at Kristiansand, which began production in July 1952, operated smoothly in 1953 and near the year end was producing cobalt at a rate of about 400,000 pounds annually. The cobalt is recovered from the matte produced at Falconbridge, Ontario, from nickel-copper ores.

Uganda.—The Kilembe mine, in western Uganda, was expected to be brought into full operation by 1956; anticipated annual production is 18,000,000 pounds of copper and 900,000 pounds of cobalt.[15]

[15] American Metal Market, vol. 60, No. 222, Nov. 18, 1953. p. 4.

Columbium and Tantalum

By Robert F. Griffith[1]

COLUMBITE-TANTALITE imports, increased domestic mine shipments of these minerals, and large imports of columbium-tantalum bearing tin-smelter slags resulted in the largest United States supply of columbium-tantalum metal in history in 1953. Columbium (niobium) has been considered vital to the jet-engine program and because of uncertain supply is vigorously sought for the National Stockpile through the medium of incentive bonus prices. Total consumption in 1953, however, was far less than supply, and primary processors were active in reestablishing commercial markets. On November 1, Order M–80, which regulated the distribution and use of columbium-tantalum-bearing steels, was revoked by the Business and Defense Services Administration.

Columbium alloys are unsurpassed for certain high-temperature applications. Requirements commensurate with accelerated military demands, however, may exceed available supply, and specifications have been designed away from columbium in favor of more plentiful materials. Furthermore, over 99 percent of the United States supply of columbium and tantalum is imported. Thus, increased use of columbium in high-temperature alloys may depend on development of larger, assured columbium supplies.

The situation with tantalum is somewhat different. Tantalum metal is in demand for use in capacitors, electronics, and chemical equipment but is produced economically only from comparatively high-grade tantalite ores. Large quantities of tantalum in columbite concentrates and in tin-smelter slags report in the form of ferrotantalum-columbium alloys, because these alloys are smelted directly from the ore without producing the pure metals. For example, the total new United States supply of tantalum metal in all forms in 1953 was about 1½ million pounds, while the available tantalum metal contained in tantalite concentrates was less than ¼ million pounds. Thus, development of extractive metallurgical processes to treat low-grade ores successfully would greatly increase the available supply of tantalum metal.

The principal source of columbium and tantalum is stream placer deposits, where the mineral columbite-tantalite is recovered in conjunction with tin (cassiterite). Recently, pyrochlore-type mineral deposits have been investigated as a source of columbium and tantalum. Large lode deposits containing pyrochlore (a complex oxide of Cb, Ta, Ca, rare earths, and possibly uranium and thorium) have been reported in Canada, Norway, Northern Rhodesia, Nigeria, and elsewhere. Difficult metallurgical problems of concentration and extraction are usually involved. In Norway, however, a process was developed for treating ore containing a pyrochlore-type mineral

[1] Commodity-industry analyst.

(koppite), and initial shipments, containing 50 percent columbium-tantalum pentoxides, were made in 1953. The pyrochlore deposits may solve the problem of sharply increasing the supplies of columbium and tantalum.

On October 9 the Government's columbium-tantalum purchase program for domestic ores was extended to December 31, 1958. The program as it applies to ores of foreign origin terminates December 31, 1956; provision is made, however, that the program for both foreign and domestic ores may terminate when the Government has purchased 15 million pounds of contained combined pentoxides (Cb_2O_5 plus Ta_2O_5).

TABLE 1.—Columbium-tantalum concentrates shipped from mines in the United States, 1944–48 (average) and 1949–53 [1]

Year	Pounds	Value
1944–48 (average)	4,879	$11,300
1949	1,020	1,785
1950	1,000	2,150
1951	925	1,528
1952	5,385	16,723
1953 [2]	14,867	29,779

[1] Includes columbite, tantalite, and microlite.
[2] Containing 3,264 pounds of columbium and 2,906 pounds of tantalum.

DOMESTIC PRODUCTION

Mine Production.—Domestic mine shipments of columbium-tantalum concentrates in 1953 were the third largest in history. Domestic production, however, still furnished less than 0.2 percent of the total United States supply. Nearly 6,000 pounds of concentrates was purchased by Government depots at Custer, S. Dak., and Franklin, N. H., from producers in the following States: Colorado, South Dakota, New Hampshire, Idaho, Connecticut, and Maine. In addition to Government-depot purchases, columbite recovered as a byproduct of spodumene mining by the Foote Mineral Co., Kings Mountain, N. C., was purchased by a Government agent; and Kennametal, Inc., Latrobe, Pa., received shipments from the Petaca district, N. Mex. South Dakota, with total shipments of 4,431 pounds, was the State with the largest production. Under the Government's domestic purchase program small lots of concentrates are assumed to contain 50 percent combined pentoxides and are accepted by visual inspection. Total United States mine shipments of 14,867 pounds were estimated to contain 3,264 pounds of columbium and 2,906 pounds of tantalum, assuming that Government depot purchases contained 25 percent each of Cb_2O_5 and Ta_2O_5.

Exploitation by dredging columbium-bearing placer deposits in Valley County, Idaho, was delayed pending market negotiations with Government agencies. The Bureau of Mines continued to investigate the recovery of columbium from the titanium-mineral deposits in the Magnet Cove area and from Arkansas bauxite deposits. The annual plant feed of the bauxite-processing industry in Arkansas, at full-capacity operation, would contain an estimated 3.6 million pounds of columbium, but the columbium occurs in ilmenite and is now discarded in waste products—black sands and brown muds. A report describing the results of extractive metallurgical studies conducted by the Bureau of Mines in 1953 was prepared and has since been issued.[2]

Refinery Production.—Producers of primary columbium-tantalum materials in the United States from the consumption of ore and concentrates are: 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., manufacturer of columbium-tantalum-bearing carbides, including "Kentanium," used in high-temperature applications. These companies supply primary columbium-tantalum materials to processors and fabricators of end-use products; production capacities are larger than current requirements.

CONSUMPTION AND USES

Relaxation of end-use controls was responsible for a slight increase in the domestic consumption of columbium-tantalum ores and concentrates in 1953. In terms of contained metal, consumption in 1953 was estimated at 300 short tons of columbium and 150 short tons of tantalum. The largest tonnage use was in the form of ferrocolumbium and ferrotantalum-columbium in the manufacture of stainless, high-temperature steels, where columbium and tantalum act as stabilizers of carbon, inhibit intergranular corrosion, and increase stability and high-temperature strength. Use of columbium in high-temperature alloys for the jet-engine program has decreased considerably since the peak year 1951, because it was determined that even the most favorable supply situation could not furnish enough columbium to meet military requirements. Consequently, an all-out effort was made to design away from columbium in favor of more plentiful materials. Conservation measures were taken by including, in military contracts with manufacturers of jet engines, specified contents of columbium, nickel, tungsten, cobalt, and chrome, in varying proportions, to conserve the metal in shortest supply. Titanium-stabilized 18–8 type stainless steel (18 percent chromium, 8 percent nickel), American Iron and Steel Institute (AISI) type 321, is a satisfactory substitute for the columbium-stabilized AISI type, 347 in many applications. The latter type, however, is preferred because oxidation of titanium during the steelmaking process tends to increase the scrap rate or rejectable material. Titanium metal is not used as a substitute for 18–8 steels. Columbium equal to 10 times the carbon content is deemed necessary to prevent the precipitation of corrosive chromium carbide at grain boundaries in 18–8 steels at elevated temperatures. The development of a low-carbon steel (0.03 percent maximum carbon), AISI type 304L, has conserved columbium. Columbium undoubtedly has an important place in the future of high-temperature alloys in order to use the available metals to the best advantage and will be required in quantities commensurate with its availability.

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

Columbium and tantalum are used as hardening additions in the nonferrous, high-temperature, cobalt-base, nickel-base, and chromium-base alloys.[3] Other uses of columbium include application in nitrided alloy steels, electrodes for welding stainless steels, grid and plate material in high-duty vacuum tubes, low-voltage rectifiers, and permanent-magnet alloys and as the carbide in cutting tools and special high-temperature cemented carbide alloys. Compared with the stainless steel and nonferrous alloys, these latter uses are small. The estimated distribution of columbium in 1953 was as follows, by use: Ferrocolumbium and ferrotantalum-columbium in steel, 73 percent; specialized nonferrous alloys, 18 percent; cemented carbides, 4 percent; welding rods, columbium metal, and miscellaneous, 5 percent.

The uses of tantalum are applicable to many of those listed for columbium. Tantalum, however, is in demand primarily in the form of ductile metal. In many respects tantalum's chemical properties are similar to those of glass. It is inert in the presence of most acids but reacts with hydrofluoric acid and strong alkali solutions. Unlike glass in many physical properties tantalum is malleable and ductile, has a thermal conductivity 40 times that of glass and 3 times that of steel, and resists thermal shock.[4] Tantalum is available in sheet, foil, rod, wire, and tubing. The metal has tensile properties comparable to cold-rolled steel and is available in thin-gage strip down to 0.0005 inch thick.[5] Tantalum is used as a construction material in the chemical industry (largely in heat exchangers), in electronic tubes and electrolytic capacitors, and in surgical and dental supplies. A tiny tantalum capacitor, 5/16 inch in length and 1/8 inch in diameter, designed for low-voltage, direct-current applications has been developed.[6] This small capacitor reportedly will allow further size reductions in miniature-size assemblies using transitors and will aid in developing commercial applications for miniature electronic products. The melting point of tantalum carbide is among the highest of the metallic compounds. Kentanium, a titanium-columbium-tantalum carbide with nickel, was tested for high-temperature (1,800°–1,900° F.) gas-turbine applications. It has been estimated that if the present 1,500° F. operating temperature of jet engines could be raised to 2,200° F., the power output could be doubled or trebled.[7] The estimated distribution of tantalum in 1953 was as follows, by use: As ferrotantalum-columbium in steel, 46 percent; chemical equipment, 18 percent; electronic uses, 17 percent (electronic tubes, 10 percent; electrolytic capacitors, 7 percent) as tantalum carbide, 9 percent; specialized nonferrous alloys, 9 percent; and for surgical, dental, and other purposes, 1 percent.

STOCKS

Columbite and tantalite were included in the list of strategic and critical materials purchased for the National Stockpile. Quantitative data on stockpile goals or on industry and Government stocks of contained columbium-tantalum at the end of 1953 were not available

[3] Nisbet, J. D., and Hibbard, W. R. Jr., A Rationalization of Measured High-Temperature Properties of Fe-Cr-Co-Ni Alloys: Jour. Metals, vol. 5, No. 9, September 1953, pp. 1149–1164.
[4] Materials and Methods, vol. 39, No. 1, January 1954, pp. 94–95.
[5] Light Metal Age, vol. 11, No. 10, October 1953, pp. 29.
[6] American Metal Market, vol. 60, No. 179, Sept. 15, 1953, pp. 1, 3.
[7] E&MJ Metal and Mineral Markets, vol. 24, No. 52, Dec. 24, 1953, p. 7.

for publication. Separate and apart from the stockpile program a Government purchase program for 15 million pounds of combined columbium-tantalum pentoxide is authorized. At the year end, 3,485,507 pounds of combined pentoxide had been acquired under this program from domestic and foreign sources.[8]

PRICES

Columbium-tantalum ores or concentrates of domestic origin are purchased in small lots (less than 2,000 pounds) at Government depots in Custer, S. Dak., Franklin, N. H., and Spruce Pine, N. C., at $1.70 per pound of concentrate. Lots offered to the Government are delivered by the seller, f. o. b. depot, and are accepted on a basis of visual inspection and an assumed 50 percent combined pentoxide content in any ratio, provided, however, that in case of rejection the seller may request an analysis at his expense. No quantitative goal was established under this program, which will be in effect through December 31, 1958. Lots of over 2,000 pounds, foreign or domestic origin, are purchased under the Government incentive bonus program as follows: For columbium ores and concentrates containing not less than 35 percent combined Cb_2O_5 and Ta_2O_5 and having a Cb_2O_5–Ta_2O_5 ratio of not less than 1 to 1, c. i. f. Atlantic ports or f. o. b. depot of purchasing agent, $1.40 per pound of combined contained pentoxides, plus $0.02 per pound for each additional percent above 35 percent, plus a 100-percent incentive bonus to the producer, which in 1953 was absorbed by the Government. Impurities not to exceed the following maximum limits: TiO_2, 8 percent; SnO_2, 8 percent; FeO, 25 percent; MnO, 13 percent. Where the seller is not the actual producer, he receives only the base purchase price; and the bonus is paid to the producer. The above schedule, including bonus, is equivalent to the following prices per pound of ore: 35 percent, $0.98; 50 percent, $1.70; and 65 percent, $2.60. Special provisions were made for high-grade tantalum ores; however, the price on the bases of combined pentoxides was comparable to the above schedule. The program will terminate December 31, 1956, or may be terminated when the Government has purchased 15 million pounds of contained combined pentoxides (Cb_2O_5 plus Ta_2O_5). Purchase agents for the Government are: Emergency Procurement Service of the General Services Administration, Washington 25, D. C.; Fansteel Metallurgical Corp., North Chicago, Ill.; Wah Chang Corp., New York, N. Y.; and Kennametal, Inc., Latrobe, Pa.

Ferrocolumbium, 50–55 percent Cb, was quoted in E&MJ Metal and Mineral Markets at $4.90 per pound of contained columbium January–November and $6.40 December 3, 1953. Ferrotantalum-columbium (approximately 40 percent Cb, 20 percent Ta, and Cb plus Ta 60 percent minimum) was quoted January–November $3.75 per pound of contained Cb plus Ta and $4.75 December 3, 1953. Columbium metal was quoted in American Metal Market as follows: Columbium powder, $75 per pound; sheet, $250 per kilogram; and rod, $280 per kilogram. Because of the small demand for these products prices were largely nominal. Tantalum metal was quoted per kilogram as follows: Powder, $73.85; sheet, $93; and rod, $137.

[8] E&MJ Metal and Mineral Markets, vol. 25, No. 6, Feb. 11, 1954, p. 6.

A leading producer offered tantalum compounds at the following prices, subject to a 10-percent discount in quantity: Tantalum carbide (TaC), \$69.40 per kilogram; tantalum oxide (Ta_2O_5), \$43.75 per kilogram; and potassium tantalum fluoride (K_2TaF_7), \$19.80 per kilogram.

In addition to the principal consumers and Government purchasing agents, other buyers of columbium-tantalum ores and concentrates include:

Colorado

Arvada: Beryl Ores Co.

Michigan

Detroit: Frankel Co., Inc.

New York

New York:
- Ayrton Metal Co.
- Alfred D. Brown Associates, Inc.
- Derby & Co., Inc.
- Mercantile Metal & Ore Corp.
- Metal Traders, Inc.
- Miles Metal Corp.
- Phillip Bros., Inc.
- J. A. Samuel & Co., Inc.
- David Taylor Co.
- Transatlantic Metal & Ore Corp.

Pennsylvania

Philadelphia: Foote Mineral Co.

Virginia

Richmond: Hyman Viener & Sons.

FOREIGN TRADE [9]

Columbite-tantalite imports in 1953 were the largest on record, slightly exceeding the previous peak years, 1944–45, and more than doubling the quantity imported in 1952. Nigeria continued to be the principal source of columbite, supplying 75 percent, followed by Belgian Congo, 14 percent. Shipments of columbium concentrates were received from Norway as a result of the successful treatment of koppite ores from the Sove field. Columbite imports contained an average of 53 percent Cb_2O_5 and 15 percent Ta_2O_5. Belgian Congo supplied 67 percent of the tantalite imports, followed by Portugal, 21 percent. Tantalite imports contained an average of 40 percent Ta_2O_5 and 30 percent Cb_2O_5. (See table 4 for analyses of columbite-tantalite concentrates by countries.) The metallic content (Cb plus Ta) of tin-smelter slags imported in 1953 was comparable to the metallic content of columbite-tantalite concentrates. These slags, containing 6.3 to 38.9 percent combined pentoxides, were imported from Belgian Congo, British Malaya, Canada, Portugal, and United Kingdom by less than 3 firms, and quantitative data are not available for publication. United States imports of columbite and tantalite concentrates were 86.8 percent, of reported world production; United Kingdom and Belgium are believed to be the other principal recipients. No imports of columbium-tantalum in other forms were reported.

[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 2.—Columbite imported for consumption in the United States, 1944–48 (average) and 1949–53, by countries, in pounds

[U. S. Department of Commerce]

Country	1944–48 (average)	1949	1950	1951	1952	1953
Australia						25, 119
Belgian Congo	23, 584	198, 585	400, 868	177, 273	354, 732	580, 232
Belgium-Luxembourg [1]	5, 425					
Bolivia	[2] 1, 574				14, 678	10, 375
Brazil	2, 928	8, 568	10, 981	6, 377	5, 017	41, 005
British Guiana					800	2, 324
India	294					
Japan [1]			31, 835			
Korea, Republic of						2, 000
Malaya					20, 264	101, 967
Mozambique	4, 409	1, 200		17, 082	21, 205	57, 894
Nigeria	2, 986, 443	1, 349, 126	1, 280, 930	1, 336, 041	1, 450, 787	3, 167, 344
Norway						26, 233
Portugal			2, 103			68, 121
Southern Rhodesia						20, 460
Spain						4, 410
Sweden						30, 847
Uganda [3]	11, 397				4, 622	19, 891
Union of South Africa	364				6, 030	34, 472
United Kingdom [1]	240					
Total: Pounds	3, 036, 658	1, 557, 479	1, 726, 717	1, 536, 773	1, 878, 135	4, 192, 694
Value	$953, 710	$561, 945	$752, 926	$1, 362, 393	$2, 368, 769	$6, 905, 497

[1] Presumably country of transshipment rather than original source.
[2] Classified by U. S. Department of Commerce as from Chile; some is believed to be the country of transshipment only.
[3] Classified by U. S. Department of Commerce as British East Africa.

TABLE 3.—Tantalite imported for consumption in the United States, 1944–48 (average) and 1949–53, by countries, in pounds

[U. S. Department of Commerce]

Country	1944–48 (average)	1949	1950	1951	1952	1953
Anglo-Egyptian Sudan	20					
Argentina	1, 861					
Australia	8, 082			1, 467	1, 590	20, 541
Belgian Congo	297, 372	38, 086	211, 433	210, 402	236, 701	507, 282
Belgium-Luxembourg [1]	640		85, 683	20, 876		
Brazil	137, 519	63, 478	13, 378		49, 813	39, 532
Canada	140					
French Guiana						10, 987
India	488					
Japan [1]			10, 691			
Malaya					2, 087	3, 639
Mozambique	950					
Netherlands [1]		29, 500				
Nigeria	14, 417	4, 480	7, 543	5, 700	2, 273	
Portugal					35, 428	154, 323
Southern Rhodesia	9, 320				233	8, 163
Spain					741	
Sweden						4, 242
Uganda [2]	3, 725					2, 050
Union of South Africa	909	1, 120				2, 036
Total: Pounds	475, 443	136, 664	328, 728	238, 445	328, 866	752, 795
Value	$384, 949	$237, 292	$244, 205	$190, 383	$398, 849	$1, 208, 134

[1] Presumably country of transshipment rather than original source.
[2] Classified by U. S. Department of Commerce as British East Africa.

TABLE 4.—Grade of columbite and tantalite concentrates imported for consumption in the United States, 1953,[1] by countries

Country	Gross weight	Columbite [2]				Value
		Cb_2O_5 [3]		Ta_2O_5 [3]		
		Percent	Pounds	Percent	Pounds	
Australia	25,119	44.3	11,121	22.0	5,532	$51,870
Belgian Congo	580,232	38.8	224,886	30.8	178,459	846,489
Bolivia	10,375	51.4	5,329	19.7	2,039	14,734
Brazil	41,005	50.9	20,871	21.8	8,952	60,350
British Guiana	2,324	31.4	730	30.0	697	5,861
British Malaya	101,967	50.0	50,904	17.2	17,474	283,569
Korea, Republic of	2,000	55.0	1,100	19.0	380	5,624
Mozambique	57,894	40.5	23,453	30.8	17,845	63,072
Nigeria	3,167,344	56.7	1,796,220	11.5	363,304	5,187,472
Norway	26,233	28.6	7,500	25.0	6,558	44,596
Portugal	68,121	40.6	27,624	27.2	18,516	123,484
Southern Rhodesia	20,460	40.5	8,283	23.4	4,779	41,512
Spain	4,410	39.4	1,739	37.2	1,641	13,500
Sweden	30,847	35.3	10,886	15.8	4,885	43,837
Uganda [4]	19,891	35.1	6,977	19.5	3,881	39,477
Union of South Africa	34,472	38.2	13,164	30.7	10,586	80,050
Total	4,192,694		2,210,787		645,528	6,905,497

Country	Gross weight	Tantalite [5]				Value
		Ta_2O_5		Cb_2O_5		
		Percent	Pounds	Percent	Pounds	
Australia	20,541	39.7	8,165	11.8	2,424	$34,427
Belgian Congo	507,282	38.6	195,674	31.6	160,339	762,474
Brazil	39,532	55.9	22,096	25.4	10,049	102,616
British Malaya	3,639	40.2	1,462	33.3	1,211	10,500
French Guiana	10,987	45.3	4,979	19.8	2,171	29,623
Portugal	154,323	39.3	60,626	30.5	47,112	224,364
Southern Rhodesia	8,163	38.2	3,120	26.8	2,186	13,339
Sweden	4,242	60.7	2,575	9.1	384	15,685
Uganda [4]	2,050	52.2	1,070	21.8	447	6,465
Union of South Africa	2,036	58.2	1,185	14.8	301	8,641
Total	752,795		300,952		226,624	1,208,134

[1] Gross weight, pounds of contained pentoxides, and value from U. S. Department of Commerce.
[2] Average grade of columbite imports; 52.7 percent Cb_2O_5, 15.4 percent Ta_2O_5.
[3] To obtain metallic content, multiply Cb_2O_5 by 0.699 and Ta_2O_5 by 0.819.
[4] Classified by U. S. Department of Commerce as British East Africa.
[5] Average grade of tantalite imports; 40.0 percent Ta_2O_5, 30.1 percent Cb_2O_5.

No columbium ore was exported from the United States. Seven pounds of columbium metal, valued at $274, and 2 pounds of primary forms, valued at $559, were exported to United Kingdom. Material classified as tantalum ore was exported as follows: 58,658 pounds valued at $6,364 to Canada; 19,332 pounds valued at $37,600 to United Kingdom. Sixty-two pounds of tantalum powder valued at $3,025 was exported to United Kingdom. Exports of tantalum primary forms totaled 822 pounds valued at $64,613. These exports went to the following countries, in order of value: Italy, Argentina, United Kingdom, France, Finland, West Germany, Canada, Spain, Sweden, Brazil, Netherlands, Switzerland, and Denmark.

No tariff restrictions apply to columbite-tantalite concentrates imported into the United States. Import duties on refined products range from 12.5 percent ad valorem on ferrocolumbium to 40 percent on special alloys. Columbium-tantalum ore, metal, alloys, scrap, and primary forms remained on the positive list of products requiring export licenses.

Dealers and producers of columbium-tantalum products in foreign countries include: H. F. Pollock & Co., Ltd., Montreal, Canada; Electro Metallurgical Co. of Canada, Ltd., Welland, Ontario; Murex Co., Rainham, Essex, England; Société Générale Metallurgique de Hoboken du Haut-Katanga near Antwerp, Belgium; and Societa per Aziona Silta, Milan, Italy.

TECHNOLOGY

Although the total United States supply of new columbium-tantalum metal in all forms was the largest in history in 1953 (over 4¼ million pounds), only part of this large supply was available in usable form because of limitations imposed by current metallurgical processes. The principal mineralogical source of columbium and tantalum is a completely isomorphous mineral series containing columbium, tantalum, iron, and manganese. The mineral is designated columbite if the columbium pentoxide content exceeds that of tantalum pentoxide and, conversely, tantalite if the tantalum pentoxide is in excess. Shipments of concentrates often contain the pentoxides in almost equal proportions; consequently, large quantities of tantalum are contained in concentrates designated as columbite. The economical production of tantalum metal by current processes requires a tantalum pentoxide content of at least 25 percent. Thus, the tantalum content of most of the columbite supply and of all the tin-smelter slags is not available for the production of tantalum metal. The process developed by J. Marignac in 1866 (or variations thereof) is the only method used commercially for separating columbium and tantalum. The separation is based on the difference in solubility of the double potassium salts in water and is a costly process. Recently, other processes have been developed on a laboratory scale and indicate less costly application for separating columbium from tantalum in low-grade materials. A liquid-liquid, countercurrent, pulse column system was developed wherein columbium and tantalum were preferentially extracted in acid and organic phases.[10] Bureau of Mines technicians at Albany, Oreg., developed a liquid-liquid method for separating columbium and tantalum and another procedure based on the reactivity of partly hydrolized tantalum and columbium chlorides with ammonium chloride followed by selective chlorination. At present ductile tantalum metal is produced by electrolysis of the fluoride to form tantalum powder. The powdered tantalum is compacted under many tons of pressure into bars or ingots, which are sintered by passage of a heavy electric current. Recently tantalum sponge metal was produced by the Bureau of Mines, Albany, Oreg., on a laboratory scale by reducing the chloride obtained from the above described separation processes with magnesium in an inert atmosphere (the Kroll process). The sponge was melted directly in an arc furnace, and the resultant tantalum metal was readily cold-rolled to sheet. Reports describing these Bureau of Mines developments were prepared for publication.

[10] Analytical Chemistry, vol. 25, No. 10, October 1953, pp. 1517–1519.

High-temperature rupture data for columbium were published,[11] and a patent was issued relative to the addition of columbium to molten ferrous metals.[12] Considerable discussion evolved over the controversial suggested change of nomenclature of element 41 from columbium to niobium.[13] Columbium is favored by United States and British mining and metallurgical engineers, while chemists appear to favor niobium. A procedure for fabricating tantalum containers from 0.001-inch-thick tantalum sheet was described.[14]

Analytical methods for determining columbium and tantalum include wet analyses employing fractional precipitation, X-ray spectroscopy, and chromotographic methods. Several references were listed in 1953.[15]

RESERVES

Columbium reserves in Arkansas have been estimated to exceed 78 million pounds of contained metal. The distribution of these reserves is:

(1) 62 million pounds contained in 44 million short dry tons of minable bauxite ore. An estimated 3.6 million pounds of columbium would be contained in the aluminum industry's annual plant feed with full-capacity operation.

(2) Impounded red mud and black sand from previous alumina operations weighing 2 million tons are estimated to contain 4.8 million pounds of columbium.

(3) The ore reserves in 3 columbium-bearing titania deposits near Magnet Cove are estimated to contain 12 million pounds of columbium.[16]

The successful development of a metallurgical process to recover these columbium reserves will depend on a method to recover also the contained titanium in usable form.

Additional data relative to domestic reserves of columbium-tantalum were presented in the 1952 Minerals Yearbook Columbium-Tantalum chapter.

WORLD REVIEW

Australia.—The Pilbara tantalite field, Western Australia, was optioned by the Blue Spec Mining Co., N. L., from Tantalite, Ltd. The Wodgina mine in the Pilbara field has been described as the world's major producer of consistently high-grade tantalite.[17]

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[11] Institute of Engineering Research, The Correlation of High-Temperature Rupture Data for Niobium: Univ. of California, Berkeley (NP-4766, Tech. Rept. 28) July 1, 1953, 11 pp.

[12] Miller, Frank Alden (assigned to Hi-Loy Co., Inc., Buffalo, N. Y.), Composition and Method for the Production of Alloys: U. S. Patent 2,659,669, Nov. 17, 1953.

[13] Chemical and Engineering News, vol. 31, No. 15, Apr. 13, 1953, pp. 1576–77; and vol. 31, No. 31, Aug. 3, 1953, p. 3208.

[14] Industrial and Engineering Chemistry, vol. 45, No. 10, October 1953, p. 2268.

[15] Dinnin, J. I., Ultraviolet Spectrophotometric Determination of Tantalum With Pyrogallol: Anal. Chem., vol. 25, No. 12, December 1953, pp. 1803–1807.

Milner, G. W. C., and Woud, A. J., Analysis of Uranium-Tantalum and Uranium-Niobium Alloys: British Inf. Services, 1953, 15 pp.

Adler, Isidore, and Avelrod, Joseph M., A Multi-Wave-Length Fluorescence Spectrometer: Jour. Opt. Soc. America, vol. 43, No. 9, September 1953, pp. 769–772.

Mercer, R. A., and Wells, R. A., A Shortened Chromotographic Method for the Determination of Niobium and Tantalum in Minerals and Ores: U. S. Atomic Energy Commission, Report CRL/AE-111, November 1953, 12 pp.

Hunt, E. C., and Wells, R. A., The Colorimetric Estimation of Niobium and Tantalum With Pyrogallol: U. S. Atomic Energy Commission, Rept. CRL/AE-112, November 1953, 12 pp.

[16] Work cited in footnote 2.

[17] South African Mining and Engineering Journal, vol. 64, part 2, No. 3165, Oct 10, 1953, p. 219.

Belgian Congo.—The M'Buye mine, Ruanda Urundi, is one of the few occurrences of columbite where it is a dominant mineral rather than an accessory one. Belgian Congo was the principal source of tantalite concentrates in 1953, supplying 65 percent of United States imports of Ta_2O_5 and was second only to Nigeria as a source of columbite. Columbite-tantalite concentrates are produced largely as a byproduct of tin mining. The principal columbium-tantalum mines of the ZaZa Quadrangle were described.[18]

TABLE 5.—World production of columbite concentrates by countries,[1] 1944–48 (average) and 1949–53, in pounds

[Compiled by Berenice B. Mitchell]

Country [1]	1944–48 (average)	1949	1950	1951	1952	1953
Argentina [2]	(3)	[4] 1,080	(3)	(3)	(3)	(3)
Belgian Congo [5]	424,683	255,780	297,675	209,437	231,042	623,902
Bolivia (exports)	1,574			1,043		3,366
Brazil	28,560	[4] 33,942	[4] 26,709	[4] 11,000	[6] 5,017	[6] 41,005
British Guiana [6]					800	2,324
French Equatorial Africa	3,249	12,984	3,655		3,527	3,514
India	204	(3)	(3)	(3)	(3)	(3)
Madagascar	4			8,598	5,732	8,377
Malaya, Federation of	[7] 1,200		17,920	56,000	105,280	116,480
Mozambique	2,744	550	7,700	[8] 11,257	32,652	[8] 58,133
Nigeria	3,386,051	1,989,120	1,935,360	2,419,200	2,896,320	4,388,160
Norway [6]						26,233
Portugal (exports)			3,009	4,526		213,846
Spain [6]						4,410
Sweden [6]						30,847
Uganda [9]	[10] 8,743	[4] 5,571	[4] 11,413	[4] 42,560	[4] 9,094	[4] 23,542
United States (mine shipments)	891	(11)	(11)	(11)	[12] 5,385	[13] 14,867
Total estimate	3,930,000	2,500,000	2,450,000	2,850,000	3,400,000	5,550,000

1 Concentrates produced in Argentina, Belgian Congo, French Equatorial Africa, Mozambique, and Portugal are frequently termed "columbite-tantalite," this designation being applied because, in general, their composition ($Cb_2O_5+Ta_2O_5$) lies in an intermediate range, neither Cb_2O_5 nor Ta_2O_5 being strongly predominant. In tabulating production of columbite and tantalite, all output designated "columbite-tantalite" has arbitrarily been placed in the columbite table.
2 Estimated average Cb_2O_5 content of concentrates.
3 Data not available; estimate by author of chapter included in total.
4 Exports.
5 In addition, tin-columbite-tantalite concentrates were produced as follows: 1947, 597,555 pounds, columbite-tantalite content unspecified; 1948, 1,148,050 pounds; 1949, 1,944,457 pounds; 1950, 2,431,674 pounds; 1951, 2,597,019 pounds; 1952, 2,813,070 pounds; 1953, 3,575,861 pounds; columbite-tantalite content averaging about 10 percent.
6 United States imports.
7 Estimate.
8 In addition to figure shown 176 pounds of samarskite was produced in 1951 and 132 in 1953.
9 Columbite-tantalite concentrates.
10 Tin-columbite-tantalite concentrates, columbite-tantalite content unspecified, produced as follows: 1947, 329 pounds; 1948, 210 pounds.
11 Columbite and tantalite production in the United States not always differentiated; therefore, see tantalite table.
12 Small quantity of tantalite is included in the columbite concentrates.
13 Small quantity of tantalite and microlite is included in the columbite concentrates.

18 Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 6, December 1953, pp. 10–15.

TABLE 6.—World production of tantalite concentrates, by countries,[1] 1944–48 (average), and 1949–53, in pounds

[Compiled by Berenice B. Mitchell]

Country [1]	1944–48 (average)	1949	1950	1951	1952	1953
Australia	7,897	3,502	16,536	5,125	16,108	18,124
Brazil	137,630	[2] 91,237	[2] 18,700	[2] 8,818	[3] 49,813	[3] 39,532
French Guiana [4]	------	------	------	------	------	13,228
Nigeria	15,263	4,980	2,240	6,720	2,240	------
Southern Rhodesia [4]	17,540	10,840	1,700	------	10,360	34,000
South-West Africa	[5] 102	5,364	12,570	3,974	4,400	17,634
Spain [6]	------	------	------	------	741	------
Sweden [6]	------	------	------	------	------	4,242
Union of South Africa	2,218	------	4,000	6,000	8,000	38,000
United States (mine shipments)	[6] 3,988	[4] 1,020	[4] 1,000	[4] 925	(7)	(7)
Total (estimate)	200,700	123,000	62,500	37,500	95,000	165,000

[1] See columbite world-production table, footnote 1. Tantalite production of Belgian Congo and Uganda are in columbite production figure. United States imports show 98 pounds tantalite received from Anglo-Egyptian Sudan in 1944; 700 pounds from Canada in 1944; 2,442 pounds from India in 1944.
[2] Exports.
[3] United States imports.
[4] Tantalite-columbite.
[5] In addition, tin-tantalite-columbite concentrates, unspecified tantalite-columbite content, produced as follows: 1944, 2,000 pounds.
[6] Principally microlite.
[7] Small quantity of tantalite is included in the columbite concentrate (see columbite table).

Bolivia.—Deposits of columbite associated with monazite and fluorspar were investigated in the districts of Santa Cruz and Cochabamba.[19]

British Guiana.—Three companies were active in the development of columbite deposits: Kennametal International S. A. was given permission to explore 75 acres in the Rumong-Rumong River basin area but withdrew from the venture the latter part of 1953; the Morabisi Mining Co. operated along the right bank of Robello Creek, a tributary of the Morabisi River; and the Columbium Corp. worked the left bank of the Morabisi River. Total production was small.[20] The occurrence of columbite along the right bank of the Puruni River was investigated.[21]

Brazil.—High-grade columbite deposits were reported in the Araxa region of Minas Geraes near the Sao Paulo border.[22] Brazil is an important source of high-grade tantalite. United States imports in 1953 contained an average of 56 percent Ta_2O_5 and 25 percent Cb_2O_5.

Canada.—A diamond-drilling exploration program was conducted by Inspiration Mining & Development Co., Ltd., on a columbium-uranium deposit under Lake Nipissing, North Bay, Ontario. Metallurgical studies conducted by Battelle Memorial Institute, Columbus, Ohio, indicate that an economic recovery process may be developed.[23] Development work was conducted by Boreal Rare Metals, Ltd., on the DeStaffany tantalum-beryllium property at Great Slave Lake. A processing plant is planned by Boreal at Cap de la Madeleine, Quebec.[24] Electro Metallurgical Co., Ltd., of Canada, Welland, Ontario, and Boreal Rare Metals, Ltd., Montreal, produce and fabricate columbium-tantalum materials; supply is imported largely from the United States.

[19] Metal Bulletin (London), No. 3815, Aug. 7, 1953, p. 26.
[20] Mining Journal (London), vol. 241, No. 6172, Dec. 4, 1953, p. 656.
[21] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 3, March 1954, pp. 5–6.
[22] Mining Journal (London), vol. 240, No. 6144, May 22, 1953, p. 602.
[23] Atomic Energy Newsletter, vol. 10, No. 11, Jan. 12, 1954.
[24] Northern Miner, Toronto, vol. 39, No. 8, May 14, 1953, p. 28.

French Guiana.—Tantalite concessions in the Sinnamary region were granted to a French-American company. Tantalite was reported in the immediate vicinity of Cayenne, and deposits of columbite were noted at Bagdad, near Saul.[25]

Kenya.—A large deposit containing columbium and rare earths was discovered at Mrima near the coast, 40 miles south of Mombasa. The columbium occurs in pyrochlore and the rare earths in monazite. Extremely fine particle sizes present problems in concentration.

Korea.—Pegmatites and placer deposits in the Republic of Korea have been reported to contain appreciable concentrations of columbite and tantalite. Hand-cobbed ore assayed 58.1 percent Cb_2O_5 and 15.6 percent Ta_2O_5. Production was reported by the Korea Rare Element Ore Development Corp.[26]

Malaya.—Columbite production, principally from alluvial deposits at Semiling in the northern part of the State of Kedah, remained at about the same level in 1953. Interest was taken in the columbium-tantalum content of slags produced at the tin-smelting works of the Straits Trading Co. and the Eastern Smelting Co. The Malayan tin slags could be an important source of columbium and tantalum if successful extraction methods are developed.[27]

Mozambique.—Columbite is produced in conjunction with beryl by Empresa Mineira do Alto Ligonha. Heavy minerals, including columbite, samarskite, and euxenite, in beach sands derived from the Alto Ligonha pegmatite belt occur along the coast between Mozambique and Quelimane.

Nigeria.—Incentive bonus prices were responsible for increased columbite production in 1953. Nigeria continued to be the principal world source of columbite. United States imports—over 3 million pounds—contained an average of 56.7 percent Cb_2O_5 and 11.5 percent Ta_2O_5. Principal producers were: Amalgamated Tin Mines Ltd.; Jantar Co., Ltd.; Bisichi Tin Co., Ltd.; Naraguta Tin Mines, Ltd.; Gold & Base Metal Mines, Ltd.; United Tin Areas of Nigeria, Ltd.; and Jos Tin Areas of Nigeria, Ltd. The producing provinces are the Plateau, Bauchi, and Kano. Although production has been from placer deposits in conjunction with tin mining, columbite-bearing biotite granites are being investigated. Reserves of columbite in biotite granite that could be mined economically at the 1953 price were estimated at 15,000 tons.[28]

Northern Rhodesia.—Pyrochlore containing 73 percent columbium-tantalum pentoxides was discovered at Nkumbwa Hill. The deposit was under consideration for exploitation.[29]

Norway.—Concentrates containing 50 percent combined columbium-tantalum pentoxides were shipped from the Cappelen deposits in the Sove field near Ulefoss to the United States by Norsk Bergvelk, A/S. Two explored deposits were estimated to contain 3,200 tons of Cb_2O_5. The pyrochlore-type mineral koppite is the principal mineralogical source. About 40 percent of the production will go to pay off a long-term development loan from the United States.[30]

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[25] Mining World, vol. 19, No. 12, November 1953, p. 86.
[26] Mining World, vol. 15, No. 8, July 1953, p. 31.
[27] Mining Journal (London), vol. 241, No. 6154, July 31, 1953, p. 135.
[28] Metal Bulletin (London), No. 3840, Nov. 3, 1953, p. 22.
[29] South African Mining and Engineering Journal, vol. 64, part 11, No. 3168, Oct. 31, 1953, p. 295.
[30] Chemical and Engineering News, vol. 31, No. 29, June 29, 1953, p. 2698.

Portugal.—United States imports of tantalite from Portugal contained an average of 39 percent Ta_2O_5 and 31 percent Cb_2O_5; Portugal was the second largest source country. Imports of columbium-tantalum-bearing tin-smelter slag, however, decreased to only one small shipment early in the year, which indicates that stocks of accumulated slags may be depleted.

Southern Rhodesia.—Columbite and tantalite are recovered from pegmatites in the Fort Victoria district in conjunction with beryl mining.

Union of South Africa.—Columbite-tantalite prospecting and mining operations were conducted in the following districts: Namaqualand, Transvaal, Swaziland, and Warmbar.[31]

United Kingdom.—A leading United Kingdom producer of ferrocolumbium advanced the price on November 30, 1953, from 40s. to 52s. 6d. per pound of metal contained for 65–75 percent (columbium plus tantalum) alloy. The new price is equivalent to $7.35. The company quoted a range of 52s. 6d. to 70s. ($7.35 to $9.80) to cover both exports and domestic sales.[32]

[31] Mining World, vol. 15, No. 1, January 1953, p. 63.
[32] Metal Bulletin (London), No. 3849, Dec. 4, 1953, p. 24.

Copper

By Helena M. Meyer[1] and Gertrude N. Greenspoon[2]

THE CONDITION of inadequate supply that had featured the copper industry since June 1950 changed in 1953 to one in which somewhat more than enough copper was available for all needs; from a world viewpoint a sizable surplus developed in 1953. The more balanced situation in the United States resulted from easing of military demand and from increasing supplies. Largely in consequence of the change and of the virtual assurance of further improvement, price and allocation controls were discontinued in February; military and Atomic Energy Commission requirements, however, were to continue to receive preferential treatment. Another evidence that the critical copper situation had eased was dissolution at the end of March of the Copper-Lead-Zinc Committee of the International Materials Conference, which had allocated copper consumption on an international scale.

Actually supplies in the United States did not expand materially, as had been expected, chiefly because of the abnormal relationship between United States and Chilean prices; receipts of copper from that country, which regularly supplied more than half of the copper imported into the United States, dropped 22 percent, while overall imports rose 9 percent. Mine, smelter, and refinery outputs from domestic primary materials were little changed from 1952, but recovery of refined copper from scrap increased 38 percent.

Despite the changed supply-requirements relationship in 1953 prices continued to dominate the industry. Many in the industry anticipated that abandonment of controls would solve all problems. After copper prices were decontrolled February 25, the situation in regard to domestic and foreign prices, except those for Chile, continued confused for only a brief time until they settled by the end of April to a range of 29.5 to 30 cents a pound and continued there throughout the remainder of the year. This was nearly midway between the widespread extremes of approximately 24.5 cents for most domestic copper and 36.5 cents for foreign metal before February 25. Chilean metal, however, continued to be quoted at 35.5 cents a pound f. a. s. Chilean ports or about 36.5 cents in the United States until December. It began to be quoted on the open market at prices meeting those of other producers early in December. In August the Chilean Government authorized the medium and small producers to export copper freely, but without recourse to Government subsidies if the price received were below 35.5 cents a pound in Chile.

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[2] Statistical assistant.

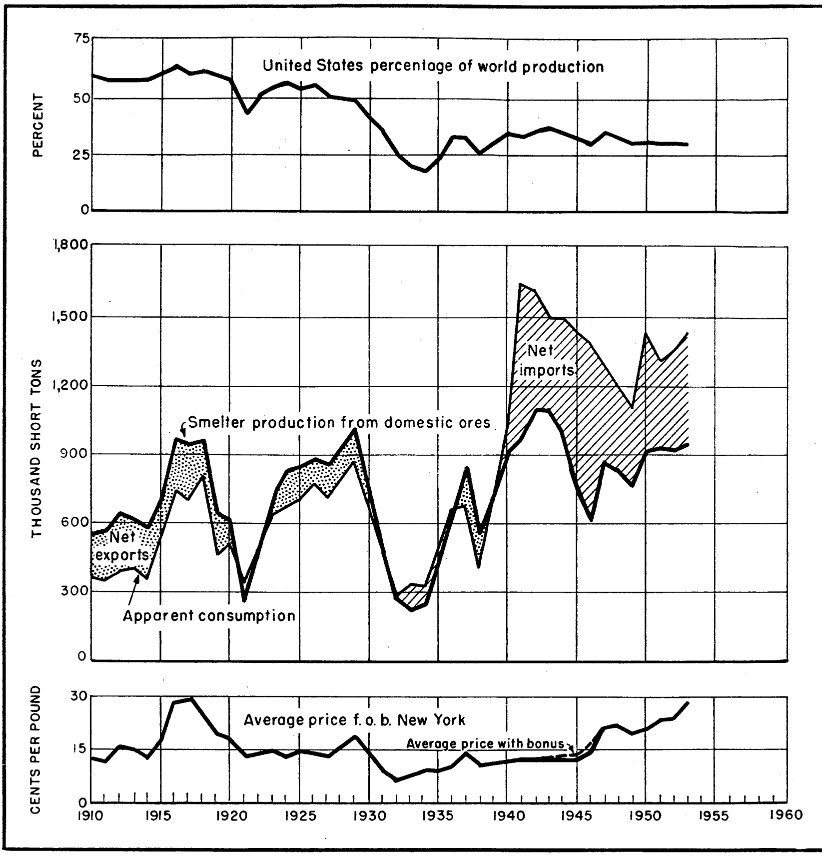

FIGURE 1.—Production, consumption, and price of copper in the United States, 1910–53.

A byproduct of the foregoing price fiasco was the accumulation of large stocks of unsold Chilean copper. By the end of the year the accumulation was reported to be about 180,000 tons. In August the Chilean Government formally requested the United States Government to purchase, for the United States National Strategic Stockpile, stocks of copper accumulated during the period when Chilean copper quotations were higher than those of other world producers; the proposal did not result in any such purchases by the year end, but at that time, the widely held opinion was that much of the metal in question would be purchased and thus withdrawn as a threat to the market.

World supplies and requirements appeared to be in approximate balance in 1953 without the high-priced Chilean metal, and the effective withholding of Chilean metal from sale undoubtedly was an important factor in the failure of prices to drop a widely anticipated 5 cents or more.

Further evidences of a more abundant supply situation from national and international viewpoints were the reopening of trading in copper on the New York Commodity Exchange on June 1, after a recess of 2 years, and resumption of free trading on the London Metal Exchange on August 5, after a lapse of 14 years.

Spectacular increases in consumption marked the end of price and allocation controls. Consumption rose from a monthly average of 123,000 tons in 1952 to 147,000 in May 1953, and to a monthly average of 138,000 tons in January–June 1953. Thereafter, the use of copper dropped markedly and in the latter half of the year averaged 23 percent less than in January to June, with the result that fabricators took only slightly more in 1953 as a whole than they were permitted by available supplies and consequently by allocation in 1952.

Action of the Office of Defense Mobilization in May 1952, permitting higher prices to be paid for foreign copper and most of the increased costs to be passed on to consumers, gave considerable impetus to imports. Thereafter, until the decontrol of domestic prices, most foreign copper sold in the United States for half again as much as domestic metal. Receipts of copper in the first 7 months of 1953, under conditions of very heavy consumption, were one-fourth as large as the monthly average for 1952. They dropped markedly in the final months and for the year as a whole exceeded 1952 by only 9 percent. The aforementioned abnormal relationship between prices for Chilean copper and that from all other sources discouraged much larger import gains in 1953. Chilean copper was only 42 percent of United States imports in 1953 compared with 42 to 63 percent in the previous 5 years. Moreover, a substantial part of the copper received from Chile in 1953 did not get into consumption.

Refined-copper exports—the dominant copper export class—dropped 37 percent in 1953 and were the smallest since 1946. Part of the decrease stemmed from the resumption of a more normal relationship with Canada; in 1952 a large tonnage of Canadian copper was refined in the United States because of a refinery strike in Canada and was returned to that country as United States exports of refined copper. Quantitative controls over copper exports were ended by the Office of International Trade in April, but export licensing requirements were retained.

Domestic mine production merely maintained the 1952 rate despite a 25-percent increase in Montana, owing to increased output from the Greater Butte Project. The largest copper-producing States showed the following changes in 1953: Utah and New Mexico each decreased 5 percent, and Montana and Nevada increased 25 and 7 percent; Arizona was virtually unchanged. New Mexico's production was adversely affected by an almost 2-week labor strike ending October 10 at the Chino mine of the Kennecott Copper Corp., Grant County.

As freely predicted in the trade, the output of refined copper from scrap rose substantially after price controls were removed. Refined copper produced from scrap at primary and secondary plants was 212,700 tons in 1953 compared with 153,700 in 1952 and 165,700 in 1951.

Industry stocks rose significantly in 1953; producers' inventories of refined and unrefined copper increased 29 percent and fabricators' stocks of refined metal (including in-process copper and primary fabricated shapes) gained 15 percent.

TABLE 1.—Salient statistics of the copper industry in the United States, 1944–48 (average) and 1949–53, in short tons

	1944–48 (average)	1949	1950	1951	1952	1953
New (primary) copper produced—						
From domestic ores, as reported by—						
Mines	807,311	752,750	909,343	928,330	[1] 925,359	926,448
Copper ore produced [2]	80,672,583	76,032,531	94,585,792	95,494,214	99,947,492	101,064,945
Average yield of copper, percent	.93	.91	.89	.90	.85	.85
Smelters	818,222	757,931	911,352	930,774	927,365	943,391
Percent of world total	33	29	31	30	30	29
Refineries	819,451	695,015	920,748	951,559	923,192	932,232
From foreign ores, matte, etc., refinery reports	275,722	232,912	319,086	255,429	254,504	360,885
Total new refined, domestic and foreign	1,095,173	927,927	1,239,834	1,206,988	1,177,696	1,293,117
Secondary copper recovered from old scrap only	473,820	383,548	485,211	458,124	414,635	429,388
Imports (unmanufactured) [3]	591,225	552,709	690,389	489,135	[1] 618,880	677,069
Refined	315,347	275,811	317,363	238,972	346,960	274,777
Exports of metallic copper [4]	174,313	195,990	192,339	166,274	[5] 212,390	[5] 171,323
Refined (ingots and bars)	91,961	137,827	144,561	133,305	174,135	109,510
Stocks at end of year (producers)	345,200	322,000	258,000	217,000	211,000	272,000
Refined copper	86,800	61,000	26,000	35,000	26,000	49,000
Blister and materials in solution	258,400	261,000	232,000	182,000	185,000	223,000
Withdrawals (apparent) from total supply on domestic account:						
Total new copper	1,362,000	1,072,000	1,447,000	1,304,000	1,360,000	1,435,000
Total new and old copper (old scrap only)	1,836,000	1,456,000	1,932,000	1,762,000	1,775,000	1,864,000
Price average [6] ....cents per pound	16.1	19.7	20.8	[7] 24.2	[7] 24.2	[7] 28.7
World smelter production, new copper	2,470,000	2,600,000	2,915,000	[1] 3,095,000	[1] 3,115,000	3,275,000

[1] Revised figure.
[2] 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."
[3] Data are "general" imports; that is, they include copper imported for immediate consumption plus material entering country under bond. Comprises copper in ingots, plates, and bars, ores and concentrates, regulus, blister, and scrap.
[4] Total exports of copper, exclusive of ore, concentrates, composition metal, and unrefined copper. Exclusive also of "Other manufactures of copper," for which quantity figures are not recorded before 1953. (See table 35.)
[5] Due to changes in classifications 1952–53 data are not strictly comparable to earlier years.
[6] Exclusive of bonus payments of the Office of Metals Reserve under Premium Price Plan, which covered the period February 1, 1942, to June 30, 1947, inclusive.
[7] Exclusive of copper produced abroad and delivered in the United States.

The 2-cent-per-pound excise tax on copper, under suspension to February 15, 1953, was further suspended to June 30, 1954. The suspension of duties on nonferrous scrap metals ceased June 30, and duties became effective automatically. Public Law 221, passed August 7, however, reinstated the suspension retroactive to June 30, 1953, and to continue until June 30, 1954.

World production continued at the alltime peacetime peak rate of 1952, which equaled the war peak in 1943. The virtually unchanged production in 1953 was due chiefly to the fact that 13- and 4-percent increases in Northern Rhodesia and Belgian Congo were offset largely by 10- and 3-percent decreases in Chile and Canada; United States production was unchanged. Chile's price policy was the chief cause of the drop in that country, but strikes lasting over 6 weeks at 2 leading properties were added factors. Properties in Quebec, Canada, were likewise beset by strikes lasting several months, which caused Canada's drop. Northern Rhodesia's output—a new alltime peak for the fourth successive year—was made despite continuing inadequate supplies of coal. Belgian Congo likewise established a new alltime peak in 1953.

DEFENSE PRODUCTION ACT STIMULATION

Efforts made in 1953 to maintain or stimulate copper production and to intensify exploration are detailed in the following discussion. The first major property to start production as a result of the Defense Production Act was the Yerington mine, Lyon County, Nev., of the Anaconda Copper Mining Co., from which the first shipment of copper precipitates was made in November to the company reduction works at Anaconda, Mont., for smelting and refining. The total material removed from the mine by the end of 1953 was 20,211,000 tons, consisting of 18,028,000 tons of overburden, 332,000 tons of ore to plant, and 1,851,000 tons of stockpiled ore. Construction of the crushing, leaching, and precipitation plants at Yerington, as well as the acid plant with its FluoSolids reactors and auxiliary facilities, was substantially completed by the year end. Expenditures to December 31, 1953, totaled $34,879,000 of which $20,489,000 was made in 1953.

At the Silver Bell property, Pima County, Ariz., of the American Smelting & Refining Co. the originally estimated total expenditure of $17,000,000 was expected to reach $18,000,000; $14,708,000 was expanded by the end of 1953 in stripping the ore body and in constructing the mill and townsite. Operations were expected to begin in the second quarter of 1954.

Of total capital expenditures in 1953 of $17,400,000 by the Phelps Dodge Corp., $7,365,000 was expended for production facilities at the Lavender Pit, Cochise County, Ariz. Production was expected to begin soon after the middle of 1954.

Copper covered by the new contracts entered into with the Miami Copper Co. in 1953 was to come from ore averaging 0.5 percent copper. Considerable quantities of molybdenum were involved.

Mining operations at the Castle Dome mine of the Castle Dome Copper Co., Inc. (subsidiary of Miami Copper Co.), Gila County, Ariz., were concluded December 4, 1953, when mineral reserves were exhausted. Immediately after the Castle Dome closed, cleaning up and dismantling of the plant were begun preparatory to moving it to the Copper Cities location, where production of concentrates was expected to start in the second half of 1954. Through 1953 Copper Cities expenditures totaled $9,040,000, of which $3,435,000 was in 1953.

Underground development was carried on at the San Manuel mine, Pinal County, Ariz., by San Manuel Copper Corp. (subsidiary of the Magma Copper Co.), and completion according to schedule was anticipated. In the early part of 1953 Utah Construction Co. and the Stearns-Roger Manufacturing Co. (a joint venture) were awarded a contract covering the design and construction of the entire surface plant, including the concentrator, smelter, railroads, and auxiliaries. Satisfactory progress by the contractors was reported by the Magma Copper Co.

A substantial amount of construction was reported as accomplished at the White Pine mine of the White Pine Copper Co. (subsidiary of the Copper Range Co.), Ontonagon County, Mich., with time schedules maintained. The essential plant site buildings were completed and the installation of equipment was under way. All phases of underground development work were well advanced, and the entire project was about 67 percent completed by December 31, 1953.

Under a General Services Administration contract with the Copper Creek Consolidated Mining Co., Pinal County, Ariz., it was planned to extract the bulk of the copper by caving the ore and leaching it in place. However, at the start production was to be by conventional mining and milling methods.

TABLE 2.—Contracts for expansion and maintenance of supply of copper under the Defense Production Act, as amended, in 1953 [1]

Type of contract, name of contractor, and location of project	Government contingent purchase commitments (pounds) [2]	Effective date of contract	Date production starts	Approximate term of contract	Commitment purchase price (per pound)
Maintenance of production:					
Copper Range Co., Champion mine, Houghton County, Mich.	7,965,000	Aug. 12, 1953	July 1, 1953	2½ years	$0.32
Riviera Mines Co., Christmas mine, Gila County, Ariz.	3,000,000	Sept. 29, 1953	Not later than Oct. 15, 1953	2¼ years	.32
Howe Sound Co., Holden mine, Chelan County, Wash.	18,700,000	Nov. 3, 1953	Sept. 1, 1953	2⅛ years	.315
Purchase:					
Miami Copper Co., Miami mine, Gila County, Ariz.	120,000,000	Feb. 13, 1953	Not later than June 30, 1955	8-8½ years	[3] [4] .2735
Banner Mining Co., Mineral Hill and Plumed Knight mines, Pima County, Ariz.	12,960,000	May 26, 1953	May 1, 1954	3 years	[5] .31
Copper Creek Cons. Mining Co., Old Reliable mine, Pinal County, Ariz.	5,500,000	June 17, 1953	Dec. 31, 1954	1½ years	.29
International Nickel Co. of Canada, Ltd., Sudbury district, Ontario, Canada.[6]	100,000,000	May 29, 1953	June 1, 1953	5 years 7 months	[3] .27
Falconbridge Nickel Mines, Ltd., Ontario, Canada.[7]	32,000,000	Mar. 27, 1953	Dec. 31, 1953	3 years	.275-.30
Advance repayment: Banner Mining Co., Mineral Hill and Plumed Knight mines, Pima County, Ariz.	12,960,000	May 26, 1953	May 1, 1954	do	(8)

Type of contract or assistance, name of contractor and location of project	Approximate amount involved	Effective date of contract
Loan:		
Campbell-Chibougamau Mines, Ltd., Merrill Island, Dore Lake, Quebec, Canada.	$5,500,000	May 18, 1953
Chibuluma Mines, Ltd., Northern Rhodesia	14,000,000	[9] Aug. 13, 1951
Rhodesia Congo Border Power, Ltd., Northern Rhodesia	22,400,000	June 17, 1953
Tax amortization [10]:		
Banner Mining Co., Pima County, Ariz	577,130	Apr. 29, 1953
Copper Creek Consolidated Mining Co., Pinal County, Ariz	245,000	Apr. 21, 1953

[1] All subsidy contracts negotiated in 1952 were automatically terminated February 25, 1953.
[2] Some contracts provide for larger production which may be sold to other purchasers.
[3] Includes escalator clause.
[4] Government purchase obligation for part of molybdenite production at floor price ($1.00 per pound for contained Mo), but option to purchase all of it at market price.
[5] Option to purchase all or part of molybdenite production at market price.
[6] Also 120,000,000 pounds of nickel.
[7] Also 100,000,000 pounds of nickel and 32,000,000 pounds of cobalt; contract provides for additional quantities of copper (20,000,000 pounds to U. S. Government up to December 31, 1958), nickel and cobalt at option.
[8] Terms of repayment of $430,565 were 17½ cents per pound of refined copper plus interest, until $43,100 has been paid and 3½ cents per pound of refined copper thereafter with interest. Repayment shall be made on or before 4½ years from date of contract.
[9] Original advance of $5,600,000 increased May 15, 1953 to $14,000,000.
[10] Amortization—5 years at 75 percent of total amount involved.

Contracts entered into in 1953 for expansion and maintenance of copper production are shown in table 2. Data for earlier years were shown in the report of this series for 1952.

Expansion at properties that received either no DPA aid or tax amortization benefits only.—Production from the Kimbley pit of the Nevada Mines Division, Kennecott Copper Corp., White Pine County, Nev., was begun on schedule; and by the end of 1953, 1,112,000 tons of ore had been shipped to the mill from this new working. Development of the Veteran-mine area, part of which was to be on claims owned by the Consolidated Coppermines Corp., as an open-pit operation was begun in October, and by the year end an estimated 4,012,000 tons of waste material had been removed from the ore body preparatory to mining. In the case of the Deep Ruth underground development (for which the company was granted accelerated amortization benefits) the work of sinking the shafts was made difficult by water encountered in substantial volume at various levels, which delayed the project beyond the anticipated date (mid-1954) to an expected March 1955 date.

Copper production from the Butte (Mont.) district increased 30 percent over 1952 owing to greater production from the Kelley mine (Greater Butte Project) of the Anaconda Copper Mining Co. At the beginning of the year ore production averaged 7,000 tons a day, which was increased to 12,000 tons by October, a rate at which it continued beyond the end of the year. Further development and construction in 1954 will provide necessary capacity for output at the rate of 15,000 tons a day when required.

Defense Materials Production Administration over-the-ceiling price contracts ceased with the abandonment of price controls. Nonetheless, three new maintenance-of-production contracts were entered into in 1953. These contracts are listed in the section on Defense Production Act Stimulation.

Defense Minerals Exploration Administration contracts entered into in 1953, and those entered into from the beginning through 1952 are shown as follows:

DMEA copper contracts awarded through 1952

State and contractor:	Location	Government participation
Alaska: Alaska Copper Corp	Third Judicial Division	$56, 274
Arizona:		
Arizona Copper Mines, Inc	Pima County	50, 000
Banner Mining Co	do	67, 895
Do	do	63, 393
Yucca Mining & Milling Co	Mohave County	29, 735
Eugene J. Meyer	Yavapai County	2, 095
California: Sierra Copper Co	Calaveras County	8, 307
Colorado: Lottie M. Loveless	La Plata County	1, 500
Idaho: Compton I. White	Bonner County	28, 655
Michigan: Calumet & Hecla, Inc	Houghton and Keweenaw Counties.	284, 096
Montana:		
Columbia Mining Co., Inc	Lewis and Clark County	12, 159
Amador Mining Co	Mineral County	36, 095
Elmer & Jessie Allen	Sanders County	5, 400
Kootenay Copper Mines, Inc	do	15, 950
J. E. Hall	do	10, 643

State and contractor—Continued	Location	Government participation
Nevada:		
Maurice M. Marshall	Elko County	$37,311
Pennsylvania Mine	Lincoln County	12,896
Harold P. Newman	Nye County	1,890
New Mexico:		
Ira L. Moseley	Hidalgo County	23,500
Chas. F. Williams	Santa Fe County	83,701
Oregon: Waite Minerals, Inc	Josephine County	15,000
Utah:		
West Park Mining Co	Wasatch County	8,100
Heber Lion Mining Co	do	2,500
Vermont: Vermont Copper Co., Inc	Orange County	25,691
Washington:		
S. J. Holden & Associates	Chelan County	3,800
Western States Copper Corp	King County	11,150
Mount Ranier Mining Co	Pierce County	1,500
Robt. Curtiss & John C. Rogers	Snohomish County	8,800
Glacier Mining Co., Inc	Whatcom County	3,708

DMEA copper contracts awarded in 1953

State and contractor:	Location	Government participation
Arizona: Richard E. Chilson	Pima County	$13,575
California:		
New Penn Mines, Inc	Calaveras County	84,561
Providence Tuolumne Gold Mines, Inc.	Humboldt County	14,410
Montana: W. J. Noon	Granite County	10,730
Washington:		
Howe Sound Co	Chelan County	109,705
Attwood Copper Mines, Ltd	Ferry County	54,598
Index Mining Co	Snohomish County	57,500

Bureau of Mines Reports.—The following Bureau of Mines reports of investigations, published recently, relate to copper in whole or in part:

4986. Investigation of the Copper Bullion Claims, Rua Cove, Knight Island, Alaska.
4989. Investigation of the Sunset Copper Mine, Snohomish County, Wash
4999. Metallurgical Investigations of Southeastern Missouri Cobalt-Nickel Resources.

The following Bureau of Mines information circulars likewise discussed copper:

7666. Review of Literature on Health Hazards of Metals. 1. Copper.
7684. Safe Storage, Handling, and Use of Commercial Explosives in Metal Mines, Nonmetallic Mines, and Quarries (revision of I. C. 7380).

Geological Survey Reports.—The following professional papers and bulletins of the Geological Survey, published recently, also relate to copper:

Professional papers:

251. Geology and Mineral Deposits of Jumbo Basin, Southeastern Alaska.
256. Geology of the San Manuel Copper Deposit, Ariz.

Bulletins:

998–A. Zinc-Copper Deposits at Tracy Arm, Petersburg District, Alaska.
998–C. Some Lead-Zinc and Zinc-Copper Deposits of the Ketchikan and Wales Districts, Alaska.

DOMESTIC PRODUCTION

Statistics on copper production may be compiled upon a mine, smelter, or refinery basis. Mine data are most accurate for showing the geographic distribution of production; smelter figures are better than mine figures for showing the actual recovery of metal and more accurate than refinery figures for showing the source of production; and refinery statistics are best for showing recovery of metal but indicate only in a general way the source of crude materials treated. Mineral Resources of the United States, 1930, part 1 (pp. 701–702), discusses differences among the three sets of figures.

TABLE 3.—Copper produced from domestic [1] ores, as reported by mines, smelters, and refineries, 1949–53, in short tons

Year	Mine	Smelter	Refinery
1949	752, 750	757, 931	695, 015
1950	909, 343	911, 352	920, 748
1951	928, 330	930, 774	951, 559
1952	[2] 925, 359	927, 365	923, 192
1953	926, 448	943, 391	932, 232

[1] Includes Alaska.
[2] Revised figure.

PRIMARY COPPER

Mine Production.—The figures for mine production are tabulated 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.

As usual, Arizona led all other States by a wide margin in production in 1953, supplying 42 percent of the total for the United States, followed by Utah, with 29 percent. Arizona's output comes from a number of important copper-producing districts and mines, whereas Utah's is predominantly from one mine, the largest copper producer in the United States. Production from Montana, New Mexico, Nevada, and Michigan, ranking next in importance as copper producers in 1953, made up 25 percent of the total. These 6 States produced 97 percent of the United States total in 1953. New Mexico ranked ahead of Montana almost without exception after World War II, but the start of production at the Greater Butte Project caused Montana to exceed New Mexico by 7 percent in 1953.

Classification of production by mining method shows that approximately 75 percent of the recoverable copper and 83 percent of the copper ore came from open pits in 1953. Most domestic copper ore was treated by flotation at or very near the mine of origin, and the resulting concentrates were shipped for smelting. Some copper ores were direct-smelted either because of their high grade or because of their fluxing qualities.

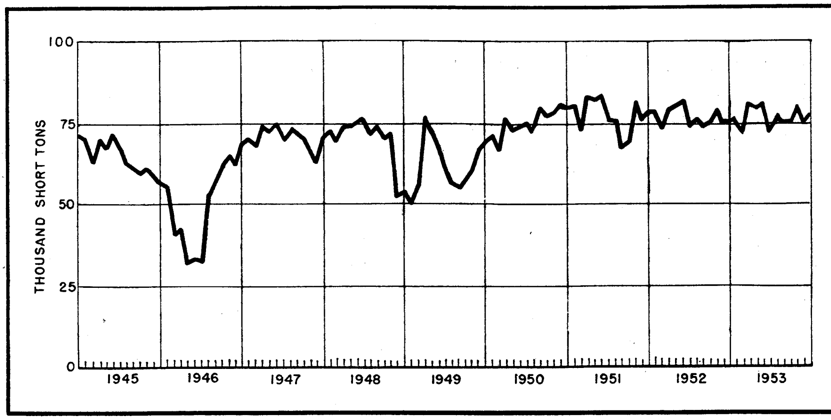

FIGURE 2.—Mine production of recoverable copper in the United States, 1945–53, by months, in short tons.

TABLE 4.—Copper ore and recoverable copper produced by open-pit and underground methods 1939–53, 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					

TABLE 5.—Mine production of recoverable copper in the United States in 1953, by months [1]

Month	Short tons	Month	Short tons
January	77,561	August	75,651
February	72,389	September	75,538
March	80,930	October	80,082
April	79,805	November	75,937
May	80,925	December	77,340
June	73,712		
July	76,578	Total	926,448

[1] Includes Alaska. Monthly figures adjusted to final annual mine production total.

The first 5 mines in table 8 produced 65 percent of the United States total, the first 10 produced 84 percent, and the entire 25 furnished 98 percent.

Quantity and Estimated Recoverable Content of Copper-Bearing Ores.—Tables 9–12 list the quantity and estimated recoverable copper content of the ore produced by copper mines in the United States in 1953. Of the total copper produced from copper ores in the United States during 1953 (1952 percentages were identical) 93 percent was obtained from ores concentrated before smelting, 3 percent from direct-smelting ores, and 4 percent from ore treated by straight leaching.

Close agreement between the output as reported by smelters and the recoverable quantity as reported by mines indicates that estimated recoverable tenor is close to actual recovery. Classification of some of the complex western ores is difficult and more or less arbitrary. "Copper ores" include not only all those that contain 2.5 percent or more recoverable copper but also those that contain less than this percentage if they are valuable chiefly for copper, notably the "porphyry ores." Mines report considerable copper from ores mined primarily for other products. These include siliceous gold and silver ores, lead and zinc ores, and pyritic ores.

Smelter Production.—The recovery of copper by smelters in the United States from ores of domestic origin totaled 943,400 tons in 1953—a 2-percent increase over the 927,400 tons in 1952. Output of United States smelters from domestic ores constituted 51 percent of the world production during 1925–29 but dropped sharply in the succeeding years until 1934, when it was only 17 percent. From 1936–41 it fluctuated between 25 and 33 percent; in 1942–44 it was slightly above 35 percent; and in 1945–53 it ranged from 29–34 percent; in 1953 alone it was 29 percent.

TABLE 6.—Mine production of copper in the principal districts [1] of the United States, 1944–48 (average) and 1949–53, in terms of recoverable copper, in short tons

District or region	State	1944–48 (average)	1949	1950	1951	1952	1953
West Mountain (Bingham)	Utah	221,401	196,101	277,655	270,183	282,098	268,511
Copper Mountain (Morenci)	Arizona	119,867	141,934	154,689	143,921	124,882	123,789
Globe-Miami	do	88,403	80,189	84,688	90,225	93,079	86,478
Summit Valley (Butte)	Montana	75,623	55,945	53,897	56,826	61,557	77,520
Central (including Santa Rita)	New Mexico	[2] 59,876	[3] 53,276	63,694	71,526	74,008	69,869
Ajo	Arizona	46,947	58,350	64,400	63,093	63,808	64,730
Robinson (Ely)	Nevada	48,324	37,533	52,087	56,198	57,148	60,557
Mineral Creek (Ray)	Arizona	20,233	18,595	36,442	50,580	49,274	47,574
Warren (Bisbee)	do	17,224	9,840	13,345	27,271	27,440	29,344
Pioneer (Superior)	do	13,595	21,616	22,636	17,662	17,716	25,093
Lake Superior	Michigan	29,289	19,506	25,608	24,979	21,699	24,097
Eureka (Bagdad)	Arizona	5,739	7,906	10,673	9,087	9,228	10,072
Ducktown	Tennessee	7,020	6,489	6,851	7,069	7,620	7,829
Orange County	Vermont	2,248	2,986	3,504	3,774	3,774	3,947
Chelan Lake	Washington	4,857	[4] 5,249	[4] 4,904	3,932	[5] 4,273	[5] 3,614
Lebanon (Cornwall mine)	Pennsylvania	4,061	3,974	4,142	5,297	3,485	3,027
San Juan Mountains	Colorado	1,232	1,974	2,582	2,712	3,157	2,376
Southeastern Missouri	Missouri	2,538	3,670	2,982	2,422	2,576	2,374
Coeur d'Alene	Idaho	1,163	1,171	1,896	1,874	1,862	2,100
Lordsburg	New Mexico	1,636	1,934	2,061	1,521	1,475	1,988
Cochise	Arizona	720	689	498	1,350	1,838	1,849
Pima (Sierritas, Papago, Twin Buttes).	do	274	348	282	334	1,090	1,353
Blackbird	Idaho	2			148	[6] 1,214	(7)
Verde (Jerome)	Arizona	18,330	17,215	13,291	9,742	4,524	626
Burro Mountain	New Mexico	[8] 1,201	(3)		(9)		(9)

[1] Districts producing 1,000 short tons or more in any year of the period 1949–53.
[2] Includes average for Burro Mountain for 1945–46 and 1948 to avoid disclosing individual company operations.
[3] Burro Mountain included with Central to avoid disclosing individual company operations.
[4] Includes Peshastin Creek and Wenatchee to avoid disclosing individual company operations.
[5] Includes Ferry to avoid disclosing individual company operations.
[6] Includes Spring Mountain and Texas to avoid disclosing individual company operations.
[7] Figures withheld to avoid disclosing individual company operations.
[8] Average for 1944 and 1947; included with Central for 1945–46 and 1948 to avoid disclosing individual company operations.
[9] Less than 1 ton.

TABLE 7.—Mine production of recoverable copper in the United States, 1943–53, with production of maximum year, and cumulative production from earliest record to end of 1953, by States, in short tons

State	Maximum production[1]		Production by years											Total production from earliest record to end of 1953
	Year	Quantity	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	
Western States and Alaska:														
Alaska	1916	59,927	27	2	5	2	12	16	4	6	1			685,905
Arizona	1951	415,870	403,181	358,303	287,203	289,223	366,218	375,121	359,010	403,301	415,870	395,719	393,525	13,886,856
California	1909	28,644	8,762	12,721	6,473	4,240	2,407	481	649	646	921	800	382	632,110
Colorado	1938	14,171	1,028	1,048	1,485	1,754	2,150	2,298	2,403	3,141	3,212	3,606	2,941	270,462
Idaho	1907	5,445	2,324	1,688	1,548	1,038	1,640	1,624	1,438	2,107	2,160	3,213	3,136	123,105
Montana	1916	176,464	134,525	118,190	88,506	58,481	57,900	58,252	56,611	54,478	57,406	61,948	77,617	7,002,565
Nevada	1942	83,663	71,068	61,232	52,595	48,616	49,603	45,242	38,058	52,569	56,474	57,537	61,850	2,144,001
New Mexico	1942	80,100	76,163	69,730	56,571	50,191	60,205	74,687	55,388	66,300	73,558	76,112	72,477	1,828,926
Oregon	1916	1,791	6	3	1	7	14	2	20	19	11	1	9	12,419
South Dakota	1918	32		1										106
Texas	1928	224	81	115	55	3	6	23	24	2	1	18		1,383
Utah	1943	323,989	323,989	282,575	226,376	114,284	266,533	227,007	197,245	278,630	271,086	282,894	269,496	6,693,332
Washington	1940	9,612	7,315	6,169	5,821	4,527	2,240	5,665	5,275	5,057	4,089	4,357	3,740	109,349
Wyoming	1900	2,102				1							1	16,327
Total			1,028,469	911,777	726,639	572,367	808,928	790,418	716,125	866,256	884,789	886,205	885,174	33,406,846
West Central States: Missouri	1949	3,670	1,340	3,302	3,399	1,857	1,760	2,370	3,670	2,982	2,422	2,576	2,374	[2] 37,832
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	46,764	42,421	30,401	21,663	24,184	27,777	19,506	25,608	24,979	21,699	24,097	4,987,340
New Hampshire	1908	[4] 94												(3)
North Carolina	1930	6,695	1,112	282										(3)
Pennsylvania	1942	6,410	5,175	4,942	3,565	2,839	3,613	5,347	3,974	4,142	5,297	3,485	3,027	(3)
South Carolina	(3)	(3)	(5)											(3)
Tennessee	1930	10,584	7,568	7,636	6,959	6,985	6,825	6,693	6,489	6,851	7,069	7,620	7,829	(3)
Vermont	1953	3,947	290	1,898	1,861	3,026	2,248	2,208	2,986	3,504	3,774	3,774	3,947	(3)
Virginia	1944	291	100	291	70		5							(3)
Wisconsin	1914	5												(2)
Total			61,009	57,470	42,856	34,513	36,875	42,025	32,955	40,105	41,119	[6] 36,578	38,900	[7] 5,657,191
Grand total	1943	1,090,818	1,090,818	972,549	772,894	608,737	847,563	834,813	752,750	909,343	928,330	[6] 925,359	926,448	[8] 39,101,869

[1] For Missouri and States east of the Mississippi, maximum since 1905.
[2] Small quantity for Wisconsin included with Missouri. [3] Data not available.
[4] The 1908 volume of Mineral Resources credits this figure to Massachusetts and New Hampshire; the 1909 volume credits it to New Hampshire alone.
[5] Less than 0.5 ton. [6] Revised figure.
[7] For States other than Michigan, figures represent largely smelter output. Excludes small quantity, not separable, for Wisconsin shown with Missouri.
[8] Largely smelter production for States east of the Mississippi except Michigan.

TABLE 8.—Twenty-five leading copper-producing mines in the United States in 1953, 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	Butte Mines	Summit Valley (Butte)	Montana	Anaconda Copper Mining Co	Copper, lead-zinc ores.
4	Chino	Central	New Mexico	Kennecott Copper Corp	Copper ore.
5	New Cornelia	Ajo	Arizona	Phelps Dodge Corp	Do.
6	Ray	Mineral Creek (Ray)	do	Kennecott Copper Corp	Do.
7	Inspiration	Globe-Miami	do	Inspiration Consolidated Copper Co	Do.
8	Ruth Pit	Robinson (Ely)	Nevada	Kennecott Copper Corp	Do.
9	Copper Queen	Warren (Bisbee)	Arizona	Phelps Dodge Corp	Copper, lead-zinc ores.
10	Miami	Globe-Miami	do	Miami Copper Co	Copper ore.
11	Magma	Pioneer (Superior)	do	Magma Copper Co	Do.
12	Castle Dome	Globe-Miami	do	Castle Dome Copper Co., Inc	Do.
13	Calumet & Hecla, Inc	Lake Superior	Michigan	Calumet & Hecla, Inc	Copper ore and tailings.
14	Morris Brooks Pit	Robinson (Ely)	Nevada	Consolidated Coppermines Corp	Copper ore.
15	Bagdad	Eureka (Bagdad)	Arizona	Bagdad Copper Corp	Do.
16	Ruth Pit Extension	Robinson (Ely)	Nevada	Consolidated Coppermines Corp	Do.
17	Kimbley Pit	do	do	Kennecott Copper Corp	Do.
18	Burra Burra, Calloway, Mary, Eureka, Boyd.	Polk County	Tennessee	Tennessee Copper Co	Copper-zinc ore.
19	Elizabeth	Orange County	Vermont	Vermont Copper Co., Inc	Copper ore.
20	Holden	Chelan Lake	Washington	Howe Sound Co	Copper-zinc ore.
21	Cornwall	Lebanon County	Pennsylvania	Bethlehem Steel Co	Magnetite-pyrite-chalcopyrite ore.
22	Champion	Lake Superior	Michigan	Copper Range Co	Copper ore.
23	Quincy	do	do	Quincy Mining Co	Copper-ore tailings.
24	Republic & Mammoth	Cochise	Arizona	Coronado Copper & Zinc Co	Copper-zinc ore.
25	Treasury Tunnel-Black Bear	Upper San Miguel	Colorado	Idarado Mining Co	Do.

TABLE 9.—Copper ore sold or treated in the United States in 1953, with copper, gold, and silver content in terms of recoverable metal [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			
Arizona	45,187,838	738,404,453	0.82	89,724	3,164,255	$0.13
California	8,454	308,600	1.83	307	1,696	1.45
Colorado	172	6,200	1.80	15	118	3.67
Idaho	66,299	1,828,300	1.38	666	23,429	.67
Michigan [2]	4,192,717	48,194,000	.57			
Montana	4,185,818	143,527,716	1.71	6,180	2,088,054	.50
Nevada	7,758,298	123,235,700	.79	60,859	187,801	.30
New Mexico	7,866,633	116,589,538	.74	1,593	107,668	.02
Oregon	59	16,000	13.56	19	72	12.37
Tennessee [3]	1,138,201	15,658,000	.69	293	68,935	.06
Utah	29,923,397	509,376,250	.85	441,623	3,412,050	.62
Vermont	292,047	7,894,000	1.35	171	43,128	.15
Washington [4]	445,010	7,398,000	.83	16,262	66,747	1.41
Wyoming	2	2,000	50.00		11	5.00
Total	101,064,945	1,712,438,757	.85	617,712	9,163,964	.30

[1] Excludes copper recovered from precipitates as follows: Arizona, 40,434,847 pounds; California, 76,100 pounds; Montana, 5,123,337 pounds; Nevada, 214,300 pounds; New Mexico, 27,627,951 pounds; Utah, 25,521,370 pounds.
[2] Includes tailings.
[3] Copper-zinc ore.
[4] Includes ore classed as copper-zinc ore and copper, gold, and silver recovered therefrom.

TABLE 10.—Copper ore concentrated in the United States in 1953, with content in terms of recoverable copper

State	Ore concentrated (short tons)	Recoverable copper content	
		Pounds	Percent
Arizona	[1] 40,996,882	[2] 621,892,697	0.76
California	7,800	260,800	1.67
Colorado	170	6,000	1.76
Idaho	64,680	1,700,000	1.31
Michigan [3]	4,192,717	48,194,000	.57
Montana	4,108,946	140,641,219	1.71
Nevada	7,666,918	120,620,600	.79
New Mexico	7,759,363	114,146,656	.74
Tennessee [4]	1,138,201	15,658,000	.69
Utah	29,922,200	509,250,000	.85
Vermont	292,047	7,894,000	1.35
Washington [5]	444,979	7,394,000	.83
Total	96,594,903	1,587,657,972	.82

[1] In addition 3,576,794 tons were treated by straight leaching.
[2] In addition 62,816,474 pounds of copper were recovered by straight leaching.
[3] Includes tailings.
[4] Copper-zinc ore.
[5] Mostly copper-zinc ore.

The figures for smelter production shown in table 13 are based upon voluntary reports from all primary smelters handling copper-bearing materials produced in the United States. Blister copper is accounted for in terms of fine-copper content. Some casting and electrolytic copper produced from ore or matte is included in the smelter production, as well as in the refinery output. In the case of Michigan, furnace-refined copper is included. Metallic and cement copper recovered by leaching is included in smelter production.

TABLE 11.—Copper ore shipped to smelters in the United States in 1953, 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	
Arizona	614,162	53,695,282	4.37	[1] 787,050,000
California	654	47,800	3.65	764,000
Colorado	2	200	5.00	5,882,000
Idaho	1,619	128,300	3.96	6,272,000
Michigan				48,194,000
Missouri				4,748,000
Montana	76,872	2,886,497	1.88	[1] 155,234,000
Nevada	91,380	2,615,100	1.43	[1] 123,700,000
New Mexico	107,270	2,442,882	1.14	[1] 144,954,000
Oregon	59	16,000	13.56	18,000
Pennsylvania				[2] 6,054,000
Tennessee				15,658,000
Utah	1,197	126,250	5.27	[1] 538,992,000
Vermont				7,894,000
Washington	31	4,000	6.45	7,480,000
Wyoming	2	2,000	50.00	2,000
Total	893,248	61,964,311	3.47	1,852,896,000

[1] Considerable copper was recovered from precipitates.
[2] From magnetite-pyrite-chalcopyrite ore.

TABLE 12.—Copper ores [1] produced in the United States, 1944–48 (average) and 1949–53, 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
1944–48 (average)	1,021,343	3.63	76,450,666	0.90	80,672,583	0.93	0.0053	0.107	$0.27
1949	645,520	3.46	72,019,010	.89	76,032,531	.91	.0057	.093	.28
1950	624,261	3.37	90,206,169	.88	94,585,792	.89	.0062	.089	.30
1951	776,558	3.63	91,021,243	.87	95,494,214	.90	.0059	.088	.29
1952	904,486	3.27	95,307,233	.82	99,947,492	.85	.0057	.082	.27
1953	893,248	3.47	96,594,903	.82	101,064,945	.85	.0061	.091	.30

[1] Includes old tailings, smelted or retreated, etc., for 1944–52.
[2] Includes some ore classed as copper-zinc ore.
[3] Includes copper ore leached.

TABLE 13.—Copper produced (smelter output from domestic ores) in the United States, 1944–48 (average) and 1949–53, and total, 1845–1953

Year	Short tons	Value [1] (thousands of dollars)
1944–48 (average)	818,222	264,107
1949	757,931	298,625
1950	911,352	379,122
1951	930,774	450,495
1952	927,365	448,845
1953	943,391	541,506
Total 1845–1953	39,207,403	12,433,842

[1] Excludes bonus payments of Office of Metals Reserve under Premium Price Plan in effect Feb. 1, 1942 to June 30, 1947.

The quantity and value of copper produced from domestic ores by smelters in the United States are shown by years for 1845–1930 in Mineral Resources of the United States, 1930, part 1 (p. 703).

Refinery Production.—The refinery output of primary copper in the United States in 1953 was made by 13 plants; 9 of these employed the electrolytic method only, 2 the furnace process on Lake Superior copper, and 1 used both the electrolytic and furnace methods. One western smelter fire refined most of its blister.

Five large electrolytic refineries are 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.; virtually all of the plant output was treated by this method in 1949. A small part went as blister to electrolytic refineries in 1953. The El Paso plant of the Phelps Dodge Refining Corp. produced fire-refined copper in addition to the electrolytic grade.

TABLE 14.—Copper smelters and refineries in the United States in 1953

[Plants that treat primary crude materials exclusively or chiefly]

Location	Company	Final product
Arizona:		
Ajo	Phelps Dodge Corp., 40 Wall St., New York 5, N. Y.	Blister.
Morenei	do	Do.
Douglas	do	Do.
Hayden	American Smelting & Refining Co., 120 Broadway, New York 5, N. Y.	Do.
Inspiration	Inspiration Consolidated Copper Co., 25 Broadway, New York 4, N. Y.	Electrolytic.
Miami	International Smelting & Refining Co., 25 Broadway, New York 4, N. Y.	Blister.
Superior	Magma Copper Co., Superior, Ariz	Do.
Maryland: Baltimore	American Smelting & Refining Co., 120 Broadway, New York 5, N. Y.	Electrolytic.
Michigan:		
Hancock	Quincy Mining Co., 63 Wall St., New York 5, N. Y.	Lake.
Hubbell	Calumet Div., Calumet & Hecla, Inc., Calumet, Mich.	Do.
Montana:		
Anaconda	Anaconda Copper Mining Co., 25 Broadway, New York 4, N. Y.	Blister.
Great Falls	do	Electrolytic.
Nevada: McGill	Kennecott Copper Corp., 161 E. 42d St., New York 17, N. Y.	Blister.
New Jersey:		
Carteret	American Metal Co., 61 Broadway, New York 6, N. Y.	Blister and electrolytic.
Perth Amboy	American Smelting & Refining Co., 120 Broadway, New York 5, N. Y.	Electrolytic.
Do	International Smelting & Refining Co., 25 Broadway, New York 4, N. Y.	Do.
New Mexico: Hurley	Kennecott Copper Corp., 161 E. 42d St., New York 17, N. Y.	Blister and fire-refined.
New York: Laurel Hill	Phelps Dodge Refining Corp., 40 Wall St., New York 5, N. Y.	Blister and electrolytic.
Tennessee: Copperhill	Tennessee Copper Co., 61 Broadway, New York 6, N. Y.	Blister.
Texas:		
El Paso	American Smelting & Refining Co., 120 Broadway, New York 5, N. Y.	Do.
Do	Phelps Dodge Refining Corp., 40 Wall St., New York 5, N. Y.	Electrolytic and fire-refined.
Utah:		
Garfield	American Smelting & Refining Co., 120 Broadway, New York 5, N. Y.	Blister.
Do	Kennecott Copper Corp., 161 E. 42d St., New York 17, N. Y.	Electrolytic.
Washington: Tacoma	American Smelting & Refining Co., 120 Broadway, New York 5, N. Y.	Blister and electrolytic.

The leaching plant of the Inspiration Consolidated Copper Co. at Inspiration, Ariz., is not, strictly speaking, a refinery, although so listed here; it produces electrolytic copper direct from leaching solutions. At one time all this copper was shipped as cathodes to other refineries, where it was melted and cast into merchant shapes. In 1946, however, over one-third went directly to consuming plants. In 1947 and 1948 the practice was continued on a considerably reduced scale, virtually ceased in 1949, but was resumed in 1950–53.

These 13 plants constitute what commonly are termed "primary refineries."

Copper-refining capacity in the United States, Canada, and Mexico is shown in table 15.

TABLE 15.—Annual capacity (in short tons) of primary refineries in the United States, Canada, and Mexico, in 1953 [1]

	Electrolytic	Lake	Fire refined
United States:			
American Metal Co., Ltd., Carteret, N. J.	144,000		56,000
American Smelting & Refining Co.:			
Baltimore, Md.	198,000		
Perth Amboy, N. J.	168,000		
Tacoma, Wash.	120,000		
Anaconda Copper Mining Co., Great Falls, Mont.	150,000		
Calumet & Hecla, Inc., Hubbell, Mich.		100,000	
Inspiration Consolidated Copper Co., Inspiration, Ariz.	39,000		
International Smelting & Refining Co., Perth Amboy, N. J.	240,000		
Kennecott Copper Corp.:			
Hurley, N. Mex.			72,000
Garfield, Utah	192,000		
Phelps Dodge Refining Corp.:			
Laurel Hill, N. Y.	140,000		
El Paso, Tex.	240,000		25,000
Quincy Mining Co., Hancock, Mich.		12,000	
	1,631,000	112,000	153,000
Canada:			
Canadian Copper Refiners, Ltd., Montreal, East, Quebec	140,000		
International Nickel Co. of Canada, Ltd., Copper Cliff, Ontario	168,000		
	308,000		
Mexico: Cobre de Mexico, S. A., Atzcapotzalco, D. F.	43,000		
Casting capacity	**United States**	**Canada**	**Mexico**
1. Electrolytic (including scrap)	1,739,000	308,000	43,000
2. Lake	112,000		
3. Fire refined (in addition to capacity reported under item 1)	153,000		
Total	2,004,000	308,000	43,000

[1] From 1953 Yearbook of American Bureau of Metal Statistics.

In addition to the primary refineries, many plants throughout the country operate on scrap exclusively, producing metallic copper and a variety of alloys. The output of these secondary plants is not included in the statements of refined copper production in tables 16 and 17 but is included in table 19 on secondary-copper production.

TABLE 16.—Primary and secondary copper produced by primary refineries in the United States, 1944–48 (average) and 1949–53, in short tons

	1944–48 (average)	1949	1950	1951	1952	1953
Primary:						
From domestic ores, etc.: [1]						
Electrolytic	706,637	606,826	821,803	835,419	819,539	826,086
Lake	28,734	17,608	29,555	25,309	21,681	23,671
Casting	84,080	70,581	69,390	90,831	81,972	82,475
Total	819,451	695,015	920,748	951,559	923,192	932,232
From foreign ores, etc.: [1]						
Electrolytic	268,775	232,912	319,086	255,429	254,504	353,727
Casting and best select	6,947					7,158
Total refinery production of new copper	1,095,173	927,927	1,239,834	1,206,988	1,177,696	1,293,117
Secondary:						
Electrolytic [2]	146,444	196,850	173,063	127,347	113,827	166,802
Casting	14,174	15,542	16,683	7,676	8,549	22,783
Total secondary	160,618	212,392	189,746	135,023	122,376	189,585
Grand total	1,255,791	1,140,319	1,429,580	1,342,011	1,300,072	1,482,702

[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 17.—Copper cast in forms at primary refineries in the United States, 1951–53

Form	1951		1952		1953	
	Thousands of short tons	Percent	Thousands of short tons	Percent	Thousands of short tons	Percent
Wire bars	774	58	767	59	829	56
Cathodes	146	11	138	11	190	13
Billets	141	10	137	10	172	11
Ingots and ingot bars	142	11	139	11	150	10
Cakes	119	9	108	8	130	9
Other forms	20	1	11	1	12	1
Total	1,342	100	1,300	100	1,483	100

TABLE 18.—Production, shipments and stocks of copper sulfate in 1944–48 (average) and 1949–53, in short tons

Year	Production		Shipments (gross weight)	Stocks at end of year [1] (gross weight)
	Gross weight	Copper content		
1944–48 (average)	108,340	27,091	103,420	10,940
1949	79,000	19,749	84,400	6,400
1950	87,300	21,814	91,300	2,200
1951	106,944	26,736	104,260	4,888
1952	94,536	23,634	92,472	6,884
1953	72,944	18,236	72,188	7,072

[1] Some small quantities are purchased and used by producing companies, so that the figures given do not balance exactly.

Copper Sulfate.—Production and shipments of copper sulfate in 1953 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 72,200 tons (92,500 in 1952) producers' reports indicated that 19,900 tons (26,100) were for agricultural, 18,000 (24,000) for industrial, and 34,300 (42,400) for other purposes, chiefly for export. Inventory changes were slight; at the end of the year stocks were higher than in the period 1949–52, inclusive, but were low in relation to years before 1949.

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 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 19 summarizes the production of secondary copper during 1944–53. Refined copper produced from scrap at primary refineries is included in the "unalloyed" class. Detailed information appears in the Secondary Metals—Nonferrous chapter of this volume.

TABLE 19.—Secondary copper produced in the United States, 1944–48 (average) and 1949–53, in short tons

	1944–48 (average)	1949	1950	1951	1952	1953
Copper recovered as unalloyed copper	187,804	250,089	260,704	186,462	173,904	242,855
Copper recovered in alloys [1]	751,303	463,054	716,535	745,820	729,293	715,609
Total secondary copper	939,107	713,143	977,239	932,282	903,197	958,464
From new scrap	465,287	329,595	492,028	474,158	488,562	529,076
From old scrap	473,820	383,548	485,211	458,124	414,635	429,388
Percentage equivalent of domestic mine output	116	95	107	100	98	103

[1] Includes copper in chemicals, as follows: 1944–48 (average), 17,533; 1949, 14,840; 1950, 17,413; 1951, 22,905; 1952, 15,388; 1953, 21,550.

CONSUMPTION

Apparent consumption of primary copper, which includes shipments to the National Stockpile when there are any, increased 6 percent in 1953. After February copper was released from allocation control although provision was made for defense and Atomic Energy Commission needs.

Thus the comparison between 1952 and 1953 was between a year under complete allocation control and one virtually free from controls. In 1952 a substantial part of the copper wanted for civilian purposes was not obtainable, but in 1953 copper was available for all needs before the middle of the year; probably only restrictive action of the Chilean Government regarding prices prevented a substantial surplus from developing.

Actual consumption of refined copper was virtually unchanged in 1953 as compared with 1952 and only slightly higher than in 1951 and 1950. In all but 1953, however, consumption was restricted by Government control to the quantity of metal available. Distribution of consumption by principal consuming groups followed the pattern of recent years with wire mills accounting for 50 percent of the total and brass mills 46 percent (1952 percentages were identical). Unlike table 20, in which all but new copper is eliminated so far as possible, table 21 does not distinguish between new and old copper but covers all copper consumed in refined form.

Some copper precipitates are used directly in the manufacture of paint and other items. The figures may not be shown separately and are not covered by table 21, which relates to refined copper only.

TABLE 20.—New refined copper withdrawn from total year's supply on domestic account, 1949–53, in short tons

	1949	1950	1951	1952	1953
Production from domestic and foreign ores, etc.	927,927	1,239,834	1,206,988	1,177,696	1,293,117
Imports [1]	275,811	317,363	238,972	346,960	274,777
Stock at beginning of year [1]	67,000	61,000	26,000	35,000	26,000
Total available supply	1,270,738	1,618,197	1,471,960	1,559,656	1,593,894
Copper exported [1]	137,827	144,561	133,305	174,135	109,510
Stock at end of year [1]	61,000	26,000	35,000	26,000	49,000
Total	198,827	170,561	168,305	200,135	158,510
Apparent withdrawals on domestic account [2]	1,072,000	1,447,000	1,304,000	1,360,000	1,435,000

[1] May include some copper refined from scrap.
[2] Includes copper delivered by industry to the National Stockpile.

TABLE 21.—Refined copper consumed in 1951–53, by classes of consumers, in short tons

Class of consumer	Cathodes	Wire bars	Ingots and ingot bars	Cakes and slabs	Billets	Other	Total
1951:							
Wire mills	23	692,656	17,311	152		57	710,199
Brass mills	131,531	72,415	124,614	187,041	135,058	308	650,967
Chemical plants			261			2,962	3,223
Secondary smelters	6,953	375	5,985	216	4	211	13,744
Foundries and miscellaneous	5,890	368	22,570	302	764	8,838	38,732
Total	144,397	765,814	170,741	187,711	135,826	12,376	1,416,865
1952:							
Wire mills	11	727,257	11,977	209		33	739,487
Brass mills	134,613	57,456	163,190	185,138	134,223	453	675,073
Chemical plants			279			3,440	3,719
Secondary smelters	8,819	8	13,203	326		562	22,918
Foundries and miscellaneous	5,947	130	23,953	161	624	7,720	38,535
Total	149,390	784,851	212,602	185,834	134,847	12,208	1,479,732
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

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.

Data on refined copper contained in shipments of copper-base mill and foundry products, by industry groups, in the fourth quarter of 1951 through the second quarter of 1953, were compiled by the Business and Defense Services Administration and published[3] in 1954. The figures are summarized in table 22.

TABLE 22.—Shipments of copper-base mill and foundry products, in the fourth quarter of 1951 through the second quarter of 1953, by industry groups, in million pounds—refined-copper content

Industry	1951		1952		1953	
	October–December	Percent of total	January–December	Percent of total	January–June	Percent of total
Direct military	79	11.7	392	14.2	177	11.4
Construction:						
Defense Electric Power Administration	42	6.2	171	6.2	88	5.7
Communications	34	5.0	127	4.6	71	4.6
Other	68	10.1	301	10.9	162	10.5
Total construction	144	21.3	599	21.7	321	20.8
Building materials	18	2.7	74	2.7	55	3.6
Communications equipment	10	1.5	40	1.4	25	1.6
Consumer durable goods	18	2.7	80	2.9	59	3.8
Electrical equipment	106	15.7	391	14.1	219	14.2
Electronics	13	1.9	54	2.0	37	2.4
Engines and turbines	9	1.3	36	1.3	19	1.2
General components	33	4.9	125	4.5	73	4.7
General industrial equipment	18	2.7	69	2.5	47	3.0
Metalworking equipment	10	1.5	42	1.5	19	1.2
Motor vehicles	63	9.3	244	8.8	159	10.3
Railroad equipment	12	1.7	44	1.6	24	1.6
Scientific and technical equipment	11	1.6	46	1.7	29	1.9
Other industries	29	4.3	79	2.9	46	3.0
Maintenance, repairs, operations	56	8.3	232	8.4	141	9.1
Other deliveries	47	6.9	215	7.8	96	6.2
Total	676	100.0	2,762	100.0	1,546	100.0

STOCKS

Industry stocks of refined and unrefined copper increased significantly in 1953.

Refined and unrefined stocks held by producers at the end of 1953 rose 29 percent over the low of 1952. Stocks of refined copper increased 88 percent over 1952 but except for 1950–52 were the lowest since 1915. Of the total stocks at the end of 1953, only 18 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

[3] United States Department of Commerce, Facts for Industry: Series BDSAF-84-2-3, June 1, 1954.

materials in process of refining at refineries. Table 23 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 23.—Stocks of copper at primary smelting and refining plants in the United States at end of year, 1948–53, in short tons

Year	Refined copper [1]	Blister and materials in process of refining [2]	Year	Refined copper [1]	Blister and material in process of refining [2]
1948	67,000	183,000	1951	35,000	182,000
1949	61,000	261,000	1952	26,000	185,000
1950	26,000	232,000	1953	49,000	223,000

[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 380,900 tons at the end of 1953 (a 15-percent increase over those on hand at the beginning of the year). Working stocks (see table 24) were 309,700 tons (6 percent more than those at the end of 1952). After accounting for unfilled sales of metal, the deficiencies in stocks in relation to unfilled orders dropped 128,900 tons to 74,700 tons at the end of 1953. Not since 1949 had stocks come so close to equaling unfilled orders.

Figures compiled by the Copper Institute show that domestic stocks of refined copper increased from 58,900 tons at the end of 1952 to 89,200 at the end of 1953. 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 de-

TABLE 24.—Stocks of copper in fabricators' hands at end of year, 1949–53, 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)
1949	354,992	82,793	285,298	189,407	−36,920
1950	290,241	92,372	288,392	313,052	−218,831
1951	280,402	32,147	295,385	303,050	−285,886
1952	331,499	32,652	292,157	275,608	−203,614
1953	380,881	25,022	309,664	170,917	−74,678

[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).

livered 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.

PRICES

Reports to the Bureau of Mines from copper-selling agencies indicated that 1,039,000 tons of domestic refined copper from primary and secondary materials was delivered to purchasers in 1953 at an average price (f.o.b. refinery, except for that part sold by the Kennecott Sales Corp., which sales were on the basis of copper delivered to consumers' plants) of 28.7 cents a pound. These figures are to be compared with 945,000 tons and 24.2 cents a pound in 1952 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 34.1 cents in 1953 and 33.6 (revised) in 1952.

TABLE 25.—Average weighted prices of copper deliveries, f. o. b. refinery, 1934–53 [1]

Year	Cents per pound	Year	Cents per pound
1934	8.0	1944	[2] 11.8
1935	8.3	1945	[2] 11.8
1936	9.2	1946	[2] 14.4
1937	12.1	1947	[2] 20.9
1938	9.8	1948	21.7
1939	10.4	1949	19.7
1940	11.3	1950	20.8
1941	[2] 11.8	1951	[3] 24.2
1942	[2] 11.8	1952	[3] 24.2
1943	[2] 11.8	1953	[3] 28.7

[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 (revised) in 1952, and 34.1 in 1953. In 1951–53 includes the copper delivered by Kennecott Copper Corp., on a delivered consumers' plant basis.

Prices again were the outstanding feature of the copper industry in 1953. Price controls did not include specific ceilings for copper, but under the General Ceiling Price Regulation the controlled price was substantially 24.5 cents a pound for electrolytic grade, delivered Connecticut Valley, when the year began. Foreign copper, on which there was no control, at the same time was selling for 36.5 cents. Price controls on copper and copper products were abandoned February 25; and thereafter, for a brief period, there was considerable confusion in regard to prices.

The Kennecott Copper Corp. immediately established a selling price for refined copper of 27.5 cents a pound, the Phelps Dodge Corp. quoted 28.5 cents, the leading custom smelter 32 cents, and later the Anaconda Copper Mining Co. established its price at the 32-cent level. Foreign copper continued at or near the 36.5-cent level. Thus, lifting price controls did not result in an immediate, uniform price structure. By the end of March, however, the three chief mine producers were quoting domestic copper at 30 cents a pound. Small producers and custom smelters were quoting up to 34.5 cents at the end of March, but this level included foreign copper in port. Domestic copper prices ranged from 29.5 to 30 cents at the end of April; and foreign copper, except Chilean, was at that approximate level. The three leading producers continued to quote the top of the range—30 cents beyond the end of the year, with other sellers of domestic and foreign copper, except Chilean, quoting that price or slightly less.

TABLE 26.—Average monthly quoted prices of electrolytic copper for domestic and export shipments, f. o. b. refineries, in the United States, 1952–53, in cents per pound

Month	1952			1953		
	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	27.425	24.37	24.200	34.780
February	24.37	24.200	27.425	25.25	24.968	34.783
March	24.37	24.200	27.425	30.36	29.289	34.451
April	24.37	24.200	27.425	30.55	29.902	32.863
May	24.37	24.200	27.908	29.72	29.683	29.710
June	24.37	24.200	34.586	29.75	29.688	29.699
July	24.37	24.200	34.815	29.72	29.687	29.482
August	24.37	24.200	34.904	29.24	29.611	29.254
September	24.37	24.200	34.824	29.37	29.623	28.688
October	24.37	24.200	34.751	29.48	29.598	28.522
November	24.37	24.200	34.681	29.62	29.651	28.848
December	24.37	24.200	34.780	29.62	29.673	29.061
Average for year	24.37	24.200	31.746	28.92	28.798	30.845

[1] American Metal Market.
[2] E&MJ Metal and Mineral Markets.

TABLE 27.—Average yearly quoted prices of electrolytic copper for domestic and export shipments, f. o. b. refineries, in the United States, 1944–53, in cents per pound

	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953
Domestic f. o. b. refinery [1]	11.87	11.87	13.92	21.15	22.20	19.36	21.46	24.37	24.37	28.92
Domestic f. o. b. refinery [2]	11.775	11.775	13.820	20.958	22.038	19.202	21.235	24.200	24.200	28.798
Export f. o. b. refinery [2]	11.700	11.700	14.791	21.624	22.348	19.421	21.549	26.258	31.746	30.845

[1] American Metal Market.
[2] E&MJ Metal and Mineral Markets.

The Chilean production of the three large American-controlled mines continued until December to be quoted at 35.5 cents a pound, f. a. s. Chilean ports, or at about 36.5 cents in the United States. This price was established in 1952 and held unchanged in 1953 by the Banco Central de Chile, which was vested by Chilean law with power to control the sale of copper for the Chilean Government. Beginning early in December Chilean copper was permitted by the Government to be quoted on the open market at 30 cents a pound. In August the Chilean Government authorized medium and small producers to export copper freely, but without recourse to Government subsidies if the price received were below 35.5 cents a pound in Chile.

The Office of Price Stabilization removed controls on prices of nonferrous scrap, primary lead, zinc, etc., on February 13, and for a short time immediately thereafter the prices of certain grades of scrap exceeded the controlled price for refined copper. This action in regard to scrap may well have hastened abandonment of price controls on primary copper and copper products.

In December the Phelps Dodge Corp. announced that, effective January 1954, the corporation and the Phelps Dodge Refining Corp. would sell copper on a uniform delivered price basis to all United States consuming points, and this method became representative of the industry. The Kennecott Copper Corp. began to sell on a delivered basis in August 1950.

In addition to the price-decontrol action another result of the more abundant supply situation in 1953 took place June 1 when the New York Commodity Exchange resumed trading in copper, after a recess of 2 years. Free trading in copper on the London Metal Exchange was resumed on August 5, after a lapse of nearly 14 years. Ever since World War II there had been considerable pressure from traders for reopening of copper sales on the Exchange.

London Price.—Table 28, giving average prices per long ton, was taken from Quin's Metal Handbook for 1953 (p. 107).

TABLE 28.—United Kingdom monthly average prices [1]

	1950			1951			1952			1953		
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
January	153	0	0	202	0	0	227	0	0	285	0	0
February	153	0	0	202	0	0	227	0	0	285	0	0
March	153	0	0	202	0	0	227	0	0	284	0	9
April	156	18	3	210	0	0	231	0	0	274	7	6
May	164	19	2	215	10	9	231	0	0	252	18	5
June	183	10	9	234	0	0	258	1	8	252	0	0
July	186	0	0	234	0	0	286	2	3	252	0	0
August	187	4	7	234	0	0	285	0	0	[2] 228	15	10
September	202	0	0	229	16	0	285	0	0	233	19	1
October	202	0	0	227	0	0	285	0	0	239	6	4
November	202	0	0	227	0	0	285	0	0	237	12	5
December	202	0	0	227	0	0	285	0	0	Not shown.		
Average	178	19	10	220	10	5	259	9	0	Not shown.		

[1] Electro, per ton, based on daily official quotation, excluding Sundays and public holidays. [2] From August, 1953, London Metal Exchange average settlement price for Standard Copper, to nearest penny.

The 1953 averages were equivalent to the following cents per pound (pounds sterling converted by using average monthly rates of exchange recorded by Federal Reserve Board):

January	35. 79	July	31. 67
February	35. 87	August	28. 75
March	35. 70	September	29. 27
April	34. 50	October	29. 98
May	31. 78	November	29. 82
June	31. 65		

FOREIGN TRADE [4]

Imports of copper were 9 percent higher in 1953 than in 1952 and doubtless would have been even greater except for the unprecedented Chilean price situation, described under Prices. As a result, Chile

[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.

failed to account for half or more of the total imports for only the second time in 13 years. Unrefined entries rose 48 percent, while refined imports decreased 21 percent, influenced both by the smaller percentage of imports from Chile and by the change in production methods at the Chuquicamata mine, Chile, where, beginning November 1952, both blister and refined copper were produced, in place of refined copper only, as previously.

Much of the foreign copper that entered the country was for refining and exportation or for refining, 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 1953 to treat foreign crude materials, both purchased and toll copper.

Exports of refined copper—the principal export class by a substantial margin—decreased 37 percent in 1953 and were the smallest since 1946. In April the Office of International Trade announced that no quantitative limit would be set for the second quarter of the year on the export of refined copper produced from foreign materials. No quotas were fixed for subsequent quarters, but throughout the year copper exports remained under licensing control.

TARIFF

Suspension of the 2-cent excise tax on copper was extended from February 15, 1953, to June 30, 1954, by a bill signed by President Eisenhower on February 14. The suspension of duties on nonferrous scrap metals expired June 30, and duties became effective automatically. The suspension was reinstated August 7, retroactive to June 30, 1953, and to continue until June 30, 1954.

IMPORTS

Total imports of unmanufactured copper rose 9 percent over 1952 and except for 1950 were the largest since the alltime record in 1945. All classes of copper shared in the increase except refined copper, which dropped 21 percent. Imports of blister copper gained 69 percent and accounted for 40 percent of total entries. The increase in unrefined copper was due substantially to greater receipts from Northern Rhodesia, which trebled the 1952 quantity, although those from Chile doubled.

TABLE 29.—Copper (unmanufactured) imported into the United States, 1944–48 (average) and 1949–53 [1]

[U. S. Department of Commerce]

Year	Contained copper (short tons)	Year	Contained copper (short tons)
1944–48 (average)	591,225	1951	489,135
1949	552,709	1952	[2] 618,880
1950	690,389	1953	677,069

[1] Data are "general" imports; that is, they include copper imported for immediate consumption plus material entering the country under bond.

[2] Revised figure.

Chile was, as usual, the chief source of supplies from abroad, accounting for 42 percent of the total but 22 percent less than 1952 and the smallest proportion since 1950. Canada, Northern Rhodesia, Mexico, and Peru were next in importance, supplying 16, 13, 10 and 4 percent, respectively. Receipts of refined copper from Chile were only about half of the 1952 quantity, but noteworthy increases were made in entries from Canada and Peru.

Cuba and the Philippines furnished smaller quantities of concentrates, but these changes were more than counterbalanced by increases in imports from Canada and elsewhere.

TABLE 30.—Copper (unmanufactured) imported into the United States, 1944–48 (average) and 1949–53, in short tons, in terms of copper content [1]

[U. S. Department of Commerce]

	Ore	Concentrates	Regulus, black or coarse copper, and cement copper	Unrefined, black, blister, and converter copper in pigs or converter bars	Refined in ingots, plates, or bars	Old and scrap copper fit only for remanufacture; and scale and clippings	Total
1944–48 (average)	8, 606	60, 405	16, 075	187, 025	315, 347	3, 767	591, 225
1949	6, 823	108, 814	2, 084	152, 376	275, 811	6, 801	552, 709
1950	2, 600	104, 168	3, 233	224, 222	317, 363	38, 803	690, 389
1951	2, 035	97, 591	3, 051	141, 922	238, 972	5, 564	489, 135
1952							
Australia	6	678					684
Bolivia	444	2, 647	6				3, 097
Canada	41	[2] 25, 529	811	26, 463	28, 326	762	[2] 81, 932
Chile	1, 592	10, 261	481	55, 544	294, 425		362, 303
Cuba	233	18, 688				1, 013	19, 934
France						1, 806	1, 806
Germany, West					8, 932		8, 932
Malta, Gozo, and Cyprus		5, 441					5, 441
Mexico	115	6, 355	1, 804	36, 832	5, 839	52	50, 997
Northern Rhodesia				28, 224	1		28, 225
Peru	557	8, 302	794	2	1, 662		11, 317
Philippines	(3)	[3] 14, 787					14, 787
Turkey				3, 779			3, 779
Union of South Africa		5, 251		3, 326		11	8, 588
Yugoslavia				8, 023	6, 810		14, 833
Other countries	[2] 210	204	4		965	[2] 842	[2] 2, 225
Total	[2] 3, 198	[2] 98, 143	3, 900	162, 193	346, 960	[2] 4, 486	[2] 618, 880
1953							
Australia	6	1, 038		9, 414	2, 543	40	13, 041
Belgian Congo					5, 799		5, 799
Belgium-Luxembourg					5, 540	75	5, 615
Bolivia	792	3, 163	17				3, 972
Canada	102	31, 373	1, 768	3, 494	67, 487	3, 223	107, 447
Chile	3, 234	12, 529		117, 520	147, 394	499	281, 176
Cuba	123	17, 634				449	18, 206
France						2, 160	2, 160
Germany, West					3, 570		3, 570
Malta, Gozo, and Cyprus		3, 680					3, 680
Mexico	357	8, 646	4, 310	44, 982	7, 513	10	65, 818
Northern Rhodesia				85, 264	2, 778		88, 042
Norway					4, 368	59	4, 427
Peru	746	8, 752	865		16, 157	3	26, 523
Philippines	(3)	[3] 13, 815					13, 815
Sweden				550	1, 603	64	2, 217
Turkey				11, 894			11, 894
Union of South Africa	1, 404	6, 008		166	666		8, 244
United Kingdom			56	326	1, 396	416	2, 194
Yugoslavia					7, 775		7, 775
Other countries	233	235	3		188	795	1, 454
Total	6, 997	106, 873	7, 019	273, 610	274, 777	7, 793	677, 069

1 Data are "general" imports; that is, they include copper imported for immediate consumption plus material entering the country under bond.
2 Revised figure.
3 Some copper in "Ore" and "Other" from Republic of the Philippines is not separately classified and is included with "Concentrates."

TABLE 31.—Copper imported for consumption in the United States, 1944–48 (average) and 1949–53, by classes[1]

[Quantity in terms of copper content]

[U. S. Department of Commerce]

Year	Ore		Concentrates[2]		Regulus, black or coarse copper, and cement copper		Unrefined, black, blister, and converter copper in pigs or converter bars		Refined in ingots, plates, or bars		Old and scrap copper fit only for remanufacture; and scale and clippings		Total value
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	
1944–48 (average)	3,973	$1,170,333	42,185	$11,923,117	6,669	$1,236,910	170,285	$49,649,229	314,744	$86,643,515	3,945	$1,232,531	$151,855,635
1949	6,890	2,500,307	115,061	43,299,684	2,006	904,225	153,097	55,286,823	276,273	110,647,508	6,765	2,436,889	215,075,436
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	274,110	182,190,014	7,827	4,017,577	425,538,413

[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 "Concentrates."

TABLE 32.—Copper (unmanufactured) imported into the United States, 1944–48 (average) and 1949–53, by countries, in short tons, in terms of copper content [1]

[U. S. Department of Commerce]

Country	1944–48 (average)	1949	1950	1951	1952	1953
Australia	843	941	1,307	1,143	684	13,041
Belgian Congo	31,500		103		(2)	5,799
Belgium-Luxembourg	18	273	[3] 474		646	5,615
Bolivia	5,358	4,671	5,220	4,449	3,097	3,972
Canada (including Newfoundland and Labrador)	54,389	82,821	82,365	54,554	[3] 81,932	107,447
Chile	350,485	285,386	292,215	268,359	362,303	281,176
Cuba	12,029	15,849	22,891	22,302	19,934	18,206
Ecuador	2,276	812	640			
France		[3] 158	3,801	1,587	1,806	2,160
Germany			44		[4] 8,932	[4] 3,570
Japan	645	1,167	54,400	1,908	223	
Malta, Gozo, and Cyprus	1,323	6,888	6,530	5,556	5,441	3,680
Mexico	62,199	64,706	62,748	47,878	50,997	65,818
Netherlands	158	234	352	47	41	175
Northern Rhodesia	[5] 24,225	[5] 27,244	[5] 87,300	43,717	28,225	88,042
Norway		[3] 37	4,098		1	4,427
Peru	29,636	22,316	28,502	10,054	11,317	26,523
Philippines	888	7,969	10,129	12,608	14,787	13,815
Sweden			57			2,217
Turkey	4,421	4,572	3,266		3,779	11,894
Union of South Africa	5,840	8,919	9,859	7,353	8,588	8,244
United Kingdom	872	1,925	940	6	37	2,194
Yugoslavia	2,523	14,727	10,998	6,223	14,833	7,775
Other countries	1,597	1,094	2,150	1,391	1,277	1,279
Total	591,225	552,709	690,389	489,135	[3] 618,880	677,069

[1] Data are "general" imports; that is, they include copper imported for immediate consumption plus material entering the country under bond.
[2] Less than 1 ton.
[3] Revised figure.
[4] West Germany.
[5] Tonnages credited to Southern Rhodesia by the U. S. Department of Commerce have been added to Northern Rhodesia, inasmuch as copper of the grades reported does not originate currently in Southern Rhodesia.

TABLE 33.—Old brass and clippings from brass or Dutch metal [1] imported for consumption in the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Year	Short tons		Value	Year	Short tons		Value
	Gross weight	Copper content			Gross weight	Copper content	
1944–48 (average)	42,085	29,423	$13,644,783	1951	6,523	4,945	$2,095,962
1949	23,486	16,038	5,543,476	1952	10,321	7,627	3,765,416
1950	37,537	27,585	7,952,578	1953	9,679	7,503	3,737,085

[1] For remanufacture.

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. Refined copper exports were 37 percent less than in 1952 and were the smallest since 1946. Most of the decrease was due to substantially lower exports to Canada and smaller shipments to the United Kingdom, Italy, West Germany, and France. Exports to Canada were abnormally large in 1952 owing to a labor strike at a Canadian refinery as a result of which Canadian copper that ordinarily would have been refined in Canada was shipped to the United States, refined, and returned in refined form.

Exports of old and scrap were at the highest level of all time. West Germany and Japan received most of the old and scrap shipped from the United States.

TABLE 34.—Copper exported from the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Year	Ore, concentrates, 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
1944–48 (average)	529	$216,384	174,313	$80,660,696	(2)	$1,632,584	174,842	[3] $82,509,664
1949	200	79,279	195,990	95,262,845	(2)	1,655,349	196,190	[3] 96,997,473
1950	616	222,592	192,339	86,711,592	(2)	1,502,917	192,955	[3] 88,437,101
1951	234	174,298	166,274	98,836,756	(2)	1,982,042	166,508	[3] 100,993,096
1952	648	494,930	212,390	155,121,116	(2)	211,201	213,038	[3] 155,827,247
1953	495	290,405	171,323	116,171,171	294	352,124	172,112	116,813,700

[1] Due to changes in classifications 1952–53 data not strictly comparable to earlier years.
[2] Weight not recorded.
[3] Includes value of other copper manufactures for which no weight is recorded.

TABLE 35.—Copper exported from the United States, 1944–48 (average) and 1949–53, in short tons

[U. S. Department of Commerce]

	Ore, concentrates, composition metal, and unrefined copper (copper content)	Refined in bars, ingots, or other forms	Rods	Old and scrap	Pipes and tubes	Plates and sheets	Wire and cable, bare [1]	Wire and cable insulated	Other copper manufactures [1]
1944-48 (average)	529	91, 961	3, 721	875	4, 986	4, 267	9, 552	58, 951	(2)
1949	200	137, 827	12, 678	8, 284	3, 344	1, 088	7, 881	24, 888	(2)
1950	616	144, 561	10, 073	9, 445	1, 988	581	7, 009	18, 682	(2)
1951	234	133, 305	521	7, 701	2, 160	572	7, 983	14, 032	(2)
1952	648	174, 135	1, 937	8, 941	2, 591	553	7, 163	17, 070	(2)
1953									
Argentina	----	4, 353	----	----	65	(3)	6	53	----
Australia	----	100	----	----	3	3	30	25	----
Austria	----	286	----	683	----	----	58	2	----
Belgium-Luxembourg	----	560	(3)	----	66	(3)	47	77	6
Brazil	----	9, 635	(3)	----	24	30	326	288	83
Canada	----	763	185	3, 661	413	55	1, 783	1, 092	174
Chile	----	7	1	----	9	9	133	648	14
Colombia	----	29	2	----	61	47	300	1, 240	1
Cuba	----	3	2	----	131	9	399	941	(3)
Denmark	----	917	56	----	----	----	10	6	----
France	----	17, 834	1	----	3	(3)	3	122	----
Germany, West	286	12, 035	----	12, 352	1	----	13	2	----
Greece	----	84	----	----	1	(3)	294	40	----
India	----	1, 830	----	244	24	----	89	316	1
Israel	----	----	6	----	15	15	96	272	----
Italy	----	10, 971	----	1, 977	31	----	421	117	----
Japan	7	2, 350	----	15, 539	13	----	670	213	----
Mexico	202	35	43	----	74	68	206	869	3
Netherlands	----	11, 362	----	6	----	----	11	19	----
Norway	----	3, 266	----	----	27	----	128	45	----
Pakistan	----	1, 430	----	----	3	1	33	7	----
Peru	----	1	1	----	123	8	57	454	9
Philippines	----	1	6	----	113	10	377	1, 085	(3)
Spain	----	----	----	56	6	(3)	422	24	(3)
Switzerland	----	6, 365	5	39	2	(3)	----	16	----
Taiwan	----	2, 176	----	----	2	1	54	998	----
Turkey	----	----	1	----	2	7	64	64	----
Union of South Africa	----	8	----	----	19	7	1, 366	194	----
United Kingdom	----	22, 367	----	11	1	----	----	26	----
Uruguay	----	176	----	----	17	12	26	10	----
Venezuela	----	1	1	----	236	18	352	1, 940	----
Other countries	----	565	11	----	137	67	1, 539	4, 417	3
Total: Short tons	495	109, 510	321	34, 568	1, 622	367	9, 313	15, 622	294
Value	$290, 405	$68, 572, 479	$271, 835	$17, 199, 337	$1, 975, 544	$453, 958	$6, 352, 613	$21, 345, 405	$352, 124

[1] Due to changes in classifications data for 1952 and 1953 not strictly comparable to earlier years.
[2] Weight not recorded.
[3] Less thanl ton.

TABLE 36.—Unfabricated copper-base alloy [1] ingots, bars, rods, shapes, plates, and sheets exported from the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Year	Short tons	Value	Year	Short tons	Value
1944–48 (average)	38,142	$14,895,942	1951	3,820	$2,951,881
1949	4,287	3,080,509	1952 [2]	5,514	5,424,662
1950	2,334	1,694,488	1953 [2]	4,520	3,596,654

[1] Includes brass and bronze.
[2] Due to changes in classifications data not strictly comparable to earlier years.

TABLE 37.—Copper-base alloys (including brass and bronze) exported from the United States, 1952–53, by classes

[U. S. Department of Commerce]

Class	1952		1953	
	Short tons	Value	Short tons	Value
Ingots	2,377	$1,944,895	2,620	$1,531,105
Scrap	6,261	2,359,726	33,613	13,038,182
Bars, rods, and shapes	2,212	2,370,947	1,259	1,231,791
Plates, sheets, and strips	925	1,108,820	641	833,758
Pipes and tubes	1,400	1,817,425	2,858	2,706,919
Pipe fittings	726	1,665,206	727	1,719,955
Plumbers' brass goods	(1)	5,247,885	2,657	6,454,039
Wire	1,532	2,337,592	634	1,334,035
Castings and forgings	739	964,860	607	912,032
Powders	62	73,969	66	88,499
Hardware	(2)	1,596,674	(2)	2,661,343
Semifabricated forms, not elsewhere classified	(2)	69,710	17	31,106
Other copper-base-alloy manufactures	(2)	569,113	(2)	420,893
Total	(2)	22,126,822	(2)	32,963,657

[1] Weight not recorded January through June; July through December 1,138 tons valued at $2,841,383.
[2] Weight not recorded.

TABLE 38.—Copper sulfate (blue vitriol) exported from the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Year	Short tons	Value	Year	Short tons	Value
1944–48 (average)	36,278	$4,190,927	1951	43,129	$8,753,641
1949	31,717	4,320,726	1952	43,421	8,482,870
1950	30,149	4,151,265	1953	32,659	6,250,121

TECHNOLOGY

Reports on the genesis of Northern Rhodesia copper deposits became available [5] during the year.

A recent paper [6] described the results of testing with colorimetric methods, using "dithizone," soil samples taken over various known copper and zinc deposits covered by glacial till. The method proved successful for copper and zinc deposits under clay and fine sand with depths up to 30 feet but fails in coarse sand and gravel unless depths are very shallow. Swamps require penetration to the underlying subsoil for sample material. Others did some work with the dithizone method but finally adopted methods which they described.[7]

Published information on the geology of the Johnson camp, northwestern Cochise County, Ariz., is limited, but a report was issued [8] in 1953.

In an article describing the geology, mining methods, etc., of the White Pine mine, Michigan, the author stated [9] as follows:

> Behind the Go-Ahead Signal for White Pine lay the solution of complex financial and metallurgical problems. Mineralogically and structurally in a class by itself among large copper deposits, there was the challenge of mining bedded ore too flat lying and too deep-seated to permit either block caving or open-pit mining. Operation and equipment more common to coal or phosphate are being adapted here to hard rock copper ore. Gearing men to machines for a new job with a tight construction schedule in a wilderness area calls for ingenuity, on-the-job training, and the best available equipment. A great deal of thought and planning has gone into the workings now taking shape beneath the townsite growing amidst the timberland in Ontonagon County, Mich.

A comparison of the various drills used in the Roan Antelope mine, Northern Rhodesia, was given in a report [10] published in 1952. Other reports [11] described drilling and drilling problems.

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[5] Garlick, W. G., Reflections on Prospecting and Ore Genesis in Northern Rhodesia: Bull. Inst. Min. and Met., vol. 63, No. 563, October 1953, pp. 9–20.
McNaughton, James H. M., The Origin of the Northern Rhodesia Copper Deposits: Bull Inst. Min. and Met., vol. 63, No. 565, December 1953, pp. 113–124.

[6] Bischoff, C. J., Testing for Copper and Zinc in Canadian Glacial Soils: Min. Eng., vol. 6, No. 1, January 1954, pp. 57–61.

[7] White, W. H., and Allen, T. M., Copper Soil Anomalies in the Boundary District of British Columbia: Min. Eng., vol. 6, No. 1, January 1954, pp. 49–52.

[8] Baker, Arthur, III, Localization of Pyrometasomatic Ore Deposits at Johnson Camp, Ariz.: Min. Eng., vol. 5, No. 12, December 1953, pp. 1272–1277.

[9] Moe, Richard F., White Pine Mine Development: Min. Eng., vol. 6, No. 4, April 1954, pp. 381–386.

[10] Wedgewood, H. J., Blast-Hole Diamond Drilling at the Roan Antelope Copper Mine: Jour. Chem. Met. and Min. Soc., South Africa, vol. 52, No. 10, part 2, April 1952, pp. 345–355.

[11] Squirrel, D. C., Problems in Diamond Drilling on the Copperbelt: Rhodesian Min. Rev., vol. 19, No. 2, February 1954, pp. 41–43, 45–46.
Dillon, R. B., Long Blast Hole Drilling by the Percussive Method at Roan Antelope Copper Mine, Northern Rhodesia: Inst. Min. and Met., vol. 63, part 7, No. 569, April 1954, pp. 321–332.
Lentz, John A., Jr., Blast Hole Drilling at New Cornelia: Min. Cong. Jour., vol. 40, No. 3, March 1954, pp. 37–39.
Sandvig, Robt. L., Push-Feed Drilling in the Butte Mines: Min. Cong. Jour., vol. 39, No. 12, December 1953, pp. 30–33 and 37.

A description of the Copper Cities deposit recently appeared.[12]

Stripping operations in progress during the year at the Veteran Pit of the Kennecott Copper Corp. in White Pine County, Nev., would have to remove 60 million tons of waste before the 20 million tons of ore, assaying less than 1 percent copper, could be mined.[13]

Over 80 percent of the copper ore and about 75 percent of the copper are produced by open-pit methods. Virtually the entire issue of a recent magazine [14] was concerned with open-pit mining.

Activity at porphyry copper deposits was at a peak in 1953 and was summarized.[15] References to other reports on the porphyry mines were given.

Tight-fitting enclosures are provided over all ore drops, crushing operations, and vibrating screens at the Ray crushing plant, Arizona, in an effort to control dust.[16]

Simplified materials handling and flexibility in solution flow featured the new leaching plant at Cananea, Mexico.[17]

A method for better testing of new flotation reagents appeared to be giving good results.[18]

Copper and zinc were recovered in Japan by use of the FluoSolid process.[19]

Developments in reverberatory furnace practice at the Noranda smelter, Quebec, over the period 1928 to 1953 were described [20] recently. Particular attention was given to:

> * * * those features which are characteristic of Canadian practice: first, the use of the suspended basic roof; second, the deliberate driving of furnaces to give tonnages in the range of 1,400 to 2,000 tons of solid charge per furnace day; and third, the continuous operation of furnaces at high tonnage for many years without any extended shutdown for repairs or rebuilding. * * *

Finally points of comparison and contrast between reverberatory furnace practice in Canada and the United States were discussed.

Over the years the smelting of copper concentrate witnessed few advances in furnace design according to an article [21] which stated as follows:

> In the construction of the individual furnaces some innovations are always being introduced. Among these are charging so that the work of smelting is a complete bath process, the use of suspended brick arches in place of sprung arches, the use of basic brick, not only in the crucible, but also in roof and sidewalls, the use of various means to feed the charge, the use of magnetite or other heavy material to construct the hearth, water cooling of bridgewall and slag skimming bay, the smelting of raw charge instead of calcine, the use of pre-heated air, and possibly the use of oxygen-enriched air for combustion. But the general outlines of the furnaces have not changed much except as to size.

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[12] Peterson, N. P., Copper Cities Copper Deposit, Globe-Miami District, Ariz.: Econ. Geol., vol. 49, No. 4, June-July 1954, pp. 362–377.

[13] Mining World, Kennecott Starts Waste Removal at Veteran Pit: Vol. 16, No. 1, January 1954, p. 93.

[14] Engineering and Mining Journal, Open-Pit Mining Guidebook: Vol. 155, No. 5, May 1954, pp. G1–BG31.

[15] Trischka, Carl, The 16 Southwest Porphyry Coppers Now in Period of Greatest Activity: Min. World, vol. 15, No. 13, December 1953, pp. 43–47.

[16] Knudsen, John F., Crushing Plant Dust Control at The Ray Mines Division, Kennecott Copper Corp.: Min. Eng., vol. 5, No. 7, July 1953, pp. 689–695.

[17] Weed, Robt. C., New Leaching Plant at Cananea: Eng. and Min. Jour., vol. 155, No. 4, April 1954, pp. 88–91.

[18] Davis, F. T., and Dorenfeld, A. C., Magma Copper Uses Factorial Design for Better Testing: Eng. and Min. Jour., vol. 154, No. 8, August 1953, pp. 97–99.

[19] Jessup, Alpheus W., How Dowa's Plant Extracts Cu-Zn from a Single Electrolyte: Eng. and Min. Jour., vol. 155, No. 1, January 1954, pp. 72–74.

[20] Anderson, J. N., Reverberatory Furnace Practice at Noranda: Jour. Metals, vol. 6, No. 6, June 1954, pp. 745–758.

[21] Slover, E. A., Hurley Furnace and Boiler Description and Design: Jour. Metals, vol. 5, No. 11, sec. 1, November 1953, pp. 1435–1441.

At the new Ajo smelter operation of a novel method of handling and charging wet concentrates to a deep-bath-type reverberatory furnace was said [22] to be yielding good results.

Current refractory practice at copper smelters was discussed in a recent article,[23] which indicated that the highest speeds of copper smelting had not yet been achieved. Extensive research to develop refractories capable of withstanding more severe treatment was continuing.

Another article [24] discussed practice at American Smelting & Refining Co. plants.

At the Copper Cliff smelter of the International Nickel Co. of Canada, Ltd., Canada, a new unit, permitting the treatment of all company copper concentrate by the oxygen-flash-smelting process which had been under investigation for several years, was put into operation by the year end.[25] An article [26] was published early in 1954.

Blister copper in one operation is the target at the Harjavalta (Finland) smelter of Outokumpo Oy, and the company metallurgists are coming close with their adaptation of flash smelting.[27]

The anode furnace of the Garfield smelter, Utah, was said [28] to be casting a greater tonnage than any other single plant in the world.

The Rönnskär (Sweden) plant was modernized with an objective, among others, of being able to handle as much as possible of the production during the day shift. As a consequence, the furnaces and casting machines are nearly 3 times as large as they would be if 3 shifts were to be utilized. A two-thirds reduction in the required labor force was claimed; and the plant, which includes an electric smelting furnace, was described.[29] The casting wheel in the refinery was of a special type permitting vertical as well as horizontal casting.

An article [30] on current requirements at the Carteret copper refinery of the United States Metals Refining Co. appeared in the press recently.

Rehabilitation of one of the copper refineries at Perth Amboy, N. J., was the subject of an article.[31]

At another Perth Amboy refinery expansion, by which copper cakes or slabs weighing from 1,800 to 3,000 pounds, compared with 840 pounds previously, were to be produced, was completed in 1953.[32]

Copper refining, rolling and drawing in a United Kingdom plant were the subject of a recent article.[33]

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[22] Byrkit, James W., Operations at New Cornelia Copper Smelter of Phelps Dodge Corporation: Jour. Metals, vol. 5, No. 4, May 1953, pp. 633–642.
[23] Rochow, William F., and McGill, Lincoln A., Current Refractory Practice as Applied in Copper Smelting: Jour. Metals, vol. 6, No. 3, March 1954, pp. 338–342.
[24] Archibald, F. W., Copper-Converting Practice at American Smelting and Refining Company Plants: Jour. Metals, vol. 6, No. 3, March 1954, pp. 358–360.
[25] International Nickel Co. of Canada, Ltd., Annual Report to Stockholders, 1953.
[26] Mining Engineering, Inco Flash Smelting Process on Commercial Basis: Vol. 6, No. 4, April 1954, pp. 361–362.
[27] Benitez, Fernando, Flash Smelting Improves Harjavalta's Metallurgy: Eng. and Min. Jour., vol. 154, No. 10, October 1953, pp. 76–80.
[28] Alston, N. R., and Winkel, M. J., Anode-Casting Operations at Garfield Smelter Geared to High Production: Jour. Metals, vol. 5, No. 9, September 1953, pp. 1075–1077.
[29] Herneryd, Olov, Sundstrom, Olaf A., and Norro, Allan, Copper Smelting in Boliden's Rönnskär Works Described: Jour. Metals, vol. 6, No. 3, March 1954, pp. 330–337.
[30] Meyer, Edwin M., Direct-Current Requirements at Carteret Copper Refinery Supplied by Three Units: Jour. Metals, vol. 6, No. 7, July 1954, pp. 811–813.
[31] Weis, G. H., Busch, D. A., Spaulding, H. K., and Paulding, G. B., Asarco Rehabilitates Copper Refinery: Jour. Metals, vol. 5, No. 4, May 1953, pp. 616–623.
[32] Steel, Anaconda's Raritan Expansion Completed: Vol. 133, No. 4, July 27, 1953, pp. 38–39.
[33] Metal Industry (London), Copper Refining, Rolling and Drawing: Vol. 83, No. 16, Oct. 16, 1953, pp. 315–318.

Better dimensional uniformity and improved soundness of rolled stock were said [34] to have resulted from use of a new reversing cold strip mill at the Chase Brass plant, Cleveland, Ohio.

Completion of a new plant for cladding metals at Carnegie, Pa., was to achieve several objectives, according to an article,[35] including increased production—from 30,000 to 80,000 tons, and reduced costs.

A report [36] published in 1953 contained a chapter on the control of quality in melting and casting copper and high-conductivity copper-base alloys.

Flexible, coiled copper tubing offers a means of obtaining high-capacity heat transfer in a small space.[37]

Specifications for cast copper-base alloys were recently summarized.[38]

Economic utilization of copper-base alloys, from the point of view of the foundryman and the user, was the subject of a recent article.[39]

The excellent ductility and heat conductivity of copper were said [40] to be employed to advantage in preparing high-capacity, small-volume heat exchangers for special application requiring operating pressures of 1,000 p. s. i.

An annual review [41] on engineering materials indicated that, with greater availability of the metal, efforts would be made to regain ground lost to substitutes. In many applications, it stated, copper was preferable to the replacement materials; in many, aluminum had taken a firm hold, and, in some cases, products were so designed as to permit a shuttling between copper and aluminum, dependent upon cost, supply, or any other condition. The article indicated that, because of scarcity, there had been little impetus to develop new alloys, but considerable effort to develop alloys that would permit savings of copper and nickel. A new alloy emerging from the experimental phase, and somewhat similar to beryllium copper in properties and uses, contains about 10 percent nickel, 1.5 percent silicon, and 4 percent aluminum. The new alloy is said to be easily formed in the solution-treated condition and can be hardened by aging to have a proportional limit of 85,000 p. s. i., a yield strength of 120,000 p. s. i., a tensile strength of 140,000 p. s. i., an elongation of 8 percent, and a modulus of elasticity of 19 million p. s. i. A possible use of the new alloy is making electrical contact springs for equipment, such as business machines.

WORLD REVIEW

World mine production continued at the alltime peacetime peak rate of 1952, which was as great as the war peak in 1943. This virtually unchanged total was achieved by 13- and 4-percent increases

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[34] Allen, Edw. C., Mill Speeds Rolling of Thin Copper Strip: Iron Age, vol. 172, No. 6, Aug. 6, 1953, pp. 143–145.

[35] Steel, New Mill Turns Out Bigger Copper-Clad Sandwiches: Vol. 133, No. 2, July 13, 1953, pp. 110, 112–115.

[36] Institute of Metals (London), The Control of Quality in the Production of Wrought Nonferrous Metals and Alloys: Monograph and Report Ser. 15, 1953, 88 pp.

[37] Materials and Methods, Fabricating Special Purpose Copper Heat Exchangers: Vol. 39, No. 3, March 1954, pp. 140–142.

[38] Materials and Methods, vol. 39, No. 2, February 1954, pp. 137, 139.

[39] Metal Industry (London), Economic Utilization of Copper-Base Alloys: Vol. 82, No. 25, June 19, 1953, pp. 499–501.

[40] Van Nieukirken, J.M., Fabricating Special Purpose Copper Heat Exchangers: Materials and Methods, vol. 39, No. 3, March 1954, pp. 140–142.

[41] DuMond, T. C., Annual Materials Engineering Review and Forecast: Materials and Methods, vol. 39, No. 1, January 1954, pp. 118, 119.

in Northern Rhodesia and Belgian Congo, which largely offset 10- and 3-percent decreases in Chile and Canada; production in the United States remained constant. Northern Rhodesia and Belgian Congo both established new high production records.

In the following discussion, covering areas outside of the United States, all figures have been converted to short tons for comparison with United States data. The world production tables 38 and 39, however, are shown as usual, in metric tons; but beginning with 1954, world-production tables, as well as world discussion, will be given in short tons.

Australia.—Smelter output almost doubled in 1953, chiefly because the new smelter at Mount Isa, Queensland, began operations in February. Mine production was 40,200 short tons, blister output 39,500 tons, and domestic refined output 16,400 tons. Much of the blister produced at Mount Isa for the time being was exported for refining on toll and return. It was said [42] to be likely that Mount Isa blister could be fire-refined up to acceptable standards and under that circumstance there would be no technical difficulty in refining all of Australia's output at home.

Austria.—The copper plant at Brixlegg was recently expanded; additions included a new roaster, a wirebar mill, and a new electrolytic plant. The new electrolytic plant has an annual capacity of nearly 9,000 short tons whereas the old plant was rated at 5,000 tons of cathodes.[43]

Belgian Congo.—Production increased 4 percent and established a new alltime peak for the fourth successive year. A total of 7,809,000 short tons of ore was extracted in 1953. The Union Minière du Haut Katanga, as heretofore, was the only copper producer in the country.

The following information was taken [44] from the company annual report to stockholders. The figures reported in metric tons have been converted and are shown here as short tons for comparison with other data in this report:

The Kolwezi concentrating plant treated 1,998,754 tons of copper and mixed ores to produce 323,947 tons of concentrate assaying 28.11 percent copper and 1.01 percent cobalt, and 36,844 tons of concentrate assaying 10.03 percent copper and 8.63 percent cobalt.

The Kipushi concentrator treated 1,037,780 tons of copper and copper-zinc ore, chiefly the latter, from the Prince Leopold mine. From the straight-copper ore there was produced 5,267 tons of 25.59-percent concentrate; the copper-zinc ore yielded 330,831 tons of 29.37-percent copper concentrate and 266,881 tons of 51.96-percent zinc concentrate.

The Ruwe concentrating plant treated 1,365,795 tons of ore from the Ruwe mine and produced 127,258 tons of concentrate with 26.18-percent copper and 108,998 tons of 6.91-percent copper material destined for further treatment.

The Kamoto washery treated 232,148 tons of copper-cobalt ores from various mines of the Western Group and recovered 9,488 tons of concentrate running 7.18 percent cobalt. The Ruashi washery

[42] Metal Bulletin (London), Australian Mineral Industry Review: No. 3907, July 6, 1954, pp. 11–12.
[43] Metal Bulletin (London), Austrian Expansion Completed: No. 3803, June 23, 1953, p. 22.
[44] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 2, August 1954, pp. 10–12.

TABLE 39.—World mine production of copper, by countries, 1944–48 (average) and 1949–53, in metric tons [1]

[Compiled by Pauline Roberts]

Country	1944–48 (average)	1949	1950	1951	1952	1953
North America:						
Canada (including Newfoundland)	215,177	239,003	239,685	244,912	234,087	228,257
Cuba	11,401	17,400	20,400	19,700	17,900	16,200
Mexico	57,320	57,246	61,699	67,351	58,463	60,148
United States	732,377	682,880	824.938	842,162	839,467	840,455
Total North America	1,016,275	996,529	1,146,722	1,174,125	1,149,917	1,145,060
South America:						
Bolivia (exports) [2]	6,250	5,074	4,704	4,846	4,703	4,463
Chile	440,275	371,095	362,757	379,726	404,742	363,130
Ecuador	[3] 2,070	704	526	2	--------	--------
Peru	25,893	27,959	30,050	32,274	30,448	34,378
Total South America	474,488	404,832	398,037	416,848	439,893	401,971
Europe:						
Austria	637	1,296	1,635	1,838	2,643	2,975
Finland	15,632	18,741	15,600	18,400	22,000	19,000
France	321	524	599	700	600	(4)
Germany:						
East [5]	[5] 15,930	10,000	10,000	12,000	15,000	15,000
West		864	1,379	1,669	2,352	2,052
Hungary	[5] 480	(4)	[5] 400	(4)	(4)	(4)
Italy	404	14	49	193	131	213
Norway	12,347	14,875	15,621	14,003	13,632	13,100
Spain [6] [7]	8,681	6,702	6,171	7,560	8,977	8,533
Sweden	14,878	16,273	16,100	14,447	15,876	13,204
U. S. S. R. [5] [8] [9]	154,000	200,000	218,000	254,000	295,000	303,000
Yugoslavia [9]	[5] 25,230	34,384	40,080	32,011	32,819	31,190
Total Europe [5] [8]	249,000	304,000	326,000	357,000	410,000	408,000
Asia:						
China [9]	797	1,874	[5] 4,000	[5] 6,000	[5] 6,000	[5] 8,000
Cyprus (exports) [2]	5,982	23,936	23,301	22,811	26,820	21,715
India	6,155	6,305	7,000	7,388	6,523	5,000
Japan	34,476	32,880	39,432	42,756	53,552	58,332
Korea, Republic of	990	28	27	6	500	1,400
Philippines	2,030	7,007	10,384	12,712	13,241	12,715
Saudi Arabia	66	49	41	(4)	(4)	(4)
Taiwan (Formosa)	1,034	[5] 1,000	[5] 1,000	[5] 1,000	[5] 1,000	260
Turkey	11,012	13,130	13,300	11,850	14,000	[5] 15,000
U. S. S. R.	(8)	(8)	(8)	(8)	(8)	(8)
Total Asia [5] [8] [10]	63,000	86,000	99,000	105,000	122,000	122,000
Africa:						
Algeria	24	--------	81	120	52	100
Angola	127	742	1,279	1,100	1,000	1,100
Belgian Congo [9]	155,178	141,399	175,920	191,959	205,749	214,148
French Morocco	261	360	18	28	808	1,090
Northern Rhodesia	208,066	259,084	297,487	319,373	329,481	372,679
Southern Rhodesia	141	80	117	95	109	211
South-West Africa	2,274	9,622	10,961	12,355	14,022	12,117
Tanganyika [11]	--------	--------	37	137	21	(12)
Union of South Africa	26,901	30,454	33,982	33,731	35,112	36,145
Total Africa	392,972	441,741	519,882	558,898	586,354	637,590
Australia	19,472	13,678	15,144	16,874	18,636	36,476
World total [5] [10]	2,220,000	2,250,000	2,510,000	2,630,000	2,730,000	2,750,000

[1] This table incorporates a number of revisions of data published in previous Copper chapters.
[2] Copper content.
[3] Based partly on United States imports.
[4] Data not available; estimate by authors of chapter included in continental and world totals.
[5] Approximate production.
[6] According to Yearbook of American Bureau of Metal Statistics.
[7] Does not include content of iron pyrites, the copper content of which may or may not be recovered.
[8] Output from U. S. S. R. in Asia included with U. S. S. R. in Europe.
[9] Smelter production.
[10] Includes estimates for Burma.
[11] Copper content of exports and local sales.
[12] Less than 0.5 ton.

TABLE 40.—World smelter production of copper, by countries, 1944–48 (average) and 1949–53, in metric tons [1]

[Compiled by Pauline Roberts]

Country	1944–48 (average)	1949	1950	1951	1952	1953
North America:						
Canada	190,928	205,098	216,094	222,682	178,098	213,900
Mexico	49,174	49,359	48,477	59,241	51,167	52,284
United States [2]	819,068	779,842	914,917	940,416	929,340	950,552
Total North America	1,059,170	1,034,299	1,179,488	1,222,339	1,158,605	1,216,736
South America:						
Chile	428,780	350,737	345,460	360,099	383,283	337,237
Ecuador [3]	1,930	------	------	------	------	------
Peru	20,247	21,119	23,227	24,351	20,539	23,408
Total South America	450,957	371,856	368,687	384,450	403,822	360,645
Europe:						
Austria	1,695	3,761	5,369	6,450	6,438	8,589
Finland	16,631	18,224	13,572	17,851	18,317	19,789
France [4]	128	(5)	(5)	(5)	(5)	(5)
Germany:						
East [6]	[6] 41,450	16,500	16,500	18,000	20,000	(5)
West [7]		145,536	202,500	212,868	194,784	218,337
Italy	182	30	18	185	175	284
Norway	5,407	9,306	9,035	8,656	10,009	12,071
Spain	6,398	6,155	4,945	4,995	4,599	6,159
Sweden	15,844	14,359	16,708	15,005	14,906	18,318
U. S. S. R. [6 8]	154,000	200,000	218,000	254,000	295,000	303,000
Yugoslavia	[6] 25,230	34,384	40,080	32,011	32,819	31,190
Total Europe [6 8 9]	268,000	448,000	527,000	570,000	600,000	635,000
Asia:						
China [7]	797	1,874	[6] 4,000	[6] 6,000	[6] 6,000	[6] 8,000
India	6,063	6,493	6,720	7,197	6,176	5,182
Japan	36,768	38,544	37,176	43,848	49,308	63,576
Korea:						
Korea, Republic of	[10] 497	308	17	222	34	20
North Korea	[6 11] 2,500	(5)	(5)	(5)	(5)	(5)
Taiwan (Formosa)	[10] 499	465	360	[6] 629	720	572
Turkey	10,403	11,283	11,700	17,526	23,330	23,760
Total Asia [6 8]	58,400	61,000	62,000	76,000	86,000	102,000
Africa:						
Angola	------	800	1,375	1,157	1,039	1,183
Belgian Congo	155,178	141,399	175,920	191,959	205,749	214,148
Northern Rhodesia	204,021	263,491	279,987	314,103	317,367	368,396
Spanish Morocco	------	------	266	127	75	57
Union of South Africa	26,161	29,717	33,342	32,922	34,203	34,995
Total Africa	385,360	435,407	490,890	540,268	558,433	618,779
Australia	[12] 19,091	9,988	15,667	15,486	20,329	35,859
World total [6]	2,240,000	2,360,000	2,645,000	2,810,000	2,825,000	2,970,000

[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: 1944–48 (average), 742,276 tons; 1949, 687,580; 1950, 826,760; 1951, 844,379; 1952, 841,287; 1953, 855,825.
[3] United States imports.
[4] Exclusive of material from scrap.
[5] Data not available; estimate by authors of chapter included in continental and world totals.
[6] Approximate production.
[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 1945–48.
[11] Average for 1946–47.
[12] Refined copper production; smelter output not available.

treated 72,972 tons of copper ore from small mines near Elisabethville and produced 20,979 tons containing 12.81 percent copper, some of which also had a little cobalt.

Owing to the greatly increased output of the Prince Leopold mine (and the use of sulfide concentrates from Kolwezi in the feeding of the Lubumbashi smelter) the company copper production rose by nearly 10,000 tons over the 1952 figure.

The output of copper was distributed as follows:

	Tons
Lubumbashi smelter (blister)	111, 831
Jadotville-Shituru (electrolytic plant)	118, 796
Jadotville-Panda (electric copper-cobalt alloy furnaces)	902
Copper recoverable contained in zinc concentrates exported	4, 493
Total	236, 022

Both the Lubumbashi smelter and the Shituru electrolytic plant were operated at near maximum capacity.

The company produced a grand total of 4,743,600 tons of copper from the beginning of operations through 1953.

Copper exported from Belgian Congo in 1953 is shown in table 41.

TABLE 41.—Copper exported from Belgian Congo in 1953, by classes and countries, in short tons [1]

Country	Wire bars	Ingots	Blister	Total
United States	6, 050		1, 090	7, 140
Belgium	39, 769	2, 170	96, 248	138, 187
France	26, 856	5, 216	4, 223	36, 295
Italy	10, 533			10, 533
Sweden	2, 150	909		3, 059
United Kingdom	4, 480			4, 480
India	2, 360	297		2, 657
Algeria	3, 197			3, 197
Union of South Africa	3, 390	280	237	3, 907
Other countries	1, 338	734		2, 072
Beira Depot	3, 543	147	12, 946	16, 636
Lobito Depot		603	1, 130	1, 733
Total	103, 666	10, 356	115, 874	229, 896
Shipments by routes:				
Beira Depot				74, 684
Lobito Depot				38, 783
Matadi				112, 406
Rail				4, 023
Total				229, 896

1 Taken from Murdock, Thos. G. (consul), Elisabethville, Belgian Congo, Belgian Congo Annual Mineral Report: Exports in 1953: State Dept. Dispatch 41, Apr. 30, 1954, 17 pp.; in metric tons converted here to short tons.

Canada.—Mine output dropped 3 percent in 1953, continuing the decline in 1952 and was the smallest since 1948; it was 8 percent above the annual average for 1944–48. The labor strike at Noranda, from August 22 beyond the end of the year, and those at other Quebec properties beginning in October caused the drop in 1953. Ontario resumed its longtime position as producer of over half of the total (52 percent in 1953) after having fallen to less than 50 percent in 1949 to 1952. In 1953 there were 20 principal mines located in seven of the 10 provinces.[45] The output of refined copper, all of it from the

45 Canada Department of Mines and Technical Surveys ,Copper in Canada ,1953 (Preliminary): Ottawa Canada, 8 pp.

TABLE 42.—Copper produced (mine output) in Canada, 1944–48 (average) and 1949–53, by Provinces, in short tons [1]

Province	1944–48 (average)	1949	1950	1951	1952	1953 (preliminary)
British Columbia	16,436	27,055	21,088	21,932	20,786	24,011
Manitoba	19,206	16,960	20,817	15,839	9,374	9,316
Newfoundland	4,881	3,617	3,221	2,899	2,959	2,762
Northwest Territories	1			1	3	
Nova Scotia					383	959
Ontario	117,282	113,043	117,210	128,809	125,343	130,123
Quebec	46,328	67,822	72,891	68,866	68,846	53,905
Saskatchewan	33,058	34,960	28,982	31,625	30,344	30,536
Total	[2] 232,311	263,457	264,209	269,971	258,038	251,612

[1] Dominion Bureau of Statistics, Department of Trade and Commerce, Government of Canada, Preliminary Report on Mineral Production, 1953.
[2] Newfoundland excluded as not united with Canada until December 1948.

refineries of The International Nickel Co. of Canada, Ltd., at Copper Cliff, Ontario, and of the Canadian Copper Refiners, Ltd., Montreal East, Quebec, was 236,000 tons compared with 196,000 tons in 1952.

Virtually all of the copper produced in *Ontario* is from the copper-nickel ores of the Sudbury area. The International Nickel Co. of Canada, Ltd., easily outranks other producers of copper in Canada. The company delivered 117,200 tons of refined copper in 1953, the same as in 1952 and little changed from the 118,500 tons in 1951. Canadian consumers received about 45 percent of the quantity in 1953, it was brought out at the company annual meeting, the remainder going to the United Kingdom, to continental Europe, and the United States. The nickel delivered in 1953 exceded the copper by 7 percent and commanded a much higher unit price. The company carried on an intensive exploration program, particularly for nickel, spending $6,085,000 in 1953. The 13,667,000 tons mined was not only replaced but a further 5,185,000 tons was added, so that reserves at the end of the year were 261,541,000 tons compared with 256,356,000 at the beginning. The nickel-copper content on December 31 was 7,817,000 tons compared with 7,795,000 on January 1. Continued progress was reported [46] in the major program for underground mining expansion, underway for a decade. Of the ore mined, the largest quantity for any year through 1953 was 11,095,000 from underground mining and 2,572,000 from surface mining. The underground goal was 13,000,000 tons. At the end of the year the company annual capacity and production rate had been increased by 12,000 tons of nickel and 10,000 tons of copper through changes in operations. The immediate result of research development was to release certain smelting capacity. The increased production of nickel and copper was contracted for a 5-year period to the United States Government, deliveries beginning in January 1954 and to be completed in 1958.

The Falconbridge Nickel Mines, Ltd.—the other important copper-mining company in Ontario—like International Nickel is more important as a producer of nickel. The company hoisted 1,164,000 tons of ore in 1953, chiefly from the Falconbridge and McKim mines. Plans were being carried out for expansion in mine, mill, smelter, and refinery capacities. Contracts with the United States Government

[46] Work cited in footnote 25.

will absorb planned increases in production for a number of years. Developed ore reserves at the Falconbridge, East, McKim, and Hardy mines were reported as 13,560,000 tons, containing 1.58 percent nickel and 0.83 percent copper, and indicated ore reserves in all Sudbury holdings were 21,011,000 tons, containing 1.57 percent nickel and 0.83 percent copper, or a total of 34,571,000 tons averaging 1.57 and 0.83 percent, respectively.

Other developments in Ontario included the putting into operation by the East Rim Nickel Mines, Ltd., of a 500-ton mill for the production of high-grade magnetic concentrates and copper-nickel concentrate for shipment to the Falconbridge smelter. Previously the company shipped ore. Milnet Mines, Ltd., about 18 miles north of Falconbridge, made daily shipments of 500 tons of nickel-copper ore to Falconbridge; the Nickel Offsets, Ltd., about 12 miles northeast of Renack, constructed and began production of copper-nickel concentrate in a new 300-ton mill; and the New Ryan Lake Mines, Ltd., near Matachewan continued to produce copper concentrate in its 150-ton mill. Ontario Pyrites Co., Ltd., continued exploration and development of its Errington and Vermilion Lake properties, 18 miles west of Sudbury. Reserves of over 10 million tons, averaging 1.15 percent copper, 0.81 percent lead, and 3.5 percent zinc, had been indicated by the end of 1953.[47]

Operations at Noranda Mines, Ltd., the principal producer of copper in *Quebec*, were hampered by the labor strike already mentioned. A total of 890,500 tons was hoisted from the Horne mine; 377,300 tons, averaging 1.78 percent copper, was direct-smelting ore, and 513,200 tons was concentrating ore. A total of 822,000 tons of ore, concentrate, and secondary materials, such as refinery slag and scrap copper and brass, was smelted and yielded 49,900 tons of anodes, of which 15,400 tons was estimated to have been recovered from the Horne mine. Horne-mine material was estimated to have also yielded 132,000 ounces of gold and 404,000 ounces of silver. Indicated ore reserves above the 2,975-foot level as of January 1, 1954, were as follows:

	Short tons	Copper, percent	Gold, ounce per ton
Sulfide ore over 4 percent copper	3,480,000	7.12	0.160
Sulfide ore under 4 percent copper	10,428,000	.67	.195
Total sulfide ore	13,908,000	2.28	.187
Siliceous fluxing ore	948,000	.09	.122
Total ore	14,856,000		

The foregoing does not include tonnages containing little or no copper in the Chadbourne ore body and the No. 5 zone of the Horne mine, as well as 1,500,000 tons of ore averaging 0.7 percent copper and 0.120 ounce gold per ton, in the No. 5 zone.

The Quemont Mining Corp., Ltd., which adjoins the Horne mine, treated 631,600 tons of ore, averaging 1.61 percent copper, 2.34 percent zinc, and 0.172 ounce gold and 1.15 ounces silver per ton,

[47] Work cited in footnote 45.

in 1953. Copper and zinc concentrates produced were 52,250 and 22,100 tons, respectively. The copper concentrate was smelted at Noranda until August 21, when that plant was closed by a labor strike, and was shipped to the United States for smelting from August 21 until October 2, when Quemont was closed by a strike that continued beyond the year end. Zinc concentrate went to the United States as usual until October 2. Commercial metals in shipments were 9,500 tons of copper, 11,400 tons of zinc, 88,500 ounces of gold, and 384,400 ounces of silver. Ore reserves at the end of 1953 above the 2,340-foot level were 9,528,000 tons, averaging 1.47 percent copper, 2.76 percent zinc, 0.159 ounce gold, and 1.07 ounces silver per ton.

At the Waite Amulet mine of Waite Amulet Mines, Ltd., subsidiary of Noranda, 242,900 tons of ore was hoisted and at the Amulet Dufault 128,000 tons. A total of 372,800 tons of ore was milled, and production totaled 15,300 tons of copper, 11,300 tons of zinc, 15,300 ounces of gold, and 255,000 ounces of silver, plus pyrite concentrate. The East Waite mine, which was brought into production in 1952, supplied 62 percent of the mill feed in 1953. The mines were closed October 21 because of a labor strike that continued in effect at the year end. Ore reserves were 1,010,000 tons at Waite Amulet, of which 895,000 contained 4.82 percent copper, 3.64 percent zinc, and gold and silver values. Reserves at the Amulet Dufault mine totaled 612,000 tons of ore, of which 527,000 tons contained 7.19 percent copper, 3.98 percent zinc, and gold and silver values.

Gaspé Copper Mines, Ltd., a subsidiary of Noranda, continued development and preparation for mining of the Needle Mountain ore bodies. Work during the year confirmed the reserve as 67 million tons, averaging 1.3 percent copper. Hydroelectric power from the Hydro-Quebec Bersimis project was expected to be available in October 1954, mine and mill operation to begin shortly thereafter, and smelter production to follow in about 4 months, about March 1955. The mill was planned for 6,500 tons a day and the smelter for 125 tons of copper anodes a day.

Canadian Copper Refiners, Ltd. (another subsidiary of Noranda and 1 of the 2 refineries in Canada), produced 110,000 tons of refined copper compared with 72,000 tons in 1952 when a labor strike interrupted production for 4 months. It was planned to increase the tankhouse by 20 percent to provide for anticipated larger receipts of copper for refining.

The Normetal Mining Corp., Ltd., milled 290,800 tons of ore, averaging 2.23 percent copper, 6.59 percent zinc, and 0.024 ounce gold, and 1.99 ounces silver per ton. Copper, zinc, and pyrite concentrates produced were 28,100, 29,400 and 14,600 tons, respectively. Copper concentrate went to the Noranda smelter until that plant closed, then was exported until October 17, when Normetal's output was halted by a strike. For the period of operation zinc concentrate was shipped to the United States and pyrite concentrate to Canada and the United States. Ore reserves at the end of the year, before allowance for dilution, were 2,416,100 tons, averaging 2.61 percent copper and 8.14 percent zinc.

At East Sullivan Mines, Ltd., 909,100 short tons of ore was milled, from which copper concentrate containing 11,400 tons of copper was produced. Ore reserves at the end of 1952 were 4,330,000 tons, and they were reported to have been reduced in 1953.

Campbell Chibougamau Mines, Ltd., sank a 4-compartment shaft to a depth of 1,230 feet and established 7 levels on property adjoining 1 of its own properties, leased from Merrill Island Mining Corp., Ltd. Production of concentrates was expected to begin in May 1955. Ore reserves, including those in the leased property, were estimated as 3,050,000 tons, averaging 2.6 percent copper and 0.08 ounce gold per ton. The mine was to obtain power from the Bersimis project.[48]

Opemiska Copper Mines, Ltd., completed construction of a 400-ton mill and began production of copper concentrate from its property 25 miles west of Chibougamau Lake in December. Indicated ore reserves were 1,054,000 tons averaging 4.82 percent copper.[49]

There were several smaller producers in the Province.

Saskatchewan and *Manitoba* together produced 16 percent of Canada's total copper in 1953. The Hudson Bay Mining & Smelting Co., Ltd., and Sherritt Gordon Mines, Ltd., accounted for almost the entire output as in the past.

The Hudson Bay Mining & Smelting Co., Ltd., operates a copper-zinc mine, copper smelter, and zinc plant at Flin Flon close to the Saskatchewan border. The ore body lies in both Provinces, but the major production has come from Saskatchewan for a number of years.

At Hudson Bay's mine 1,497,100 tons of ore was mined; and 1,478,100 tons, assaying 2.71 percent copper, 4.8 percent zinc, and 0.078 ounce gold and 1.15 ounces silver per ton, were milled. The ore yielded 298,100 tons of copper concentrate and 115,400 tons of zinc concentrate. The copper smelter treated 416,700 tons of company concentrates, direct-smelting ore, zinc-plant residue, and 20,400 tons of custom concentrates. The company shipped blister copper to the refineries containing 40,200 tons of copper, 112,900 ounces of gold, and 1,692,500 ounces of silver and 94,600 pounds of selenium. The company continued underground development at its Schist Lake copper-zinc mine and its North Star copper mine and started underground exploration at the Birch Lake and Coronation copper mines. At Cyprus Mines, Ltd., subsidiary of Hudson Bay, 86,500 tons of ore assaying 2.89 percent copper, 5.2 percent zinc, and 0.034 ounce gold and 0.74 ounce silver per ton, was mined. Ore reserves on January 1, 1954, including properties wholly owned or controlled and within trucking distance of Flin Flon, but excluding Cyprus, were 17,638,000 tons, averaging 3.25 percent copper, 3.9 percent zinc, and 0.074 ounce gold and 1.02 ounces silver per ton. Cyprus reserves were reduced to only 45,700 tons.

The 144-mile railway extension from Sherridon to Lynn Lake was completed in November, the concentrator building was completed and one ball mill begun by the Sherritt Gordon Mines, Ltd., in the same month. The mill feed in 1953 was derived from development work at the "A" and "EL" mines and from undercutting at the "A". The copper concentrate was to be shipped temporarily to another company for smelting, and the nickel concentrate was to be stored pending completion of Sherritt Gordon's chemical-metal-

[48] Smallwood, J. P., Power From Bersimis: Compressed Air Mag., vol. 59, No. 5, May 1954, pp. 128–133.
[49] Work cited in footnote 45.

lurgical plant at Fort Saskatchewan, Alberta. Estimated ore reserves at Lynn Lake continued as 14,100,000 tons, averaging 1.223 percent nickel and 0.618 percent copper.

In *British Columbia* production was chiefly from properties of the Granby Consolidated Mining, Smelting & Power Co., Ltd., and Britannia Mining & Smelting Co., Ltd., with some from property of the Tulsequah Mines, Ltd. (subsidiary of the Consolidated Mining & Smelting Co. of Canada, Ltd.), and some coming from copper matte recovered by the last-named company in the refining of lead at Trail. Granby treated 1,810,000 tons of ore, averaging 0.88 percent copper, and produced concentrates containing 12,500 tons of copper. Ore reserves at the year end were 2,948,000 tons, averaging 0.93 percent copper. Britannia produced 839,400 tons of ore; 28,800 tons of concentrate averaging 29 percent copper was produced, and a small quantity came from mine-water precipitates.[50]

The Buchans Mining Co., Ltd., in central *Newfoundland* milled 346,000 tons of zinc-lead-copper ore; 11,800 tons of copper concentrate containing about 2,900 tons of copper was produced and shipped to a smelter in the United States.[51] Ore reserves on December 31 were estimated at 5,084,000 tons of assured and probable ore.

In *New Brunswick* two massive zinc-lead ore bodies estimated to contain 60 million tons averaging 5 percent zinc, 2 percent lead, and 0.5 percent copper, were said to have been outlined to a depth of 1,000 feet in properties of the Brunswick Mining & Smelting Corp., Ltd. Adjoining one of the ore bodies, the Austin Brook, a zone was found containing 3,630,000 tons, averaging 1.01 percent copper. Initial developments were carried out to bring the properties into production.[52]

Elsewhere in Canada production came from zinc-lead-copper ore from the Stirling mine of the Mindamar Metals Corp., Ltd., Cape Breton Island, *Nova Scotia;* The Rankin Inlet Nickel Mines, Ltd., began sinking a 350-foot shaft on its nickel-copper deposit, *Northwest Territories;* and exploration of the Wellgreen property in the Kluane Lake district, *Yukon Territory,* was continued by the Hudson Bay Exploration & Development Co., Ltd., and ore reserves increased from 67,000 to 257,600 tons, assaying 1.14 percent copper, 1.83 percent nickel, 0.059 percent cobalt, and 0.004 ounce gold, 0.063 ounce platinum, and 0.051 ounce palladium per ton.

Exports of ingots, bars, and billets from Canada in 1953, as compared with 1952, were as follows, by countries of destination, in short tons:

Destination:	*1952*	*1953*
United States	52, 630	74, 655
United Kingdom	41, 643	51, 384
France	8, 537	2, 940
Brazil	2, 835	2, 345
India	2, 582	-------
Sweden	1, 786	-------
Australia	1, 707	-------
Pakistan	1, 119	-------
Other	836	670
Total	113, 675	131, 994

[50] Work cited in footnote 45.
[51] Work cited in footnote 45.
[52] Work cited in footnote 45.

Exports of copper in ore, matte, regulus, etc., totaled 51,160 (34,435 in 1952) tons, of which the United States was the destination of 35,715 (24,640) tons, Norway, 9,060 (8,180), West Germany 2,925 (470), Japan 2,330 (18), and the United Kingdom 1,120 (1,125) tons. In addition, 6,900 (22,800) tons of rods, strips, sheets, and tubing were shipped, of which 3,100 (10,880) tons went to the United States, and 2,310 (2,490) to Switzerland.

Imports of refined copper totaled 5,515 tons in 1953 compared with 12,970 tons in 1952.

Chile.—Although other major copper-producing countries had either greater or virtually unchanged outputs in 1953, Chile—regularly the world's second largest source of copper—had its smallest production since 1950 and relinquished second place to Northern Rhodesia. This failure to hold its own could be attributed to its arbitrary sales policy, described in this report under Prices.

The following notes on tax and exchange rates were taken from the annual report to stockholders of the Kennecott Copper Corp.:

> Effective January 1, 1953 the Chilean tax on earnings of U. S. copper companies was increased by a surcharge of 20 percent—from 50 to 60 percent. In April 1953 the Chilean authorities ruled that the increase was retroactive to January 1, 1952, instead of January 1, 1953. A tax assessment on Braden Copper Company for the year 1952, amounting to $3,798,051, was paid in 1953 and charged to Earned Surplus. Payment was made under protest and legal reservations filed. Action is now being taken to test the legality of the assessment.
>
> During 1953 there were two exchange rates at which the Braden Copper Company was allowed to buy pesos. Peso requirements for operating expenditures were purchased partly at 19.37 pesos to the U. S. dollar and partly at the bank rate of exchange, which for 1953 was fixed at 110 pesos to the dollar. The average rate obtained by the company in 1953 for these expenditures was 38.56. During the year pesos for construction expenditures were purchased at the 110 rate. At the beginning of 1953, the open-market rate was 130.50 pesos to the dollar, and at the end of the year it was 217.30.

Outputs of the three leading mines in 1952 and 1953 in short tons were as follows:

	1952		1953	
	Ore treated	Bar copper produced	Ore treated	Bar copper produced
Andes	8,122,500	52,100	6,970,200	45,600
Braden	9,775,200	185,000	8,175,800	140,500
Chuquicamata	16,278,300	177,600	13,470,400	173,600

According to a recent report [53] the Braden Copper Co. in mid-June reduced its output from 14,000 short tons monthly to 11,000, and immediately thereafter the Chile Exploration Co. and Andes Copper Mining Co. curtailed production. By July the combined output had dropped from 38,000 tons monthly to between 29,000 and 30,000 tons, and the reduced rate continued beyond the year. In addition, about 27,000 tons was lost at Chuquicamata and Andes because of strikes lasting over 6 weeks from about the middle of October. A 15-day strike of administrative workers at the Chuquicamata mine halted operations completely in March.

[53] Courand, Claude (counselor for economic affairs), Annual Minerals, Iron and Steel and Petroleum Report—Chile—1953: State Dept. Dispatch 787, Santiago, Chile, Apr. 6, 1954, 24 pp.

Chile's production was smaller despite increased capacity owing to improvements at Braden and Andes before 1953 and to the reaching of full operation by mid-1953 of the new sulfide plant at Chuquicamata. The new plant and the old oxide plant were each said [54] to be capable of producing over 11,000 tons monthly, or together 22,000 compared with a 1952 average of less than 17,000. Both plants used the oxide crushers in 1953; but, according to the annual report to stockholders, the primary and secondary crushing plants were to be completed early in 1954, marking completion of the current construction phase of the new sulfide plant.

The Paipote National smelter increased its average monthly output from 1,100 tons at the beginning to 1,300 at the end of the year, despite the closing during August for relining of its furnace.

According to the report mentioned in footnote 53:

> Throughout the year the exports of manufactured and semimanufactured copper, so lucrative during 1951 and early 1952, were subject to Government-imposed discriminatory exchange rates which tended to wipe out most of the profit margin. This fact coupled with general market deterioration virtually eliminated the manufactured copper export trade with the exception of minor finished product shipments to neighboring countries and about 11,000 tons of semimanufactures taken by Argentina.

TABLE 43.—Principal types of copper exported from Chile, in 1953, by countries, in short tons

	Refined		Standard (blister)	Total
	Electrolytic	Fire-refined		
January–December: United States	70,061	104,655	126,818	301,534
January–November: [1]				
Bolivia	33			33
Brazil	2,379		165	2,544
Uruguay	22	20		42
France	110			110
Germany		323	11,791	12,114
Italy	4,575		168	4,743
	7,119	343	12,124	19,586

[1] 12 months not available when report was written.

Chilean exports of the chief types of copper, by countries, are shown in table 43. Other copper exports from Chile were 16,080 tons of ore (11,440 to Germany, 4,420 to the United States, and 220 to Japan), 20,400 tons of concentrates (15,860 to the United States, 2,910 to Japan, and 1,630 to Germany), 840 tons of precipitates (all to Germany), and 860 tons of cement copper (all to Japan). In 1952 other copper exports from Chile were 4,470 tons of ore (4,150 to Germany and 320 to the United States), 27,130 tons of concentrates (20,730 to the United States, 4,560 to Japan, and 1,840 to Germany), 1,570 tons of cement copper (890 to Japan and 680 to the United States), 690 tons of precipitates (630 to Germany and 60 to Japan), and 195 tons of remelted scrap bars (185 to Belgium and 10 to Italy). Ore and concentrates are in terms of copper content.

The Nord Deutsche Affinerie announced [55] on December 1 that a 2-year contract was signed in Santiago on November 27 for the sale

[54] Work cited in footnote 53.
[55] American Metal Market, Copper: Vol. 60, No. 231, Dec. 2, 1953, p. 4.

of 20,000 tons of copper annually to that company by medium and small Chilean copper producers. The company was to refine all of the blister produced at Paipote and to smelt excess copper ore that it was not possible to handle at that plant.[56]

Finland.—Copper is by far the outstanding nonferrous metal produced in Finland. The Government-owned company—Outokumpu Oy—possesses and operates all five active copper mines, the Outokumpu, Aijala, Ylöjärvi, Orijärvi, and Nivala, in that order of importance. The Haveri mine of Vuoksenniska Oy yields a small quantity of copper in addition to gold and the Metsämenttu mine a small quantity in addition to zinc. In addition to iron and sulfur the copper ores contain small percentages of zinc and nickel as well as precious metals, and the Outokumpu main mine contains a small percentage of cobalt.

All active mines were operated at full capacity in 1953. Completion of a new shaft at the Outokumpu mine made possible an increase in ore extraction to a new peak—683,900 short tons at that deposit; total copper ore for all mines was 1,208,000 tons.

The Harjavalta copper smelter produced 25,800 tons of anode copper and the Pori plant 21,800 tons of cathodes, 26,300 tons of ingots, 2,400 tons of rolled products, 4,700 tons of drawn products, and 91 tons in copper sulfate, as well as gold, silver, nickel, selenium, and platinum products.

Finland's imports of copper and copper manufactures were 4,300 tons, about one-fourth from West Germany, partly as a consequence of the agreement between Outokumpu Oy and Duisburger Kupferhütte on the processing of Finnish pyrite sinter. Finnish exports of unworked, semimanufactured, and manufactured copper (mainly uncovered copper cable) totaled 8,900 tons, and in addition 4,600 tons of insulated copper cable was exported. Exports were chiefly to the Soviet Union, Poland, and Sweden, in that order of importance.[57]

Kenya.—The Macalder mine now operated by Macalder-Nyanza Mines, Ltd., a subsidiary of the Colonial Development Corp., produced about 3,000 tons of copper concentrate in its pilot mill. Concentrate from this mine was to be smelted at the Jinja electric smelter in Uganda when completed.[58]

Northern Rhodesia.—New copper-mine production records continued to be made in 1953, as a new alltime peak for the fourth successive year was established; production was 13 percent higher than in 1952, 17 percent above 1951, and 25 percent above 1950. Blister output amounted to 235,300 short tons in 1953 compared with 224,900 in 1952, and electrolytic copper production was 170,800 and 125,000 tons, respectively. The new record was made despite continuing unsatisfactory supplies of coal. Efforts to overcome the power problem are indicated later in this chapter.

During 1953 the Federation of Rhodesia and Nyasaland was formed, comprising Southern and Northern Rhodesia and Nyasaland. The chairman of Roan Antelope, Mufulira, and Rhodesian Selection Trust reported as follows to stockholders:

> This year has seen the birth of the Federation of Rhodesia and Nyasaland. On the broadest political grounds this is a development greatly to be welcomed.

56 Engineering and Mining Journal, vol. 155, No. 2, February 1954, p. 196.
57 Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 5, November 1954, p. 8.
58 Spalding, Jack, East Africa: Min. Jour. (London), 1954 Ann. Rev., May 1954, p. 129.

Our affairs in future will come partly into the province of the Federal Government and partly into that of the Northern Rhodesia Territorial Government. We hope that we shall be found ready to play our full part in the great political and economic developments that lie ahead of Central Africa.

One of the first-fruits of Federation, with its declared object of partnership, was the move, publicly announced last May, by the copper companies to initiate discussions on the industrial colour bar on the Copperbelt. This problem permits of no easy or quick solution. It is one common to many parts of Africa. Any attempt to solve it is apt to evoke suspicion, alarm, resentment and prejudice. Yet nothing is clearer than that the present situation is untenable both in principle and in practice; nor, unfortunately, is the inevitability of change in this case one which can be contemplated as being likely to take place under conditions of gradualness. To harbour this delusion is to blind oneself deliberately to the lessons of history, and can lead only to the rude awakening which has occurred, often in tragic circumstances, elsewhere in Africa. Once this is recognized I am confident that the action of the companies in attempting to deal with this problem will be seen in its real light, namely, an attempt to do justice to the legitimate aspirations of one section of their employees while at the same time safeguarding the continued industrial and social security of the other section of their employees. The subject is a challenge to the European claim of leadership without domination, and to the liberal principles of British Colonial policy.

On the satisfactory solution of this problem depends, perhaps more than on any other, the continued prosperity of this industry, which in all other respects would appear to be endowed with more than usual advantages and talents. These can be harnessed to the benefit of employees, shareholders, our country of production, and the free world generally, for many years ahead, if wisdom will prevail where at present suspicion reigns; without wisdom, all will suffer.

On July 1, 1953, Rhodesian Selection Trust, Mufulira, Chibuluma, and Roan Antelope transferred their seat of control from the United Kingdom to Northern Rhodesia.

The Rhodesia Congo Border Power Corp., Ltd., was incorporated in Northern Rhodesia on April 13 to acquire assets of the Northern Rhodesia Power Corp., Ltd., registered in the United Kingdom, and the latter company was liquidated. The four Northern Rhodesian copper-producing companies hold the stocks of the new company in equal proportions. The new company assumed responsibility for importing hydroelectric power from Belgian Congo (hoped to be available in 1957) and concluded an agreement with the Export-Import Bank, United States, for loan facilities up to £8,000,000. Additional hydroelectric power would be made available upon completion of anticipated development of Kafue River, Kariba Gorge, and Shire River schemes. The Kafue River project was to be started almost immediately, it was said,[59] and to be ready to provide essential power to the Rhodesian copper industry before 1960, when the Belgian Congo would no longer have power to spare for sale to Rhodesian plants.

A book on Northern Rhodesian copper, entitled "Copper Venture," with particular reference to Mufulira and Roan Antelope, was recently published. This book was reviewed in the May 1953 issue of Economic Geology as follows:

It is a story of pioneers in this area. It starts first with the story of Cecil Rhodes and his part in exploring the Rhodesia, and in the discoveries and development of Northern Rhodesia. The old prospectors who made first discoveries are given their credit, and the operations of the early prospecting companies are unfolded. The real start was the staking of claims by William Collier in 1902 but actual activity began when A. Chester Beatty took interest in the region in 1925. We learn of the early part played by Russel J. Parker, T. Field, Arthur

[59] Metal Bulletin (London), Kafue Power Scheme: No. 3828, Sept. 22, 1953, p. 21.

Storkey, Anton Gray, Austin Bancroft and others, and of the initiation of mining operations by David D. Irwin, and of the welding of British and American interest. Largely, the book is a great tribute to A. Chester Beatty who is credited with this fine example of Empire building.

It is an interesting story, well written and well authenticated, and gives a fine picture of the development of the greatest individual copper-belt in the world within the space of a quarter-century.

A total of 4,845,600 tons of ore, containing 2.28 percent copper, was mined by Roan Antelope Copper Mines, Ltd., in the fiscal year ended June 30, 1953, or 11 percent more than in the previous fiscal year. Company concentrates smelted yielded 97,800 tons of copper compared with 90,700 tons in 1952. Both the ore and blister totals represented new alltime peaks for Roan Antelope, the former for the third successive year and the latter for the second. Ore reserves at the end of June 1953 were reported as 90,400,000 short tons averaging 3.22 percent copper.

Mufulira Copper Mines, Ltd., produced 2,972,000 short tons of ore in the fiscal year ended June 30; a total of 2,963,400 tons was milled, and 85,200 short tons of primary copper was produced, of which 56,800 tons was blister, 21,500 electrolytic, and the remainder refinery operating stocks. Mine and mill capacity was rated at 285,000 tons of ore a month but was scheduled to be increased in 1956 to about 340,000 tons. Construction of a third reverberatory and expansions to the refinery were planned. Refinery cathodes were first produced in November 1952, and by the year end the tankhouse was running at rated capacity of 3,000 tons a month; the extension, which will double this capacity and include a wire bar furnace and casting section, was expected to come into operation early in 1956. But for a 3-week strike of African employees and a continued shortage of fuel the company estimated output would have reached 100,800 short tons of copper. Ore reserves at the end of the year were 231,730,000 tons, averaging 3.24 percent copper and including 25,000,000 for Chambishi and 70,000,000 (formerly carried as 21,000,000 tons of 3.47-percent ore, but greater if the cutoff point is lowered to 1 percent) for Baluba. The Baluba fraction contained 0.18 percent cobalt. It was decided that the Baluba ore body was submarginal, and development was postponed.

Chibuluma Mines, Ltd., a wholly owned subsidiary of Mufulira, began development of its copper and cobalt property under a United States General Services Administration loan, which was increased to £5,000,000. The loan was repayable in metals. Production was expected to start in 1955 and to attain an annual rate of 18,000 short tons of copper. Estimated ore reserves on June 30 were 7,300,000 tons averaging 5.23 percent copper and 0.25 percent cobalt.

Bancroft Mines, Ltd., was formed in 1953 to develop and equip the mine to produce about 4,000 tons of copper a month, at an estimated cost of £12,000,000. Ore reserves were reported as about 80 million tons, averaging 3.6 percent copper. It was expected that production would start in 1957. A concentrator was to be constructed at Kirila Bomwe to treat ore from both the Konkola and Kirila Bomwe (North and South) ore bodies. The concentrates were to be smelted at the Nkana smelter of Rhokana Corp., Ltd., at Nkana.

The Rhokana Corp., Ltd., mined 3,630,000 short tons of ore from the Nkana and Mindola mines and milled 3,629,000 tons in the fiscal year ended June 30, 1953. Finished copper produced was 33,000 tons of blister and 50,100 tons of electrolytic copper. The smelter produced 161,600 tons of copper compared with 153,100 tons in the fiscal year ended June 30, 1952. Of the 1952–53 total 33,000 tons (29,000 in 1951–52) was blister, and 46,300 (55,700) was anode copper for Nkana; and 31,100 (22,900) was blister, and 51,200 (45,500) was anode copper for Nchanga. In 1951–52, in addition, 33 tons of blister was produced from Broken Hill lead-copper matte. Production at the smelter was affected adversely by the shortage of coal and by labor troubles, but nonetheless a new record was established. A labor strike that began October 20 lasted to November 9, 1952. Ore reserves at the end of June 1953 were as follows:

	Short tons (millions)	*Copper (percent)*
Nkana north ore body	26	2. 93
Nkana south ore body	20	2. 78
Mindola ore body	51	3. 48
Total	97	3. 19

The cobalt content of ore produced in the fiscal year was 0.15 percent.

In the year ended March 31, 1953, 2,038,000 short tons of ore was mined, and 1,984,000 tons (containing 6.84 percent copper) was milled by Nchanga Consolidated Copper Mines, Ltd. Finished copper produced totaled 31,700 short tons of blister and 72,800 tons of electrolytic. Concentrates were again treated, chiefly at the Nkana smelter, but some were treated at smelters of Mufulira and Roan Antelope; an increased quantity was put through the leaching plant, causing increased production and the greater proportion of electrolytic copper. Ore reserves on April 1, 1953, were 133 million tons, averaging 4.59 percent copper.

Refinery operations at the plant of Rhodesia Copper Refiners, Ltd., were restricted by the shortage of power as a result of poor deliveries of coal. Electrolytic copper production in the fiscal year ending June 30, 1953, was 125,000 short tons, compared with 114,600 in the year ended June 30, 1952. The increase was due entirely to the greater quantity of cathodes received from the Nchanga leaching plant. Considerable progress was made in extensions to the plant for producing vertically cast copper, and that type was expected to be available for market by mid-1954.

TABLE 44.—Copper exported from Northern Rhodesia 1953, in short tons [1]

Destination	Blister	Electrolytic			Copper slimes
		Bar and ingot	Cathodes	Wire bars	
Canada	6,358				
United States	86,580				
Belgium	10,917	140	616	4,144	78
France				3,497	
Germany	10,585				
Italy			615	4,032	
Netherlands			56	280	85
Sweden				14,102	
United Kingdom	140,214	207	47,012	79,700	5
Union of South Africa		195		7,249	
Other	112	1	10	75	
Total	254,766	543	48,309	113,079	168

[1] Taken from Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 2, 1954, p. 17.

Norway.—Mine production decreased for the third successive year; it was 4 percent less than in 1952 and 16 percent below the recent peak in 1950. Copper is Norway's second most important mineral but is produced chiefly as a byproduct of pyrite concentration. The two exceptions are the Røros mine, where copper is the primary product, and Mofjellet, where zinc predominates. The Løkken mine, the largest pyrite producer, shipped most of its ore to the nearby Thamshavn smelter, where it was treated by the Orkla process to produce elemental sulfur and copper matte. Production by mines in 1949 to 1952 is shown in table 45.

Table 45 does not include substantial quantities of copper contained in untreated cupriferous pyrites. In 1952, 214,700 short tons, containing about 4,000 tons of copper, was exported. The new Skorovas pyrite mine, with an annual capacity of 150,000 tons, was expected to export large quantities of cupriferous pyrite without further treatment beginning in 1953.

TABLE 45.—Production of copper concentrates and matte in Norway, 1949–52, in short tons

	1949	1950	1951	1952
Concentrates:				
Sulitjelma	14, 200	14, 600	14, 600	15, 000
Røros	3, 500	4, 500	2, 900	3, 500
Folldal	3, 700	3, 700	4, 100	3, 700
Bjørkaasen	1, 000	1, 400	1, 000	1, 500
Vigsnes	900	1, 200	1, 100	1, 200
Mofjellet	200	300	400	400
Matte: Løkken	13, 200	17, 100	17, 000	15, 700
Total	36, 700	42, 800	41, 100	41, 000

Most of the copper concentrates produced in Norway were treated at either the Sulitjelma or Røros smelter. Sulitjelma was producing at a rate of about 3,000 tons of blister annually and Røros about 700 tons. Norwegian copper materials are refined on a toll basis in West Germany and Sweden and returned for use in Norway. The only refinery producing electrolytic copper was Falconbridge Nikkel-verk A/S, Kristiansand S., a subsidiary of Falconbridge Nickel Mines, Ltd., Toronto, Canada, which refined Canadian copper-nickel matte in Norway on a toll basis. Output of electrolytic copper was 6,650 tons in 1952 and expansion to 12,000 tons annually was proposed.

A. B. Boliden, a Swedish company, announced that preliminary exploration of a copper deposit near Kautokein, northern Norway, was favorable and that further exploration would be made if a concession were granted by the Norwegian Government.[60]

Philippines.—Copper production averaged nearly 12,000 tons annually in 1949–52; all of the production was exported in crude form, chiefly as concentrates to the United States for smelting and refining. Imports of copper and copper manufactures, on the other hand, averaged over 4,000 tons annually in 1947–51, inclusive. As a result of a

[60] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 2, August 1953, pp. 10–12.

recent study the establishment of a smelting and refining industry was recommended.[61]

Southern Rhodesia.—At the annual meeting of the Messina (TVL) Development Co., Ltd., March 1954, the chairman made the following remarks [62] regarding Southern Rhodesia holdings:

> * * * After a slow beginning, due mainly to heavy rains, which disrupted our road communications, work at Umkondo is proceeding satisfactorily, and I am still hopeful that we will get into production there in October or November this year. * * * as soon as the power station is in operation the task of dewatering the old workings and preparing the mine for production will be greatly accelerated. Meanwhile laboratory tests * * * indicate that good recoveries are to be expected from both sulphide and oxide ore. The average grade appears to be about 7% Cu., but, as I indicated last year, the tonnage is likely to be limited.

The copper resources of Southern Rhodesia were the subject of a recent report.[63]

Sweden.—Mine production in 1953 decreased as compared with 1952. According to a recent report,[64] the Kristineberg mine, owned and operated by the Boliden Mining Co., continued to be the principal copper producer in 1952 and in 1953 as well. Ore reserves were estimated as at least 13 million short tons of copper- and zinc-bearing pyrites. Indications are that the Kristineberg ore body, which continues to great depth, is far larger. Sweden's refinery copper output in 1952, the highest since World War II, was 32,200 short tons, of which 31,700 was electrolytically refined by Boliden at Rönnskär and 500 were furnace refined. The high rate was estimated to have been continued in the first half of 1953. Boliden was trying to obtain a concession for further exploring a promising copper deposit in northern Norway.

Union of South Africa.—Production was little changed in 1953 compared with other recent years. The O'okiep Copper Co., Ltd., Cape Province, and Messina Development Co., Ltd., Northern Transvaal, have the only mines operated for copper, the former producing blister and the latter fire refined. A recent report [65] advocated establishment of an electrolytic refinery in the Union. This article stated that Messina's reserves were 90,000 tons, a 6-year supply, and O'okiep's, 392,000 tons, a 16-year supply. Actual reserves were said to be larger. Another report [66] described copper deposits on or near the Messina Fault. The Nababeep mine, which has been the mainstay of the O'okiep company, was in its final stages and should be mined out by 1957, when a recently discovered ore body in the Nababeep West section will have been opened. The new ore body, only partly developed, contained 17,410,000 tons of ore. The East O'okiep mill was being expanded from 35,000 to 50,000 tons of ore monthly.[67]

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61 Quicho, Rufino B., The Outlook of Copper Smelting and Refining in the Philippines: Philippine Soc. Min. Met. and Geol. Eng., Mining Newsletter, vol. 4, No. 5, May 1953, pp. 4, 5, 7–21.
62 South African Mining and Engineering Journal, The Messina (TVL) Development Co., Ltd.: Vol. 65, part 1, No. 3188, Mar. 20, 1954, pp. 101–103.
63 Mining and Industrial Magazine, Mineral Resources of Southern Rhodesia, Copper: Vol. 43, Nos. 10 and 11, October and November 1953, pp. 419, 421–422, 448–451, 478.
64 Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 6, December 1953, pp. 18–19.
65 Maas, N. J., Possibilities for the Establishment of an Electrolytic Copper Refinery in the Union: South African Min. and Eng. Jour., vol. 64, part II, No. 3162, Sept. 19, 1953, pp. 83, 85, 87, 89.
66 Schwellnus, Dr. C. M., The Important Copper Deposits Occur Along or Near the Messina Fault: South African Min. and Eng. Jour., vol. 64, part I, No. 3147, June 6, 1953, pp. 557, 559, 561, 563.
67 Mining Journal (London), Namaqualand's Mineral Wealth: vol. 241, No. 6175, Dec. 25, 1953, pp. 751–755.

United Kingdom.—Consumption of primary and secondary copper dropped 22 percent, marking the first decline since 1949, and was the smallest tonnage in over a decade. Press reports throughout the year anticipated a considerable drop in the world price for copper before the year end; contributing notably to the smaller consumption, no doubt, were consumers' efforts to keep inventories to minimum levels if prices followed the expected course. Of the total consumption of copper, 344,000 short tons was refined copper and 91,300 scrap for wrought products; 15,500 tons was refined and 48,700 scrap for castings, miscellaneous products, and sulfate. Stocks of blister and refined copper, at producers' and consumers' plants and in London Metal Exchange warehouses and elsewhere, were 61,900 tons on December 31, 1953, compared with 147,800 at the beginning of the year.

An event of outstanding importance was resumption of free trading in copper on the London Metal Exchange on August 5 after a lapse of nearly 14 years. The initial offer of 3-month copper was for £220 per long ton (contrasted with the £252 price of the British Ministry of Metals up to August 5) and the price fluctuated between that and £199 for the remainder of the day. Some spot metal sold for £215.[68] Cash prices after a "remarkably short period for readjustment" settled [69] to between £230 and £240 until the end of the year.

In endeavoring to bridge the gap between the resumption of free trading and the filling of sellers' inventories the British Ministry of Metals planned continuation of the selling of copper. A press statement released [70] July 30, 1953 was, as follows:

Private Trading in Copper

The Ministry of Materials announces that, after discussions with producers, consumers and the London Metal Exchange, it has made arrangements to supply copper to the United Kingdom market during the transitional period of a few months after the resumption of private trading. During this period the Ministry will still be importing copper bought up to 4th August, 1953, at overseas points of delivery (e. g., Beira for Rhodesian supplies). In order to fill the gap that will occur between 5th August and the time at which supplies through trade channels can reach this country in sufficient quantities there will be releases from the Government's trading stocks. The amount to be released is at present estimated at about 60,000 tons. It will be available for sale through normal commercial channels. The prices at which these sales (apart from sales direct to consignment stockholders) will be made will be based on the average market price over an extended period of months. The releases represent no addition to the metal which would in any case be delivered in the United Kingdom to meet the requirements of consumers.

As with tin, lead, and zinc there will be a Government Broker to handle Ministry sales of copper on the London Metal Exchange. After consultations with the Chairman of the London Metal Exchange, the Minister has appointed Mr. L. Guy of the firm of C. Tennant Sons & Co., Ltd., to act as Government Broker. Consumers will be expected to secure their supplies through normal commercial channels, and it is intended that the Government Broker shall be a seller only when the needs of the market cannot be met from other sources. In the normal course his sales will consist only of standard copper as defined in the Metal Exchange contract. Details of the procedure whereby non-standard copper may be obtained from the Government Broker in exceptional cases of need are being made known separately.

The arrangements described above represent the present limit of intended sales of Ministry copper to the market (apart from small continuing sales of copper

[68] Metal Bulletin (London), Copper Prices Tumble: No. 3815, Aug. 7, 1953, pp. 17–18.
[69] Scott, Ursel Baliol, Copper: Min. Jour. (London), Ann. Rev., 1954 ed., May 1954, pp. 13–15.
[70] Ministry of Materials, Press Notice M. M. 44/53, July 30, 1953.

bought under a long term contract). Some of the remaining stocks will not however be transferred to the strategic stockpile at present and the Ministry reserves the right to dispose of further quantities if developments, in the opinion of the Government, so require.

The Ministry will continue to accept orders for copper on the existing delivery terms until the end of public trading, i. e. orders may be for delivery in the current or the immediately succeeding month. The latest delivery possible will therefore be 30th September. Orders will be accepted if they are either posted on or before 3rd August or if they are telegraphed before 2 p. m. on 4th August.

The Minister of Supply has made an Order (S. I. 1953 No. 1082), effective from 5th August, 1953, revoking the Copper Distribution Orders 1951 and 1953. The acquisition, use, and disposal of unwrought copper within the United Kingdom will therefore be freed from all controls as from the 5th August. Arrangements for the import of copper on private account were announced by the Board of Trade Import Licensing Branch in Notice to Importers No. 575 dated 15th July, 1953. Arrangements for exports after the end of public trading will be announced by the Board of Trade shortly.

The Ministry of Materials announced[71] in June that the Government was not going to liquidate its stockpile of strategic raw materials.

According to the British Bureau of Nonferrous Metal Statistics, imports of copper into the United Kingdom in 1952 and 1953 were as follows, in short tons:

	1952	1953
Northern Rhodesia	274, 768	246, 739
Canada	41, 919	52, 967
United States	49, 974	25, 243
Germany	17, 922	22, 883
Belgium	31, 061	20, 055
Other	12, 932	8, 730
	428, 576	376, 617

Of the above quantities, 247,287 tons was electrolytic in 1953, 121,674 tons blister, and 7,656 tons fire-refined compared with 232,124, 191,040, and 5,412 tons, respectively, in 1952.

Exports of copper in 1952 and 1953, in short tons, were as follows:

	1952	1953
Rough copper	3, 578	10, 031
Refined	852	13, 567
Brass and bronze ingots	7, 803	24, 032

In addition to the above, 9,533 (3,447 in 1952) tons of blister and 10,476 (45) tons of refined copper were reexported in 1953.

Yugoslavia.—Output amounted to 1,394,400 short tons of ore, 34,300 tons of blister copper, and 30,600 tons of electrolytic copper. Development of the Majdanpek deposit continued, with plans for a mill at Majdanpek and modern smelter at the Bor mine to treat both Bor and Majdanpek concentrates and to produce sulfuric acid (or superphosphate) from the sulfuric dioxide gases.

Completion of the Sevojno rolling mill and Svetozarevo cable plant by 1955 was to increase Yugoslav consumption of copper to nearly 44,000 tons—19,300 tons of electrolytic copper at Sevojno, 17,300 of electrolytic at Svetozarevo, 4,400 tons of blister copper by the chemical industry, and 2,500 tons of electrolytic copper by other industries. Continued output of copper products by the Impol aluminum rolling mill and the Novisad cable works, would add 5,000 tons to the annual copper requirements.

[71] Metal Bulletin (London), Britain to Retain Strategic Stockpile: No. 3803, June 23, 1953, pp. 12–13.

A recent report [72] stated that successful exploitation of the Majdanpek would provide 28,000 tons of copper a year which, with output from the Bor, would make 61,000 tons annually.

Exports were 16,200 tons of electrolytic copper in 1953 compared with 14,000 tons in 1952.

Ore reserves at the Bor mine were estimated as 39 million tons, averaging 2.2 percent copper, and those at Majdanpek were estimated as about 125 million tons, averaging 0.85 percent copper.[73]

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[72] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 1, July 1954, pp. 6–7.
[73] Bureau of Mines ,Mineral Trade Notes: Vol. 37, No. 3, September 1953, pp. 17–18.

Diatomite

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

A RECORD RATE of production of diatomite in the United States was reached in 1953; the 3-year average, 1951-53 inclusive, exceeded 300,000 short tons for the first time.

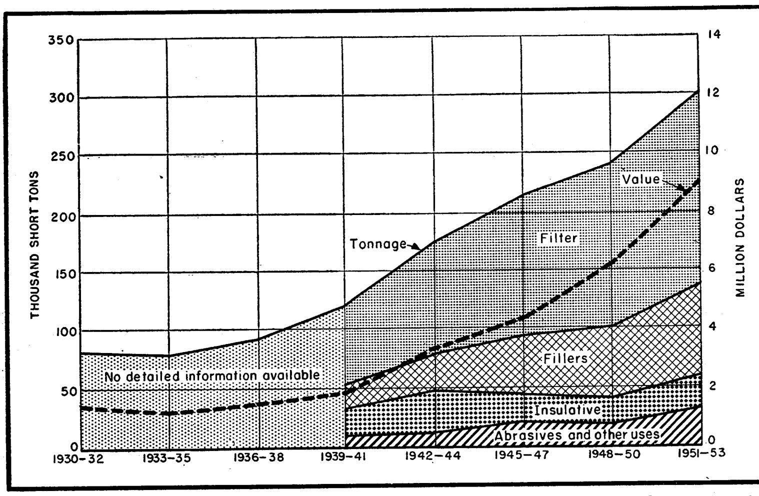

FIGURE 1.—Production, value, and use of diatomite in the United States, 1930–53.

DOMESTIC PRODUCTION

Diatomite (also known as diatomaceous earth or kieselguhr) is a siliceous material consisting of the remains of aquatic organisms known as diatoms. Large deposits of this material, the purest varieties of which are chalklike in appearance, are mined in the United States.

California is the leading diatomite-producing State, followed in order by Nevada, Oregon, and Washington. Occurrences of diatomite are known in 17 other States, and at certain of these localities it has been produced commercially in the past. Although other deposits were being examined with the view to starting commercial operations, production during 1953 was restricted to the States mentioned.

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 302,816 valued at $9,074,355 in 1951–53. The Bureau of Mines publishes only 3-year averages for this commodity.

Since 1930 the production and average price of diatomite at the

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

mine in the United States, in short tons, as reported to the Bureau of Mines, have been as follows:

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

CONSUMPTION AND USES

The diatomite industry in the United States is constantly developing new uses for its products; moreover, consumers have come to expect high-quality standards and uniformity of grade in diatomaceous products. Large deposits of relatively uniform material permit adherence to specifications; this has been an important factor in the industry's successful development of markets.

Filtration Medium.—The major market of diatomite is in the filtration of sugar, beverages, water, pharmaceuticals, oils, and many other liquids. The great number and exceedingly small size of the diatomite cells facilitate its use as a filtering medium. Fifty-four percent of the 1953 production was used for this purpose.

Mineral Fillers.—Twenty-six percent of the 1953 diatomite output was used as filler in rubber, paper, asphalt products, plastics, explosives, insecticides, paints, and many other products.

Insulation Material.—Owing to its high percentage of voids and high melting point, diatomite is used as a heat and sound insulator in industrial equipment and structures. Nine percent of the production was so used in 1953.

Miscellaneous Uses.—Diatomite is also used as an absorbent, as a mild abrasive, as a catalyst carrier, in ceramics and glazes, as a raw material for ultramarine pigment and sodium silicate, and in various other ways. Eleven percent of the 1953 production was consumed for miscellaneous purposes. The "grease bricks" used on buffing wheels are about one-third diatomite, by weight.

PRICES

The Oil, Paint and Drug Reporter quoted the following 1953 prices for diatomite: Domestic, bags, c. l., Atlantic coast, ton, $52–$55; California, ton, $42–$45; l. c. l. warehouse, $85–$90; purified, bags, c. l., Atlantic coast, ton $65; California, $53; l. c. l., warehouse, $95–$100; Atlantic coast, $95–$100; imported Mexican, white, bags, c. l., Atlantic coast, lb., 3 cents; l. c. l., Atlantic coast, lb., 6 cents.

FOREIGN TRADE

Export and import statistics of diatomite are not reported separately by the United States Department of Commerce, but tonnages are known to be imported. Crude diatomite is imported into the United States free of duty under paragraph 1775 of the Tariff Act of 1930 as crude material n. s. p. f.

TECHNOLOGY

The industrial uses of diatomite were enumerated in an article in a technical journal, which also described the production and processing of that material, the types of diatomite required for various end uses, and literature on that subject cited.[3] Diatomaceous Earth was the title of a bulletin issued by one of the larger diatomite-producing companies, describing its production, its use as a filter, as a filler, for insulation, and as a catalyst carrier.[4] Research into new potential uses for diatomite and the improvement of the commercial grades now in use is being conducted by the same firm.[5] A report on the diatomite industry in California, with special reference to the origin of that material and the geology of its commercial deposits, was included in a publication by the Mineral Information Service of that State.[6] Diatomite filters are incorporated in a new type of mobile water-purification unit developed by the United States Army. This unit is applicable to the types of water usually encountered in the field and requires a minimum of manpower.[7] In industrial filtration operations where the high silica content of diatomite is a disadvantage in filtering alkaline solutions, the addition of carbon as a filtering medium has been recommended.[8] The many uses for diatomite and a description of the deposits that are currently operating was the subject of an article in a State mining journal.[9] A patent has been issued on a method for mining diatomaceous earth with cement clinker.[10] A new plant for the processing of diatomaceous earth to be used as an extender in certain types of paint and enamel was erected by one of the larger paint companies.[11]

WORLD REVIEW

World production of diatomite is shown in table 2.

Algerian diatomite production now exceeds 25,000 tons annually. The larger part is exported, France and Great Britain being the principal customers.[12]

[3] Hull, William Q., Keel, Harvey, Kenney, John, Jr., and Gamson, Bernard W., Diatomaceous Earth: Ind. Eng. Chem., vol. 45, No. 2, February 1953, pp. 256–269.

[4] Industrial and Engineering Chemistry, vol. 45, No. 6, June 1953, p. 124–A.

[5] Chemical and Engineering News, New Era of Prosperity Predicted for DE: Vol. 31, No. 29, July 20, 1953, pp. 2988–2989.

[6] Leppla, P. W., Diatomite: State of California Dept. of Natural Resources, Division of Mines, Nov. 1, 1953, 7 pp.

[7] Lowe, Harry N., Jr., Schmitt, Richard P., and Spaulding, Charles H., Army's New Mobile Water-Purification Unit: Eng. News Record, vol. 151, No. 13, Sept. 24, 1953, pp. 39–41.

[8] Chemical and Engineering News, Carbon as a Filter Aid: Vol. 31, No. 45, Nov. 9, 1953, p. 4722. Industrial and Engineering Chemistry, Carbon Cohort for Diatoms: Vol. 45, No. 12, December 1953, pp. 15A–17A.

[9] California Mining Journal, Lompoc Becomes World Center for Diatomaceous Earth: Vol. 22, No. 11, July 1953, p. 27.

[10] Frankenhoff, Charles A., Diatomaceous Earth and Portland-Cement Compositions: U. S. Patent 2,654,674, Oct. 6, 1953.

[11] Chemical and Engineering News, National Lead Starts Plant for Diatomaceous Extender Pigments: Vol. 31, No. 2, Jan. 12, 1953, p. 152.

[12] Bureau of Mines, Mineral Trade Notes, Diatomite: Vol. 36, No. 3, March 1953, pp. 31-32.

The operations of the diatomite deposits on the Island of Skye (Scotland) have been expanded and improved by the erection of a drying and calcining plant at Uig.[13]

To meet the domestic demand in Finland, formerly supplied by imports, a firm is exploiting local deposits of diatomite, and small quantities have even been exported.[14]

TABLE 2.—World production of diatomite, by countries,[1] 1944–48 (average) and 1949–53, in metric tons [2]

[Compiled by Helen L. Hunt]

Country [1]	1944–48 (average)	1949	1950	1951	1952	1953
North America:						
Canada	54	54	44	83	25	3
Costa Rica	12	129	7	454	680	390
United States	190,300	[3] 232,800	[3] 232,800	[4] 272,000	[4] 272,000	[4] 272,000
South America: Chile	[5] 321	3,313	154	([6])	([6])	([6])
Europe:						
Austria	3,236	3,536	3,285	3,894	3,901	[7] 4,000
Denmark:						
Diatomite	2,978	4,038	4,122	4,859	[7] 5,000	[7] 5,000
Moler [7]	42,000	70,000	70,000	95,000	100,000	100,000
Finland	763	1,457	1,025	1,345	1,121	[7] 1,000
France	22,652	37,632	35,400	37,000	40,000	[7] 40,000
Germany, West	([6])	29,335	33,707	43,952	47,852	50,350
Italy	[8] 3,588	6,629	11,487	10,565	8,500	10,000
Sweden	1,650	1,844	1,780	1,847	1,572	[7] 1,500
United Kingdom:						
Great Britain	3,521	10,770	3,796	9,348	17,273	[7] 20,000
Northern Ireland	11,768	7,914	6,546	8,866	8,838	7,384
Africa:						
Algeria	5,210	13,581	13,710	20,992	20,016	25,704
Egypt	1,180	1,178	1,062	2,752	711	119
Kenya	[5] 685	2,224	2,613	4,286	6,027	4,448
Union of South Africa	516	1,155	436	87	1,080	109
Oceania:						
Australia	4,396	4,128	6,321	8,869	6,468	2,883
New Zealand	243	96	121	121	207	([6])
Total (estimate)	350,000	480,000	480,000	580,000	590,000	600,000

[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 1948–52.
[4] Average annual production 1951–53.
[5] Average for 1945–48.
[6] Data not available; estimate by author of chapter included in total.
[7] Estimate.
[8] Average for 1946–48.

[13] Chemical Age (London), New Diatomite Factory: Vol. 69, No. 1782, Sept. 5, 1953, p. 494. Quarry Managers Journal, Diatomite Factory for Skye: Vol. 37, November 1953, p. 245.
[14] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 2, February 1954, p. 58.

Feldspar, Nepheline Syenite, and Aplite

By Brooke L. Gunsallus [1] and Frances P. Uswald [2]

FELDSPAR

PRODUCTION of crude feldspar in 1953 increased 8 percent in tonnage and 24 percent in value. Ground-feldspar sales increased 1 percent in quantity and 6 percent in value. Inventories of crude feldspar increased in 1953. Quantity sales of ground feldspar to the pottery industry remained the same, sales to the glass industry increased 1 percent, and sales to the enamel industry decreased 34 percent in 1953 compared with 1952. The drop in feldspar tonnage shipped to the enamel industry resulted mainly from the use of substitute materials.

Production in the automobile industry continued to expand in 1953, resulting in an increased production of flat glass, a large consumer of feldspar.

Modernization of mine and plant facilities, a large increase in the proportion of feldspar obtained by flotation, and higher prices for the finished product were noteworthy features of the feldspar industry in 1953.

The International Minerals & Chemical Corp., Consolidated Feldspar Department, modernized and improved its plants in North Carolina and Tennessee. The capacity of its Spruce Pine, N. C., flotation mill was increased 50 percent, new fine-grinding plants were installed at Erwin, Tenn., and new equipment for feldspar flotation was installed at Kona, N. C.[3]

The Bell Minerals Corp. purchased the West Paris, Maine, operations of the United Feldspar & Minerals Corp. A program of rehabilitation was instituted throughout the plant, and the production capacity was increased.[4]

The Golding-Keene Co., Keene, N. H., feldspar producer since 1922, and its subsidiary, the Standard Flint & Spar Corp., Trenton, N. J., were sold during 1953. The new owners operated as the Golding-Keene Co.[5]

Imports of crude feldspar from Canada increased 6 percent in 1953 compared with 1952. Imports of crude nepheline syenite were

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1 Commodity-industry analyst.
2 Statistical clerk.
3 Glass Industry, vol. 34, No. 12, December 1953, p. 680.
Manufacturers Record, vol. 122, No. 11, November 1953, p. 124.
Pit and Quarry, vol. 46, No. 6, December 1953, p. 64.
Rock Products, vol. 56, No. 12, December 1953, p. 120.
Engineering and Mining Journal, Feldspar: Vol. 155, No. 2, February 1953, pp. 112, 133.
4 Glass Industry, vol. 34, No. 2, February 1953, p. 106.
Pit and Quarry, vol. 45, No. 10, April 1953, p. 88.
Rock Products, vol. 56, No. 5, May 1953, p. 58.
5 Rock Products, vol. 56, No. 8, August 1953, p. 222.

TABLE 1.—Salient statistics of the feldspar industry in the United States, 1944–48 (average) and 1949–53

	1944–48 (average)	1949	1950	1951	1952	1953
Crude feldspar:						
Domestic sales:						
Long tons	425,893	369,378	407,925	[1] 400,439	[1] 420,831	[1] 452,600
Value	$2,280,978	$2,278,441	$2,558,390	$2,815,587	$3,696,018	$4,594,450
Average per long ton	$5.36	$6.17	$6.27	$7.03	$8.78	$10.15
Imports:						
Long tons	18,141	15,826	12,367	17,128	5,576	5,901
Value	$136,552	$107,925	$84,136	$146,565	$53,016	$60,501
Average per long ton	$7.53	$6.82	$6.80	$8.56	$9.51	$10.25
Ground feldspar: Sales by merchant mills:						
Short tons	436,856	386,707	446,523	454,615	458,920	463,876
Value	$5,155,895	$5,609,101	$6,343,619	$6,932,878	$6,712,481	$7,148,689
Average per short ton	$11.80	$14.50	$14.21	$15.25	$14.63	$15.41

[1] Includes flotation concentrates.

negligible in 1953, as in 1952 and 1951. Imports of ground nepheline syenite increased 30 percent in 1953 compared with 1952; Canada was the sole supplier. Sales of aplite in 1953 increased 9 percent over 1952.

DOMESTIC PRODUCTION

Crude Feldspar.—Crude feldspar sold or used by producers in 1953 (table 2) increased 8 percent in quantity and 24 percent in value over 1952. The value of the 1953 crude production was the highest in the history of the industry, exceeding the previous high value of 1952 by 24 percent, although the quantity produced in 1953 was only the fourth highest production on record. The average value in 1953 was $10.15 per long ton compared with $8.78 in 1952 and $7.03 in 1951. As in 1952, 10 States reported production.

In 1953 California, Colorado, North Carolina, and South Dakota reported increases over 1952. North Carolina continued to be the largest producer, with 59 percent of the quantity produced (57 percent in 1952 and 42 percent in 1951). South Dakota was second, with 11 percent of the total (10 percent in 1952 and 12 percent in 1951), and Colorado was third, with 10 percent of the total (9 percent in 1952 and 13 percent in 1951).

The tonnage of feldspar and feldspathic rock treated in flotation plants became a factor in feldspar production in 1951 and increased in 1952. In 1953 about 35 percent of all salable feldspar was obtained by flotation.

TABLE 2.—Crude feldspar sold or used by producers in the United States, 1944–48 (average) and 1949–53

Year	Long tons	Value: Total	Value: Average per ton	Year	Long tons	Value: Total	Value: Average per ton
1944–48 (average)	425,893	$2,280,978	$5.36	1951	400,439	$2,815,587	$7.03
1949	369,378	2,278,441	6.17	1952	420,831	3,696,018	8.78
1950	407,925	2,558,390	6.27	1953	452,600	4,594,450	10.15

TABLE 3.—Crude feldspar sold or used by producers in the United States, 1951–53, by States

State	1951		1952		1953	
	Long tons	Value	Long tons	Value	Long tons	Value
Colorado	50, 451	$283, 153	38, 268	$224, 385	43, 508	$267, 642
Connecticut	13, 811	107, 083	10, 929	87, 432	9, 829	63, 049
Maine	19, 273	154, 695	18, 644	147, 371	17, 637	117, 090
New Hampshire	(1)	(1)	(1)	(1)	28, 961	286, 069
North Carolina	166, 361	1, 230, 404	240, 364	2, 416, 031	268, 042	3, 290, 495
South Dakota	48, 559	290, 520	40, 163	220, 954	50, 601	321, 026
Texas	(1)	(1)	2, 600	31, 200		
Virginia	30, 979	232, 099	(1)	(1)	(1)	(1)
Other States [2]	71, 005	517, 633	69, 863	568, 645	34, 022	249, 079
Total	[3] 400, 439	2, 815, 587	[3] 420, 831	3, 696, 018	[3] 452, 600	4, 594, 450

[1] Included with "Other States" to avoid disclosure of individual company operations.
[2] Includes Arizona, California, Georgia (1951), New Hampshire (1951–52), Texas (1951), Virginia (1952–53), and Wyoming (1953).
[3] Flotation concentrates included in total.

The application of froth flotation to pegmatites has provided the feldspar industry with a new source of raw material.

Flotation feed is treated in a number of successive operations to separate feldspar and byproduct quartz and mica from impurities such as pyrite, tourmaline, free iron, and possibly others. Feldspar produced by this method is remarkably pure and uniform in composition.

Feldspar concentrates obtained by flotation of feldspathic rocks and sands are listed by the Bureau of Mines under crude-feldspar production for statistical purposes.

Ground Feldspar.—Ground feldspar sold by merchant mills in the United States increased 1 percent in 1953 compared with 1952 and was the largest quantity sold since 1948. The total value increased 6 percent in 1953 compared with 1952, and the average selling price increased from $14.63 to $15.41. The number of producing States was 13 in 1953 compared with 14 in 1952.

As has been the case for several years, North Carolina again was by far the largest grinder of feldspar, followed by Colorado, Tennessee, and South Dakota. Ground-feldspar production in each of the large producing States increased in 1953 over 1952. New Jersey also reported an increase, but New York and Virginia reported decreases.

TABLE 4.—Ground feldspar sold by merchant mills [1] in the United States, 1944–48 (average) and 1949–53

Year	Active mills	Domestic feldspar			Canadian feldspar			Total	
		Short tons	Value		Short tons	Value		Short tons	Value
			Total	Average		Total	Average		
1944–48 (average)	28	422, 797	$4, 851, 616	$11. 48	14, 059	$304, 279	$21. 64	436, 856	$5, 155, 895
1949	27	369, 824	5, 212, 246	14. 09	16, 883	396, 855	23. 51	386, 707	5, 609, 101
1950	23	429, 787	5, 952, 019	13. 85	16, 736	391, 600	23. 40	446, 523	6, 343, 619
1951	23	441, 816	6, 633, 378	15. 01	12, 799	299, 500	23. 40	454, 615	6, 932, 878
1952	24	448, 839	6, 473, 203	14. 42	10, 081	239, 278	23. 74	458, 920	6, 712, 481
1953	22	454, 692	6, 909, 177	15. 20	9, 184	239, 512	26. 08	463, 876	7, 148, 689

[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, 1951–53, by States

State	1951			1952			1953		
	Active mills	Short tons	Value	Active mills	Short tons	Value	Active mills	Short tons	Value
Arizona	(2)	(2)	(2)	(2)	(2)	(2)	1	60,204	$766,832
Colorado	(2)	(2)	(2)	(2)	(2)	(2)	2		
Connecticut	2	25,740	$528,246	2	19,109	$386,191	2	11,647	226,300
New Jersey	1			1			(2)	(2)	(2)
Georgia	1	47,755	668,347	----	----	----	----	----	----
Virginia	2			(2)	(2)	(2)	(2)	(2)	(2)
Maine	3	20,504	376,258	3	16,791	317,365	3	17,901	354,639
New Hampshire	2	34,149	716,660	2	28,592	605,342	2	32,397	700,653
New York	1			1			1		
North Carolina	3	197,704	2,886,655	3	270,775	3,714,084	2	272,059	3,891,684
Tennessee	1			1			1		
Texas	----	----	----	1	2,000	30,000	----	----	----
Other States[3]	7	128,763	1,756,712	10	121,653	1,659,499	8	69,668	1,208,581
Total	23	454,615	6,932,878	24	458,920	6,712,481	22	463,876	7,148,689

[1] Excludes potters and others who grind for consumption in their own plants.
[2] Included with "Other States" to avoid disclosure of individual company operations.
[3] Includes (number of active mills in parentheses) Arizona (1 in 1951–52), California (1 in 1951, 2 in 1952–53), Colorado (2 in 1951–52), Illinois (1), New Jersey (1 in 1953), South Dakota (2), and Virginia (2 in 1952–53).

The percentage of total shipments of ground feldspar for several States was: North Carolina-Tennessee, 59 percent (59 percent in 1952 and 43 percent in 1951); New York-New Hampshire, 7 percent (6 percent in 1952 and 7 percent in 1951); Connecticut, 3 percent (Connecticut-New Jersey, 4 percent in 1952 and 6 percent in 1951); Arizona-Colorado, 13 percent (concealed in 1952 and 1951); and Maine, 4 percent (4 percent in 1952 and 5 percent in 1951).

CONSUMPTION AND USES

Crude Feldspar.—Many merchant grinders also mine feldspar, either themselves or through affiliated firms. A large part of their supply of crude feldspar, however, is purchased from small operators.

Most feldspar consumers buy material already ground, sized, and ready for use in their manufactured products. Some pottery, enamel, and soap manufacturers, however, purchase all or part of their requirements crude and crush and grind it to their own specifications in their own mills. Consumers in the United States buy some crude feldspar from producers in Canada. A small but carefully selected tonnage is used in manufacturing artificial teeth.

Ground Feldspar.—Glass, pottery, and enamel industries in 1953 consumed 97 percent of the ground feldspar sold by merchant mills compared with 99 percent in each of the previous 4 years (table 6). In 1953 glass consumed 55 percent (55 percent in 1952 and 43 percent in 1951); pottery, 39 percent (39 percent in 1952 and 51 percent in 1951); and enamel, 3 percent (5 percent in 1952 and 5 percent in 1951). The remaining 3 percent was consumed by other industries, including soaps and abrasives. The tonnage shipped to the glass industry increased 1 percent, shipments to the pottery industry remained about the same, and shipments to the enamel industry decreased 34 percent.

The uses of ground feldspar sold by merchant mills in the United States, 1937–53, are listed in table 6. There has been a 66-percent

TABLE 6.—Ground feldspar sold by merchant mills in the United States, 1937–53, in short tons, by uses

Year	Glass	Pottery	Enamel	Other	Total
1937 [1]	142, 028	102, 346	25, 111	9, 787	279, 272
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, 662	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

[1] New classification for ceramic uses adopted in 1937 was as follows: Glass, pottery, enamel, and other ceramics. Except for glass, figures for 1937 are not directly comparable with those for earlier years.

increase in ground tonnage in this period, but the quantity consumed annually by each of the following—glass, pottery, and enamel—bore about the same ratio to total annual production in 1953 as in 1937. In 1953 glass used 55 percent (51 percent in 1937); pottery, 39 percent (37 percent in 1937); and enamel, 3 percent (9 percent in 1937).

The percentage of total consumption by States in 1953 (table 7) was as follows (comparable 1952 and 1951 figures are shown in parentheses): Pennsylvania, 14 percent (1952—14 percent, 1951—13 percent); Ohio, 14 percent (1952—13 percent, 1951—15 percent); Illinois, 13 percent (1952—11 percent, 1951—12 percent); New Jersey, 10 percent (1952—10 percent, 1951—12 percent); West Virginia, 11 percent (1952—11 percent, 1951—8 percent); and New York, 7 percent (1952—7 percent, 1951—7 percent).

TABLE 7.—Ground feldspar shipped, by States of destination, from merchant mills in the United States, 1949–53, in short tons

Destination	1949	1950	1951	1952	1953
California	8, 385	(1)	(1)	(1)	11, 386
Illinois	51, 202	56, 513	53, 940	51, 808	61, 751
Indiana	25, 962	28, 875	25, 692	30, 976	20, 024
Maryland	16, 371	20, 861	19, 109	17, 214	16, 871
Massachusetts	1, 944	5, 733	6, 176	4, 715	5, 010
New Jersey	44, 243	53, 430	54, 968	47, 046	45, 835
New York	19, 900	22, 362	31, 086	31, 614	30, 950
Ohio	52, 533	68, 186	70, 245	60, 884	63, 410
Oklahoma	15, 722	(1)	(1)	(1)	(1)
Pennsylvania	57, 160	57, 190	60, 306	65, 167	66, 302
Tennessee	7, 917	11, 202	10, 679	13, 392	14, 468
West Virginia	30, 393	37, 246	37, 062	52, 421	51, 029
Wisconsin	10, 749	12, 580	11, 558	9, 880	8, 617
Other destinations [2]	44, 226	72, 345	73, 794	73, 803	68, 223
Total	386, 707	446, 523	454, 615	458, 920	463, 876

[1] Included with "Other destinations."
[2] Includes Arkansas, California (1950–52), Colorado, Connecticut, Kentucky, Louisiana, Michigan, Minnesota, Mississippi, Missouri, Oklahoma (1950–53), Puerto Rico (1949–50, 1952–53), Rhode Island, Texas, and Washington (1949–50 and 1952), shipments that cannot be segregated by States, and small shipments to Belgium, Canada, Cuba, and Mexico. Also includes specified shipments to Alabama (1949 and 1952–53), Arizona (1952), Florida (1949 and 1952–53), Georgia (1952–53), Kansas (1952), Maine (1950 and 1953), New Hampshire (1953), North Carolina (1952–53), North Dakota (1952), and Virginia (1952).

Names and addresses of merchant grinders of feldspar in the United States in 1953 are listed below:

Abingdon Potteries, Inc., 801 West Main Street, Abingdon, Ill.
Bell Minerals Co., West Paris, Maine.
Clinchfield Sand & Feldspar Corp., 413 Washington Ave., Towson 4, Baltimore, Md.
Consolidated Feldspar Dept., International Minerals & Chemical Corp., Erwin, Tenn.
Del Monte Properties Co., Box 150, Pacific Grove, Calif.
Eureka Mica Mining & Milling Co., 190 West State Street, Trenton, N. J.
Feldspar Flotation, Inc., Spruce Pine, N. C.
Feldspar Milling Co., Burnsville, N. C.
Gladding, McBean & Co., 2901 Los Feliz Blvd., Los Angeles, Calif.
Golding-Keene Co., Box 456, Keene, N. H.
J. F. Morton, Inc., P. O. Box 232, Trenton 2, N. J.
North Carolina Feldspar Corp., Erwin, Tenn.
Topsham Feldspar Co., Box 34, Topsham, Maine.
Western Feldspar Milling Co. Box 671, Salida Colo.
Worth Spar Co., P. O. Box 763, Middletown, Conn.

Apparent Consumption.—Domestic production, imports, and apparent domestic consumption for the period 1925–53 are shown in table 8. The increase in domestic production from 1925 to 1953 was 144 percent, while the increase in apparent domestic consumption during the same period was only 118 percent, reflecting the decrease in imports. The average value per long ton of domestic crude feldspar sold or used in 1925 was $7.08 compared with $4.39 in 1939 and $10.15 in 1953. The average value per long ton of apparent domestic consumption in 1925 was $7.21 compared with $4.46 in 1939 and $10.15 in 1953.

TABLE 8.—Crude feldspar sold or used by producers in the United States, imports, and apparent domestic consumption, 1925–53

Year	Production		Imports		Apparent domestic consumption	
	Long tons	Value	Long tons	Value	Long tons	Value
1925	185,706	$1,315,654	24,994	$203,524	210,700	$1,519,178
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

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 1953 the average selling price per long ton for all feldspar mined in the United States was $10.15 compared with $8.78 in 1952, $7.03 in 1951, and $6.27 in 1950.

The average selling price per short ton for ground feldspar in 1953 was $15.41, a 5-percent increase from 1952 and a 1-percent increase over 1951. Of the large producing States, the one having the highest average selling price per short ton was New Jersey—$26.85 ($27.85 in 1952 and $26.64 in 1951), followed by New York, $26.08 ($23.74 in 1952 and $23.40 in 1951); and Illinois, $21.27 ($21.49 in 1952 and $20.47 in 1951). North Carolina, by far the largest producer, received only $14.22 per short ton in 1953 ($13.71 in 1952 and $14.68 in 1951). The State reporting the lowest average selling price per short ton in 1953 was Colorado—$11.65 ($10.76 in 1952 and $11.11 in 1951).

Quotations on ground feldspar appearing in E&MJ Metal and Mineral Markets for December 1953 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 $3.00 per ton to bulk quotation for bags and bagging). Quotations on Virginia feldspar were not listed in E&MJ for 1952 or 1953. 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 [6]

Crude-feldspar imports for consumption in 1953 totaled 5,901 long tons (all from Canada) valued at $60,501. Compared with 1952, there was a 6-percent increase in tonnage and a 14-percent increase in value; however, except for 1952, the imported tonnage for 1953 was the lowest since 1933.

Based on reports by merchant grinders to the Bureau of Mines, the ground feldspar exported from the United States in 1953 totaled 2,989 short tons, a decrease of 13 percent below 1952. Countries of destination were Canada, Mexico, Cuba, Puerto Rico, and Belgium.

TABLE 9.—Feldspar imported for consumption in the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Year	Crude		Ground		Year	Crude		Ground	
	Long tons	Value	Long tons	Value		Long tons	Value	Long tons	Value
1944–48 (average)	18,141	$136,552	2	$107	1951	17,128	$146,565	(1)	$26
1949	15,826	107,925			1952	5,576	53,016		
1950	12,367	84,136			1953	5,901	60,501	98	2,740

1 Less than 1 ton.

6 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.

Cornwall Stone.—Imports for consumption of unmanufactured cornwall stone in 1953 increased 118 percent compared with 1952. Imports of ground cornwall stone increased 77 percent. The source of imports, either crude or ground, was the United Kingdom.

TABLE 10.—Cornwall stone imported for consumption in the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Year	Unmanufactured		Ground		Year	Unmanufactured		Ground	
	Long tons	Value	Long tons	Value		Long tons	Value	Long tons	Value
1944–48 (average)	717	$9,779	71	$1,575	1951	944	$9,453	110	$3,462
1949	772	11,200	20	572	1952	300	3,170	30	800
1950	1,128	11,792	111	2,160	1953	655	7,018	53	1,376

TECHNOLOGY

A description of the feldspar flotation process, including a flowsheet and illustrations, of the Kona plant of International Minerals & Chemical Corp., Consolidated Feldspar Department, was published.[7] About 250 tons of glass or pottery feldspar, 120 tons of quartz (glass sand), and 20 tons of mica concentrates are recovered per day from 700 to 800 tons of alaskite ore.

The results of a study on the use of high-potash and intermediate-alkali feldspars in a wide range of whiteware bodies were discussed.[8]

The results of studies made from 1942–45 by the Federal Geological Survey of the pegmatites of the Black Hills of South Dakota as a part of its program of strategic minerals investigations were published.[9] This work, in part, was carried on in conjunction with sampling, underground, and surface exploration, and diamond drilling conducted by the Federal Bureau of Mines. Descriptions, maps, and diagrams of deposits were given. Data on feldspar are included.

A similar report by the Federal Geological Survey on investigations of New England pegmatites from 1942–45 also was published in 1953.[10] Five types of commercial feldspar-producing pegmatites containing associated mica, beryl, and other strategic minerals were examined. A total of 180 mines and prospects was described in this report, which contained geologic maps and sections.

WORLD REVIEW

The estimated world production of feldspar in 1953 showed a 1-percent decrease compared with 1952. The output of China and of U. S. S. R., for which no data are available, is not included in the total.

The ratio of United States output to estimated world output in 1953 was 57 percent compared with 52 percent in 1952, 53 percent in 1951, and 58 percent in 1950.

[7] Lutjen, G. P., Kona Plant Features Flexibility in Feldspar Flotation Eng. and Min. Jour., vol. 154, No. 5, May 1953, pp. 92–95.

[8] Kyonka, J. C., and Cook, R. L., The Properties of Feldspars and Their Use in Whitewares: University of Illinois Eng. Exp. Sta., Bull. 422, 1953, 34 pp.

[9] Page, L. R., and others, Pegmatite Investigations 1942–45, Black Hills, South Dakota: Geol. Survey Prof. Paper 247, 1953, 228 pp. (42 maps).

[10] Cameron, E. N., and others, Pegmatite Investigations 1942–45, New England: Geol. Survey Prof. Paper 255, 1953, 352 pp. (38 maps).

TABLE 11.—World production of feldspar by countries,[1] 1944–48 (average) and 1949–53, in metric tons [2]

[Compiled by Helen L. Hunt]

Country [1]	1944–48 (average)	1949	1950	1951	1952	1953
North America:						
Canada (sales)	32,650	33,518	32,248	36,967	18,386	18,655
United States (sold or used)	432,729	375,307	414,472	406,866	427,585	459,864
South America:						
Argentina	4,820	(3)	(3)	(3)	(3)	(3)
Brazil [4]	63	11,111	12,000	(3)	(3)	----------
Chile	[5] 318	125	871	1,200	[4] 1,000	[4] 1,000
Peru	[5] 186	300	----------	131	----------	----------
Uruguay	1,352	811	710	675	898	792
Europe:						
Austria	837	1,912	3,909	3,751	2,578	1,353
Czechoslovakia [4]	7,723	(3)	(3)	(3)	(3)	(3)
Finland	4,690	10,074	8,000	8,198	9,790	9,327
France	30,724	47,514	47,727	66,000	65,000	60,000
Germany, West	28,674	48,262	76,712	71,531	119,291	116,023
Italy	7,168	13,522	18,071	29,144	25,476	23,602
Norway	14,564	27,482	23,695	31,118	29,297	[4] 23,000
Portugal	974	1,240	----------	470	700	60
Spain (quarry) [6]	2,655	396	1,650	1,760	----------	----------
Sweden	26,525	38,959	36,031	41,072	47,871	(3)
Asia:						
India	948	863	1,800	3,439	2,052	(3)
Israel	35	----------	----------	----------	----------	----------
Japan [7]	11,555	20,055	13,187	26,528	24,194	25,078
Africa:						
Egypt	29	----------	----------	----------	----------	----------
Eritrea	[8] 167	200	----------	----------	----------	----------
Kenya	50	20	----------	----------	----------	----------
Madagascar	9	----------	----------	----------	----------	----------
Southern Rhodesia	----------	----------	3,520	1,148	----------	----------
Union of South Africa	1,423	3,549	6,001	3,343	7,479	5,568
Australia [9]	8,047	10,902	13,276	15,080	13,807	6,884
Total (estimate)	622,000	660,000	720,000	770,000	820,000	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] Average for 1945–48.
[6] In addition, the following quantity of feldspar is reported as ground, but there is no crude production data to support this ground figure: 1949, data not available; 1950, 8,254 tons; 1951, 11,043 tons; 1952, 10,359 tons; 1953, 10,663 tons.
[7] In addition, the following quantities of aplite and other feldspathic rock were produced: 1949, 50,943 tons; 1950, 45,679 tons; 1951, 59,919 tons; 1952, 17,124 tons; 1953, data not available.
[8] Average for 1946–48.
[9] Includes some china stone.

NEPHELINE SYENITE

Domestic Deposits.—A report was published on the nepheline syenite deposits of Arkansas.[11] These deposits are scattered and outcrops indicate that they cover approximately 15 square miles. The possibility of using Arkansas syenite in colored and other ceramic products, such as low-voltage electrical porcelain and grinding wheels, was discussed.

Nepheline syenite occurs in New Jersey, California, and other localities in the United States, but all domestic material found thus far in any appreciable tonnage contains too much iron for most ceramic purposes.

Uses.—Nepheline syenite was introduced commercially about 1940 and at first was used almost entirely in the manufacture of glass, particularly container glass where a high alumina content is desired.

[11] Smoothers, W. J., Williams, N. F., and Reynolds, H. J., Ceramic Evaluation of Arkansas Nepheline Syenite: Arkansas Div. Geol., Inf. circ. 116, 1952, 21 pp.

Later the use of nepheline syenite was extended to various 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 grading wheels and in refractory cements.

Domestic consumption of nepheline syenite increased from 1944 through 1953 owing mainly to increased requirements in the glass-container industry, which had a phenomenal growth. Small increases in consumption occurred in other branches of the ceramic industry. In 1953 nepheline syenite imports for consumption were 16 percent of the combined apparent domestic consumption of nepheline syenite and feldspar; in 1952 it was 13 percent; and in 1944 it was 9 percent.

To have commercial interest nepheline syenite must be amenable to treatment for the removal of iron-bearing impurities such as tourmaline, hornblende, magnetite, and biotite so that the iron content can be reduced to a maximum of about 0.08 percent.[12]

A comprehensive annotated bibliography listed outstanding papers pertaining to research and industrial develpment of nepheline syenite in ceramics.[13]

TABLE 12.—Nepheline syenite imported for consumption in the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Year	Crude		Ground		Year	Crude		Ground	
	Short tons	Value	Short tons	Value		Short tons	Value	Short tons	Value
1944–48 (average)	50,126	$189,456	1,934	$30,692	1951			65,773	$936,256
1949	41,215	167,567	18,779	248,224	1952	4	$125	68,398	984,050
1950	8,966	36,453	54,242	703,008	1953	181	659	89,195	1,308,058

Prices.—Price quotations on nepheline syenite are not reported in trade journals. The Great Lakes Foundry Sand Co., the sole United States importer of this material, furnished the following prices per net ton in effect in 1953, f. o. b. Lakefield, Ontario, Canada, carlots, in bulk: Glass grade (24-mesh) $13.50; and Pottery grade (200-mesh) $18.50. An additional charge of $3.00 per ton was quoted for bagged material.

Foreign Trade.—Imports of ground nepheline syenite increased 30 percent in 1953 over 1952. The average value per ton (foreign market value) of ground nepheline syenite imported was $14.67 in 1953 ($14.39 in 1952 and $14.23 in 1951).

The American Nepheline, Ltd., Lakefield, Ontario, Canada, is the only producer of crude and ground nepheline syenite in the Western Hemisphere. In 1951 the company dismantled its grinding plant at Rochester, N. Y., and moved it to Ontario, Canada. Since then (table 12), except for minor quantities of crude, only ground nepheline syenite has been imported into the United States for consumption.

[12] Bruce, C. G., Nepheline Syenite in Canada, 1953 (Preliminary): Canada Dept. of Mines and Tech. Surveys, Ottawa, 1953, p. 2.

[13] Koenig, C. J., Literature Abstracts Pertaining to Nepheline Syenites: Ohio State Univ. Eng. Exp. Sta. Bull. 130, 1947, 33 pp.

World Review.—The installation of additional production facilities was approved by the directors of American Nepheline, Ltd.[14]

Although deposits of nepheline syenite have been reported in India and Finland, no activity has been reported. It is known that deposits of nepheline syenite were being worked in U. S. S. R. on a commercial scale, but production data are not available.

APLITE

The tonnage of aplite produced in the United States decreased progressively from 1949 through 1952, but sales increased 9 percent in 1953 over 1952. As has been the case for a number of years, there are only two aplite producers in the United States, and the Bureau of Mines cannot publish production or sales data. The names and addresses of aplite producers are as follows:

Dominion Minerals, Inc., Piney River, Va.

International Minerals & Chemical Corp., Erwin, Tenn.

[14] Northern Miner, Toronto, Canada, vol. 39, No. 19, July 1953, pp. 1, 10.

Ferroalloys

By Robert W. Geehan[1]

NEW HIGHS in production and shipments of ferroalloys during 1953 reflected higher steel production. Manufacturers of ferroalloys added several new units to productive capacity to keep abreast of the expanding capacity of the steel industry. The Marietta, Ohio, plant of Electro Metallurgical Co. was described.[2] Construction was begun in 1949 and was scheduled for completion in 1954. Capacity was about 500 tons of ferroalloys per day; about 1,500 tons of ores may be consumed daily. Three melting-furnace buildings were constructed; 12 submerged-arc, 3-phase furnaces were in operation. Additional facilities comprised a large unit housing 8 vacuum-type furnaces for production of very low carbon ferrochrome; a 200,000-kw. powerplant to provide the energy needed; and units for production of electrolytic manganese and chromium.

DOMESTIC PRODUCTION

Vanadium Corp. of America added a $3,500,000 unit for production of very low carbon ferrochromium to the Graham, W. Va., plant. New facilities were also added to its Cambridge, Ohio, plant.[3]

TABLE 1.—Ferroalloys produced and shipped from furnaces in the United States, 1952–53 [1]

Alloy	1952			1953		
	Production (short tons)	Shipments		Production (short tons)	Shipments	
		Short tons	Value		Short tons	Value
Ferromanganese	758, 721	738, 088	$133, 996, 006	907, 533	900, 110	$185, 192, 588
Ferrosilicon	781, 888	760, 981	84, 095, 168	808, 605	772, 697	86, 096, 619
Ferrochromium [2]	248, 421	242, 572	88, 937, 103	284, 793	253, 636	97, 849, 597
Ferrophosphorus	50, 850	53, 960	2, 672, 731	54, 361	36, 795	1, 790, 109
Ferrotitanium Ferrovanadium	12, 051	11, 577	13, 328, 409	11, 954	11, 824	13, 757, 060
Ferrotungsten Ferromolybdenum Other molybdenum products	33, 372	33, 366	52, 019, 126	23, 570	23, 167	40, 496, 355
Spiegeleisen Silicomanganese Manganese briquets	176, 628	177, 074	26, 586, 156	226, 376	192, 656	32, 855, 142
Other ferroalloys [3]	20, 768	20, 848	7, 224, 269	19, 094	18, 073	8, 159, 379
Total	2, 082, 699	2, 038, 466	408, 858, 968	2, 336, 286	2, 208, 958	466, 196, 849

[1] Data on some products are combined in this table because of confidentiality rules that prevent release of information on individual plants.
[2] Includes ferrochrome-silicon, Chrom-X, Chrom sil-X.
[3] Ferrocolumbium, ferroboron, zirconium-ferrosilicon, and miscellaneous ferroalloys.

[1] Assistant chief, Ferrous Metals and Alloys Branch.
[2] American Metal Market, vol. 60, No. 97, May 21, 1953, pp. 1, 13.
Iron Age, vol. 171, No. 22, May 28, 1953, pp. 70–71.
[3] Skillings' Mining Review, vol. 42, No. 31, Nov. 7, 1953, p. 11.

The Tenn-Tex Alloy & Chemical Corp. plant near Houston, Tex., was said to have the capacity to produce over 2,500 tons of ferromanganese and ferrosilicon a month; equipment includes 3 electric furnaces.[4]

TABLE 2.—Producers of ferroalloys in the United States in 1953

Producer	Plant	Alloy
American Agricultural Chemical Co.	South Amboy, N. J.	Ferrophosphorus (byproduct).
Anaconda Copper Mining Co.	Anaconda, Mont. Black Eagle, Mont.	Ferromanganese.
Bethlehem Steel Co.	Johnstown, Pa.	Do.
Chromium Mining & Smelting Co., Ltd.	Riverdale, Ill.	Chrom Sil-X, Chrom-X.
Climax Molybdenum Co.	Langeloth, Pa.	Ferromolybdenum, calcium molybdate, molybdenum silicide, ammonium molybdate, molybdenum oxide, oxide briquets, molybdenum trioxide, sodium molybdate, cobalt-molybdenum, molybdenum sulfide.
Electro-Metallurgical Co.	Alloy, W. Va. Ashtabula, Ohio Columbiana, Ohio Holcomb Rock, Va. Marietta, Ohio Niagara Falls, N. Y. Portland, Oreg. Sheffield, Ala.	Ferromanganese, silicomanganese, manganese briquets, manganese metal, ferrosilicon, silicon metal, silicon briquets, zirconium-ferrosilicon, ferrochromium, chromium briquets, chromium metal, ferrotungsten, ferrovanadium, ferroboron, ferrocolumbium, ferrotitanium, ferrotantalum-columbium.
General Abrasive Co., Inc.	Niagara Falls, N. Y.	Ferrosilicon (byproduct).
Globe Iron Co.	Jackson, Ohio	Silvery pig iron, ferrosilicon.
Hanna Furnace Corp.	Buffalo, N. Y.	Do.
Inland Steel Co.	E. Chicago, Ind.	Spiegeleisen.
Jackson Iron & Steel Co.	Jackson, Ohio	Silvery pig iron.
Kaiser Aluminum & Chemical Corp.	Permanente, Calif.	Ferrosilicon.
Keokuk Electro-Metals Co.	Keokuk, Iowa Wenatchee, Wash.	Ferrosilicon, silvery pig iron, silicon metal.
E. J. Lavino & Co.	Reusens, Va. Sheridan, Pa.	Ferromanganese.
Metal & Thermit Corp.	Carteret, N. J.	Ferrotitanium.
Molybdenum Corp. of America	Washington, Pa.	Ferromolybdenum, molybdic oxide, ferrotungsten, manganese boride, ferroboron.
Monsanto Chemical Co.	Anniston, Ala.	Ferrosilicon.
	Columbia, Tenn.	Ferrophosphorus (byproduct).
Montana Ferro-Alloys Co.	Woodstock, Tenn.	Ferrochromium, chrome silicide.
New Jersey Zinc Co.	Palmerton, Pa.	Spiegeleisen, ferromanganese.
Ohio Ferro-Alloys Co.	Brilliant, Ohio	Ferrochromium, ferrochromesilicon, ferrosilicon.
	Philo, Ohio	Ferrosilicon, ferrosiliconboron, simanal, silicon metal, ferromanganese, silicomanganese, manganese sulfide, manganese briquets.
	Tacoma, Wash.	Ferrosilicon, silicon metal, ferrochromium, ferrochromium briquets.
Oldbury Electro-Chemical Co.	Niagara Falls, N. Y.	Ferrophosphorus (byproduct).
Pacific Northwest Alloys, Inc.	Mead, Wash.	Ferrosilicon, ferrochromium.
Pittsburgh Metallurgical Co.	Calvert City, Ky.	Ferrosilicon, silicon metal, ferrochromium, ferrochrome silicon.
	Niagara Falls, N. Y.	Ferrosilicon, ferrochromium.
	Charleston, S. C.	Ferrosilicon, ferrochromium, ferrochrome silicon, silicomanganese.
Reading Chemical Co.	Wyomissing, Pa.	Ferrotungsten.
Tennessee Products & Chemical Corp.	Chattanooga, Tenn.	Ferrosilicon, ferrosilicon briquets, ferromanganese, silicomanganese, manganese briquets, silicomanganese briquets.
Tennessee Valley Authority	Muscle Shoals, Ala.	Ferrophosphorus (byproduct).
Tenn-Tex Alloy-Chemical Corp.	Houston, Texas	Ferromanganese, ferrosilicon, spiegeleisen.
Titanium Alloy Mfg. Div., National Lead Co.	Niagara Falls, N. Y.	Ferrotitanium, ferrocarbontitanium.
U. S. Steel Corp., subsidiaries	Clairton, Pa. Etna, Pa. Duquesne, Pa. Ensley, Ala.	Ferromanganese, spiegeleisen.
Vanadium Corp. of America	Bridgeville, Pa. Cambridge, Ohio Graham, W. Va. Niagara Falls, N. Y.	Ferrotitanium, ferrocarbontitanium, ferrovanadium, ferrosilicon, silicon briquets, silicon metal, ferrochromium, ferrochromium briquets, chrome silicon alloy, alsifer, grainals, aluminovanadium, ammonium metavanadate, titanium-aluminum.

[4] Chemical Engineering, vol. 60, No. 2, February 1953, p. 116.

TABLE 2.—Producers of ferroalloys in the United States in 1953—Continued

Producer	Plant	Alloy
Victor Chemical Works	Mount Pleasant, Tenn.	Ferrophosphorus (byproduct).
Virginia-Carolina Chemical Corp.	Charleston, S. C. Nichols, Fla.	Do.
Westvaco Chemical Div., Food Machinery & Chemical Corp.	Pocatello, Idaho	Do.

Pacific Northwest Alloys, Inc., a subsidiary of Chromium Mining & Smelting Corp., leased a portion of the Government-owned magnesium plant at Spokane, Wash., for production of ferroalloys. Equipment includes four arc furnaces. In August one furnace was producing ferrochromium; capacity was said to be 750 tons per month. Another furnace was producing ferrosilicon.[5]

Capacity for producing silvery pig iron at the blast furnace of Jackson Iron & Steel Co., Jackson, Ohio, was increased 15 percent.

In 1953 ferroalloys were made in 12 blast-furnace plants, 39 electric-furnace plants, 4 aluminothermic plants, and 2 miscellaneous plants. Pennsylvania again led all other States in quantity produced (29 percent) and in value of shipments (30 percent); Ohio was second. Output was also reported from Alabama, California, Florida, Idaho, Illinois, Indiana, Iowa, Kentucky, Montana, New Jersey, New York, Oregon, South Carolina, Tennessee, Texas, Virginia, Washington, and West Virginia.

Ferromanganese, ferrosilicon, and spiegeleisen are produced in blast furnaces; however, the only ferroalloy containing a high percentage of the alloying metal that is mainly so produced is ferromanganese. Most of the ferromolybdenum, a small part of the ferromanganese and ferrotitanium, and some ferrotungsten are produced by the aluminothermic method. The other ferroalloys and a portion of all those mentioned above, except spiegeleisen, are produced in electric-furnace plants.

The ferromanganese produced in 1953 again averaged 77 percent manganese (77 percent in 1952, 76 percent in 1951); output was from 7 blast-furnace plants, 10 electric-furnace plants, and 1 aluminothermic unit. The blast-furnace group continued to contribute nearly three times as much material as the others combined but the ratio of blast-furnace to total ferromanganese continued to decline. The steel industry consumed nearly all the ferromanganese used in 1953. High-carbon ferromanganese is satisfactory for the bulk of steel production but the low-carbon alloy is required in some steels, for example, austenitic stainless steels.

Production of spiegeleisen increased 67 percent in 1953 compared with 1952; however, shipments were virtually the same in both years. Spiegeleisen is a product usually manufactured in a blast furnace; during 1953 a small portion of the output came from electric furnaces. The average manganese content was 19 percent in 1953. Uses are essentially the same as those of ferromanganese, but more time is required for melting if equivalent quantities of manganese are compared. The product also provides more carbon per unit of manganese;

[5] American Metal Market, vol. 60, No. 117, June 18, 1953, p. 1; vol. 60, No. 164, Aug. 24, 1953, p. 1.

this is an advantage in the production of certain high-carbon steels and a disadvantage when low- or medium-carbon steels are produced. Spiegeleisen is normally made from manganese-bearing material too low grade for use in producing ferromanganese.

Silicomanganese is used in producing low-carbon ferromanganese and for introduing manganese into low-carbon steels. Production for the latter purpose increased 5 percent in 1953 compared with 1952; the quantity produced for the former purpose is not included in table 1.

From the standpoint of tonnage, more ferromanganese was produced in 1953 than any other ferroalloy; this is particularly noteworthy because ferrosilicon has been the leading tonnage product in this group for many years. Production and shipments of ferrosilicon listed on table 1 include silvery pig iron, ferrosilicon of various grades, and ferrosilicon briquets; the average silicon content of material produced in 1953 was 33 percent. Silvery pig iron is produced in blast furnaces and electric furnaces, ferrosilicon is manufactured in electric furnaces, and ferrosilicon briquets are produced from the latter and standardized as to silicon content (normally either 1 or 2 pounds per briquet). During 1953 there was a substantial decline in exports of ferrosilicon; but imports—nearly all from Canada—remained much the same as in 1952.

Table 3 lists silicon metal and the various grades of ferrosilicon consumed, along with an end-use breakdown based on a tabulation that lists the entire consumption of each reporting plant under the most important use at that location. Silvery pig iron is used chiefly by iron foundries. Standard-grade ferrosilicon (about 50 percent silicon), consumed mainly by the steel industry, is used as a deoxidizer and solidifier in manufacturing most grades of killed and semikilled steel. The higher grade alloys are used in ladle additions in gray-iron foundries, in the manufacture of high-silicon steel for use in electrical equipment and spring steel, and in plants producing magnesium by the ferrosilicon method. Ferrosilicon briquets are used at both steel plants and iron foundries. Silicon alloys containing other elements are produced for special uses.

Silicon metal is used by firms producing aluminum and magnesium products and by establishments manufacturing low-carbon and nonferrous alloys. Consumption reported to the Bureau of Mines in 1953 indicated the following distribution: 66.8 percent to aluminum and aluminum-magnesium producers, 24.5 percent to aluminum and base-metals producers, 6.0 percent to base-metals producers, 1 percent to iron, steel, and ferroalloys firms, 1.3 percent to refractories producers, and 0.4 percent to a miscellaneous group.

Production of ferrophosphorus increased to a new high; but, compared with 1952, there was a sharp decline in shipments as a result of a 50-percent reduction in exports. All ferrophosphorus production in 1953 was a byproduct of the manufacture of other phosphorus products in electric furnaces.

Output of ferroboron was 42 percent more than in 1952. Several other boron compounds were also available; these included boron-silicon, manganese-boron, nickel-boron, boron carbide, calcium boride, and mixtures containing several elements. Boron is used to aid hardenability of steel; the quantity added is ordinarily only a few thousandths of 1 percent.

TABLE 3.—Consumption of ferrosilicon, silicon metal, and miscellaneous silicon alloys in the United States in 1953, by end use, in short tons [1]

Alloy	Silicon content, percent	Steel ingots and castings [2]	Steel castings [2]	Iron foundries and miscellaneous	Total
Silvery pig iron	5-13	11,000	20,000	161,000	192,000
Do	14-20	55,000	6,000	126,000	187,000
Ferrosilicon	[3] 21-55	161,000	18,000	23,000	202,000
Do	56-70	28,000	(4)	(4)	28,000
Do	71-80	45,000	1,000	20,000	66,000
Do	81-89	4,000	(4)	1,000	5,000
Do	90-95	6,000	(4)	4,000	10,000
Silicon metal or refined silicon		(4)	(4)	15,000	15,000
Other silicon alloys [5]		37,000	5,000	36,000	78,000
Total		347,000	50,000	386,000	783,000

[1] Tonnages listed were developed from a sample of consumers which was expanded, using 1952 data as a base.
[2] Data for castings made by companies that also produce steel ingots are included with "Steel ingots and castings" and excluded from "Steel castings."
[3] Nearly all this material is in the range from 40 to 55 percent silicon.
[4] Less than 500 tons.
[5] Including Sil-X, Alsifer, and ferrosilicon briquets.

The output of ferrochromium reached an alltime high in 1953; the production of ferrochrome-silicon declined and that of ferrochromium briquets increased compared with 1952 data. Production of ferrotitanium and alloys of silicon-aluminum-iron declined in the same period; increases were made in the output of ferrocolumbium, ferrotungsten, ferrovanadium, ferromanganese briquets, and zirconium-ferrosilicon.

PRICES

Changes in standard specifications and methods of quotation led to some confusion in regard to actual prices for ferromanganese. In May the United States Steel Corp. altered its selling basis from the gross to the net ton and lowered its standard-grade to 74–76 percent Mn

TABLE 4.—Prices of ferroalloys, 1953

Material	Unit	Price	
		Jan. 1, 1953	Dec. 31, 1953
Ferrochromium:			
High-carbon	Lb. of Cr	$0.2475	$0.2475
Low-carbon	do	.3450	.3450
Ferrocolumbium	Lb. of Cb	4.90	[1] 6.40
Ferromanganese: 78-82 percent Mn	Gross ton	225.00	See text
Ferromolybdenum	Lb. of Mo	1.32	1.32
Ferrophosphorus: 23-25 percent P	Gross ton	75.00	[2] 65.00
Ferrosilicon:			
50 percent Si	Lb. of Si	.124	.124
75 percent Si	do	.143	.143
Ferrotungsten: 75-85 percent W	Lb. of W	4.85	[3] 4.10
Ferrovanadium:			
Open-hearth grade	Lb. of V	3.00	3.00
Crucible grade	do	3.10	3.10
Low C and Si	do	3.20	3.20
Silicomanganese	Lb	.114	.114
Spiegeleisen: 19-21 percent Mn	Gross ton	85.00	86.00

[1] Change Dec. 3.
[2] Change Feb. 26 per gross ton, 23-25 percent P, carlots, f. o. b. Siglo, Mount Pleasant, Tenn. Unitage of $3 for each 1 percent of P above or below the 24-percent base.
[3] Apr. 16, $4.35; Oct. 22, $4.10.

TABLE 5.—Ferroalloys and ferroalloy metals imported for consumption in the United States, 1952–53, by varieties

[U. S. Department of Commerce]

Variety of alloy	1952			1953		
	Gross weight (short tons)	Content (short tons)	Value	Gross weight (short tons)	Content (short tons)	Value
Chromium metal	151	(1)	$255,476	177	(1)	$300,141
Ferrocerium and other cerium alloys	3	(1)	43,733	2	(1)	18,464
Ferrochrome or ferrochromium:						
Containing 3 percent or more carbon	18,540	10,165	3,672,671	18,094	10,100	3,656,204
Containing less than 3 percent carbon	2,814	1,940	1,177,836	15,188	10,504	6,741,729
Ferrochromium-tungsten, chromium-tungsten, and chromium-cobalt-tungsten (tungsten content)	(1)	(2)	4,814	(1)	(3)	5,330
Ferromanganese:						
Containing not over 1 percent carbon				18,805	14,195	3,356,477
Containing over 1 and less than 4 percent carbon	23,535	18,890	6,905,950	27,718	23,011	9,039,048
Containing not less than 4 percent carbon	40,560	32,139	7,852,994	79,995	61,001	14,785,484
Ferromolybdenum, molybdenum metal and powder, calcium molybdate, and other compounds and alloys of molybdenum (molybdenum content)	(1)	(4)	7,887	(1)	(5)	988
Ferrosilicon	12,824	2,235	671,802	13,803	2,206	834,712
Ferrosilicon-aluminum, ferroaluminum-silicon, and Alsimin				252	(1)	94,254
Ferrotitanium	112	(1)	116,744	172	(1)	114,507
Ferrotungsten	315	239	1,150,999	377	302	1,686,690
Ferrovanadium	11	(1)	22,132	9	(1)	12,584
Manganese-silicon (manganese content)	(1)	50	20,936	(1)	158	33,986
Silicon-aluminum and aluminum-silicon	2	(1)	988	44	(1)	16,330
Silicon metal (silicon content)	(6)	(6)	624	(7)	(8)	633
Spiegeleisen	44	(1)	3,658	785	(1)	63,149
Spiegeleisen containing not more than 1 percent carbon and manganese-boron (manganese content)				(1)	(9)	324
Tungsten and combinations, in lump, grains, or powder:						
Tungsten metal (tungsten content)	(1)	1	7,123	(1)	33	224,924
Tungsten carbide (tungsten content)	(1)	(10)	1,677	(1)	8	79,653
Combinations containing tungsten or tungsten carbide (tungsten content)				(1)	(11)	226
Tungsten-nickel and other compounds of tungsten, n. s. p. f. (tungsten content)	(1)	(12)	658	(1)	66	257,494
Tungstic acid and other alloys of tungsten, n. s. p. f. (tungsten content)	(1)	3	8,578	(1)	(13)	364

1 Not recorded.
2 64 pounds.
3 83 pounds.
4 144 pounds.
5 10 pounds.
6 2 pounds.
7 3 pounds.
8 2 pounds.
9 300 pounds.
10 137 pounds.
11 23 pounds.
12 134 pounds.
13 122 pounds.

from the former standard of 78–82 percent. The base price was set at $200 per net ton f. o. b. Etna, Pa., with a $2 penalty or premium for each 1 percent below or above standard. At that time other producers quoted $225 per gross ton, basis 78–82 percent, f. o. b. shipping point.[6] In June Electro Metallurigical Co. announced a new base price of 13.15 cents per pound of contained manganese, f. o. b. shipping point, for standard 76 to 80-percent-Mn ferromanganese.[7] In both cases these prices remained in effect at the end of the year.

6 E&MJ Metal and Mineral Markets, vol. 24, No. 22, May 28, 1953, p. 3.
7 American Metal Market, vol. 60, No. 114, June 13, 1953, p. 1.

TABLE 6.—Ferromanganese and ferrosilicon imported for consumption in the United States, 1952–53, by countries

[U. S. Department of Commerce]

Country	Ferromanganese (manganese content)				Ferrosilicon (silicon content)			
	1952		1953		1952		1953	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Canada	22,735	$5,473,927	286	$94,221	2,230	$669,421	2,124	$819,386
France	2,995	579,759	16,827	4,464,421	5	2,381		
Germany, West	25	5,198	38,894	9,358,900			(1)	153
Japan			17,445	4,007,749				
Mexico			70	16,075				
Norway	24,674	8,550,625	24,604	9,223,263				
Taiwan							82	15,173
Yugoslavia	600	149,435	81	16,380				
Total	51,029	14,758,944	98,207	27,181,009	2,235	671,802	2,206	834,712

1 Less than 1 ton.

Effective January 1, 1954, the Keokuk Electro-Metals Co. reduced the base price of electric-furnace silvery pig iron $3.50 per gross ton. The prices per gross ton changed to $92 for 14.01- to 14.50-percent silicon material plus $1 for each additional half percent of silicon, f. o. b. Keokuk, Iowa, or Wenatchee, Wash., freight allowed to normal trade areas.

FOREIGN TRADE [8]

The most significant changes in imports during 1953 compared with 1952 were substantial increases in receipts of low-carbon ferrochromium and both low- and high-carbon ferromanganese. On the other hand, exports of ferroalloys declined from a value of $7,796,498 to $3,382,569 during the same period.

TECHNOLOGY

Ferrosilicon, Including Silvery Pig Iron.—Silvery pig iron and low-grade ferrosilicon are manufactured in both blast and electric furnaces; silicon metal and standard-grade ferrosilicon are produced in electric furnaces. Products manufactured include a complete range from silvery pig iron containing about 9 percent Si to silicon metal with at least 98 percent Si. Also produced is very pure silicon metal for use in electronics. Output of very pure silicon for use in transistors was reported,[9] and a use of silicon-alloy junction diodes was developed.

Ferrosilicon represents the largest tonnage item produced by the electric-furnace segment of the ferroalloys industry; as a result, the popular grades are manufactured in large furnaces. Power is an especially important cost factor; the raw materials used are not as costly as those used to produce other ferroalloys.

The blast furnace of Jackson Iron & Steel Co. at Jackson, Ohio, a producer of silvery pig iron, was modernized. The unit was reported to be the only blast furnace in the United States that used coal, in

8 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.

9 E&MJ Metal and Mineral Markets, vol. 24, No. 20, May 14, 1953.

TABLE 7.—Ferroalloys and ferroalloy metals exported from the United States, 1944–48 (average) and 1949–53, by varieties

[U. S. Department of Commerce]

Variety of alloy	1944–48 (average)		1949		1950		1951		1952		1953	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Spiegeleisen	2,093	$75,179	-----	-----	363	$21,351	85	$4,130	34	$3,888	-----	-----
Ferrochrome	2,870	964,880	2,200	$942,792	347	134,341	240	96,635	1,274	518,721	607	$285,900
Ferromanganese	8,850	1,292,099	6,627	1,360,279	580	139,876	633	206,614	1,453	474,686	1,112	389,064
Ferromolybdenum	908	1,122,118	478	718,722	589	927,271	742	1,224,257	545	925,324	323	548,502
Ferrophosphorus	17,879	471,163	5,050	168,205	42,789	868,480	55,044	2,218,790	44,351	2,592,245	22,959	1,147,707
Ferrosilicon	2,114	251,547	2,555	436,402	1,983	242,245	2,775	387,664	7,240	1,439,465	1,698	287,539
Ferrotitanium and ferrocarbontitanium	615	95,212	179	40,918	171	42,741	175	107,718	325	88,664	185	48,722
Ferrotungsten	474	1,450,358	310	861,189	166	408,958	142	1,007,424	148	1,150,465	18	122,949
Ferrovanadium	189	655,422	97	350,558	41	183,307	61	190,346	147	529,360	[1] 78	[1] 296,157
Other ferroalloy	164	92,323	316	161,297	88	31,969	274	131,641	193	73,680	703	256,029
Total	36,156	6,470,301	17,812	5,040,362	47,117	3,000,539	60,171	5,575,219	55,710	7,796,498	27,683	3,382,569

[1] Due to changes in classification data not strictly comparable to earlier years.

addition to coke, in making pig iron. The modernization project, completed in November, included enlarging and relining the stack, enlarging the casting ladle pit to accommodate 75-ton hot-metal ladles, installation of an electric mud gun, construction of a 30-foot-diameter primary and a 3-stage secondary gas cleaner, together with facilities for transportation of dust, and provision of storage for and cooling of the water needed for furnace operation.[10]

Ferrochromium, Including Ferrochrome-Silicon.—Ferrochromium was produced in electric furnaces; output included high-carbon, low-carbon, very low carbon, nitrogen-bearing, ferrochrome-silicon, and exothermic ferrochromium and ferrochrome-silicon. Requirements of the steel industry for a very low carbon source of chromium led to construction of 2 plants for production of ferrochromium with carbon content ranging from 0.01 to 0.06 percent. Electro Metallurigcal Co. installed equipment for producing pellets; ferrochromium and silica are pulverized, pelletized, and heated in a high vacuum. Pellets marketed were reported to contain 63 to 66 percent chromium, 5 to 7 percent silicon, and 0.01 to 0.025 percent carbon.[11] Vanadium Corp. of America began to produce very low carbon ferrochromium, using a process developed by Société d'Électro-Chimie d'Ugine of France. The product, physically similar to normal ferrochromium, was said to contain 67 to 72 percent chromium, 1 percent maximum silicon, and 0.025 to 0.06 percent carbon.[12]

A patent was issued covering a process for production of ferro-chrome-silicon-aluminum. The method provides for reduction of chromium and aluminum from ore; any magnesia present is reduced and volatilized.[13]

Chrome silicide produced by the Bureau of Mines from low-grade domestic ore was used to produce a satisfactory heat of AISI grade 403 steel. The chrome silicide tested averaged 28.03 percent Cr, 47.46 percent Si, 22.02 percent Fe, and 0.039 percent C; a standard-grade material produced from imported ore used in similar heats of steel averaged 39.38 percent Cr, 43.89 percent Si, and 0.044 percent C.

Several methods for introducing chromium into steel were discussed at the 10th Electric Furnace Steel Conference of the American Institute of Mining and Metallurgical Engineers.[14]

Other Ferroalloys and Substitutes.—A patent was issued covering a cerium-base master alloy for use in preparing magnesium alloys. The composition of the master alloy was listed as follows: Cerium 77 to 89 percent, manganese 8 to 20 percent, nickel 2 to 5 percent, and tungsten 0.2 to 0.5 percent.[15]

A comprehensive description of the use of aluminum as a deoxidizer was given in the book Aluminum in Iron and Steel, by Samuel L. Case and Kent R. VanHorn, published in 1953.

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[10] American Metal Market, vol. 60, No. 217, Nov. 10, 1953, pp. 1, 13.
[11] Iron Age, vol. 171, No. 22, May 28, 1953, pp. 70–71.
[12] Skillings' Mining Review, vol. 42, No. 31, Nov. 7, 1953, p. 11.
[13] Kuhlmann, A. M., Niagara Falls, N. Y. (assigned to Union Carbide & Carbon Corp.), Process for the Production of a Ferrochrome-Silicon-Aluminum Alloy: U. S. Patent 2,631,936, Mar. 17, 1953.
[14] McFarlane, N. B., Substitute Sources of Chromium for Low-Carbon Chromium Stainless Steels, Electric-Furnace Steel: Proc., vol. 10, 1952, pp. 231–237; abs. in Metal Prog., vol. 63, No. 2, February 1953, pp. 110, 198–200.
[15] Kent, Henry (New York, N. Y.), Cerium-Base Alloy: U. S. Patent 2,642,358, June 16, 1953.

WORLD REVIEW

Canada.—Dominion Magnesium, Ltd., began production of ferrosilicon at Beauharnois, Quebec, for use in producing magnesium from dolomite. The new plant will have a capacity of 6,000 tons of ferrosilicon per year when completed.[16] Canada also had other units for production of ferrosilicon; ferrochromium and ferromanganese were produced; and all three products were exported.

India.—The Indian Tariff Commission recommended discontinuance of the import duty on ferrosilicon, subject to a review if the industry finds itself unable to meet foreign competition. Ferrosilicon was produced at the Mysore iron and steel works, Bhadravati, Mysore State; the plant, owned and operated by the Mysore State Government, produced 4,069 long tons of ferrosilicon in 1952. Ferromanganese was also produced in India; financing was sought for a proposed new ferromanganese plant at Orissa.[17]

Norway.—In the year ended August 31, 1953, Norway was to send Belgium-Luxembourg 10,000 tons (45-percent basis) of ferrosilicon, 4,000 tons of ferromanganese, 500 tons of ferrochromium, 2,500 tons of silicomanganese, and other products in return for steel, copper, and lead.[18]

Southern Rhodesia.—Ferrochromium was produced by Rhodesian Alloys, Ltd. at the Gwelo plant. The firm is a joint company formed by John Brown & Co. in association with British South Africa Co. and Anglo-American Co. Chrome ore was obtained from the heavy-media separation plant at Selukwe and from the Windsor mine at Que Que. Output is low-carbon ferrochromium.

Spain.—A plant with an annual capacity for producing 350 metric tons of ferrophosphorus was planned; the proposed location was Lugones, Oviedo. Production from existing plants in Spain comprised ferrochromium, ferromanganese, ferrosilicon, and ferrotungsten.

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16 Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 6, June 1953, pp. 10-11.
17 Foreign Commerce Weekly, vol. 49, No. 9, Mar. 2, 1953, p. 10.
18 Metal Bulletin (London), No. 3761, Jan. 20, 1953, p. 12.

Fluorspar and Cryolite

By John E. Holtzinger[1] and Louise C. Roberts[2]

CONSUMPTION of fluorspar reached an alltime high in 1953, reflecting the high rates of output of steel and aluminum and increased demand for fluorine compounds by the chemical industry. Supplies of all grades were plentiful. Imports increased to a new high, but domestic production and shipments declined. Quoted prices remained relatively high throughout most of the year, and the total value reported for shipments from domestic mines established a new record.

Almost all of the drop in domestic production was attributable to a sharp reduction in output of metallurgical-grade fluorspar. Production of ceramic-grade fluorspar also declined slightly, but output of acid-grade concentrates increased. As in previous years, the Illinois-Kentucky district was the major producing area. However, Colorado displaced Kentucky as the second largest producing State, and the total output from Western States accounted for a larger portion of the domestic production than in any previous year. Domestic production capacity was reduced. One flotation plant was destroyed by fire, and several producers reported closing of mines or curtailment of operations because of difficulty in marketing their output.

Consumers' stocks, at an alltime high at the beginning of the year, were gradually reduced throughout the year. Stocks at mines increased slightly.

TABLE 1.—Salient statistics of fluorspar in the United States, 1944–48 (average) and 1949–53, in short tons

Year	Shipments from domestic mines	Foreign trade		Consumption	Industry stocks at end of year		
		Imports for consumption	Exports		Domestic mines [1]	Consumers' plants	Total
1944–48 (average)	335,383	82,466	1,395	370,371	22,842	110,612	133,454
1949	236,704	95,619	802	345,221	37,039	130,621	[2] 167,660
1950	301,510	164,634	740	426,121	19,038	164,685	[2] 183,723
1951	347,024	181,275	1,173	497,012	13,283	169,126	[2] 182,409
1952	331,273	352,503	675	520,197	27,464	252,193	[2] 279,657
1953	318,036	361,219	767	586,798	31,896	227,511	[2] 259,407

[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, and 15,492 tons in 1953 (none in 1944–48).

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

DOMESTIC PRODUCTION

Production of finished fluorspar of domestic origin totaled 322,700 short tons in 1953, including 208,500 tons of flotation concentrates. In addition, crude ore estimated as equivalent to about 16,900 tons of finished concentrates was mined but not milled during 1953, making total new production (expressed in terms of finished fluorspar) 339,600 short tons. In 1952 production of finished fluorspar totaled 345,400 short tons, of which 178,700 tons was flotation concentrates, and total new production was equivalent to 358,500 tons of finished fluorspar. Of the output in 1953, 8 mines (producing over 10,000 tons each) supplied 132,100 tons or 39 percent; 19 mines (producing 5,000 to 10,000 tons each) supplied 127,600 tons or 38 percent; 20 mines (producing 1,000 to 5,000 tons each) supplied 59,100 tons or 17 percent; and 5 mines (producing 500 to 1,000 tons each) supplied 3,200 tons or slightly less than 1 percent. Thus 52 mines produced 322,000 tons or 95 percent of the total. The remainder was produced by treating tailings from previous milling operations or from crude ore mined at an undetermined number of small mines or prospects.

The trend toward increased consumer-operated ("captive") production continued. In 1953 mines operated by consumers produced an equivalent of 105,900 short tons of finished fluorspar; and total output from captive mills, including production from stockpiled and purchased crude ore and tailings, was 105,900 short tons. In 1952 consumer-operated mines produced an equivalent of 95,200 short tons of finished fluorspar, and mill production of finished fluorspar by captive operations (including output from stockpiled and purchased crude ore and tailings) totaled 106,600 tons. Most of the captive production is acid grade, produced by the 3 major aluminum producers and 2 manufacturers of fluorine chemicals. However, a substantial quantity of metallurgical-grade fluorspar also was produced by United States Steel Corp. at its mines and mill near Mexico, Ky., and Inland Steel Co. at its mill near Marion, Ky.

TABLE 2.—Fluorspar shipped from mines in the United States, 1952–53, by States

State	1952			1953		
	Short tons	Value		Short tons	Value	
		Total	Average		Total	Average
Colorado	29,185	$1,505,968	$51.60	53,276	$2,872,360	$53.91
Illinois	188,293	9,481,223	50.35	163,303	8,567,026	52.46
Kentucky	48,308	1,863,262	38.57	47,244	2,100,493	44.46
Utah	17,304	438,699	25.35	15,527	374,944	24.15
Other States:						
New Mexico	16,443	823,320	50.07	17,822	729,523	40.93
Montana	16,160	1,241,162	39.10			
Nevada	14,798			18,487	963,832	52.14
Idaho						
Arizona	434			1,951	128,730	54.16
Tennessee	348			426		
Total	331,273	15,353,634	46.35	318,036	15,736,908	49.48

Production from mines in Illinois—the leading producing State—dropped sharply and was at the lowest rate since 1950. Total output in 1953 was 168,100 tons of finished fluorspar, of which 111,300 tons was flotation concentrates. In 1952 production of finished fluorspar totaled 192,600 tons, including 114,500 tons of flotation concentrates. The bulk of the 1953 production came from mines in Hardin County, and a smaller tonnage was supplied from properties in Pope County. Principal producing mines were the Fairview, Blue Diggings, Hamp, and Argo, operated by Aluminum Co. of America; Crystal and No. 1 mines, of the Minerva Oil Co.; the Rosiclare, North Boundary, Hillside, and South Boundary-Recovery shaft, of the Rosiclare Lead & Fluorspar Mining Co.; Mahoning Mine Shaft Nos. 2, 3, and 5 and the Deardorf, East Green, and North Green Mines of the Ozark-Mahoning Co.; the Victory mine, operated by the Victory Fluorspar Mining Co.; the Goose Creek mine, of the Goose Creek Mining Co.; the Douglas mine, operated by the Hicks Creek Mining Co. and P. M. T. Mining Co.; the Mackey-Humm mine, operated by the Mackey-Humm Fluorspar Mining Co.; and the Empire mine, operated by Egyptian Mining Co.

Strikes involving wage disputes closed operations of the Minerva Oil Co., Ozark-Mahoning Co. and Aluminum Co. of America in August. All workers had returned by October 6.

The Aluminum Co. of America reconditioned shaft No. 4, carried out other development work on the Good Hope vein in Hardin County, and was engaged in exploratory drilling on prospects in Pope County.

The Minerva Oil Co. completed construction of a flotation annex to the Crystal mill and started production of flotation concentrates from the Crystal property near the middle of the year. Fines from the heavy-medium separation unit and from previous milling operations were used as feed for the flotation units. Production from the Crystal mine and heavy-medium plant was suspended near the first of December because of the poor market for metallurgical-grade fluorspar. However, the flotation plant continued operation on ponded fines. Operations at the Minerva Oil Co. No. 1 mine and mill near Elizabethtown, Ill., were described in a recent publication.[3]

The geology of the deposits is discussed, and mining and milling methods are described.

For the sixth consecutive year production in Kentucky declined, totaling 42,400 short tons of finished fluorspar in 1953 compared with 55,600 tons in 1952. Most of the 1953 output came from Crittenden and Livingston Counties, although a small tonnage also was produced in Caldwell County. No production was reported from Central Kentucky mines. Major producing mines were the Tabb No. 1, Yandel No. 22, and Big Four of the United States Steel Corp.; the Commodore of the Ozark-Mahoning Co.; the Beavers, operated by J. Willis Crider Fluorspar Co.; and the Carr, operated by Roberts-Frazer, mining branch of the Kentucky Fluor Spar Co. In addition to the mine production, the Pennsylvania Salt Manufacturing Co. produced acid-grade concentrates from stockpiled tailings and purchased crude ore at its mill near Mexico, Ky.; and the Inland Steel Co. produced metallurgical-grade material from tailings and purchased crude ore at its mill near Marion. The United States Steel Corp. completed remodeling of its Mexico mill to utilize a combination of

[3] Anderson, C. E., Minerva Oil Co.: Deco-Trefoil, March-April 1953, pp. 7-14.

heavy-medium and flotation processes. The capacity of the mill was increased substantially.

Colorado, the leading western producer, displaced Kentucky as the second largest producing State in 1953, with a total output of 53,800 short tons compared with 29,600 tons in 1952. All of the 1953 output was flotation concentrates. Principal producing mines were as follows: Boulder County—Burlington mine, operated by General Chemical Division, and the Argo, Afterthought, Blue Jay, Emmett, and Spartan No. 5, operated by Ozark-Mahoning Co.; Chaffee County—the Poncha mine, operated by Reynolds Metals Co.; Jackson County—the Northgate deposits, operated by the Ozark-Mahoning Co. The Northgate deposits and mill serving them were described in an article.[4] This operation was a major factor in increasing Colorado production in 1953.

Production in Utah declined to about 16,000 short tons in 1953 compared with 17,300 tons in 1952. The entire output—all of metallurgical grade—was from mines near Delta, Juab County. Mines were operated by the Willden Bros., T. A. Claridge, the Bell Hill Mining Co., the Hilltop Mining Co., Ward Leasing Co., and Davis Mining Co.

To avoid disclosure of individual company operations separate production figures for Nevada and Idaho cannot be revealed; however, total production from these States was 17,800 tons in 1953. Production in Nevada increased considerably over 1952, chiefly as the result of increased output by the Kaiser Aluminum & Chemical Corp. mine and mill near Fallon. Operations at the Kaiser mine and mill, which supplies acid-grade concentrates for use in production of aluminum, are described in a recent publication.[5] J. Irving Crowell, Jr., produced metallurgical-grade fluorspar from the Daisy mine in Nye County.

Fire destroyed the Fluorspar Mines, Inc., flotation plant near Challis, Idaho, in April; consequently, production from that State was considerably reduced in 1953 compared with 1952. This was the only producer of fluorspar in Idaho.

Production of metallurgical-grade fluorspar from the Crystal Mountain mine near Darby, Mont., declined during 1953. The deposit was operated by Cummings-Roberts, a California concern.

In the Southwest, production increased in Arizona but declined considerably in New Mexico. A large factor in the increased output from Arizona was the initial production of acid-grade fluorspar concentrates from old tailings of base metal mines in the Castle Dome district by Holmestake Mining Co. The tailings were treated at the firm's mill at Winterhaven, Calif. A small tonnage of flotation concentrates also was produced by Arizona Eastern Fluorspar Corp. at Duncan, Ariz. Feed for the Duncan mill was mined in Graham County. The remaining production credited to Arizona was derived from crude ore mined in Graham and Greenlee Counties and shipped to Deming, N. Mex., for treatment at the General Chemical Division flotation plant.

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[4] Quinn, J. E., Acid-Grade Fluorspar Production, Ozark-Mahoning Co., Northgate, Colo.: Deco-Trefoil November-December 1953, pp. 7-14.

[5] Engineering and Mining Journal, Kaiser Streamlines Mining and Processing of Nevada Fluorspar: Vol. 154, No. 10, October 1953, pp. 96-98.

Production in New Mexico was considerably less than in 1952, chiefly because Shattuck-Denn Mining Corp. closed its Los Lunas mill near midyear. In recent years this mill had been a major producer of acid-grade fluorspar, using as feed crude ore from the Zuni Mine and purchased ore from producers in New Mexico, Arizona, and Mexico. The Zuni mine was inactive throughout the year.

Fluorspar deposits in the Eagle Mountains, Hudspeth County, Tex., were described.[6] According to the report, fluorspar occurs as replacement deposits in limestone and as fissure veins in rhyolite, with reserves containing a minimum of 30 percent CaF_2 estimated at about 100,000 short tons.

Although shipments of fluorspar produced from domestic mine were at the lowest rate since 1950, the total value of domestic shipments increased and was at an alltime high. The increased value was attributed to the great proportion of acid-grade concentrates shipped and higher average prices for all grades of fluorspar. Of the total shipments in 1953, 64,900 tons was shipped by river or river-rail for delivery to consumers compared with 64,800 tons in 1952.

Fluorspar shipments in 1953 comprised 103,933 short tons of fluxing gravel and foundry lump (including 9,756 tons of flotation concentrates which were blended with fluxing gravel) and 214,100 tons o

TABLE 3.—Fluorspar shipped [1] from mines in the United States, by States, 1944–48 (average) and 1949–53, with shipments of maximum year and cumulative shipments from earliest record to end of 1953, in short tons [2]

State	Maximum shipments		Shipments by years							Total shipments from earliest record to end of 1953	
	Year	Short tons	1944–48 (average)	1949	1950	1951	1952	1953 Short tons	1953 Percent of total	Short tons	Percent of total
Arizona	1953	1,951	1,073	846	952	1,623	434	1,951	0.6	21,102	0.2
California	1934	181	5	------	------	------	------	------	------	341	(3)
Colorado [4]	1944	65,209	42,007	22,324	18,489	20,661	29,185	53,276	16.8	677,739	7.7
Idaho	1951	(5)	------	------	------	} 9,408					
Nevada	1953	(5)	7,644	5,847	7,577		14,798	18,487	5.8	143,219	1.6
Illinois [4]	1951	204,328	163,551	120,881	154,623	204,328	188,293	163,303	51.3	4,700,102	53.3
Kentucky [4]	1941	142,862	89,244	63,438	80,137	68,635	48,308	47,244	14.9	2,758,664	31.3
New Hampshire	1917	1,274	------	------	------	------	------	------	------	8,302	.1
Montana	1952	16,160	64	422	41	------	16,160	} 17,822			
New Mexico	1944	42,973	25,500	12,844	20,036	24,402	16,443		5.6	396,641	4.5
Tennessee	1953	[6] 426	------	------	------	140	[6] 348	[6] 426	.1	2,111	(3)
Texas	1944	4,769	2,245	1,770	719	------	------	------	------	14,779	.1
Utah	1950	18,936	4,012	8,332	18,936	17,827	17,304	15,527	4.9	102,917	1.2
Washington	1945	132	34	------	------	------	------	------	------	382	(3)
Wyoming	1944	19	4	------	------	------	------	------	------	19	(3)
Total	1944	413,781	335,383	236,704	301,510	347,024	331,273	318,036	100.0	8,826,318	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 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.

[6] Gillerman, E., Fluorspar Deposits of the Eagle Mountains, Trans-Pecos, Texas: Geol. Survey Bull. 989, 1953, 98 pp.

flotation concentrates. Almost all of the fluxing gravel and foundry lump fluorspar was shipped to steel plants and iron foundries, although small tonnages also were sold to ferroalloy plants, smelters of secondary metals, producers of fluxing compounds, and for export. Of the flotation concentrates shipped 74 percent went for the manufacture of hydrofluoric acid or the General Services Administration and about 15 percent to glass and enamel plants. The remainder was shipped to manufacturers of steel and ferroalloys, to aluminum- and magnesium-reduction works, to welding-rod manufacturers, and to smelters of secondary metals.

TABLE 4.—Fluorspar shipped from mines in the United States, 1952–53, by uses

Use	1952				1953			
	Quantity		Value		Quantity		Value	
	Percent of total	Short tons	Total	Average	Percent of total	Short tons	Total	Average
Steel	42.9	142,058	$5,013,018	$35.29	34.4	109,250	$3,873,430	$35.45
Iron foundry	1.1	3,641	147,444	40.50	1.0	3,141	130,117	41.42
Glass	9.0	29,781	1,322,172	44.40	8.7	27,535	1,277,119	46.38
Enamel	1.1	3,706	181,018	48.84	1.6	5,033	273,595	54.36
Hydrofluoric acid	41.2	[1] 136,514	[1] 7,927,232	[1] 58.07	50.0	[1] 159,196	[1] 9,478,649	[1] 59.54
Miscellaneous	4.5	14,908	731,577	49.07	4.1	13,186	667,092	50.59
Exported	.2	665	31,173	46.88	.2	695	36,906	53.10
Total	100.0	331,273	15,353,634	46.35	100.0	318,036	15,736,908	49.48

[1] Includes shipments to General Services Administration.

TABLE 5.—Fluorspar shipped from mines in the United States, by grades and industries, 1952–53, in short tons

Grade and industry	1952	1953
Fluxing gravel and foundry lump:		
Ferrous	[1] 135,227	[1] 103,833
Nonferrous	580	45
Miscellaneous	752	
Exported	40	55
Total	[1] 136,599	103,933
Ground and flotation concentrates:		
Ferrous [2]	[1] 15,940	[1] 14,821
Nonferrous	4,601	4,437
Glass and enamel	33,487	32,568
Hydrofluoric acid	[3] 136,949	[3] 159,196
Miscellaneous	3,072	2,441
Ground and flotation concentrates—Continued		
Exported	625	640
Total	[1] 194,674	[1] 214,103
All grades:		
Ferrous	151,167	118,654
Nonferrous	5,181	4,482
Glass and enamel	33,487	32,568
Hydrofluoric acid	[3] 136,949	[3] 159,196
Miscellaneous	3,824	2,441
Exported	665	695
Grand total	331,273	318,036

[1] Fluxing gravel includes (and flotation concentrates exclude) the following quantities of flotation concentrates blended with fluxing gravel: 1952, 8,701 tons; 1953, 9,812 tons.
[2] Includes pelletized gravel.
[3] Includes shipments to General Services Administration.

CONSUMPTION AND USES

Consumption of all grades of fluorspar reached a record 586,800 short tons in 1953, an increase of about 13 percent over the previous high of 1952. The steel industry continued to be the largest single consumer and used more fluorspar than in any previous year. However, most of the increased usage resulted from increased consumption for the manufacture of hydrofluoric acid, a vital chemical used to produce synthetic cryolite and aluminum fluoride for the aluminum industry and as the major source of fluorine for the chemical industry. Consumption for chemical uses totaled 223,400 tons in 1953 compared with 178,300 tons in 1952, the previous record year.

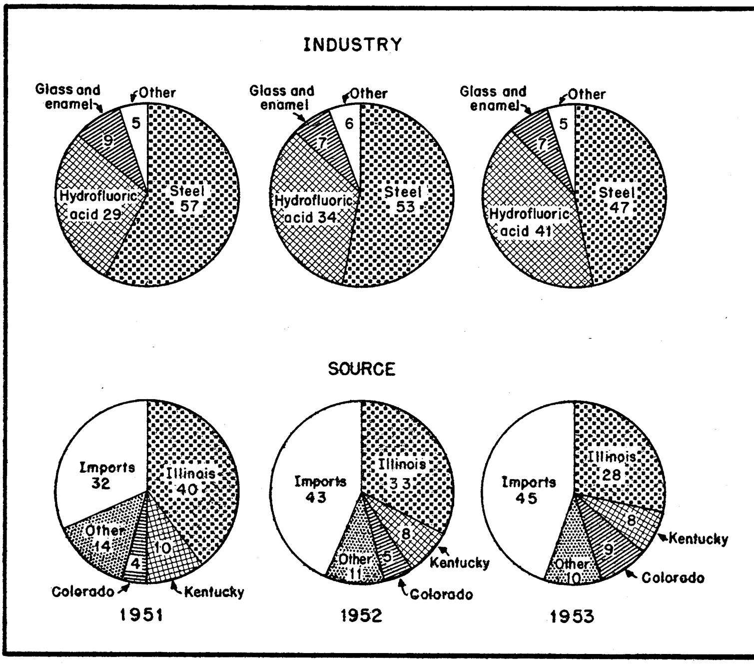

FIGURE 1.—Fluorspar sales (domestic and foreign) to consumers in the United States, 1951–53, by consuming industries and by sources, in percent.

TABLE 6.—Fluorspar (domestic and foreign) consumed and in stock in the United States, by industries, 1952–53, in short tons

Industry	1952			1953		
	Consumption	Stocks at consumers' plants Dec. 31	In transit to consumers' plants Dec. 31	Consumption	Stocks at consumers' plants Dec. 31	In transit to consumers' plants Dec. 31
Basic open-hearth steel	237,483			252,442		
Electric-furnace steel	34,627	200,530	416	35,027	171,177	------------
Bessemer steel	366			138		
Iron foundry	7,005	3,428	59	12,432	5,725	68
Ferroalloys	2,952	1,242	------------	5,224	1,366	------------
Hydrofluoric acid [1]	178,267	34,511	------------	223,359	37,261	997
Primary aluminum [2]	3,731	1,629	107	4,022	1,856	------------
Primary magnesium	5,739	548	50	3,180	445	------------
Glass	33,837	6,126	91	32,955	5,486	410
Enamel	5,205	1,151	------------	5,863	1,057	91
Cement	346	1,090	------------	319	782	------------
Miscellaneous	10,639	1,938	1	11,837	2,356	------------
Total	520,197	252,193	724	586,798	227,511	1,566

[1] Fluorspar used in making artificial cryolite and aluminum fluoride (aluminum raw materials) is included in the figures for hydrofluoric acid, an intermediate in their manufacture.
[2] Figures on consumption represent fluorspar used as a flux; *see* footnote 1.

TABLE 7.—Production of basic open-hearth steel and consumption and stocks of fluorspar (domestic and foreign) at basic open-hearth steel plants, 1944–48 (average) and 1949–53

	1944–48 (average)	1949	1950	1951	1952	1953
Production of basic open-hearth steel ingots and castings..........long tons..	65,853,400	62,634,000	76,873,000	83,118,000	75,297,000	85,690,000
Consumption of fluorspar in basic open-hearth steel production.....short tons..	184,204	183,045	212,928	242,180	237,483	252,442
Consumption of fluorspar per long ton of basic open-hearth steel made.. pounds..	5.6	5.8	5.5	5.8	6.3	5.9
Stocks of fluorspar at basic open-hearth steel plants at end of year....short tons..	70,660	97,400	128,300	133,100	195,700	163,595

Fluorspar was reported consumed in 39 States and the District of Columbia in 1953. Illinois, Pennsylvania, and Ohio were the leading consuming States, consuming about 45 percent of the total.

TABLE 8.—Fluorspar (domestic and foreign) consumed in the United States, by States, in 1952–53, in short tons

State	1952	1953
Alabama, Florida, Georgia, Mississippi, North Carolina, and South Carolina	13,963	18,556
Arkansas, Kansas, Louisiana, and Oklahoma	47,434	51,331
California	14,626	26,914
Colorado, Utah, and Wyoming	17,551	23,512
Connecticut	1,496	1,370
Delaware, District of Columbia, and New Jersey	31,590	47,737
Illinois	94,259	100,079
Indiana	29,155	29,898
Iowa, Minnesota, Nebraska, South Dakota, and Wisconsin	5,609	5,009
Kentucky	19,520	24,920
Maryland	6,310	6,649
Massachusetts and Rhode Island	1,757	1,829
Michigan	20,625	24,149
Missouri	5,069	5,216
New York	16,644	21,308
Ohio	71,240	74,065
Oregon and Washington	4,256	2,775
Pennsylvania	91,261	92,003
Tennessee	719	594
Texas	20,612	22,394
Virginia	702	307
West Virginia	5,799	6,183
Total	520,197	586,798

STOCKS

Stocks held by consumers at the end of 1953 totaled 227,500 short tons compared with 252,200 at the end of 1952 (see table 6). Almost all of this reduction in inventories was accounted for by a drop in stocks at steel plants.

According to reports of producers, the quantity of fluorspar in stock at mines or shipping points at the close of 1952 totaled 208,100 short tons. These stocks comprised 31,900 tons of finished fluorspar and 176,200 tons of crude fluorspar, estimated as equivalent to about 55,000 tons of finished fluorspar.

TABLE 9.—Stocks of fluorspar at mines or shipping points in the United States, by States, at end of year, 1951–53, in short tons

	1951		1952		1953	
	Crude [1]	Finished	Crude [1]	Finished	Crude [1]	Finished
Arizona				10		
Colorado	14,986	812	49,417	1,263	88,213	1,693
Idaho	150		100	100		
Illinois	32,541	6,781	42,380	11,118	57,725	15,920
Kentucky	6,598	5,092	11,190	12,404	10,009	7,515
Montana				1,227		
Nevada		150	6,351	1,205	20,301	6,184
New Mexico	7,558	348	12,707	119		
Tennessee		100		18		134
Utah						450
Total	61,833	13,283	122,145	27,464	176,248	31,896

[1] This crude (run-of-mine) fluorspar must be beneficiated before it can be marketed.

PRICES

Prices of metallurgical and acid grades of fluorspar declined slightly during the year, but the price quoted for ceramic-grade material increased. Metallurgical-grade fluorspar containing 70 percent or more effective CaF_2 was quoted at $43 per short ton, f. o. b. Illinois-Kentucky mines, until May, when the price receded to $42.50 per ton; that containing 60 percent or more effective CaF_2 was quoted at from $40 to $41 per short ton, f. o. b. Illinois-Kentucky mines, until April, after which prices ranging from $38 to $41 were quoted; metallurgical-grade pellets containing 60 percent effective CaF_2 were quoted at $34.00 per short ton, f. o. b. mine, until April, when the price was advanced to $37 per short ton.

At the beginning of the year ceramic-grade fluorspar containing a minimum of 95 percent calcium fluoride, with calcite and silica variable and Fe_2O_3 not exceeding 0.14 percent, was quoted at $45 per short ton, f. o. b. Rosiclare, Ill. In June the price was advanced to $50 per short ton.

Acid-grade concentrates, f. o. b. Rosiclare, Ill., Jamestown and Northgate, Colo., and Los Lunas, N. Mex., were quoted at $60 per short ton for most of the year. However, effective October 1, prices at Rosiclare, Ill., and Northgate, Colo., were reduced to $57.50 per ton.

Imported fluorspar, c. i. f. United States ports, duty paid, was quoted at about $40 per short ton for metallurgical-grade and $60 or $62 for acid grade.

FOREIGN TRADE [7]

Imports.—Increasing to a new record, imports exceeded domestic production for the second consecutive year. Mexico continued to be the leading foreign supplier, shipping about half of the total quantity imported. Of the total imports in 1953, the United States Government imported 109,900 short tons duty free; in 1952 the Government imported 55,500 tons duty free.

[7] 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.

TABLE 10.—Fluorspar imported for consumption in the United States in 1953, by countries and customs districts

[U. S. Department of Commerce]

Country and customs district	Containing more than 97 percent calcium fluoride		Containing not more than 97 percent calcium fluoride		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
Canada:						
Buffalo			1,243	$49,417	1,243	$49,417
Ohio			2,406	84,791	2,406	84,791
Philadelphia	18,371	$572,461			18,371	572,461
Rochester	(1)	33			(1)	33
Total	18,371	572,494	3,649	134,208	22,020	706,702
France:						
Maryland	309	15,988			309	15,988
Philadelphia	194	5,987	661	9,497	855	15,484
Total	503	21,975	661	9,497	1,164	31,472
French Morocco: Philadelphia			3,279	53,396	3,279	53,396
Germany, West: Philadelphia	28,783	1,329,713	3,562	69,711	32,345	1,399,424
Italy:						
Maryland	3,356	160,500			3,356	160,500
Philadelphia	42,582	2,136,231	7,930	145,969	50,512	2,282,200
Total	45,938	2,296,731	7,930	145,969	53,868	2,442,700
Mexico:						
Arizona			4,769	70,288	4,769	70,288
El Paso	17,662	636,432	32,975	621,759	50,637	1,258,191
Galveston			63	1,027	63	1,027
Laredo	62,560	2,380,661	72,126	1,260,931	134,686	3,641,592
New Orleans			98	1,836	98	1,836
St. Louis			72	1,394	72	1,394
San Diego	88	3,346			88	3,346
Total	80,310	3,020,439	110,103	1,957,235	190,413	4,977,674
Netherlands: Philadelphia	3,482	179,107	539	11,388	4,021	190,495
Spain:						
Maryland			3,904	56,208	3,904	56,208
Philadelphia	32,056	1,369,221	16,326	292,180	48,382	1,661,401
Total	32,056	1,369,221	20,230	348,388	52,286	1,717,609
Tunisia: Philadelphia			1,701	26,364	1,701	26,364
United Kingdom:						
Galveston	100	3,531			100	3,531
New York			22	1,827	22	1,827
Rochester	(1)	73			(1)	73
Total	100	3,604	22	1,827	122	5,431
Total: 1953	209,543	8,793,284	151,676	2,757,983	361,219	11,551,267
1952	127,982	5,782,719	224,521	4,744,865	352,503	10,527,584

[1] Less than 1 ton.

Several domestic producers expressed concern over the effect of the increased volume of imports on the domestic industry. On October 29 the United States Tariff Commission announced an investigation of the import duty on fluorspar containing over 97 percent CaF_2.[8] Requested by the Ozark-Mahoning Co.—the largest domestic fluorspar producer in 1953—the investigation was to have been carried out under section 7 of the Trade Agreements Extension Act of 1951, as amended ("escape clause") and under general powers of investigation pursuant to the Tariff Act of 1930. However, the inquiry was

[8] Foreign Commerce Weekly, vol. 50, No. 19, Nov. 9, 1953, p. 19.

discontinued at the request of the petitioner. Reasons for the withdrawal were not announced. Duty rates for fluorspar in effect in 1953 were $2.10 per long ton for material containing over 97 percent CaF_2 and $8.40 per long ton for material containing no more than 97 percent CaF_2.

As shown in table 11, which is compiled from data supplied by importers and domestic producers milling or otherwise handling imported fluorspar, most imports are sold to steel producers and hydrofluoric acid manufacturers. The quantities in table 11 represent the finished product recovered from milling or drying foreign ores or concentrates, rather than the crude ore milled or concentrates dried.

TABLE 11.—Imported fluorspar delivered to consumers in the United States, 1952–53, by uses

Use	1952			1953		
	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	166,849	$5,722,780	$34.30	[1] 161,827	[1] $5,186,789	$32.05
Hydrofluoric acid	59,706	3,487,635	58.41	[1] 80,961	4,585,249	56.64
Ferroalloys	240	7,340	30.58	1,029	32,718	31.80
Glass and enamel	4,381	266,107	60.74	6,215	387,294	62.32
Other	17,574	966,799	55.01	11,491	504,335	43.89
Total	248,750	10,450,661	42.01	[1] 261,523	10,696,385	40.90

[1] Partly estimated.

Exports.—Fluorspar producers reported exports to Canada, Venezuela, and Colombia of 695 short tons valued at $36,906 in 1953. In addition to the exports reported by producers, dealers exported small quantities to Mexico, Brazil, and Japan.

TABLE 12.—Fluorspar reported by producers as exported from the United States, 1944–48 (average) and 1949–53

Year	Short tons	Value		Year	Short tons	Value	
		Total	Average			Total	Average
1944–48 (average)	1,391	$48,829	$35.10	1951	1,148	$51,809	$45.13
1949	783	32,521	41.53	1952	665	31,173	46.88
1950	728	29,746	40.86	1953	695	36,906	53.10

TECHNOLOGY

Recent advances in fluorine technology and new uses for fluorine chemicals were considered in several articles during the year. Methods of preparation and the chemical and physical properties of fluorine, hydrofluoric acid, and numerous inorganic and organic fluorine compounds were reviewed.[9] The authors included a general discussion of fluorine chemistry and an extensive bibliography.

[9] Haszeldine, R. N., and Sharpe, A. G., Fluorine and Its Compounds: John Wiley & Sons, Inc., New York, N. Y., 1951, 153 pp.

A series of articles concerning the use of anhydrous fluorides in metallurgy was published.[10] The author discussed economic aspects of the use of fluorides for such purposes and compared their use with that of chlorides in similar operations. Methods of producing anhydrous fluorides and reactions with oxides, sulfides, and other halogens are described. The possible use of various methods for fluoride reduction is discussed. The report also reviewed the electrolytic reduction of aluminum with special reference to the fluorine chemistry involved and described fusion electrolysis of several other metals from their fluorides.

Properties and uses of fluorocarbon plastics also were described.[11] The article lists forms in which the plastics are available and describes their use for gaskets, packing materials, corrosion resistant linings, electronic insulation, nonstick materials, flexible bellows, and diaphragms. Reportedly the plastics have outstanding resistance to attack by chemicals, light, and aging; have wide temperature-tolerance limits and good electrical properties; but in pure form lack dimensional stability.

A doctoral thesis discussed the applicability of geochemical methods to prospecting for fluorspar in the Illinois-Kentucky district.[12] Samples taken from 2 areas overlying bedded-replacement deposits in Illinois and 1 area overlying a vein-type deposit along the Babb fault system in Crittenden County, Ky., were tested for fluorine, vanadium, barium, and strontium and for copper, lead and zinc, the last 3 being determined together as zinc equivalent. The author concluded that copper, lead, and zinc show the most promise as indicators of mineralization but that fluorine is technically unsuited as an indicator element.

Production of high-purity calcium fluoride and silica from a highly siliceous fluorspar ore was described in a patent assigned to Godfrey L. Cabot, Inc.[13] Hydrofluoric acid is reacted with the fluorspar to form fluosilicic acid (H_2SiF_6) and calcium fluoride (CaF_2); the calcium fluoride product is removed and the fluosilicic acid vaporized and hydrolyzed at high temperatures to form hydrogen fluoride and silica. Hydrogen fluoride is separated from the gaseous reaction product and scrubbed with water, releasing hydrofluoric acid, which then may be recycled to the process.

A patent issued late in 1952 describes a method of briquetting fluorspar fines for metallurgical uses.[14] A dry mixture of fluorspar fines, portland cement, and hydrated lime is combined with a binder consisting of an iron gel dispersed in a silica gel and compressed into briquets.

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[10] Kroll, W. J., Anhydrous Fluorides in Metallurgy: Metal Industry, vol. 83, No. 5, July 31, 1953, pp. 81–82; No. 6, August 7, 1953, pp. 101–104; No. 7, August 14, 1953, pp. 124–126; No. 8, Aug. 21, 1953, pp. 141–143.
[11] O'Keefe, Philip, Fluorocarbon Plastics—What They Can Do—How To Use Them: Materials and Methods, vol. 37, No. 4, April 1953, pp. 110–114.
[12] Nackowski, M. P., Geochemical Prospecting Applied to the Illinois-Kentucky Fluorspar Area: Dissertation Abs., vol. 12, No. 4, pp. 410–411.
[13] Engelson, G. E., and Secord, R. N. (assigned to Godfrey L. Cabot, Inc.), Production of Calcium Fluoride: U. S. Patent 2,631,083, Mar. 10, 1953.
[14] Kern, F. E., Method of Making a Slag-Forming Agent: U. S. Patent 2,620,267, December 2, 1952.

WORLD REVIEW

Argentina.—Deposits of fluorspar were said to have been located by exploration work in the Bajo de Valcheta district of the Rio Negras territory.[15] Ore reserves were estimated at 100,000 tons.

Canada.—Production of fluorspar in Canada was reported to total 90,078 short tons valued at C$2,657,104 in 1953 compared with 82,187 tons valued at C$2,523,408 in 1952.[16] Imports were 20,161 tons valued at C$546,915 in 1953, decreasing from 22,714 tons valued at C$648,968 imported in 1952. Mexico was the leading foreign supplier; smaller quantities were shipped from the United Kingdom, Italy, Spain, and the United States. Exports from Canada to the United States totaled 22,020 tons valued at US$706,702 in 1953 (see table 10).

Almost all of the output in Canada was mined in Newfoundland by two producers—Newfoundland Fluorspar, Ltd., and St. Lawrence Corp. of Newfoundland, Ltd. Output by the latter company totaled 32,362 short tons in 1953, including 21,085 tons of acid-grade concentrates, 4,806 tons of metallurgical grade, and 6,471 short tons of heavy-medium concentrates.[17] The firm completed installation of a heavy-medium separation unit in 1953 as part of an expansion contract entered into with the United States Government in 1952. Output from the heavy-medium unit is to be shipped to the United States for further concentration at a flotation plant at Wilmington, Del.

Newfoundland Fluorspar, Ltd., a subsidiary of Aluminium Co. of Canada, Ltd., also completed installation of sink-float equipment.[18] Output by this firm was reported at 63,933 short tons in 1953—49,997 tons of heavy-medium separation sink and 17,536 tons of fines. All was shipped to Arvida, Quebec, where the parent company operates a flotation plant.

Canadian prices for ceramic-grade fluorspar, quoted in December by the Aluminum Co. of Canada, f. o. b. Arvida, were as follows:

Ceramic coarse grade: (a) In 100 lb. bags, carload, $61.50; L. C. L. to one ton $70.70, less than one ton, $76.85. (b) In bulk: any quantity, $57.75.

Ceramic fine grade: (a) In 100 lb. bags, carload, $63.50; L. C. L. to one ton $73, less than one ton, $79.35. (b) In bulk: any quantity, $59.75.

Specifications: 96% CaF_2 minimum with maximum 2% $CaCO_3$, 3% SiO_2, and 0.2% Fe_2O_3.[19]

Italy.—Production of fluorspar in Italy was reported to total 84,000 short tons in 1953.[20] Free market value at Milan was 10,000 lire per metric ton, an equivalent of about $17.64 per short ton. Italy was a major supplier of fluorspar to the United States in 1953 (see table 10) and also shipped about 2,500 short tons to New Zealand.

Mexico.—Mexico continued to be the leading foreign supplier of fluorspar to the United States, with about half of the total imports in 1953 (see table 10). Production in Mexico—estimated at about

[15] Mining World, vol. 15, No. 10, September 1953, p. 85.
[16] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 5, May 1954, pp. 38–39.
[17] Canada Department of Mines and Technical Surveys, Fluorspar in Canada in 1953 (Preliminary): Ottawa.
[18] Work cited in footnote 17.
[19] Northern Miner (Toronto), vol. 39, No. 39, Dec. 17, 1953, p. 10.
[20] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 4, October 1954, p. 55.

TABLE 13.—World production of fluorspar, by countries, 1944–48 (average) and 1949–53 in metric tons [1]

[Compiled by Helen L. Hunt]

Country	1944–48 (average)	1949	1950	1951	1952	1953
North America:						
Canada	42,934	58,492	58,253	67,323	74,558	81,717
Mexico (exports)	49,954	55,772	65,747	66,761	188,000	166,000
United States (shipments)	304,253	214,733	273,524	314,813	300,524	288,516
Total	397,141	328,997	397,524	448,897	563,082	536,233
South America:						
Argentina (shipments)	2,524	(2)	(2)	(2)	(2)	(2)
Bolivia (exports)	[3] 69	264	61	38	80	19
Brazil	[4] 796	537	[5] 600	(2)	----------	----------
Total [5]	3,400	3,000	3,000	3,000	3,000	3,000
Europe:						
Belgium	[4] 1,256	(2)	(2)	(2)	(2)	(2)
France	22,442	46,029	41,653	50,816	56,189	54,700
Germany:						
East [5]	[5] 84,000 (East and West)	40,000	60,000	70,000	80,000	80,000
West		46,942	92,520	143,741	157,338	245,000
Italy	15,878	20,810	29,183	41,019	58,684	76,270
Norway	2,540	895	838	903	680	[5] 700
Spain	26,077	59,594	33,168	59,674	62,504	78,360
Sweden (sales)	3,218	----------	4,284	5,087	4,469	[5] 4,500
Switzerland	104	----------	----------	----------	----------	----------
U. S. S. R.	(6)	(6)	(6)	(6)	(6)	(6)
United Kingdom	54,262	67,575	64,019	75,954	77,040	80,398
Total [5]	210,000	286,000	330,000	452,000	501,000	624,000
Asia:						
China	[5] 28,000	(2)	(2)	(2)	(2)	(2)
India	337	----------	----------	----------	----------	----------
Japan	2,328	960	2,425	3,996	3,952	16,537
Korea:						
Korea, Republic of	[5] 25,000 (Republic and North)	1,560	5,467	4,243	5,553	11,012
North Korea		(2)	(2)	(2)	(2)	(2)
Turkey	[7] 38	500	----------	----------	----------	100
U. S. S. R.[5]	72,000	70,000	80,000	80,000	80,000	80,000
Total [5]	128,000	84,000	101,000	95,000	100,000	123,000
Africa:						
French Morocco	[8] 10	445	40	1,968	3,304	2,892
Southern Rhodesia	[4] 83	239	447	111	----------	338
South-West Africa	----------	----------	73	779	4,418	5,117
Tunisia	112	352	----------	----------	2,470	2,040
Union of South Africa	4,106	4,857	6,948	12,280	10,290	14,541
Total	4,311	5,893	7,508	15,138	20,482	24,928
Australia	934	571	585	497	87	308
World total (estimate)	744,000	710,000	840,000	1,015,000	1,190,000	1,310,000

[1] This table incorporates a number of revisions of data published in previous Fluorspar chapters.
[2] Data not available; estimate by senior author of chapter included in total.
[3] Average for 1945–48.
[4] Average for 1947–48.
[5] Estimate.
[6] U. S. S. R. in Europe included with U. S. S. R. in Asia, as the deposits are predominantly in Asiatic Russia.
[7] Average for 1946–48.
[8] Average for one year only as 1948 was first year of production.

183,000 short tons in 1953 and 207,000 tons in 1952[21]—has been expanded in response to market growth in the United States.

The fluorspar industry of Mexico is scattered in a number of States, including Coahuila, Chihuahua, Durango, and Sonora. Developments in Coahuila were reviewed in a paper presented at a fluorspar symposium conducted at the annual meeting of the American Institute of Mining and Metallurgical Engineers in February 1954.[22] According to the paper three major areas have been discovered—a north central field in the vicinity of Musquiz; a northern field from Boquillas to San Jose de las Piedras; and a southern field centering about Punta de la Paila. Deposits in the north central field are mainly of the replacement type in limestone. They occur as pods and irregular bodies close to canyon walls. Most deposits in the region do not outcrop but are covered by caliche or float; many were said to have been discovered by locating anthills of fluorspar. In the northern field the deposits are veinlike occurring in all types of rock in shattered zones where intrusives have penetrated limestone. Ores in the southern district, around La Paila, occur as vein-type deposits in limestone and were reported to be of higher grade than Encantada ores.

Operations at the Fluorita de Mexico, S. A., mill at Musquiz, Coahuila, were described in a recent publication.[23] According to the report the mill started production early in 1953; ore was supplied from the Mariposa mine and the Encantada region northwest of Musquiz. A discussion of the ore deposits in the area, mining methods employed, transportation, water and power facilities, mill production data, and a flowsheet of the mill are included.

Spain.—Production of fluorspar in Spain in 1953 was reported at 85,700 short tons—51,000 tons of metallurgical grade and 34,700 tons of acid grade.[24] Domestic consumption of metallurgical and acid grade totaled 8,700 and 1,700 short tons, respectively; 32,300 tons of metallurgical grade and 30,800 tons of acid grade were exported. Spain was an important supplier of fluorspar to the United States in 1953 (see table 10).

Union of South Africa.—Production of fluorspar in the Union of South Africa totaled 16,000 short tons in 1953 compared with 11,300 in 1952.[25] Approximately 3,900 tons was sold locally in 1953, and 8,900 tons was exported. The bulk of the exports went to Japan and Formosa. In 1952 local sales were reported at 5,700 tons, and about the same quantity was exported.

United Kingdom.—A survey of the fluorspar industry in England and Wales was published recently.[26] The report includes a general introduction reviewing industrial uses of fluorspar, production, exports, prices, marketing, occurrences, origin, and possible substitutes and describes in more detail producing areas in West Durham, Northwest Yorkshire, North Derbyshire, Cornwall, Devon, and Scotland.

[21] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 4, April 1954, p. 41.
[22] Hewitt, W. P., Coahuila Fluorspar: Unpublished paper presented at annual meeting of AIME, February 1954.
[23] Deco-Trefoil, Fluorita de Mexico, S. A.: Bull. MH-B72, 1954, 8 pp.
[24] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 4, April 1954, pp. 41–42.
[25] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 2, August 1954, p. 56.
[26] Dunham, K. C., Fluorspar: Mem. Geol. Survey, Special Repts. on Mineral Resources of Great Britain, vol. 4, 4th ed., Dept. of Sci. and Ind. Research, Geological Survey and Museum, London, 1952, 143 pp.

According to the report, British reserves of fluorspar—in terms of 100 percent CaF_2—totaled 1,336,750 tons as of June 1948. Of these, 277,750 tons was listed as "proved and provable" and 959,000 tons as "prospective." Slightly over a third of the reserves was said to exist in dumps of previous mining operations.

Before 1938 the United Kingdom was a major source of fluorspar to the United States, but since that year exports to the United States have been negligible.

CRYOLITE

The only known commercial deposit of natural cryolite is at Ivigtut, Greenland, where the mineral has been mined for almost 100 years. According to a recent report, ore reserves at Ivigtut are limited; Danish geologists were making a geological study of the area to serve as a basis for exploration.[27] Reserves of ore have been variously estimated as sufficient to sustain economic operations for 15 to 25 years.

In the United States synthetic cryolite is produced by Aluminum Co. of America at East St. Louis, Ill., and the Reynolds Metal Co. at Hurricane Creek, Ark. In addition, aluminum producers recover cryolite from spent potlinings of reduction cells.

Imports of artificial and natural cryolite into the United States during the year totaled 26,300 long tons valued at $3,528,100 compared with 34,300 long tons valued at $3,124,800 in 1952. Of the 1953 imports, 17,300 tons came from Greenland, 200 tons from Denmark, 2,000 tons from France, 6,000 tons from Germany, and 800 tons from Italy. Exports of cryolite—artificial and natural—totaled 117 tons in 1953 valued at $35,000. Most of these exports went to Canada, but smaller quantities were shipped to Cuba, Mexico, and the Union of South Africa.

National Production Authority Order M-99, which provided for controls over stocks and distribution of cryolite, was revoked on May 20, 1953.

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[27] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 5, November 1953, pp. 48-49.

Gem Stones

By Robert D. Thomson,[1] George Switzer,[2] and Eleanor V. Blankenbaker[3]

AS IN past years, gem production in the United States resulted largely from the efforts of amateur lapidaries who spent their leisure time searching for cuttable material. The many varieties of quartz, such as agate, jasper, and petrified wood, were the chief materials recovered in this way.

A few small gem-mining companies operated deposits chiefly for turquois, opal, tourmaline, and jade. Because only a small percentage of the total was produced on a commercial scale, precise statistics on the value of the domestic output of gems cannot be compiled. The value was estimated at $500,000 to $600,000.

The popularity of gem cutting as a hobby has increased tremendously in the past 10 years. An editor of one of the leading magazines in this field estimated that there were perhaps 50,000 home gem-cutting shops, and the total value of gems produced was millions of dollars. Almost all such production remained in private collections without passing through trade channels.

DOMESTIC PRODUCTION

In the following section the principal gems produced domestically in 1953 and areas for which information was obtained are given in detail. Materials produced in small quantities and their sources are listed in table 1.

Agate.—There was no significant change in agate production in the United States in 1953 compared with 1952.

In Oregon an estimated 15 tons of agate was recovered, with a total value of about $12,000. The Fulton agate beds, Jefferson County, reportedly produced about 7 tons valued at $1,000 per ton. An area in Crook County northeast of Prineville, reportedly yielded 11,500 pounds of agate valued at 10 cents per pound, while 2,000 pounds was reported found in the Crooked River area.

Production of agate in Montana was reported to have been about 2,000 tons; from the quantity worked stones valued at perhaps $15,000 were cut.

In Texas the Marfa-Alpine area in Presidio and Brewster Counties and the Big Bend area in Brewster County were the chief sources, with a reported production valued at about $8,000.

[1] Commodity-industry analyst.
[2] Smithsonian Institution; consulting mineralogist to the Bureau of Mines.
[3] Statistical clerk.

TABLE 1.—Localities in the United States where gem materials were reported to have been found in 1953

State, county, and locality	Gem material
Alabama: Jackson County: Bridgeport	Chalcedony.
Alaska:	
Homer	Black petrified wood.
Jade Mountain, north of Kobuk River	Jade (nephrite).
Sequoia (southeast Alaska)	Petrified wood.
Arizona:	
Apache County: Apache Indian Reservation	Obsidian and peridot.
Cochise County: Mule Mountain	Agate and amethyst.
Gila County:	
Globe-Miami area	Azurite, chrysocolla, epidote, garnet, obsidian, opal, amethyst, carnelian, bloodstone, agate, agatized wood, crocidolite, serpentine, turquois, and peridot.
Rice	Peridot.
Roosevelt Dam	Amethyst.
Graham County:	
Ash Spring Canyon, San Francisco River	Petrified wood, banded agate (blue and green), and obsidian.
Moonshine Canyon, San Francisco River	Opal, opalized wood, onyx, and chalcedony.
Potter Canyon, San Francisco River	Turquois, azurite, malachite, agate, and opalized wood.
Greenlee County:	
Clifton	Agate.
Coronado Trail, Metcalf	Turquois, malachite, azurite, variscite, chalcedony, amethyst, garnet, agate (blue banded), and chrysocolla.
Granville	Onyx.
Guthrie, York, and Sheldon	Chalcedony, turquois, azurite, opal, onyx, petrified and opalized wood, agate (black banded, orchid), quartz (rose and white).
Morenci	Turquois and agate.
Maricopa County:	
Bronco Canyon	Agate and jasper.
Cavecreek	Onyx, agate, petrified wood.
Fish Creek	Agate.
Gila Bend Mountains	Chalcedony.
Lake Pleasant—Slow Springs	Agate.
New River	Agate, opal, and jasper.
Phoenix	Amethyst and agate.
Saddle and Fourth of July Mountains	Agate and chalcedony.
Seven Springs	Jasper.
Wickenburg	Agate.
Wintersburg	Do.
Navajo County:	
Holbrook	Agatized wood.
Navajo Indian Reservation	Garnet.
Pinal County: Perlite	Obsidian.
Yavapai County:	
Bradshaw Range	Agate.
Castle Hot Springs	Do.
Limestone Canyon—Cottonwood Springs	Agate (purple banded); petrified, opalized, and agatized wood; chalcedony; limonite; jasper (red and green); carnelian; and moonstone.
Rock Springs	Agate.
Yuma County:	
Bouse	Jasper and agate.
Castle Dome district	Agate, jasper, opal, and petrified wood.
Arkansas:	
Garland County	Rock quartz.
Hot Spring County: Magnet	Smoky quartz.
Montgomery County	Rock quartz.
California:	
Alameda County: Berkeley Hill	Agate.
Calaveras County	Chrysoprase.
Del Norte County: Crescent City	Agate, jasper, and petrified wood.
El Dorado County: Placerville	Petrified and opalized wood, jasper, and agate.
Fresno County: Coalinga district	Jasper, chert, and petrified wood.
Humboldt County: Eel River and Van Duzen River.	Jasper and jade.
Imperial County:	
Black Mesa	Petrified wood and dumortierite.
Picacho district	Agate.
Winterhaven	Agate and fossil wood.
Inyo County:	
Bishop area	Garnet, epidote, clear and smoky quartz crystal, obsidian, petrified wood, agate, and jasper.
Owl Springs	Agate.

TABLE 1.—Localities in the United States where gem materials were reported to have been found in 1953—Continued

State, county, and locality	Gem material
California—Continued	
Kern County:	
Horse Canyon	Agate and jade.
Rosamond	Rhodonite.
Mendocino County: Northern part	Jade, jasper, opal, and quartz.
Monterey County:	
Monterey Coast	Agate, nephrite, and jadeite.
Monterey	Jade, rhodonite, jasper, and agate.
Plumas County	Rose quartz.
Riverside County:	
Banning	Corundum.
Beaumont	Garnet, epidote, and tourmaline.
Cabazon	Chalcedony and agate.
Hemet	Rose quartz, tourmaline, topaz, and beryl.
Juniper Flats (between Lakeview and Hemet).	Aquamarine.
Near Wiley Well	Agate.
Nuevo	Asteriated rose quartz.
Thomas Mountain (between Hemet and Palm Springs).	Rose quartz and amazonstone.
San Benito County: Dallas gem mine	Benitoite, nephrite, and jadeite.
San Bernardino County:	
Mojave and Needles district	Jasper, agate, and bloodstone.
Yucaipa and Mentone district	Rhodonite.
San Diego County:	
George Ashley mine, Pala	Kunzite, beryl, tourmaline, and quartz.
Himalaya and Herriot Mines	Tourmaline, beryl, topaz, and quartz.
Mesa Grande district	Tourmaline.
Pala	Kunzite.
Ramona	Tourmaline and garnet.
Rincon	Tourmaline and kunzite.
San Diego	Do.
San Luis Obispo County:	
Cayucos	Quartz.
Morro Bay	Jasper and jade.
Nipomo area	Agate, jasper, and moss agate.
Northern part of county	Jasper.
Shell Beach	Onyx (travertine).
Santa Clara County: Morgan Hill and Stone Canyon.	Jasper.
Siskiyou County: Happy Camp district	Nephrite, jade, and idocrase.
Trinity County	Agate, jasper, and rhodonite
Colorado:	
Chaffee County:	
Brown Canyon	Petrified wood and agate.
Salida	Jasper.
Delta County: Roubideau Canyon	Do.
Elbert County: Bijou Basin (near Elbert)	Opalized wood.
El Paso County:	
Cheyenne Canon	Garnet and tourmaline.
Colorado Springs	Topaz.
Tarryall Mountains	Do.
Fremont County:	
Canon City	Agate.
Garden Park	Do.
Larimer County:	
Red Feather Lakes	Amethyst.
Wellington	Amazonstone.
Mesa County:	
Fruita	Agate.
Unaweep Canyon	Amethyst.
Whitewater	Flint and petrified wood.
Montrose County: Crystal	Amazonstone, phenacite, smoky quartz, and topaz.
Saguache County:	
Poncho Pass	Agate.
Villa Grove	Turquois.
Teller County:	
Clyde	Topaz.
Cripple Creek	Zircon.
Divide	Amethyst.
Florissant	Petrified wood.
Pike's Peak	Agate.
Florida: Hillsborough County: Tampa Bay (Ballast Point).	Agatized coral.
Georgia:	
Cobb County: Kennesaw Mountain (near Marietta).	Topaz.
Morgan County: Buckland	Amethyst.
Paulding County: Dallas	Garnet.
Rabun County: Clayton area	Ruby, garnet, amethyst, and smoky quartz

TABLE 1.—Localities in the United States where gem materials were reported to have been found in 1953—Continued

State, county, and locality	Gem material
Georgia—Continued	
Troup County: La Grange	Rose quartz, aquamarine, and amethyst.
Wilkes County: Graves Mountain (11 miles from Washington).	Rutile, kyanite, and lazulite.
Idaho:	
Benewah County: Emerald and Ruby Creeks	Star garnet.
Blaine County: Muldoon location	Agate and petrified wood.
Butte County: Craters of the Moon	Do.
Canyon County: Caldwell	Agate and agatized wood.
Lemhi County: Salmon	Opalized wood.
Nez Perce County: Lewiston	Opal, star garnet, petrified wood, agate, jasper, and sapphire.
Owyhee County: Bruneau Dester location	Petrified wood, jasper, opalized wood, and agate.
Indiana: Elkhart County: Goshen	Agate and jasper.
Iowa:	
Lee County: Fort Madison	Jasper.
Page County: Clarinda	Agate.
Kansas:	
Franklin County: Ottawa	Petrified wood.
Wallace County: Wallace	Opal.
Louisiana:	
Ouachita County: West Monroe	Agate, jasper, and petrified wood.
Vernon County: Leesville	Petrified wood.
Maine: Androscoggin County: Minot	Garnet.
Maryland:	
Baltimore County:	
Baltimore Harbor	Flint.
Butler	Garnet.
Dyer Quarry	Serpentine.
Calvert County: Calvert Cliffs	Jasper.
Carroll County: New Windsor	Azurite and malachite.
Cecil County: State Line Chrome Pits	Serpentine.
Frederick County: Libertytown	Malachite.
Harford County: Cardiff	Serpentine.
Washington County: Camp Ritchie	Cuprite.
Michigan:	
Emmet County: Petoskey	Fossil coral ("Petoskey stone").
Keweenaw County:	
Ahmeek	Agate and thomsonite.
Delaware mines	Chlorastrolite.
Isle Royale beaches	Agate and thomsonite.
Minnesota:	
Carlton County: Moose Lake	Agate and jasper.
Cook County:	
North shore of Lake Superior	Thomsonite and agate.
Tom Lake	Do.
Lake County: Grand Marais	Do.
Mississippi:	
Harrison County: Biloxi	Jasper.
Wayne County: Waynesboro	Petrified wood.
Missouri: Cape Girardeau County: Ozark Mountains (west of Cape Girardeau).	Agate and jasper.
Montana:	
Custer County: Miles City	Agate and sapphire.
Fergus County: Lewistown	Sapphire.
Granite County:	
Anaconda and Meyers Gulches	Do.
West fork of Rock Creek	Do.
Lewis and Clark County: Helena	Sapphire, garnet, ruby, and spinel.
Madison County	Tourmaline.
Missoula County: Lola Creek district	Smoky and colorless quartz.
Park County to Dawson County: Yellowstone River.	Agate.
Powell County: Dry Cottonwood Creek Gulch	Sapphire.
Prairie County: Terry	Agate and petrified wood.
Silver Bow County: Butte	Sapphire.
Yellowstone County: Billings	Moss agate.
Nebraska:	
Jefferson County:	
Fairbury	Jasper, agate, and petrified wood.
Steele City	Do.
Sioux County: Orella	Agate, chalcedony, and petrified wood.
Nevada:	
Clark County: Las Vegas Wash	Amethyst.
Douglas County	Topaz.
Humboldt County: Virgin Valley, Thousand Creek.	Opal and rhodonite.
Lander County: Battle Mountain area	Turquois.

TABLE 1.—Localities in the United States where gem materials were reported to have been found in 1953—Continued

State, county, and locality	Gem material
Nevada—Continued	
Lincoln County:	
Acoma district	Chalcedony.
Bristol silver-mining district	Chrysocolla and malachite.
Hiko district	Jasper.
Washoe County: Sparks	Petrified wood, agate, jasper, idocrase, garnet, and obsidian.
New Hampshire:	
Cheshire County:	
Alstead	Aquamarine.
Marlow	Green tourmaline.
Surry	Amethyst.
Walpole	Blue tourmaline.
Westmoreland	Amethyst.
Coos County	
Milan	Topaz.
Stark	Amethyst and smoky quartz.
Grafton County: Plymouth	Aquamarine.
Rockingham County: Raymond (Chandler feldspar mine).	Spodumene.
Sullivan County: Tempster	Aquamarine.
New Jersey:	
Morris County: Stirling	Carnelian.
Passaic County: New Street quarry in Paterson	Prehnite.
Sussex County: Franklin	Friedelite.
New Mexico:	
Luna County: Deming	Agate.
Santa Fe County: Santa Fe	Beryl.
New York:	
Erie County: Buffalo	Satin-spar (calcite)
Orange County: Forest of Dean magnetite mine	Sunstone.
North Carolina:	
Ashe County	Garnet, moonstone, rutile, aquamarine, and golden beryl.
Avery County: Cranberry	Unakite.
Macon County: Caler Fork of Cowee Creek	Corundum.
Orange County: Hillsboro	Moss agate.
North Dakota: McLean County: Coleharbor	Petrified wood.
Oklahoma:	
Canadian County: El Reno	Jasper, petrified wood, and agate.
Comanche County: Zircon mine, Wichita Mountain.	Zircon.
Dewey County: Taloga	Jasper, petrified wood, and agate.
Greer County: Mangum	Alabaste.
Jackson County: Altus	Smoky quartz.
Ottawa County: Miami-Oklahoma district	Sphalerite.
Pushmataha County: Antlers	Green quartz.
Oregon:	
Baker County: Greenhorn	Agatized fern.
Crook County:	
Carey Ranch	Agate.
Crooked River country	Moss agate.
Eagle Rock	Agate.
Ochoco Mountains, Lucky Strike bed	Moss agate and carnelian.
Powell Butte	Agate.
Prineville	Do.
View Point beds	Do.
Curry County: Brookings	Jade.
Deschutes County	Moss agate and carnelian.
Harney County:	
Glass Butte obsidian field	Obsidian.
Steens Mountains	Agate.
Jackson County: Medford	Agate, jasper, and petrified wood.
Jefferson County:	
Fulton agate beds	Agate.
Madras	Amethyst.
Pony Butte-Priday Ranch	Agate.
Lane County: Bear Creek	Do.
Malheur County: Sucker Creek	Agate, jasper, and petrified wood.
Polk County: Dallas	Jasper, agate, and petrified wood.
Union and Wallowa Counties: Wallowa Mountains.	Agate.
Wheeler County: Fossil district	Do.
Pennsylvania:	
Adams County: Greenstone	Cuprite.
Lancaster County: Woods mine	Serpentine.

TABLE 1.—Localities in the United States where gem materials were reported to have been found in 1953—Continued

State, county, and locality	Gem material
South Carolina:	
Anderson County: Pelzer	Tourmaline.
Chesterfield County: Chesterfield (Old Brewer gold mine).	Topaz.
Florence County: High Hill Creek	Petrified wood.
South Dakota:	
Custer County:	
Black Hills and Bad Lands	Rose quartz, star beryl, jasper, jade, chert, and agate.
Custer	Beryl, rose and star quartz, and agate.
Pennington County: Keystone	Beryl, rose and star quartz, and tourmaline.
Tennessee: Carter County: Roan Mountain	Unakite.
Texas:	
Brewster County:	
Alpine	Agate.
Rio Grande River and Big Bend area	Agate and jasper.
DeWitt County	Agate, agatized and opalized wood, and jasper.
Duval County	Do.
Fayette County: Muldoon	Opalized and petrified wood.
Gonzales County:	
Gonzales	Do.
Nixon	Do.
Hidalgo County: Mission	Agate.
Lee County: Giddings	Opalized and petrified wood.
Llano County: Llano	Amethyst, garnet, smoky quartz, quartz, and black tourmaline.
Mason County: Streeter	Topaz.
Potter County: Amarillo	Petrified wood.
Presidio County: Marfa	Agate and jasper.
Trinity County: Trinity	Opalized and petrified wood.
Walker County: Huntsville	Do.
Webb County: Laredo	Agate.
Zapata County: Zapata and Falcon Dam on Rio Grande River.	Do.
Utah:	
Box Elder County: Lucin	Variscite.
Garfield County: Escalante	Agate, dinosaur bone, and petrified wood.
Kane County: Orderville	Agate.
Millard County: Black Rock	Obsidian.
Salt Lake County: Murray	Onyx.
Sevier County: Salina	Agate.
Tooele County: Dugway Pass	Quartz.
Washington County: Hurricane	Agate.
Wayne County:	
Hanksville	Agate and petrified wood.
Torrey	Petrified wood, dinosaur bone, jasper, and agate.
Vermont: Windsor County: Chester	Pyrite.
Virginia: Rockbridge County: Vesuvius	Unakite.
Washington:	
Cowlitz County: Kalama	Carnelian and sardonyx.
Kittitas County:	
Cle Elum	Agate.
Ellensburg	Do.
Horse Canyon	Chalcedony.
Lewis County:	
Chehalis	Carnelian and sardonyx.
Toledo	Do.
Yakima County: Toppenish	Do.
Wisconsin:	
Ashland County: Chippewa River	Jasper.
Clark County: Owen	Agate and jasper.
Wyoming:	
Carbon County: Kortes Dam	Jade (nephrite).
Fremont County:	
"Cottonwood-Haypress" and Warm Springs	Do.
Dubois	Agate.
Lander	Jade (nephrite) and agate.
North side Beaver Divide and Green Mountains.	Jade (nephrite), iris agate, moss agate, jasper, agatized wood, sapphire, garnet, aventurine, hematite, and serpentine.
Sweetwater County:	
Agate fields	Agate.
Eden Valley	Petrified wood.
Between Liman and Little America	Agate.

Agate valued at $2,200 was found in San Bernardino County, Calif., principally in the Mojave Desert region. The value of gem stones from other areas in California, as shown in table 1, is not known.

The total production of agate in Arizona was reported to be 12 tons, valued at about $12,000. The principal localities were the Saddle Mountain area, in Maricopa, Pinal, and Graham Counties, in the Bradshaw Range east of Wickenburg, Maricopa County, and near Holbrook, Navajo County, from areas just outside the Petrified Forest National Monument.

The agate fields near Deming, Luna County, N. Mex., reportedly yielded about 50 tons of material (value not reported). Production from the Salida and Pike's Peak area, Chaffee County, Colo., was valued at $2,000. In Florida production of agatized coral from Tampa, Hillsborough County, was reported as 1,000 pounds, valued at $3,000.

The Iris and Fairburn agate were described in 1953.[4]

Jade.—The decline in jade mining in Wyoming, noted in the past several years, continued in 1953 owing to depletion of known deposits. There was virtually no production of good-quality material worth $30 to $100 per pound. Production was reported as follows: Apple green, 100 pounds at $30 per pound; black, olive, etc., 2,000 pounds at $1 per pound; snowflake, 1,500 pounds at $2 per pound.

A jade boulder (possibly idocrase) weighing 1,350 pounds was found in Shasta County, Calif., and it was estimated that after cutting it may be worth about $25,000.[5] A small quantity of jade, none of fine quality, was produced in Mendocino, Monterey, and San Benito Counties, Calif.

The Empire Jade Co. and the Shungnak Jade Products Co. produced a small quantity of nephrite jade from the Shungnak district, Northwestern Alaska region, in 1953. By careful selection and cutting gem-quality jade was obtained and made into jewelry. Scraps from the cutting and inferior-quality grade, unsuitable for cutting, were cut into blocks and sold to tourists as souvenirs.

Three articles were published in 1953 on jade.[6]

Opal.—The opal mines in Virgin Valley, Humboldt County, Nev., produced opal valued at approximately $60,000.

Topaz.—Topaz continued to be produced from the Streeter-Kotempsie area of Mason County, Tex. Both white and blue topaz were found by amateur gem collectors by washing and sifting stream gravels in the area. The 1953 production was reported as 10,000 grams, with an estimated value ranging from $4,000 to $10,000.

Tourmaline.—Operations in the famous gem-producing area of Mesa Grande, San Diego County, Calif., produced more tourmaline than in the past several years. Production from the Himalaya mine, operated by R. R. Potter, was reported as 168 pounds, valued at $6,000. Morganite (pink beryl) also was produced, at a value of $3,000.

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[4] Jones, F. T., The Iris Agate Described: Mineralogist, vol. 21, No. 1, January 1953, pp. 3–10.
Putnam, G. G., Fairburn Agate: Mineral Notes and News, No. 187, April 1953, pp. 8, 43.

[5] California Mining Journal, vol, 23, No. 2, October 1953, p. 30.

[6] Webster, Robert, Jade and Jadelike Minerals :Mineralogist, vol. 21, No. 12, December 1953, pp. 435–438.
Long, F. W., Some Alaska Jade Trails: Mineralogist, vol. 21, Nos. 6–7–8, June-August 1953, pp. 243–249, 258, 260, 262, 264, 266, 268, 270.
Halphern, J. M., Arctic Jade: Rocks and Minerals, vol. 28, No. 5–6, May–June 1953, pp. 237–242.

Turquois.—Principal production of turquois during 1953 was from mines in the vicinity of Battle Mountain, Humboldt County, Nev. The Royal Blue Mines Co., operated by Lee F. Hand of Battle Mountain, reported producing turquois valued at more than $110,000. About 2,000 pounds of good grade turquois and 3,000 pounds of lighter colored material was produced in Arizona from the Miami-Globe district, Gila County. A small quantity of fine-quality turquois was produced from Villagrove Turquoise Lode, near Villagrove, Saguache County, Colo.

SYNTHETIC GEMS

Synthetic star sapphire and ruby gem stones were produced in Europe and the United States in 1953. Production by domestic industry declined sharply in 1953 compared with 1952 because of increased imports of foreign synthetic stones, which were sold at lower prices than similar stones produced in the United States. Linde Air Products Co., Division of Union Carbide & Carbon Corp., a producer of synthetic star stones, petitioned the United States Tariff Commission to ban imports on these products originating in Europe.[7]

Synthetic emerald was produced only by the Chatham Research Laboratories in San Francisco, Calif. Production in 1953 was essentially the same as in 1952—about 60,000 carats, of which 50 percent was low-quality, 40 percent medium-quality, and 10 percent fine gem quality.

A small production of titania (synthetic rutile) was reported by two United States manufacturers.

The cultured-pearl industry in Japan, which had nearly regained its prewar status, was set back by a typhoon which destroyed much of the crop that was to have been harvested in late 1953. In some areas losses as high as 60 percent of the crop were reported. The damage was expected to cause a 20-percent rise in cultured-pearl prices. Major purchasers of cultured pearls urged the Japanese Government to establish marketing quotas to prevent flooding of the market with inferior quality material.

CONSUMPTION

Total sales of diamonds and other gem stones by retail jewelers in the United States declined slightly in 1953 compared with 1952. Total sales of diamonds, including both gem and industrial, by the Central Selling Organization on behalf of all major producers amounted to $176,500,000 compared with $201,600,000 in 1952. Sales of gem diamonds by the Diamond Trading Co. during 1953 were $121,341,000, a small decrease compared with 1952.

Large quantities of semiprecious gem stones were collected in the United States by gem-stone enthusiasts. The stones were cut and polished in home lapidary shops for handmade jewelry or private collections or by commercial lapidary shops. Activity in this field has been increasing through the efforts of several technical journals and local gem societies.

[7] Chemical and Engineering News, vol. 31, No. 35, Aug. 31, 1953, pp. 3552–3553.

FOREIGN TRADE [8]

Imports of gem stones into the United States increased 4 percent in 1953 compared with 1952 (table 2). Diamonds ranked first, with 83 percent of the imports, based on value, followed by imitation stones (synthetic and other), 12 percent; and pearls (natural and cultured), 3 percent, as shown in table 2.

TABLE 2.—Precious and semiprecious stones (exclusive of industrial diamonds) imported for consumption in the United States, 1952–53

[U. S. Department of Commerce]

Commodity	1952 Carats	1952 Value	1953 Carats	1953 Value
Diamonds:				
Rough or uncut (suitable for cutting into gem stones), duty-free	[1] 709,043	[1] $52,192,621	733,630	$57,010,629
Cut but unset, suitable for jewelry, dutiable	438,546	51,671,643	444,247	50,549,942
Emeralds:				
Rough or uncut, duty-free	8,790	22,213	15,561	27,987
Cut but not set, dutiable	11,162	449,726	26,952	320,739
Pearls and parts, not strung or set, dutiable:				
Natural		465,165		264,873
Cultured or cultivated		3,373,383		3,769,758
Other precious and semiprecious stones:				
Rough or uncut, duty-free		226,632		203,667
Cut but not set, dutiable		2,125,456		2,218,868
Imitation, except opaque, dutiable:				
Not cut or faceted		97,502		40,720
Cut or faceted:				
Synthetic		[1] 536,047		677,029
Other		[1] 13,413,526		14,872,795
Imitation, opaque, including imitation pearls, dutiable		39,142		127,641
Marcasites, dutiable:				
Real		75,285		94,813
Imitation		11,061		2,589
Total		[1] 124,699,402		130,182,050

[1] Revised figure.

TABLE 3.—Diamonds (exclusive of industrial diamonds) imported for consumption in the United States, 1952–53, by countries

[U. S. Department of Commerce]

Country	Rough or uncut: Carats	Rough or uncut: Value Total	Rough or uncut: Value Average	Cut but unset: Carats	Cut but unset: Value Total	Cut but unset: Value Average
1952						
Australia				142	$41,882	$294.94
Belgium-Luxembourg	4,852	$430,417	$88.71	186,682	22,956,814	122.97
Bermuda	9,545	300,102	31.44			
Bolivia	71	2,119	29.85			
Brazil	9,719	479,114	49.30	2,056	242,763	118.08
British Guiana	1,061	53,855	50.76	22	3,349	152.23
British Malaya	1,723	115,367	66.96			
Canada	3,847	383,463	99.68	169	36,694	217.12
Denmark				15	2,528	168.53
France	50,490	1,075,560	21.30	784	321,310	409.83
French Equatorial Africa	13,976	396,924	28.40			
French Morocco				6	602	100.33
Germany, West				17,658	1,364,251	77.26
India				2,821	25,539	9.05
Indonesia				14	2,532	180.86

[8] Figures on imports and exports compiled by Mae. B. Price and Elise 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, 1952–53, by countries—Continued

[U. S. Department of Commerce]

Country	Rough or uncut			Cut but unset		
	Carats	Value		Carats	Value	
		Total	Average		Total	Average
Israel and Palestine	1	$47	$47.00	128,206	$10,017,374	$78.13
Italy	359	60,808	169.38	187	29,641	158.51
Japan				5	1,250	250.00
Lebanon				7	1,573	224.71
Mexico				111	13,143	118.41
Netherlands	2,271	219,467	96.64	33,636	4,246,138	126.24
Portuguese Asia, n. e. s.				1,021	7,476	7.32
Surinam	135	8,999	66.66			
Switzerland	[1] 94,052	[1] 6,997,845	[1] 74.40	3,319	582,130	175.39
Thailand	1,338	153,564	114.77	968	134,883	139.34
Union of South Africa	[1] 48,515	[1] 1,276,049	[1] 26.30	54,011	10,737,727	198.81
United Kingdom	[1] 440,162	[1] 39,387,889	[1] 89.48	6,706	902,044	134.51
Venezuela	26,926	851,032	31.61			
Total 1952	[1] 709,043	[1] 52,192,621	[1] 73.61	438,546	51,671,643	117.82
1953						
Argentina				18	4,263	236.83
Australia				3	1,771	590.33
Belgian Congo				300	63,603	212.01
Belgium-Luxembourg	19,116	1,818,663	95.14	215,438	25,554,634	118.62
Bermuda	8,985	502,677	55.95			
Brazil	398	99,448	249.87	34	8,722	256.53
British Guiana	2,307	83,958	36.39	30	2,847	94.90
British Malaya	560	65,162	116.36			
British West Africa	121	726	6.00			
Canada	4,744	448,338	94.51	95	88,241	928.85
Dominican Republic				1	235	235.00
France	11,631	280,922	24.15	1,098	170,306	155.11
French Equatorial Africa	39,963	940,002	23.52			
Germany, West	167	1,667	9.98	22,196	1,633,341	73.59
Gold Coast	450	4,219	9.38			
Hong Kong				1	93	93.00
India				2,974	52,853	17.77
Israel and Palestine				122,218	10,276,874	84.09
Italy				48	30,647	638.48
Japan				55	4,919	89.44
Mexico				165	10,239	62.05
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
Union of South Africa	56,592	2,336,405	41.29	46,441	8,455,833	182.08
United Kingdom	524,826	47,625,107	90.74	3,271	526,641	161.00
Venezuela	51,779	1,587,872	30.67	3	745	248.33
Total 1953	733,630	57,010,629	77.71	444,247	50,549,942	113.79

[1] Revised figure.

TECHNOLOGY

Descriptions of lapidary equipment, the general principles of construction, and applications of the various cabochon and facet machines were described in magazine articles to guide amateur lapidaries.[9]

The merits of cutting certain gem stones by the freeform method were emphasized.[10]

The procedure for cutting and grading diamonds involves intricate steps and requires skills developed through years of painstaking work.

[9] Morrow, I. L., Gem-Cutting Equipment to Make in the School Shop: Industrial Arts and Vocational Education, vol. 42, October 1953, pp. 285–286.
Sinkankas, John, Lapidary Machinery, part I—Cabochon Machinery: Rocks and Minerals, vol. 28, No. 1–2, January-February 1953, pp. 44–48; part II—Faceting Machinery, No. 3–4, March-April 1953, pp. 147–153.
Walker, D. B., A Horizontal Lap Wheel: Mineralogist, vol. 21, No. 10, October 1953, pp. 373–374, 376, 378.

[10] Sanger, Lucille, Cutting the Freeform: Rocks and Minerals, vol. 28, No. 9–10, September-October 1953, pp. 493–494.

The history of diamond polishing and present-day methods for cutting and polishing diamonds for market were described.[11]

On the basis of end use diamonds are classified as (1) gem and (2) industrial. Diamonds of good color and perfection are used for gem purposes, and the remainder are used in industry because of their hardness.[12] Studies were conducted to determine, by microscopic techniques, the growth features of diamonds, phenomena produced by etching, limitations of polishing, and the rate of abrasive resistance.[13]

Further work was done on coloring diamonds by irradiation in a cyclotron or nuclear reactor. Green was the main color obtained, but brown and other colors also were obtained. Formation of blue diamonds from yellow by exposure to high-energy electrons was described.[14]

Investigations of natural and synthetic emerald showed that synthetic stones had a greater transparency to short-wave ultraviolet light. Results of the experiments present a possible method for distinguishing natural from synthetic emerald.[15]

The history of gem-stone synthesis and methods used for producing synthetic sapphire, ruby, and emerald were discussed.[16]

Tumbling gems for polishing rough gem materials has been known for more than 100 years, but just recently the technique has become popular with amateur lapidaries. Mechanics and use of a tumbling barrel were described.[17]

A discussion to aid the layman, to clarify the meaning of brilliance and fire and the factors that influence each, was published in 1953.[18]

Patents were issued on methods for growing synthetic corundum and spinel gems on a seed [19] and for growing synthetic rutile.[20]

Absorption spectra of pink and green tourmaline were measured by a Hilger-medium quartz spectograph. Absorption curves showed that color was unaffected by heating at less than 800° C., and between 800°–1,000° C. the pink crystals were decolorized, with loss in weight and partial destruction of the lattice. Green tourmaline turned

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[11] Industrial Diamond Review, Early Diamond Polishing in London: Vol. 13, No. 149, April 1953, p. 80.
Grodzinski, P., The History of Diamond Polishing: Industrial Diamond Rev., vol. 13, No. 147, suppl. 1, February 1953, pp. 1–13. Diamond Technology; Production Methods for Diamond and Gem Stones: N. A. G. Press, Ltd., London, 2d rev., 1953, 784 pp.
Holstein, O., The Craft of Diamond Polishing: Jour. Gemmol., vol. 4, No. 1, January 1953, pp. 14–23.
Kaplan, G. R., Procedure for the Cutting and Grading of Diamonds: Gems and Gemology, vol. 8, Winter Issue, 1953, pp. 355–360.

[12] Kraus, E. H., Classification and Description of Varieties of Diamond: Ind. Diamond Rev., vol. 13, No. 149, April 1953, p. 86.

[13] Tolansky, S., The Surfaces of Diamonds: Ind. Diamond Rev., vol. 13, No. 157, December 1953, pp. 271–276.

[14] Custers, J. F. H., Artificial Coloration of Diamonds: Optima, vol. 3, 1953, pp. 8–12.

[15] Anderson, R. W., A New Test for Synthetic Emerald: Gemmologist (London), vol. 22, No. 264, July, 1953, pp. 115–117.

[16] Davids, E. B. and Tindula, R. W., Synthetic Gemstones: Off. Tech. Services, Tech. Div. Rept. IR–11392, May 1953, 7 pp.
Frondel, C., Commercial Synthesis of Star Sapphires and Star Rubies: Econ. Geol., vol. 48, No. 4, June–July 1953, p. 325.
Kaspar, J., Synthetic Corundum, part II: Ind. Diamond Rev., vol. 13, No. 149, April 1953, pp. 81–84. Synthetic Corundum, part III: Ind. Diamond Rev., vol. 13, No. 150, May 1953, pp. 102–104.
Miles, Joel, Man-Made Gem Stones: Mineralogist, vol. 21, No. 9, September 1953, pp. 325–326, 328, 330, 332.
Webster, R., Synthetic Gemstones: Gemmologist (London), vol. 21, No. 249, 1952, pp. 66–70.
Weyl, W. A., Synthetic Minerals: Econ. Geol., vol. 48, No. 4, June-July 1953, pp. 288–305.

[17] Leeson, Bert, The Tumbling Barrel, How Does It Work: Min. Notes and News, No. 187, April 1953, pp. 9, 52.
Mitchell, R. C., How to Tumble Gems: Lapidary Jour., vol. 6, No. 6, February 1953, pp. 442–446.

[18] Pough, F. H., Brilliance and Fire as Gemstone Properties, part I: Jewelers' Circ.-Keystone, vol. 123, No. 11, August 1953, pp. 140, 187–190; part II, No. 12, September 1953, pp. 112, 136–138, 140.

[19] Barnes, M. H. (assigned to Union Carbide & Carbon Corp.), Synthetic Gem Production: U. S. Patent 2,634,554, Apr. 14, 1953.

[20] Eversole, W. G. and Drost, Wilfred (assigned to Union Carbide & Carbon Corp.), Synthetic Rutile and Method of Making: U. S. Patent 2,610,129, Sept. 9, 1952.

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brownish at lower temperatures. Results of experiments to determine the relationship between color and either lattice structure or chemical composition were reported.[21]

A polariscope consisting of a cylindrical shell with polaroid plates can be used to determine whether a gem is singly or doubly refractive. Details were given for building a handmade instrument.[22]

Certain gem stones, when exposed to ultraviolet rays, will glow or luminesce. Selected gem stones were subjected to ultraviolet and X-ray radiation and their reactions were recorded.[23]

A historical survey of the spectroscope and its application in gemmology was published in a technical journal.[24]

WORLD REVIEW

Production of diamonds (including industrial diamonds) in 1953 increased 7 percent compared with 1952, as shown in table 4. Belgian Congo ranked first, with 63 percent, principally industrial diamonds, and Union of South Africa second, with 13 percent, mainly gem-quality diamonds. A detailed review of the world diamond industry in 1952 was published in 1953.[25]

Australia.—The value of opal production in 1953 was $174,000—an increase of $31,000 over the 1952 figure and the highest annual value recorded since 1907. The increase was probably due to a rise in average quality rather than to the quantity of material produced. Most of the opal produced in 1953 was from the Coober Pedy and Andamooka fields in South Australia.[26]

A book describing the Lightning Ridge opal area was published in 1953.[27]

The Anakie field in Central Queensland is the only Australian producer of sapphires. Production has been declining in recent years. Production for 1953 was valued at $1,617. A geological report on the Anakie field published during the year stated that 21 men were engaged in mining sapphires in April 1953.[28]

Belgian Congo.—The most important diamond fields are in the Kasai, Bushimae, and Kundelungu districts. Some sporadic deposits occur in Aruwimi, Izuri, and Itimbiri districts.[29] Tshikapa is considered the focal point for the diamond industry in Belgian Congo and was described in an article.[30]

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[21] Bradley, J. E. S., and Bradley, Olive, The Coloring of Pink- and Green-Zoned Tourmaline: Mineral, Mag. (London), vol. 30, No. 220, March 1953, pp. 26–32.

[22] Gems and Minerals, How to Make a Polariscope: No. 194, November 1953, pp. 10–12.

[23] Gemmologist (London), Luminescence in the Service of Gemmology: Vol. 22, No. 260, March 1953, pp. 46–49; No. 261, April 1953, pp. 74–76.

Webster, Robert, Gemstone Luminescence: Gemmologist (London), vol. 22, No. 262, May 1953, pp. 77–80; No. 263, June 1953, pp. 98–103; No. 264, July 1953, pp. 123–126; No. 265, August 1953, pp. 139–143; No. 266, September 1953, pp. 161–164; No. 267, October 1953, pp. 188–191; No. 269, December 1953, pp. 229–231.

Anderson, B. W., Crossed Filters for the Study of Fluorescence: Gemmologist (London), vol. 22, No. 260, March 1953, pp. 39–45.

[24] Anderson, B. W., The Spectroscope and Its Applications to Gemmology: Gemmologist (London), vol. 22, No. 266, September 1953, pp. 153–158; No. 267, October 1953, pp. 173–176; No. 268, November 1953, pp. 198–201; No. 269, December 1953, pp. 218–222.

[25] Foshag, W. F. and Switzer, George, Diamond Industry, 1952: Jewelers' Circ.-Keystone, vol. 123, No. 10, July 1953, pp. 98–100, 108–110, 142–144; No. 11, August 1953, pp. 142, 144, 238, 240, 243, 245; No. 12, September 1953, pp. 108, 110, 153.

[26] J. A. Dunn, chief mineral economist, Bureau of Mineral Resources, Department of National Development, Commonwealth of Australia, letter to Bureau of Mines.

[27] Idriess, I. L., Lightning Ridge, the Land of Black Opals: Anglobooks, New York, N. Y., 1953, 238 pp.

[28] Queensland Government Mining Journal (Australia), vol. 54, No. 622, August 1953, pp. 570–571.

[29] Fieremans, C. [Geology and Geochemistry of the Diamond Fields of Belgian Congo]: Tech. Wetensch. Tijdschr, vol. 22, 1953, pp. 71–82.

[30] Gemmologist (London), Diamond City of the Congo: Vol. 22, No. 267, October 1953, pp. 182–187; No. 268, November 1953, pp. 202–207.

TABLE 4.—World production of diamonds, 1950–53, by countries, in metric carats

(Including industrial diamonds)

	1950	1951	1952	1953
Africa:				
Angola	538,867	734,324	743,302	729,377
Belgian Congo	10,147,471	10,564,667	11,608,763	12,580,256
French Equatorial Africa	111,407	136,000	163,400	140,144
French West Africa	126,346	101,000	136,080	180,000
Gold Coast	[1] 950,000	1,752,878	2,189,557	2,167,364
Sierra Leone	655,474	475,759	451,426	472,934
South-West Africa	488,422	478,075	541,027	617,411
Tanganyika	164,996	108,625	143,023	170,679
Union of South Africa:				
Lode	1,516,194	1,967,272	2,093,138	[2] 2,397,755
Alluvial	[3] 231,674	[3] 289,063	[3] 282,681	[4] 300,000
Brazil [1]	200,000	200,000	200,000	200,000
British Guiana	37,462	43,260	38,305	35,306
Venezuela	60,389	63,226	98,291	84,790
Other countries	3,000	3,000	5,000	5,000
Grand total	15,232,000	16,917,000	18,694,000	20,081,000

[1] Estimate.
[2] Pipe mines under De Beers control.
[3] Includes an estimated 100,000 carats for State mines of Namaqualand.
[4] Includes: (1) Approximately 117,000 carats for pipe mines outside De Beers control and (2) an estimated 100,000 carats for State mines of Namaqualand.

British Guiana.—The Government increased its royalty on diamonds in 1953 to $0.50 per carat.

There were several independent diamond buyers and cutters in Georgetown, but the domestic diamond market was controlled by a local syndicate, comprised of Krakowsky & Correia Co. and Morabisi Mining Co. There was considerable prospecting in the Kurupung area and Anaborong River area, as well as in the vicinity of Kurashi Creek, a tributary of the Cuyuni River.[31] The Kurupung Placers Co. early in the year finished prospecting in the Kurupung area and found that the deposits were not large enough for commercial exploitation. The company began investigation in the Eping Basin.[32]

Burma.—A book on the geology and gem stones of the Mogok Stone Tract was published.[33]

Canada.—Several large diamonds were found along the banks of the Rainy River near Fort Francis, Ontario, and prospectors were lured to the area in expectation of finding more.[34]

A supplementary list of gem materials found in Canada was compiled.[35]

Ceylon.—Corundum gems produced in Ceylon include ruby and white and yellow sapphire; gem-quality alexandrite, amethyst, aquamarine, garnet, spinel, and zircon also are produced.[36] Production in 1953 was estimated to be worth $420,000.

Colombia.—The Government-owned Muzo and Cosquez emerald mines were opened in 1953 on a full-time production basis after 4 years of sporadic production. The principal reason for production

[31] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 5, May 1953, p. 33.
[32] Mining Journal (London), vol. 241, No. 6172, December 1953, p. 656.
[33] Iyer, L. A. N., The Geology and Gem Stones of the Mogok Stone Tract, Burma: Mem. Geol. Survey India, vol. 82, 1953, 100 pp.
[34] California Mining Journal, Diamond Discovery in Canada Starts Prospecting: Vol. 22, No. 11, July 1953, p. 28.
[35] Field, D. S. M., List of Canadian Gems and Ornamental Minerals: Canadian Min. Jour., vol. 74, No. 4, April 1953, pp. 82–83.
[36] Parkinson Kenneth, Ceylon; the Island of Gems: Gemmologist (London), vol. 22, No. 258, January 1953, pp. 5–7.

being suspended was the guerilla activities in the area. With the change of government in July, the new administration was able to renew production.

French Equatorial Africa.—It was reported in 1953 that the Government expected to double its diamond production within the next 4 years. It was planned to increase output gradually until it reaches 400,000 carats per year.[37]

India.—New gem-quality emerald occurrences were reported near Rajnagar near Deogarh in Kishangarh and in southwest Jaipur. The important deposits in Rajasthan are at Kalaguman. The emeralds are marketed at auctions held periodically under supervision of the Rajasthan State authorities at Jaipur.[38]

As a result of a field examination in 1953, it was reported that profitable production could be increased from the diamond deposits in the Panna area, Vindhya Pradesh. It was recommended that accurate quantitative information be obtained regarding the extent and location of the reserves and that investment of greater capital in mining and milling equipment be considered in an effort to increase the production.[39]

Japan.—Most of Japan's cultured-pearl fisheries are along the coast of the Ku Peninsula. The industry is based on the fact that a grain of sand put into the oyster irritates it and causes the particle to be coated with a secretion, which in 7 to 8 years will harden and form a gem pearl. Artificially cultivated pearls can be marketed at a much lower price than those that occur naturally. Japan is the most important producer of cultured pearls.[40]

Union of South Africa.—De Beers Consolidated Mines recently divided the Diamond Corp. into two companies by forming a new company called De Beers Investment Trust, Ltd. Diamond Corp. will confine its activities to the diamond trade, and the new company will handle the financial affairs of Diamond Corp.

Descriptions of diamond mining and recovery at Kimberley [41] and of the early diamond industry [42] were published.

BIBLIOGRAPHY

BERKHOLZ, M. F. Gems From the Sea. Gems and Minerals, No. 193, October 1953, pp. 9–11.

BEYMER, MARGUERITE. Rockhounds in the Making. M. Beymer, The Dalles, Oreg., 1953, 112 pp.

CALIFORNIA DIVISION OF MINES. California's Lithium Gems. Min. Inf. Service, vol. 6, No. 9, September 1953, p. 6.

DIETRICH, R. V. Virginia Mineral Localities. Virginia Polytech. Inst., Eng. Exp. Sta. Bull. Ser. 88, 1953, 57 pp.

DURAND, PAUL. Judging Gems. Technicraft Publishers, Hollywood, Calif., 1952, 58 pp.

FENTON, C. L., AND FENTON, M. A. Riches From the Earth. John Day Co., Inc., New York, N. Y., 1953, 159 pp.

FRENCH, BEVAN. Some Recent Franklin, N. J., Minerals. Rocks and Minerals, vol. 28, No. 7–8, July–August 1953, pp. 349–351.

[37] Mining World, vol. 15, No. 10, September 1953, p. 75.

[38] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 5, May 1953, pp. 36–37.
Brown, J. C., Emeralds in India: Gemmologist (London), vol. 22, No. 265, August 1953, pp. 133–136; No. 266, September 1953, pp. 165–168.

[39] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 5, May 1953, pp. 33–36.
Mining Journal (London), The Muygawon Diamond Deposits of the Panna District, India: Vol. 241, No. 6165, October 1953, p. 442.

[40] Messmer, Jacqueline, S–H–H Pearls: Deco Trefoil, vol. 17, No. 3, May–June 1953.

[41] Daniel, R., Diamond-Mining Practice in Kimberley, South Africa: Bull. Inst. Min. Met., vol. 62, 1953, pp. 201–228.

[42] Kisch, T. B., South Africa's First Diamonds: Gemmologist (London), vol. 22, No. 258, January 1953, pp. 9–13.

GEMMOLOGIST (LONDON). Jet—a Gem That Was a Vegetable. Vol. 22, No. 265, August 1953, pp. 146–150.

———. The Beauty of Star Stones. Vol. 22, No. 259, February 1953, pp. 34–37.

GRITZNER'S GEODE PUBLICATION. A Mineral Collector's Guide to "the Jade State," Wonderful Wyoming. Gritzner's Minerals, Mesa, Ariz., 2d ed., 1953, 12 pp.

GUBELIN, E. J. Inclusions as a Means of Gemstone Identification. Gemmological Inst. America, Los Angeles, Calif., 1953, 220 pp.

HENRY, D. J. Gem Trail Journal—Principle (sic) California Locations. L. R. Gordon, Long Beach, Calif., 2d ed., 1952, 93 pp.

———. The Rock Collector's Nevada and Idaho. L. R. Gordon, Long Beach, Calif., 1953, 72 pp.

INGLESBY, A. L. Mineral Collecting in Utah. Mineralogist, vol. 21, No. 2, February 1953, pp. 51–55.

JENSEN, D. E. Mineral Collector's Guide. Ward's Natural Science Establishment, Inc., Rochester, N. Y., 1953, 36 pp.

KELLEY, V. C., AND SILVER, CASWELL. Geology of the Caballo Mountains. Univ. of New Mexico Press, Albuquerque, N. Mex., 1953, 286 pp.

LAME, C. C. Star Garnet and Opal From Idaho. Commercial Printing Co., Lewiston, Idaho, May 1953, 16 pp.

LIDDICOAT, R. T. Handbook of Gem Identification. Gemmological Inst. America, Los Angeles, Calif., 4th ed., 1953, 350 pp.

MCCLURE, S. M. Mineral Collecting in Illinois. Mineralogist, vol. 21, No. 9, September 1953, pp. 291–293.

MCCLURE, S. M., AND SKAGGS, JOHN. Mineral Collecting in Illinois—part VII, Minerals of the Drift. Mineralogist, vol. 21, No. 3, March 1953, pp. 103–106.

MITCHELL, R. From Rocks to Gems. Popular Mechanics Mag., vol. 100, July 1953, pp. 145–151, and August 1953, pp. 155–158.

NATIONAL JEWELER. Birthstone Lists. October 1952, p. 142.

PEARL, R. M. Colorado Gem Trails. Mineral Book Co., Colorado Springs, Colo., 1953, 125 pp.

POUGH, F. H. A Field Guide to Rocks and Minerals. Houghton Mifflin Co., Boston, Mass., 1953, 333 pp.

———. A Short Course in Gemmology—Quartz. Jewelers' Circ.–Keystone, vol. 123, No. 4, January 1953, pp. 96, 144–146.

———. A Short Course in Gemmology—the Translucent and Opaque Stones Other Than Quartz. Jewelers' Circ.–Keystone, vol. 123, No. 5, February 1953, pp. 96, 126–29.

QUICK, LELANDE. Rockhounds Buyers Guide. Lapidary Jour., Palm Desert, Calif., 1953, 160 pp.

SEAMAN, D. M. Pegmatite Minerals of the United States; part I—Elements, Sulfides, and Simple Oxides. Rocks and Minerals, vol. 28, No. 1–2, January–February 1953, pp. 13–16.

SHAUB, B. M. Moonstone From Olmstedville, N. Y. Rocks and Minerals, vol. 28, No. 9–10, September–October 1953, pp. 451–454.

STEWART-REMINGTON, JOHN, AND FRANCIS, WILFRID. The Composition and Assaying of Minerals. Philosophical Library, Inc., New York, N. Y., 1953, 128 pp.

WALTON, SIR JAMES. Physical Gemmology. Sir Isaac Pitman & Sons, Ltd., London, England, 1952, 304 pp.

WRIGHT, L. A., STEWART, RICHARD, GAR, T. E., JR., AND HAZENBUSH, G. C. Mines and Mineral Deposits of San Bernardino County, Calif. California Jour. Mines and Geol., vol. 49, Nos. 1 and 2, 1953, pp. 49–257.

WYOMING COMMERCE AND INDUSTRY COMMISSION. Mineral and Rock Localities in Wyoming. Cheyenne, Wyo., 1953, 3 pp.

Gold

By James E. Bell [1] and Kathleen M. McBreen [2]

REVERSING the downtrend that marked 1951 and 1952, United States mine production of recoverable gold in 1953 rose 3 percent over that in the preceding year. In some areas gold production dropped because straight gold mining was curtailed further owing to rising costs of labor and supplies or because of less activity at base-metal mines that yield gold as a byproduct, owing to reduced prices for lead and zinc. In other areas, however, gold production from straight gold mining or yield of byproduct gold from copper mining increased substantially, and resulted in the overall gain.

South Dakota was again the leading State in gold production in 1953, a position held since 1949. Utah, the leading gold producer in the war years 1943–45, was again second in 1953, scoring a new high. With its gold production declining steadily since 1947, California, in first place in 1946–48, second in 1949, and third in 1950–52, was forced into fourth place in 1953 by Alaska, which had ranked fourth in 1947–52. South Dakota, Utah, Alaska, and California furnished 77 percent of the total United States gold yield of 1953. Nearly all of the South Dakota output of gold was obtained from gold ore produced at the Homestake mine; the Utah production was principally byproduct gold from large-scale mining of low-grade copper ore in the West Mountain (Bingham) district; Alaska's gold was almost entirely from placer operations, mainly bucketline dredging; and the California output was principally from straight gold mining, both lode and placer. Of the domestic gold produced in 1953, 21 percent was recovered by placer methods, 37 percent by amalgamation and cyanidation, and 42 percent in the smelting of ores and concentrates.

Production of gold outside the United States was slightly less in 1953 than in 1952, with gains in the Union of South Africa and Australia more than offset by drops in Canada and the Soviet Union. The world production rate of gold in recent years has remained well below prewar averages.

In the Union of South Africa less ore was milled, but the average grade was higher; the average profit from gold per ton of ore declined, reflecting higher costs. Recovery of byproduct uranium in the Rand gold field, which was begun late in 1952, increased substantially in 1953; the initial profits demonstrated that this source of additional revenue probably would permit mining ore containing less gold. Rapid development of the new gold field in the Orange Free State continued throughout 1953, and 5 of the 13 properties in the area had reached the production stage by the end of the year.

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

TABLE 1.—Salient statistics of gold in the United States,[1] 1944–48 (average) and 1949–53

	1944–48 (average)	1949	1950	1951	1952	1953
Mine production, fine ounces	1,530,183	1,991,783	2,394,231	[2] 1,980,512	1,893,261	1,958,291
Ore (dry and siliceous) produced (short tons):						
Gold ore	2,501,879	3,376,139	3,584,360	2,606,202	2,339,160	2,198,688
Gold-silver ore	393,425	412,378	433,461	368,184	237,211	81,658
Silver ore	311,735	476,960	627,349	492,143	502,208	555,050
Percentage derived from—						
Dry and siliceous ores	37	45	43	39	40	40
Base-metal ores	35	28	31	36	38	39
Placers	28	27	26	25	22	21
Net consumption in industry and the arts	$90,763,123	$108,842,471	$97,845,753	$69,476,979	$96,350,540	$75,000,000
Imports	$960,255,952	$771,390,261	$162,748,661	$81,258,502	$740,254,160	$47,024,515
Exports	$378,935,089	$84,935,678	$534,035,794	$630,381,566	$55,921,206	$44,808,300
Monetary stocks (end of year)[3]	----------	$24,427,000,000	$22,706,000,000	$22,695,000,000	$23,186,000,000	$22,030,000,000
Price, average, per fine ounce[4]	$35.00	$35.00	$35.00	$35.00	$35.00	$35.00
World production, fine ounces (estimated)	27,760,000	31,000,000	32,700,000	33,500,000	34,200,000	33,500,000

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.

The United States Treasury continued to purchase gold at $35 per fine troy ounce in 1953. Throughout all of 1953 except December, there was a steady net outflow of gold from the United States, which led to a decline in Treasury gold reserves of nearly $1,200 million.

Legislation proposed in 1953 in the United States included a bill to increase the Treasury price of gold and another to permit free marketing of domestic newly mined gold. No action was taken by the Congress on either bill during the year.

Of interest was the appearance on world markets in the latter part of 1953 of gold from the Soviet Union. It was estimated that about 1 million ounces of Soviet gold was sold on continental free markets. Additional to such sales to private holders, it was persistently reported by the press that perhaps as much as 2 million ounces of Soviet gold was sold to the Bank of England, but such transactions were not confirmed officially.

The litigation by some domestic gold-mining claimants to obtain compensation for damages suffered through 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, Volume I, Minerals Yearbook 1952. Such damages were under study by the United States Court of Claims during 1953, but to the end of the year the findings of the Court Commissioner on which test cases would be briefed had not been filed.

Propaganda for higher official national gold prices, based on raising the United States Treasury price for gold ($35 per ounce), carried on strongly in recent years by many gold producers and some foreign governments, decreased markedly in 1953. Apparently it was felt in some quarters that the beneficial effects to the gold-mining industry of increasing the price of gold would shortly become nullified by the inflationary effects that would follow; also, that the propaganda for raising the price of gold was being poorly received by the American public. The National City Bank of New York in its Monthly Letter of April 1953, stated:

> In all the theorizing about the price of gold, it would be well not to overlook the very practical fact that only an act of Congress can change the gold parity of the dollar. Not only has the President's former power to revalue lapsed long since, but—more important—in the Bretton Woods Agreements Act of July 31, 1945, whereby the United States joined the International Monetary Fund, it was specifically stated that:
>
> "Unless Congress by law authorizes such action, neither the President nor any person or agency shall on behalf of the United States * * * propose or agree to any change in the par value of the United States dollar."
>
> In view of this country's ample gold stock, its experience with inflation, and the commitments by the new Administration to protect the buying power of the dollar, it seems inconceivable that any alteration of the gold parity of the dollar would be approved.

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 and Silver of Bureau of Mines Minerals Yearbooks for the past several years.

In September 1951 the International Monetary Fund yielded to growing demand to permit member gold-producing countries to form their own regulations regarding the sale of newly mined gold on the free market. The result of this action was that the quantity of gold available for such disposal was greatly increased, and it was estimated that in 1952 around 12 million ounces of new gold was bought for private hoarding. Reacting to the more abundant supply, however, the premium price of gold on the continental free market declined in 1952 from about $39 per ounce at the beginning of the year to $36.75 in November.

The premium price of gold continued its downward trend during 1953, dropping steadily from around $38 per ounce in January to $35 in November. In addition to the plentiful supply of newly mined gold, other factors in the decline were lower buying power in the Far East and the substantial sales of gold on world markets by the Soviet Union. It was estimated the free gold markets absorbed around 7 million ounces of newly mined gold in 1953.

An article analysing methods for stimulating gold production was published in 1953.[3]

A forecast of free market prospects made in January 1954 follows:[4]

> There are no visible factors at the time of writing likely to affect violently the present level of free market prices. Supplies are more than adequate for the comparatively modest demand. Political and economic upheavals seem for the time being to be less threatening and certainly much less of an influence on the market than formerly; and finally, and perhaps most important, there appears to be much less money available in those centres in which gold holding is traditionally favoured as a form of investment.

According to information available to the Bureau of Mines, the quantity of "natural gold" sold in 1953 on the domestic open market at prices higher than the United States Treasury price of $35 per ounce was insignificant. Most of the "natural gold" was sold in nugget form for use in making jewelry.

DOMESTIC PRODUCTION

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 49 years 1905–53 show a total excess of gold of 38,531 ounces (a difference of 0.02 percent).

[3] Merrill, C. W., Peace and Gold: Mines Magazine, vol. 43, No. 3, March 1953, pp. 49–59.
[4] Samuel Montagu & Co., Ltd., Bankers and Bullion Merchants: London, Annual Bullion Review 1953. page 6.

TABLE 2.—Gold produced in the United States,[1] 1905–53, according to mine and mint returns, in fine ounces of recoverable metal

Year	Mine	Mint	Year	Mine	Mint
1905–48	149, 391, 654	149, 645, 851	1952	1, 893, 261	1, 927, 000
1949	1, 991, 783	1, 921, 949	1953	1, 958, 291	1, 970, 000
1950	2, 394, 231	2, 288, 708			
1951	[2] 1, 980, 512	1, 894, 726	Total 1905–53	159, 609, 732	159, 648, 234

[1] Includes Alaska.
[2] Revised figure.

MINE PRODUCTION

Although mine production of recoverable gold in the United States was 3 percent greater in 1953 than in 1952, it was 7 percent lower than the average for the postwar years 1947–51 and only 40 percent of the alltime high established in 1940. Reflecting the difficulties of high costs of labor and supplies in relation to the fixed price of gold, production in most straight gold mining areas continued to decline in 1953. The output of byproduct gold derived from base metal ores also declined in some areas, owing to curtailment of mining because of lower prices for lead and zinc. On the other hand, straight gold mining gained in Alaska and South Dakota in 1953, and byproduct gold from copper ore rose to a new record high in Utah, with the overall result that domestic gold production showed a moderate increase.

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 1953, by months

	Fine ounces		Fine ounces
January	129, 103	August	178, 104
February	130, 416	September	193, 540
March	148, 478	October	187, 530
April	144, 277	November	173, 117
May	165, 602	December	158, 323
June	165, 837		
July	183, 964	Total	1, 958, 291

[1] Includes Alaska.

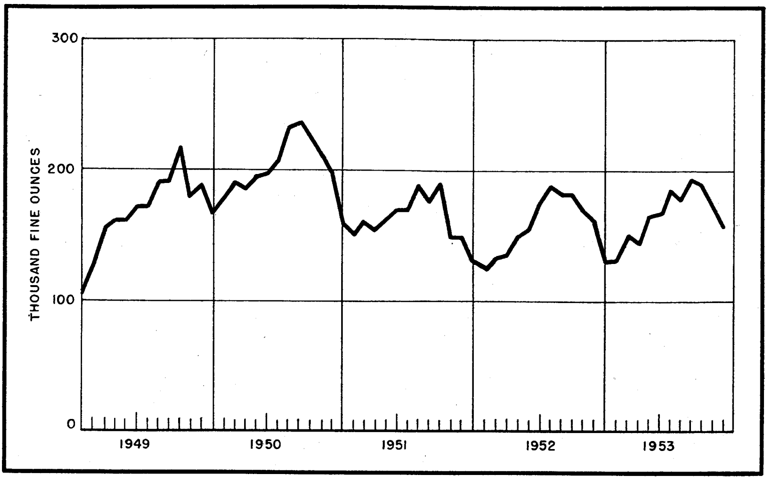

FIGURE 1. Mine production of gold in the United States, 1949–53, by months, in terms of recoverable gold.

Mines are grouped in two main classes—placers and lodes. The placers are those in which gold and silver (and, in a few placers, platinum) are recovered from gravel as native metals or in natural alloy. Except for such small-scale hand methods as those utilizing the gold pan, the rocker, or the dry washer, all placer recovery methods employ sluice boxes; methods are distinguished by the means used for delivering the gravel to the sluices. Those methods where gravel is delivered mechanically include 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 1953; the West Mountain district has ranked second in this period. The Fairbanks, Alaska, district gained third rank over the Grass Valley-Nevada City, Calif., gold-ore district in 1952 and was again third in 1953. These 3 leading districts produced about 56 percent of the domestic gold output of 1953.

Of the 25 leading gold producers operating in the United States in 1953, 8 were lode gold mines, 5 were placers worked by bucketline dredges, 5 were copper mines, 3 were lead-zinc mines, 1 was a zinc-copper mine, and 3 produced more than 1 type of ore. The entire 25 mines on the list supplied about 85 percent of the domestic output of 1953.

TABLE 4.—Mine production of recoverable gold in the United States, 1944–48 (average) and 1949–53, by districts that produced 10,000 fine ounces or more during any year (1949–53), in fine ounces [1]

District or region	State	1944–48 (average)	1949	1950	1951	1952	1953
Lawrence County	South Dakota	232,968	464,650	567,996	458,040	482,511	534,984
West Mountain (Bingham)	Utah	283,859	286,155	428,313	407,196	417,607	450,882
Grass Valley-Nevada City	California	(2)	(2)	(2)	(2)	(2)	(2)
American River (Folsom)	do	71,335	98,435	91,260	86,867	[3] 73,366	65,275
Chelan County	Washington	30,631	48,183	64,711	46,458	[4] 54,135	[3,4] 61,468
Republic (Eureka)	do	21,438	23,751	24,929	(2)	(4)	(4)
Robinson	Nevada	41,872	38,703	49,878	60,055	59,521	61,093
Cripple Creek	Colorado	43,755	13,460	5,779	27,699	48,527	51,559
Yuba River	California	(2)	(2)	(2)	(2)	(2)	(2)
Upper San Miguel	Colorado	27,462	35,217	52,567	34,030	34,822	39,876
Ajo	Arizona	31,200	38,455	37,632	33,805	36,372	36,599
Warren (Bisbee)	do	19,832	11,837	13,695	25,338	26,697	29,840
Park City Region	Utah	16,413	19,443	24,125	18,476	13,827	27,919
Summit Valley (Butte)	Montana	14,463	15,742	23,092	15,674	16,918	19,871
Bullion	Nevada	9,241	16,791	20,405	(2)	17,824	(2)
Big Bug	Arizona	8,642	14,035	19,328	19,724	17,317	17,788
Battle Mountain	Nevada	(2)	(2)	(2)	(2)	(2)	(2)
Pioneer (Superior)	Arizona	7,658	12,839	14,392	12,207	[3] 11,665	14,480
Alleghany	California	(2)	(2)	14,314	10,776	9,683	13,112
California (Leadville)	Colorado	(2)	(2)	(2)	(2)	18,405	9,321
Mother Lode	California	(2)	21,948	24,513	(2)	7,127	3,524
Animas	Colorado	19,630	10,658	12,874	9,407	9,657	2,225
Verde (Jerome)	Arizona	8,732	10,790	9,421	7,325	4,328	797
Comstock	Nevada	5,271	18,540	9,691	267	10	143
Round Mountain	do	1	--------	(2)	(2)	(2)	60
Oroville (Palermo)	California	15,071	22,701	(2)	(2)	2,946	47
Scott River	do	(2)	(2)	12,289	3,919	6	14
Merced River (Snelling)	do	(2)	(2)	(2)	4,768	(2)	9
Fairplay	Colorado	(2)	(2)	(2)	(2)	2,019	--------
Potosi	Nevada	(2)	(2)	(2)	--------	--------	--------
Yellow Pine	Idaho	16,324	53,576	48,472	19,605	17,638	--------

[1] Exclusive of Alaska.
[2] Figure withheld to avoid disclosure of individual company operations.
[3] Corrected figure.
[4] Chelan and Ferry Counties combined in 1952–53 to avoid disclosure of individual company output.

TABLE 5.—Twenty-five leading gold-producing mines in the United States in 1953, in order of output

Rank	Mine	District	State	Operator	Source of gold
1	Homestake	Whitewood	South Dakota	Homestake Mining Co	Gold ore.
2	Utah Copper	West Mountain (Bingham)	Utah	Kennecott Copper Corp	Copper ore.
3	Fairbanks Unit	Fairbanks	Alaska	U. S. Smelting, Refining & Mining Co	Dredge.
4	Natomas	American River (Folsom)	California	Natomas Co	Do.
5	Yuba Unit	Yuba River	do	Yuba Consolidated Gold Fields	Do.
6	New Cornelia	Ajo	Arizona	Phelps Dodge Corp	Copper ore, old tailings.
7	Empire Star Group	Grass Valley-Nevada City	California	Empire Star Mines, Ltd	Gold ore.
8	Brunswick	do	do	Idaho Maryland Mines Corp	Do.
9	Copper Queen	Warren (Bisbee)	Arizona	Phelps Dodge Corp	Copper, lead-zinc ores.
10	Ruth Pit	Robinson	Nevada	Kennecott Copper Corp	Copper ore.
11	Nome Unit	Nome	Alaska	U. S. Smelting, Refining & Mining Co	Dredge.
12	Park Galena-Mayflower	Blue Ledge	Utah	New Park Mining Co	Lead-zinc ore.
13	Gold King	Wenatchee River	Washington	Lovitt Mining Co	Gold ore.
14	Treasury Tunnel, etc	Upper San Miguel	Colorado	Idarado Mining Co	Copper-lead-zinc ores.
15	Ajax Group	Cripple Creek	do	Golden Cycle Corp	Gold ore.
16	Knob Hill	Republic	Washington	Knob Hill Mines	Do.
17	Goldacres	Bullion	Nevada	London Extension Mining Co	Do.
18	Iron King	Big Bug	Arizona	Shattuck Denn Mining Corp	Lead-zinc ore, zinc tailings.
19	Smuggler Union	Upper San Miguel	Colorado	Telluride Mines, Inc	Lead-zinc ore.
20	Greenan Placers	Battle Mountain	Nevada	Natomas Co	Dredge.
21	Holden Group	Chelan Lake	Washington	Howe Sound Co., Chelan Division	Copper-zinc ore.
22	Portland, Dakota, Clinton, Decorah.	Portland, Bald Mountain	South Dakota	Bald Mountain Mining Co	Gold ore.
23	Butte Hill Mines	Summit Valley	Montana	Anaconda Copper Mining Co	Copper, lead-zinc ores.
24	Magma	Pioneer (Superior)	Arizona	Magma Copper Co	Copper ore.
25	Morris Brooks Pit	Robinson	Nevada	Consolidated Coppermines Corp	Do.

TABLE 6.—Mine production of recoverable gold in the United States, 1943–53, with production of maximum year, and cumulative production from earliest record to end of 1953, by States, in fine ounces

	Maximum production [1]		Production by years											Total production from earliest record to end of 1953
	Year	Quantity	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	
Western States and Alaska:														
Alaska	1906	1, 066, 030	99, 583	49, 296	68, 117	226, 781	279, 988	248, 395	229, 416	289, 272	[2] 239, 486	240, 557	253, 783	27, 864, 476
Arizona	1937	332, 694	171, 810	112, 162	77, 223	79, 024	95, 860	109, 487	108, 993	118, 313	116, 093	112, 355	112, 824	11, 642, 084
California	1852	3, 932, 631	148, 328	117, 373	147, 938	356, 824	431, 415	421, 473	417, 231	412, 118	339, 732	258, 176	234, 591	104, 395, 955
Colorado	1900	1, 391, 364	137, 558	111, 455	100, 935	142, 613	168, 279	154, 802	102, 618	130, 390	116, 503	124, 594	119, 218	39, 974, 347
Idaho	1871	212, 850	30, 808	25, 008	17, 780	42, 975	64, 982	58, 454	77, 829	79, 652	45, 064	32, 997	17, 630	8, 217, 357
Montana	1865	870, 750	59, 586	50, 021	44, 597	70, 507	90, 124	73, 091	52, 724	51, 764	30, 502	24, 161	24, 768	17, 399, 255
Nevada	1910	913, 265	144, 442	119, 056	92, 265	90, 680	89, 063	111, 532	130, 399	178, 447	121, 036	117, 203	101, 799	26, 366, 480
New Mexico	1915	70, 681	5, 563	6, 918	5, 604	4, 009	3, 146	3, 414	3, 249	3, 414	3, 959	2, 949	2, 614	2, 205, 580
Oregon	1940	113, 402	1, 097	1, 369	4, 467	17, 598	18, 979	14, 611	16, 226	11, 058	7, 927	5, 509	8, 488	5, 774, 350
South Dakota	1939	618, 536	106, 444	11, 621	55, 948	312, 247	407, 194	377, 850	464, 650	567, 996	458, 101	482, 534	534, 987	24, 339, 613
Texas	1929	1, 279	4			9	45	57	40	49	32	39		8, 552
Utah	1953	483, 430	390, 470	344, 223	279, 979	178, 533	421, 662	368, 422	314, 058	457, 551	432, 216	435, 507	483, 430	13, 555, 824
Washington	1950	92, 117	65, 244	47, 277	57, 860	51, 168	34, 965	70, 075	71, 994	92, 117	67, 405	54, 776	62, 560	2, 632, 562
Wyoming	1869	7, 498		20	2	105	1, 486	115	389		9	1	1	80, 042
Total			1, 360, 937	995, 799	952, 715	1, 573, 073	2, 107, 188	2, 011, 778	1, 989, 816	2, 392, 141	[2]1,978,065	1, 891, 358	1, 956, 693	284, 456, 477
West Central States: Missouri	1900	33												33
States east of the Mississippi:														
Alabama	1936	4, 726			5	1								49, 495
Georgia	1882	12, 094	12	5		21	76	19	18		3			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	131	21					13					1, 164, 601
Pennsylvania	1942	2, 499	2, 218	2, 115	1, 588	1, 150	1, 518	2, 200	1, 645	1, 764	2, 179	1, 500	1, 134	[5] 37, 224
South Carolina	1941	15, 508	147											318, 801
Tennessee	1930	696	303	222	148	95	303	156	171	160	108	241	293	22, 397
Vermont	1953	171	17	100	104	165	100	104	120	146	156	162	171	[5] 1, 378
Virginia	1938	2, 943	50	132	12									167, 558
Total			2, 878	2, 595	1, 857	1, 432	1, 997	2, 479	1, 967	2, 090	2, 447	1, 903	1, 598	2, 671, 537
Grand total			1, 363, 815	998, 394	954, 572	1, 574, 505	2, 109, 185	2, 014, 257	1, 991, 783	2, 394, 231	[2]1,980,512	1, 893, 261	1, 958, 291	287, 128, 047

[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] 1908–53 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 1953. 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.

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 1953 [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	441	1.497				
Arizona	2,252	.278	2,467	0.315	22,772	0.028
California	241,548	.455			107	.037
Colorado	182,038	.294	48,616	.038	22,619	.140
Idaho	17,292	.440	32	3.844	313,554	.003
Montana	1,476	1.287	14,572	.054	2,333	.004
Nevada	155,993	.130	1,832	.133	2,569	.019
New Mexico	1,445	.189	124	.363	371	.003
Oregon	1,156	1.021				
South Dakota	1,479,735	.362				
Texas						
Utah			14,015	.084	190,725	.021
Washington	115,312	.400				
Wyoming						
Total	2,198,688	.354	81,658	.061	555,050	.016
States east of the Mississippi						
Total	2,198,688	.354	81,658	.061	555,050	.016

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 1953 [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			34	0.206		
Arizona	[2]45,264,368	0.002	6,059	.222	1	
California	8,517	[3].044	7,489	.023		
Colorado	172	.087	29,066	.063		
Idaho	66,299	.010	152,575	.003	53,792	
Montana	4,185,818	.001	6,949	.050		
Nevada	[2]7,758,567	[4].008	11,376	.063		
New Mexico	[5]7,884,048	(6)	54,824			
Oregon	59	.322				
South Dakota			67	.045		
Texas						
Utah	29,941,541	.015	5,826	.043		
Washington	1,186	.018	3,989			
Wyoming	2					
Total	95,110,577	.006	278,254	.018	53,793	
States east of the Mississippi	5,622,965		168			
Total	100,733,542	.006	278,422	.018	53,793	

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					[7]475	1.404
Arizona	7,619	0.029	421,479	0.045	[2]45,727,017	.002
California			132,922	.006	390,583	[3].285
Colorado	187,106	.011	734,900	.075	1,204,517	.098
Idaho	75,664		1,410,977	.001	[8]2,090,185	.006
Montana	[9]28,143		1,862,057	.008	[9]6,101,348	.004
Nevada	326		96,739	.023	8,027,402	[4].011
New Mexico	135,869	.004	10,369	.007	[3]8,087,050	
Oregon					1,215	.987
South Dakota					1,479,802	.362
Texas						
Utah	20,143	.001	526,554	.068	[10]30,698,804	.016
Washington	(11)	(11)	[12]1,585,923	[12].010	1,706,410	.037
Wyoming					2	
Total	454,870	.006	6,781,920	.022	105,514,810	.015
States east of the Mississippi	2,712,592		1,472,221		[13]9,807,946	(13)
Total	3,167,462	.001	8,254,141	.018	115,322,756	.013

1 Missouri excluded.
2 Includes copper precipitates.
3 Includes metal recovered from tungsten ore or tungsten tailings.
4 Includes metal recovered from manganese ore.
5 Includes copper precipitates and old slag.
6 Includes 381 ounces of gold recovered from 4,353 tons of blister copper.
7 Includes 34 tons of lead ore containing 7 ounces of gold produced in 1952 and shipped in 1953.
8 Includes 75,664 tons of old zinc slag.
9 Includes 28,089 tons of old zinc slag.
10 Includes 20,143 tons of old zinc slag.
11 Combined with lead-zinc ore to avoid disclosure of individual output.
12 Includes zinc ore to avoid disclosure of individual output.
13 Excludes magnetite-pyrite ore and gold and silver therefrom.

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.

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 otherwise indicated.

TABLE 8.—Mine production of gold in the United States,[1] 1944–48 (average) and 1949–53, by percentage from sources and in total fine ounces

Year	Placers	Dry ore	Copper ore	Lead ore	Zinc ore	Zinc-lead, zinc-copper, lead-copper, and zinc-lead-copper ores	Total fine ounces
1944–48 (average)	28.5	36.7	26.4	0.6	0.4	7.4	1,530,183
1949	26.8	44.8	19.8	.6	.2	7.8	1,991,783
1950	25.5	43.1	23.1	.7	.1	7.5	2,394,231
1951	24.8	38.9	27.5	.5	.2	8.1	1,980,512
1952	22.5	39.5	29.4	.4	.2	8.0	1,893,261
1953	20.9	40.4	30.9	.3	.1	7.4	1,958,291

[1] Includes Alaska.

TABLE 9.—Mine production of gold in the United States in 1953, 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	253,116	660		7				253,783
Arizona	109	2,039	90,093	1,346		219	19,018	112,824
California	123,346	109,953	[1] 377	170			745	[1] 234,591
Colorado	1,629	58,628	15	1,838		2,092	55,016	119,218
Idaho	5,887	8,622	666	436	17		2,002	17,630
Montana	1,223	2,689	6,180	344			14,332	24,768
Nevada	16,310	20,612	[2] 61,902	722			2,253	[2] 101,799
New Mexico	5	319	[3] 1,603	14		596	77	2,614
Oregon	7,289	1,180	19					8,488
Pennsylvania			[4] 1,134					1,134
South Dakota		534,984		3				534,987
Tennessee			293					293
Utah	9	5,265	441,882	253		13	36,008	483,430
Vermont			171					171
Washington	29	46,146	21	1		([5])	[6] 16,363	62,560
Wyoming	1							1
Total	408,953	791,097	604,356	5,134	17	2,920	145,814	1,958,291

[1] Includes metal recovered from tungsten ore or tungsten tailings.
[2] Includes metal recovered from manganese ore.
[3] Includes 381 ounces of gold recovered from 4,353 tons of blister copper.
[4] From magnetite-pyrite ore.
[5] Combined with lead-zinc ore to avoid disclosure of individual output.
[6] Includes zinc ore to avoid disclosure of individual output.

TABLE 10.—Gold produced in the United States from ore and old tailings, in 1953 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 (fine ounces)	Concentrates smelted and recoverable metal		Short tons	Fine ounces
				Concentrates (short tons)	Fine ounces		
Western States and Alaska:							
Alaska	[2] 475	[2] 440	437	32	204	35	26
Arizona	[3][4] 42,150,223	[3] 41,423,025	72	1,331,215	84,293	[4] 727,198	28,350
California	[5] 390,583	378,276	95,576	30,524	14,445	12,307	1,224
Colorado	1,204,517	1,175,899	71,827	125,671	42,040	28,618	3,722
Idaho	[6] 2,090,185	1,993,769	6,581	242,383	4,413	96,416	749
Montana	[7] 6,101,348	5,965,610	65	640,414	18,875	135,738	4,605
Nevada	[4][8] 8,027,402	7,917,546	19,305	291,390	62,495	109,856	3,689
New Mexico	[9] 8,087,050	7,961,301	266	249,436	1,424	125,749	919
Oregon	1,215	1,156	142	127	1,038	59	19
South Dakota	1,479,802	1,479,735	534,984			67	3
Utah	[10] 30,698,804	30,448,505		977,962	477,603	250,299	5,818
Washington	1,706,410	1,650,035	3,858	91,110	34,658	56,375	24,015
Wyoming	2					2	
Total	101,938,016	100,395,297	733,113	3,980,264	741,488	1,542,719	73,139
States east of the Mississippi	[11] 9,807,946	[11] 9,807,946		631,686	1,598		
Grand total	111,745,962	110,203,243	733,113	4,611,950	743,086	1,542,719	73,139

[1] Missouri excluded.
[2] Excludes ore reported in prior years that produced 223 ounces of gold shipped in 1953.
[3] Excludes 3,576,794 tons of ore leached from which no gold was recovered.
[4] Includes copper precipitates.
[5] Excludes tungsten ore.
[6] Includes 75,664 tons of old zinc slag.
[7] Includes 28,089 tons of old zinc slag.
[8] Excludes manganese ore.
[9] Includes copper precipitates and old slag.
[10] Includes 20,143 tons of old zinc slag.
[11] 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, 1944–48 (average) and 1949–53 [1]

Year	Bullion and precipitates recoverable (fine ounces)		Gold from all sources (percent)			
	Amalgamation	Cyanidation	Amalgamation	Cyanidation	Smelting [2]	Placers
1944–48 (average)	238,977	188,986	15.6	12.3	43.6	28.5
1949	450,618	290,938	22.6	14.6	36.0	26.8
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

[1] Includes Alaska.
[2] Both crude ores and concentrates.

TABLE 12.—Gold produced at amalgamation and cyanidation mills in the United States in 1953, by States

State	Amalgamation: Bullion recoverable (fine ounces)	Cyanidation: Bullion and precipitates recoverable (fine ounces)	Gold from all sources in State (percent): Amalgamation	Gold from all sources in State (percent): Cyanidation
Western States and Alaska:				
Alaska	437		0.17	
Arizona	72		.06	
California	74,203	21,373	31.63	9.11
Colorado	20,632	51,195	17.31	42.94
Idaho	5,412	1,169	30.70	6.63
Montana	65		.26	
Nevada	873	18,432	.86	18.11
New Mexico	266		10.18	
Oregon	142		1.67	
South Dakota	365,442	169,542	68.31	31.69
Washington	17	3,841	.03	6.14
Wyoming				
Total	467,561	265,552	23.90	13.57
States east of the Mississippi				
Grand total	467,561	265,552	23.88	13.56

PLACERS

Continuing a downtrend, production of placer gold in the United States declined from 426,000 ounces in 1952 to 409,000 in 1953; these quantities corresponded to 23 and 21 percent, respectively, of the total domestic outputs for those years. Most of the drop in 1953 was in California and Nevada; it reflected the progressive exhaustion of gravels that could be worked profitably under continuing high operating costs and the fixed price of gold.

Eighty-four percent of the total placer gold of 1953 was recovered by bucketline dredges. The total quantity of gold recovered by bucketline dredges in the United States to the end of 1953 is recorded as 22,925,000 ounces, of which 13,437,000 ounces was produced in California, 6,690,000 in Alaska (some from single-dipper dredges and hydraulicking), 785,000 in Montana, 701,000 in Idaho, and 1,312,000 in other States.

The gold-placer-mining method second in importance in 1953 was nonfloating washing plants, with mechanical earth-moving equipment for gravel delivery. Small-scale hand methods, dragline dredging, and hydraulic mining were in third, fourth, and fifth places, respectively.

TABLE 13.—Gold production at placer mines in the United States, by class of mine and method of recovery, 1944–48 (average) and 1949–53 [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:						
1944–48 (average)	46	60	83,130,061	343,826	$12,033,889	$0.145
1949	52	74	110,897,581	425,863	14,905,205	.134
1950	43	63	108,250,189	492,939	17,252,865	.159
1951	36	56	93,214,943	404,305	14,150,675	.152
1952	37	56	69,940,758	358,492	12,547,220	.179
1953	21	41	65,313,835	343,132	12,009,620	.184
Dragline dredges:						
1944–48 (average)	[1] 38	[1] 36	[2] 4,945,343	[1] 26,826	[1] 938,924	.190
1949	35	31	4,583,055	22,789	797,615	.174
1950	23	21	4,623,474	21,032	736,120	.159
1951	25	23	2,342,647	8,820	308,700	.132
1952	16	16	1,936,587	8,517	298,095	.154
1953	14	13	659,600	2,453	85,855	.130
Becker-Hopkins dredges:						
1944–48 (average)	----------	----------	1,000	6	224	.224
1949–53	----------	----------	----------	----------	----------	----------
Suction dredges:						
1944–48 (average)	5	4	40,338	266	9,296	.230
1949	12	13	278,765	1,418	49,630	.178
1950	17	14	263,800	1,422	49,770	.189
1951	13	9	180,500	717	25,095	.139
1952	9	9	74,100	305	10,675	.144
1953	7	8	87,700	341	11,935	.136
Nonfloating washing plants:						
1944–48 (average)	[1] 88	[1] 87	[2] 3,041,882	[1] 35,471	[1] 1,241,485	.408
1949	183	183	4,995,465	70,974	2,484,090	.497
1950	185	183	8,510,139	85,932	3,007,620	.353
1951	117	115	7,049,566	69,592	2,435,720	.346
1952	103	102	4,795,100	54,866	1,920,310	.400
1953	128	128	4,019,325	58,295	2,040,325	.508
Gravel hydraulically handled:						
1944–48 (average)	[1] 119	----------	[2] 1,743,062	[1] 20,632	[1] 722,113	.414
1949	81	----------	779,800	7,107	248,745	.319
1950	88	----------	639,585	4,342	151,970	.238
1951	51	----------	257,800	3,460	121,100	.470
1952	33	----------	130,401	1,326	46,410	.356
1953	48	----------	440,290	1,923	67,305	.153
Small-scale hand methods:						
Wet:						
1944–48 (average)	[1] 220	----------	[2] 402,848	[1] 6,386	[1] 223,524	.555
1949	279	----------	248,076	4,234	148,190	.597
1950	250	----------	261,562	4,856	169,960	.650
1951	148	----------	99,804	3,106	108,710	1.089
1952	119	----------	101,152	2,598	90,930	.899
1953	139	----------	152,565	2,534	88,690	.581
Dry:						
1944–48 (average)	10	----------	3,040	133	4,641	1.527
1949	13	----------	2,870	144	5,040	1.756
1950	7	----------	2,200	88	3,080	1.400
1951	4	----------	550	27	945	1.718
1952	----------	----------	----------	----------	----------	----------
1953	3	----------	9,875	103	3,605	.365
Underground placers (drift):						
1944–48 (average)	[1] 25	----------	[2] 10,334	[1] 575	[1] 20,125	1.947
1949	26	----------	3,717	206	7,210	1.940
1950	34	----------	12,790	802	28,070	2.195
1951	19	----------	4,275	498	17,430	4.077
1952	14	----------	4,370	159	5,565	1.273
1953	13	----------	3,778	172	6,020	1.593
Unclassified placers:						
1944–48 (average)	38	----------	(3)	1,466	51,317	(3)
1949–53	----------	----------	----------	----------	----------	----------
Grand total placers:						
1944–48 (average)	[4] 588	----------	[2] 93,317,908	435,587	15,245,538	.163
1949	[4] 680	----------	121,789,329	532,735	18,645,725	.153
1950	647	----------	122,563,739	611,413	21,399,455	.175
1951	413	----------	103,150,085	490,525	17,168,375	.166
1952	331	----------	76,982,468	426,263	14,919,205	.194
1953	373	----------	70,686,968	408,953	14,313,355	.202

[1] Data for Alaska not separately available; included with "Unclassified placers" for 1944.
[2] Data for Alaska not available and not included for year 1944.
[3] Data not available for year 1944.
[4] A mine using more than 1 method of recovery is counted but once in arriving at total for all methods.

Alaska produced 62 percent of the United States placer gold in 1953, California 30, Nevada 4, Oregon 2, and Idaho 1. Alaska led in production by bucketline dredging, nonfloating washing plants, and hydraulic mining; Idaho by dragline dredging; and California by small-scale hand methods and underground placer mining. A small production by dry placer mining was reported in 1953 in Arizona.

Table 13 shows the placer gold produced in the United States, classified by mining methods, in 1949–53. Additional information on placer mining may be found in the State reviews of volume III.

REFINERY PRODUCTION

Table 14 contains official estimates of production of gold 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, 1944–48 (average), and 1949–53, and approximate distribution by source (State), in 1953

[U. S. Bureau of the Mint]

State or Territory:	*Fine ounces*
1944–48 (average)	1, 520, 857
1949	1, 921, 949
1950	2, 288, 708
1951	1, 894, 726
1952	1, 927, 000
1953:	
Alaska	265, 100
Arizona	112, 000
California	240, 000
Colorado	122, 000
Idaho	26, 000
Montana	24, 600
Nevada	110, 000
New Mexico	2, 700
Oregon	8, 300
Pennsylvania	1, 260
South Dakota	532, 300
Tennessee	260
Texas	8
Utah	462, 800
Vermont	170
Washington	62, 500
Wyoming	2
Total	1, 970, 000

CONSUMPTION AND USES IN INDUSTRY AND THE ARTS

Gold has been used for centuries for coinage in most nations of the world. In recent times gold coins have been withdrawn from circulation generally, and the monetary use of gold is mostly as a reserve in the form of bullion to give stability to paper currency and for settlement of international balances.

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, 1792–1953[1]

Period	Fine ounces	Value[2]
1792–1847	1,187,170	$24,537,000
1848–73	60,021,278	1,240,750,000
1874–1953	228,959,723	5,611,130,080
Total	290,168,171	6,876,417,080

[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.

Gold leaf is used for window signs, printing titles on books, and decorating picture frames and many other articles. In making gold leaf the extreme malleability of gold is utilized. Most gold leaf 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 1953 exceeded the total new production from domestic mines for the year by 9 percent.

TABLE 16.—Net industrial[1] consumption of gold in the United States, 1944–48 (average) and 1949–53

[U. S. Bureau of the Mint]

Year	Gold (dollars)		
	Issued for industrial use	Returned from industrial use	Net industrial consumption
1944–48 (average)	130,171,728	39,408,605	90,763,123
1949	148,975,571	40,133,100	108,842,471
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

[1] Including the arts.

PRICES AND MONETARY STOCKS

Since January 1934 the price of gold at the United States Mint has been $35 per fine troy ounce.

Gold holdings of the United States Treasury declined $1,156,000,000 from $23,186,000,000 on December 31, 1952, to $22,030,000,000 on December 31, 1953, according to figures published in the Federal Reserve Bulletin. Except for a slight gain in December, the decline was steady throughout the year. The net outflow of gold from the United States resulted largely from international loans and grants by the United States Government. Total world gold reserves are not positively known, inasmuch as data for some countries are not available; however, the Federal Reserve Board estimated that the world monetary reserves of gold totaled $36,170,000,000 on December 31, 1953, exclusive of holdings of the Soviet Union.

FOREIGN TRADE[5]

The excess of exports over imports of gold that prevailed during 1950 and 1951 was replaced by an excess of imports over exports in 1952 and again in 1953. The excess of imports in 1953, however, was slight.

[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 17.—Value of gold imported into and exported from the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

	Imports	Exports	Excess of imports over exports [1]
1944–48 (average)	$960, 255, 952	$378, 935, 089	$581, 320, 863
1949	771, 390, 261	84, 935, 678	686, 454, 583
1950	162, 748, 661	534, 035, 794	−371, 287, 133
1951	81, 258, 502	630, 381, 566	−549, 123, 064
1952	740, 254, 160	55, 921, 206	684, 332, 954
1953	47, 024, 515	44, 808, 300	2, 216, 215

[1] Excess of exports over imports indicated by minus sign.

TABLE 18.—Gold imported into the United States in 1953, 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	
Australia	36, 101	$1, 260, 430	1, 545	$54, 727	
Austria	2	76			
Belgian Congo			38	1, 313	
Belgium-Luxembourg	2, 101	73, 538	5	175	
Bolivia	1, 021	35, 698			
Brazil	399	13, 953			
British Guiana	4, 664	163, 627			
British West Africa, n. e. c	28	971			
British Western Pacific Islands			26	906	
Canada	169, 869	5, 932, 753			
Chile	26, 529	928, 569			
Colombia	6, 478	228, 527	16, 453	574, 377	
Cuba	1, 181	41, 265			
Ecuador	23, 156	804, 466			
El Salvador	16, 152	565, 255			
Guatemala	3	102			
Honduras	46, 965	1, 643, 437			
Iran	2	68			
Malta, Gozo, and Cyprus	1, 535	53, 593			
Mexico	104, 683	3, 646, 868			
Mozambique	87	3, 037			
Nicaragua	73, 461	2, 565, 057			
Northern Rhodesia	587	20, 542			
Norway	9	300			
Panama	86	3, 028			
Peru	21, 157	738, 608	269, 834	9, 444, 183	
Philippines	103, 676	3, 626, 343			
Portugal	14, 036	491, 289			
Southern Rhodesia	2, 412	84, 387			
Spain					$31, 525
Switzerland					3, 000
Turkey	4, 149	145, 319			
Union of South Africa	([1])	8	394, 360	13, 802, 582	
United Kingdom	1, 048	36, 438			
Uruguay	2	60			
Venezuela	117	4, 115			
Total	661, 696	23, 111, 727	682, 261	23, 878, 263	34, 525

[1] Less than 1 troy ounce.

TABLE 19.—Gold exported from the United States in 1953, 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	
Afghanistan			51,441	$1,800,440	
Belgium-Luxembourg			201	7,307	
Brazil			771	27,335	
Canada			88,000	3,224,191	$4,505,779
Ceylon			18	700	
Chile			5,355	188,420	
Cuba			25	874	
Egypt			3,363	123,258	
El Salvador			8,110	283,845	
France			21,314	769,326	
Germany, West			119,355	4,232,457	
Ireland	29	$1,126			
Kuwait			101,998	3,674,561	
Lebanon			146,835	5,145,115	
Mexico	8	280			
Netherlands			8,864	319,780	7,942,848
Netherlands Antilles			49	1,907	
Panama			764	27,841	
Peru			888	31,164	
Philippines			108,779	5,786,297	
Portugal			89,072	3,156,941	
Switzerland			14,516	508,184	
Tangier			13,558	485,860	
Turkey			2,472	86,868	
United Kingdom	1,087	39,100			
Uruguay			11,407	427,574	
Venezuela			55,971	2,008,922	
Total	1,124	40,506	853,126	32,319,167	12,448,627

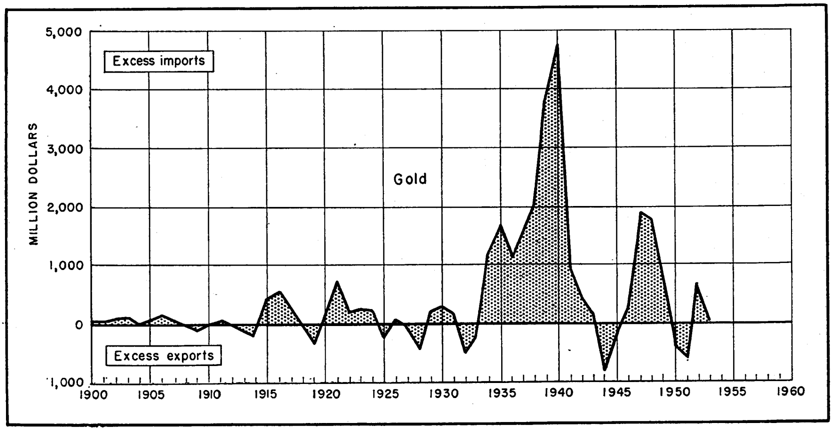

FIGURE 2.—Net imports or exports of gold, 1900–53.

WORLD REVIEW

Reversing an uptrend that started in 1946, the world rate of gold production was 2 percent smaller in 1953 than in the preceding year. Gains in Australia and the Union of South Africa were more than offset by declines in Canada and the Soviet Union. However, the 1953 output was 11 percent below the average for the 5 prewar years 1936–40.

According to the Bureau of the Mint, the world output of gold from 1943 through 1953 was 1,784,708,100 fine ounces valued at $46,244,-110,800.

It has been estimated that, of the total gold yield of the world, 60 percent is held by governments and central banks, 25 percent is owned privately, and 15 percent has been lost or destroyed.

Australia.—Despite rising costs of labor and supplies, gold production in Australia was 10 percent greater in 1953 than in 1952. The increasing use of labor-saving machinery in ore production was an important factor in the larger yield. Most of the Commonwealth's gold output comes from Western Australia, which in 1953 produced around 75 percent of the total.

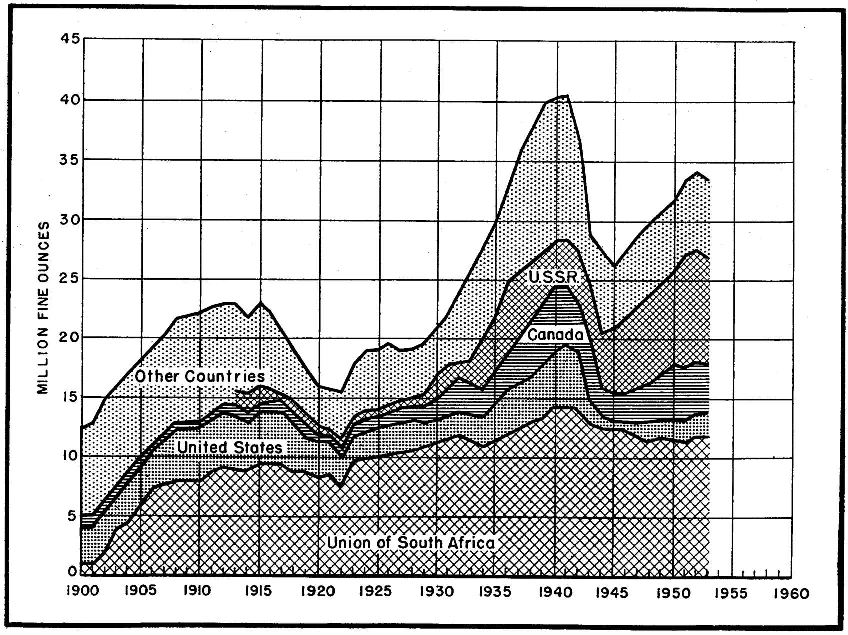

FIGURE 3.—World production of gold, 1900–53.

TABLE 20.—World production of gold, 1944–48 (average) and 1949–53, by countries,[1] in fine ounces [2]

[Compiled by Pauline Roberts and Berenice B. Mitchell]

Country [1]	1944–48 (average)	1949	1950	1951	1952	1953
North America:						
United States (including Alaska) [3]	1,518,159	1,921,949	2,288,708	1,894,726	1,927,000	1,970,000
Canada	3,020,478	4,123,518	4,441,227	4,392,751	4,471,725	4,068,516
Central America and West Indies:						
Costa Rica [4]	2,199	284	115	1	------	------
Cuba	453	[4] 5,692	[4] 6,915	[4] 835	[4] 881	[4] 1,181
Dominican Republic [4]	385	993	475	411	332	------
Guatemala [4]	56	5	397	7	4	3
Haiti	55	------	------	------	------	------
Honduras	15,071	25,832	36,545	31,216	31,967	38,988
Nicaragua (exports)	212,772	219,139	229,206	251,160	254,675	261,899
Panama	200	[5] 9,657	1,118	2,897	------	------
Salvador (exports)	18,534	27,091	29,053	27,097	27,682	23,359
Mexico	452,207	405,550	408,122	394,007	459,370	483,483
Total	5,240,580	6,739,700	7,441,900	6,995,100	7,173,700	6,847,400
South America:						
Argentina (estimate)	6,600	8,000	8,000	8,000	8,000	8,000
Bolivia	11,130	33,533	7,716	3,200	10,996	[5] 1,032
Brazil	[6] 177,880	[6] 183,500	[6] 195,500	[6] 200,000	[6] 180,000	115,775
British Guiana	19,788	18,988	12,366	13,485	22,237	11,350
Chile	197,828	179,144	190,172	173,646	176,025	130,693
Colombia	443,138	359,474	379,412	430,723	422,240	436,045
Ecuador	72,958	98,382	96,403	12,601	24,294	29,239
French Guiana	17,503	14,757	12,249	12,056	8,231	2,576
Peru	146,679	113,754	127,458	144,765	130,944	128,211
Surinam	4,915	3,794	4,546	6,494	6,134	6,482
Uruguay	[6] 400	------	------	------	------	------
Venezuela	54,935	61,378	34,462	2,861	4,797	27,304
Total	[6] 1,154,000	1,075,000	1,068,000	1,008,000	994,000	897,000
Europe:						
Austria	[6] 1,622	(7)	(7)	(7)	(7)	(7)
Bulgaria	[6] 2,000	(7)	(7)	(7)	(7)	(7)
Czechoslovakia	2,507	(7)	(7)	(7)	(7)	(7)
Finland	9,272	14,587	9,465	18,500	20,100	19,483
France	39,996	55,537	63,594	68,127	45,011	36,202
Germany:						
East	[6][8] 1,000 (East and West)	(7)	(7)	(7)	(7)	(7)
West		1,447	[6] 1,500	1,498	2,009	6,398
Hungary	[9] 6,744	(7)	(7)	(7)	(7)	(7)
Italy	9,259	10,385	10,674	12,089	14,854	12,153
Portugal	6,848	10,385	15,465	18,358	17,940	14,854
Rumania	82,128	112,528	(7)	(7)	(7)	(7)
Spain	4,361	30,318	13,217	12,777	8,944	8,256
Sweden	87,398	80,280	78,866	70,474	65,877	(7)
U. S. S. R. (estimate)[10]	5,800,000	7,000,000	8,000,000	9,500,000	9,500,000	[11] 9,000,000
Yugoslavia	[6] 16,141	34,594	42,760	21,380	36,266	[6] 34,300
Total (estimate)	6,100,000	7,400,000	8,400,000	9,800,000	9,800,000	9,300,000
Asia:						
Burma	72	158	150	131	43	647
China	39,147	[6] 60,000	108,000	[6] 100,000	[6] 100,000	[6] 100,000
Cyprus	192	(7)	(7)	(7)	(7)	(7)
India	168,096	164,203	196,925	226,475	243,629	211,124
Indonesia (estimate)	12,800	35,000	42,000	(7)	(7)	(7)
Japan	74,924	84,492	135,033	177,472	201,392	227,627
Korea:						
Korea Republic	[6] 233,492 (Republic and North)	5,466	14,854	7,620	18,647	15,860
North (estimate)		300,000	200,000	(7)	(7)	(7)
Malaya	3,494	13,617	18,436	17,018	19,806	18,203
Philippines	57,503	287,844	333,991	393,602	469,408	480,625
Sarawak	201	1,523	1,440	931	843	442
Saudi Arabia	44,131	66,835	66,202	73,104	69,394	81,566
Taiwan (Formosa)	10,607	19,644	30,446	30,511	33,147	24,821
Thailand	[6] 1,200	(7)	(7)	(7)	(7)	(7)
U. S. S. R.	(10)	(10)	(10)	(10)	(10)	(10)
Total (estimate)	646,000	1,040,000	1,150,000	1,290,000	1,420,000	1,430,000

See footnotes at end of table.

TABLE 20.—World production of gold, 1944–48 (average) and 1949–53, by countries,[1] in fine ounces [2]—Continued

[Compiled by Pauline Roberts and Berenice B. Mitchell]

Country [1]	1944–48 (average)	1949	1950	1951	1952	1953
Africa:						
Angola	695	319	201	61	40	20
Bechuanaland	8,300	256	261	493	1,245	1,109
Belgian Congo [12]	328,741	333,853	339,415	352,308	368,737	371,020
Egypt	2,557	7,045	10,724	16,469	17,059	14,234
Eritrea	2,323	2,243	1,042	675	(7)	[6] 3,000
Ethiopia	42,967	45,102	43,524	32,937	27,291	26,696
French Cameroon	14,172	8,938	7,170	5,422	2,604	1,029
French Equatorial Africa	72,897	57,273	54,996	52,849	51,655	54,180
French Morocco	1,093	643	119	2,069	4,051	2,533
French West Africa	[6 13] 28,219	[13] 47,000	[13] 96,000	5,700	1,500	749
Gold Coast	575,757	676,934	689,441	698,676	691,460	730,963
Kenya	31,211	20,072	22,945	19,765	10,210	9,603
Liberia	17,416	14,656	11,025	[5 14] 9,806	[5 14] 949	863
Madagascar	4,663	1,663	1,935	1,951	1,784	1,640
Mozambique	6,280	2,468	997	861	831	[6] 1,000
Nigeria	5,201	2,515	2,238	1,566	1,348	689
Northern Rhodesia [15]	1,874	1,186	1,432	857	2,523	3,308
Sierra Leone	1,258	2,330	3,484	3,261	2,638	1,451
Southern Rhodesia	548,548	528,180	511,163	486,907	496,731	501,057
South-West Africa	147	32	32			
Sudan	2,883	4,114	3,503	1,495	1,545	(7)
Swaziland	3,909	2,841	1,794	322	1	
Tanganyika (exports)	51,550	68,989	65,127	65,224	64,693	69,886
Uganda (exports)	1,918	650	509	223	201	511
Union of South Africa	11,843,311	11,705,048	11,663,713	11,516,450	11,818,681	11,940,616
Total	13,598,000	13,535,000	13,535,000	13,275,000	13,570,000	13,740,000
Oceania:						
Australia:						
Commonwealth	792,344	890,204	867,837	895,536	980,435	1,075,080
New Guinea	29,284	93,045	80,099	94,085	122,431	120,568
Papua	143	450	788	248	149	141
Fiji	81,037	104,036	103,421	93,635	78,282	[6] 80,500
New Zealand	119,217	84,874	76,527	75,115	59,151	38,656
Total	1,022,025	1,172,609	1,128,672	1,158,619	1,240,448	[6] 1,315,000
World total (estimate)	27,760,000	31,000,000	32,700,000	33,500,000	34,200,000	33,500,000

[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] Average for 1945–48.
[9] Includes gold mined in Transylvania, which temporarily formed part of Hungary.
[10] Output from U. S. S. R. in Asia included with U. S. S. R. in Europe.
[11] Production is believed to have decreased because of a probable diversion of forced labor into other activities.
[12] Includes Ruanda-Urundi.
[13] Estimate based on reported production.
[14] Year ended September 30 of year stated.
[15] Included is yield from Nkana-mine refinery slimes accumulated during the war: 1946–48 (average), 2,713 ounces; 1949, 972; 1950, 1,296; 1951, 756; 1952, 2,503; and 1953, 2,999.

Canada.—Ranking third among the gold-producing countries of the world, Canada was exceeded in gold output by only the Union of South Africa and (probably) the Soviet Union. However, the gold production of Canada declined 9 percent in 1953 compared with that of the preceding year and was lowest since 1948. The drop was due mainly to strikes that closed some mines for long periods during the latter part of the year. High-cost operations continued to receive aid through Government subsidy under the Emergency Gold Mining

Assistance Act. For many years gold was the leading mineral in Canada in output value, but in 1953 gold was forced into fourth place, preceded in order by petroleum, nickel, and copper.

The gold outputs of the Provinces or Territories in 1952 and 1953 were as follows:[6]

	(Fine ounces)	
	1952	1953
Province or Territory:		
Newfoundland	8, 595	7, 575
Nova Scotia	1, 433	3, 402
Quebec	1, 113, 204	1, 018, 575
Ontario	2, 513, 691	2, 182, 544
Manitoba	141, 947	132, 500
Saskatchewan	93, 585	87, 150
Alberta	111	55
British Columbia	273, 059	267, 000
Northwest Territories	247, 591	292, 741
Yukon	78, 519	69, 663
Total	4, 471, 735	4, 061, 205

Of the 1953 output of gold, 89 percent was derived from straight gold mining and 11 percent was recovered as a byproduct of base-metal mining.

Colombia.—The gold output of Colombia exceeds that of other countries in South America by a large margin. Compared with 1952 gold production in Colombia in 1953 was up 3 percent to 436,100 ounces, of which about three-fourths was recovered by placer mining and the remainder by gold-lode mining. Some of the smaller mines were forced to close because of rising costs. An effort to aid gold producers was made by the Colombian Government by permitting sale of newly mined gold on the free market and by relaxing various exchange control regulations.

Philippines.—Although the gold output of the Philippines rose 2 percent in 1953 to 481,000 ounces, the condition of the Philippine gold-mining industry was far from prosperous. The industry as a whole was reported to have suffered a net loss of $400,000 in 1953, and 3 out of 10 major producers were forced to close their mines. Lower prices for gold on the free market and rising labor costs, due largely to social legislation, more than offset favorable action by the Government during the year by which gold mines were exempted from various taxes. As the year closed further relief, perhaps in the form of Government subsidy for high-cost mines, was being sought by the Philippine gold-mining industry.

Union of South Africa.—Although the quantity of gold ore milled in the Union of South Africa was 4 percent less in 1953 than in the preceding year, the average recovery of gold per ton of ore was greater, and gold production increased 1 percent to 11,941,000 ounces. Average working costs per ton of ore were up 2s. 4d. (32.6 cents) and average

[6] Canadian Mining Journal, vol. 75, No. 2, February 1954, p. 58.

working profits per ton declined 1s. (14 cents) per ton. Shortages of power, water, and native labor were serious problems to some mines during 1953. Government regulations continued to permit gold producers to sell up to 40 percent of new output on the free market, but revenue from free market sales declined because of the sharp drop in premium gold prices in 1953.

Five of the 13 separate companies with holdings in the new gold field in the Orange Free State had reached a preliminary production stage in 1953 and were treating ore derived from development workings. Five additional mines were expected to progress to the same phase in 1954.

To the end of 1953 three mines in the Transvaal had announced profits from the production of byproduct uranium. Twelve additional mines in the Transvaal and 7 in the Orange Free State had announced their acceptance for participation in the uranium program. Additional information on the production of byproduct uranium from gold mining in the Union of South Africa will be found in the chapter on Uranium, Radium, and Thorium in this volume.

Some interesting facts as of the end of 1953 were released by the Chamber of Mines: Since the discovery of the Witwatersrand gold field in 1886, the gold output of the Union of South Africa had totaled around 525 million ounces. The three largest mines were still the Randfontein Estates, Crown Mines, and Government Areas. The three producing the most gold were the Blyvooruitzicht, Daggafontein, and Crown Mines. The deepest mine in the Union was the Crown, with workings reaching a vertical depth of 9,714 feet below the surface.

TABLE 21.—Salient statistics of gold mining in the Union of South Africa, 1944–48 (average), and 1949–53

[Transvaal Chamber of Mines]

	1944–48 (average)	1949	1950	1951	1952	1953
Ore milled (tons)	56, 665, 500	56, 881, 550	59, 515, 200	58, 645, 800	60, 500, 000	60, 032, 768
Gold recovered (fine ounces)	11, 836, 239	11, 708, 013	11, 663, 713	11, 516, 450	11, 818, 681	11, 940, 616
Gold recovered (dwt. per ton)	4. 011	3. 942	3. 759	3. 756	3. 767	3. 893
Working revenue	£97, 927, 948	£110, 617, 476	£139, 491, 029	£137, 494, 860	[1] £141,271,310	£142, 198, 156
Working revenue per ton	34s. 7d.	38s. 11d.	46s. 11d.	46s. 11d.	47s. 1d.	48s. 5d.
Working cost	£70, 647, 392	£76, 667, 643	£87, 956, 643	£93, 494, 860	£102, 525, 003	£107, 306, 956
Working cost per ton of ore	25s. 0d.	27s. 0d.	29s. 7d.	31s. 10d.	34s. 2d.	36s. 6d.
Working cost per ounce of metal	124s. 7d.	136s. 9d.	157s. 3d.	169s. 6d.	181s. 6d.	187s. 7d.
Working profit	£27, 279, 557	£33, 949, 793	£51, 534, 386	£44, 157, 054	£38, 746, 307	£34, 891, 200
Working profit per ton	9s. 7d.	11s. 11d.	17s. 4d.	15s. 1d.	12s. 11d.	11s. 11d.
Premium gold sales					£3, 699, 124	£1, 934, 421
Estimated uranium profits					£125, 000	£1, 828, 067
Dividends	£13, 068, 997	£17, 394, 046	£24, 699, 544	£22, 787, 806	£19, 804, 928	£18, 207, 830

[1] Revised figure.

Graphite

By Frank D. Lamb[1] and Eleanor V. Blankenbaker[2]

STRONG DEMAND for natural graphite following the outbreak of war in Korea in 1950 resulted in an abnormal increase in the number of operating mines throughout world graphite-producing areas. The large increase in production from these mines in 1952 and 1953 more than met the requirements of both industry and Government purchasing, and surpluses of some types of graphite existed during 1953. Madagascar, Ceylon, Canada, and Mexico continued to supply the bulk of the graphite required in the United States; and, except for a continued lack of experienced workers at the Mexican amorphous graphite mines, no difficulties were experienced by producers in meeting these requirements.

DOMESTIC PRODUCTION

The quantity of crystalline and amorphous graphite produced from domestic mines in 1953 increased 12 percent over that produced in 1952, but shipments were 5 percent less in quantity and 18 percent less in value. These figures reflected the condition of the market for graphite in the United States during the past 2 years and indicated that increasing availability of foreign graphite would continue to reduce the consumption of domestic graphite.

TABLE 1.—Salient statistics of the graphite industry in the United States, 1952–53

	1952		1953	
	Short tons	Value	Short tons	Value
Natural graphite:				
Production	5,606	(1)	6,281	(1)
Sales	5,081	$594,618	4,850	$488,008
Consumption [2]	26,911	4,048,787	34,821	4,771,967
Imports:				
Crystalline flake	[3] 8,878	[3] 1,473,516	10,579	1,608,960
Lump, chip, or dust	67	10,733	79	7,958
Amorphous (natural)	[3] 33,504	[3] 1,357,035	40,382	1,176,613
Artificial	337	18,502	283	15,647
Total imports	[3] 42,786	[3] 2,859,786	51,323	2,809,178
Exports:				
Crystalline flake, lump, or chip	158	57,068	94	38,178
Amorphous (natural)	1,501	139,020	1,571	153,900
Other natural graphite	127	15,037	95	8,032
Total exports	1,786	211,125	1,760	200,110

[1] Figures not available.
[2] Minimum quantities as reported by consumers to the Bureau of Mines.
[3] Revised figure.

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

The Bureau of Mines is not at liberty to publish separate statistics on natural crystalline and amorphous graphite, but combined figures for 1944–48 (average) and 1949–53 are shown in table 2.

TABLE 2.—Production and shipments of natural graphite in the United States, 1944–48 (average) and 1949–53

Year	Production (short tons)	Shipments		Year	Production (short tons)	Shipments	
		Short tons	Value			Short tons	Value
1944–48 (average)	6,041	6,205	$312,697	1951	7,135	6,808	$771,434
1949	6,102	5,213	475,264	1952	5,606	5,081	594,618
1950	5,102	5,605	427,908	1953	6,281	4,850	488,008

CONSUMPTION

Although the coverage of the Bureau of Mines graphite consumption canvass was increased substantially for 1953, it remained incomplete. However, for the more strategic uses of graphite the consumption data obtained were believed to be reasonably accurate, and the discrepancies in the canvass data related largely to amorphous graphite used for foundry facings, paints, and other nonstrategic uses. Data on consumption of natural graphite by uses, as reported to the Bureau of Mines, are shown in table 3.

TABLE 3.—Consumption of natural graphite in the United States in 1953, by uses

Use	Short tons	Value
Foundry facings	11,944	$1,025,481
Steelmaking	7,751	784,173
Lubricants	4,960	707,919
Crucibles, retorts, stoppers, sleeves, and nozzles	3,383	782,154
Batteries	2,003	158,718
Pencils	1,601	416,189
Paints and polishes	673	27,346
Carbon brushes	646	272,005
Brake linings	588	170,206
Packings	441	197,953
Bearings	111	53,366
Other [1]	720	176,457
Total	34,821	4,771,967

[1] Includes roofing granules, rubber goods, adhesives, and insulation.

PRICES

Quotations for Madagascar flake graphite decreased early in 1953 but were later increased and at the year end the trade-journal listings were as follows: Per pound, carlots, f. o. b. shipping point (United States), crystalline flake, natural, 85–88 percent carbon, crucible grade, 13 cents; 96 percent carbon, special and dry usage, 22 cents; 94 percent carbon, normal and wire drawing, 19 cents; 98 percent carbon, special for brushes, etc., 26½ cents. Amorphous, natural, for foundry facings, etc., up to 85 percent carbon, 9 cents. Madagascar, c. i. f. New York, "standard grades, 85–87 percent carbon," $235 per 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.

The freight rate for shipping graphite from Madagascar to New York has ranged for several years between $33 and $36.50 per metric ton, depending upon quality. This was lowered in 1953 to a flat rate of $30 per metric ton, thus reducing the cost of Madagascar graphite delivered in the United States.[3]

FOREIGN TRADE [4]

Increases in imports of Mexican amorphous graphite and Madagascar flake resulted in an overall increase of 17 percent in imports of all types of graphite in 1953. The total value of the graphite imported decreased about 2 percent from the 1952 figures, as shown in table 4.

A record 9,927 tons of crystalline graphite (80 percent flake, 20 percent fines) was imported by industry and Government from Mada-

TABLE 4.—Graphite (natural and artificial) imported for consumption in the United States, 1944–48 (average) and 1949–53

[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
1944–48 (average)	3,727	$377,608	1,517	$183,523	32,986	$949,419	87	$4,778	38,317	$1,515,328
1949	2,228	277,368	235	27,313	29,298	954,388	44	1,398	31,805	1,260,467
1950	6,130	725,172	100	7,514	37,255	1,335,142	184	12,518	43,669	2,080,346
1951	10,227	1,412,787	336	29,096	43,830	1,561,494	90	7,420	54,483	3,010,797
1952										
Canada	181	53,695	------	--------	1,326	128,320	334	17,441	1,841	199,456
Ceylon	------	--------	56	9,664	[1] 3,228	648,863	------	------	[1] 3,284	658,527
France	30	13,228	------	--------	------	--------	------	------	30	13,228
Germany, West	457	79,569	------	--------	221	21,758	------	------	678	101,327
India	------	--------	------	--------	28	3,875	------	------	28	3,875
Madagascar	[1] 8,210	[1] 1,327,024	------	--------	(2)	(2)	------	------	[1] 8,210	[1] 1,327,024
Mexico	------	--------	------	--------	27,321	447,248	------	------	27,321	447,248
Mozambique	------	--------	------	--------	100	4,914	------	------	100	4,914
Norway	------	--------	11	1,014	1,277	100,963	------	------	1,288	101,977
Switzerland	------	--------	------	--------	[1] 3	[1] 1,061	3	1,061	[1] 6	[1] 2,122
United Kingdom	------	--------	(3)	55	(3)	33	------	------	(3)	88
Total	[1] 8,878	[1] 1,473,516	67	10,733	[1] 33,504	[1] 1,357,035	337	18,502	[1] 42,786	[1] 2,859,786
1953										
British East Africa	11	1,356	------	--------	27	1,168	------	------	38	2,524
Canada	292	67,463	------	--------	2,762	264,977	281	15,200	3,335	347,640
Ceylon	------	--------	77	6,650	1,570	171,204	------	------	1,647	177,854
Colombia	------	--------	------	--------	28	3,866	------	------	28	3,866
France	2	662	------	--------	------	--------	------	------	2	662
Germany, West	347	50,115	1	863	1,137	126,190	------	------	1,485	177,168
Madagascar	9,927	1,489,364	------	--------	------	--------	------	------	9,927	1,489,364
Mexico	------	--------	------	--------	34,136	553,443	------	------	34,136	553,443
Norway	------	--------	------	--------	678	50,945	------	------	678	50,945
Switzerland	------	--------	------	--------	5	1,922	2	447	7	2,369
Union of South Africa	------	--------	------	--------	27	753	------	------	27	753
United Kingdom	------	--------	1	445	12	2,145	------	------	13	2,590
Total	10,579	1,608,960	79	7,958	40,382	1,176,613	283	15,647	51,323	2,809,178

[1] Revised figure.
[2] Revised to none.
[3] Less than 1 ton.

[3] Foreign Commerce Weekly: Vol. 50, No. 17, Oct. 26, 1953, p. 12.
[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 exported from the United States, 1952–53, by countries of destination

[U. S. Department of Commerce]

Country	Amorphous		Crystalline flake, lump, or chip		Natural, n. e. s.	
	Short tons	Value	Short tons	Value	Short tons	Value
1952						
Argentina	4	$1,935	14	$8,050		
Australia			11	1,163		
Austria	9	1,825				
Belgium-Luxembourg	4	502				
Canada	1,152	88,578	11	8,997	121	$12,865
Canal Zone					(1)	116
Chile	17	2,897	16	4,554		
Colombia			2	1,877		
Cuba	16	1,922	35	8,160	1	104
Denmark	6	840	(1)	224		
Dominican Republic			3	492	(1)	223
Ecuador			1	291		
France	24	4,466				
Germany, West	74	9,753				
Guatemala			(1)	158		
India	19	2,160	3	1,556		
Israel and Palestine	6	1,074	6	1,215		
Italy	1	369				
Japan	5	847				
Mexico	5	812	24	9,159	2	528
Netherlands			1	1,130		
Netherlands Antilles			1	576		
Nicaragua					1	120
Peru	1	106	1	842	(1)	593
Philippines	8	1,168	21	4,274	1	189
Saudi Arabia					1	164
Turkey			4	2,766		
Union of South Africa	1	568				
United Kingdom	143	18,204				
Venezuela	6	994	4	1,584	(1)	135
Total	1,501	139,020	158	57,068	127	15,037
1953						
Austria	3	527				
Bahamas					7	732
Canada	1,341	115,847	17	12,298	88	7,169
Chile	16	3,917	7	2,715		
Colombia	2	282	(1)	412		
Cuba	19	2,563	13	2,778		
Denmark	11	2,223	(1)	124		
Ecuador			(1)	101		
El Salvador			(1)	165		
France	11	1,414				
French Morocco	6	953				
Germany, West	38	5,026				
India	10	870	(1)	126		
Israel and Palestine	4	703	6	1,544		
Japan	35	7,819				
Mexico	3	549	22	8,884		
Netherlands Antilles			3	1,620		
Nicaragua			(1)	129		
Peru			3	1,104		
Philippines	20	3,057	18	4,901		
Saudi Arabia					(1)	131
Union of South Africa	10	1,590				
United Kingdom	19	2,750				
Venezuela	23	3,810	5	1,277		
Total	1,571	153,900	94	38,178	95	8,032

1 Less than 1 ton.

gascar, reflecting the greatly accelerated production rate of the past 3 years. Only 1,647 tons of graphite was imported from Ceylon compared with 3,284 in 1952, and imports from Mexico rose to 34,136 tons from 27,321 tons in 1952.

The United States tariff rates on graphite, effective January 1, 1948, remained in force during 1953. They are: Amphorous, 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.

Exports of natural graphite, 1949–51, were: 1949, 1,352 tons, $158,694; 1950, 1,397 tons, $173,700; 1951, 1,504 tons, $195,948. Data for 1952 and 1953 are shown in table 5.

TECHNOLOGY

The increased supply of crystalline flake graphite and the evidence of a decreasing world market indicated the need for new uses for natural graphite to maintain production at or near the 1953 rate. Especially needed were uses for crystalline fines such as those produced from domestic mines in Alabama and Texas. In this connection some promise was shown with experimental use of flake graphite as an oil-well drilling-mud additive.[5]

The work of the Bureau of Standards describing the properties of foreign and domestic natural graphite was reported.[6] An explanation of how extremely fine size graphite protects bearing surfaces was published,[7] and the various forms of carbon and graphite shapes available to industry were described.[8] At the Oak Ridge National Laboratory of the Atomic Energy Commission a compilation of data on crucibles, including those made with graphite, for calcining, sintering, melting, and casting was reported.[9]

The Benjamin Franklin graphite mine near Chester Springs, Pa., was operated by the F. M. Equipment Co. for the National Industrial Reserve Division of the General Services Administration from late in May through the end of the year. Information obtained during the experimental operation showed that appreciable quantitites of strategic grades of graphite can be produced, but at high cost, from Pennsylvania ores.

WORLD REVIEW

Available statistics on world production of graphite for 1944–48 (average) and 1949–53 are shown in table 6.

Canada.—Frobisher, Ltd., operated the Black Donald mine near Calabogie, Ontario, by open-pit methods to recover the graphite from the remaining ore reserves. Exploration activities were continued by Frobisher, Ltd., to locate additional reserves in the Kirkham area north of Kingston, Ontario.

[5] Townsend, A. A., Graphite's Role as a Drilling-Mud Additive: Oil and Gas Jour., vol. 51, No. 21, September 1952, pp. 268–270.

[6] Mackles, L., Heindl, R. A., and Mong, L. E., Chemical Analyses, Surface Area, and Thermal Reactions of Natural Graphite and Refractoriness of the Ashes: Jour. Am. Ceram. Soc., vol. 36, No. 8, August 1953, p. 266.

[7] Warburton, H., How Collodial Graphite Protects Bearing Surfaces: Iron Age, vol. 172, No. 2, July 9, 1953, pp. 135–136.

[8] Werking, L. C., Formed Carbon and Graphite in Industry: Bull. Ceram. Soc., vol. 32, No. 2, February 1953, pp. 40–44.

[9] Schwartz, M. A., White, G. D., and Curtis, C. E., Crucible Handbook: U. S. Atomic Energy Commission, Tech. Inf. Service, Oak Ridge, Tenn., ORNL–1354, Apr. 17, 1953, 28 pp.

Ceylon.—A new graphite-mining company—Loganayaki Mines, Ltd.—was reported to have been registered in Ceylon.

Hong Kong.—A deposit of amorphous graphite on West Brother Island, Hong Kong, was being mined to produce a reported 1,000 tons per month of graphite containing 80 to 85 percent of graphitic carbon.

TABLE 6.—World production of natural graphite, by countries,[1] 1944–48 (average) and 1949–53, in metric tons [2]

[Compiled by Helen L. Hunt]

Country [1]	1944–48 (average)	1949	1950	1951	1952	1953
North America:						
Canada	1,888	1,948	3,253	1,423	1,851	3,153
Mexico	24,361	23,812	24,626	32,286	24,152	30,330
United States (amorphous and crystalline)	5,481	5,536	4,628	6,473	5,086	5,698
South America:						
Argentina	[3] 378	(4)	(4)	(4)	(4)	(4)
Brazil	1,920	556	471	610	(4)	----------
Europe:						
Austria	8,746	14,400	14,685	18,227	19,711	14,683
Czechoslovakia	11,908	(4)	(4)	(4)	(4)	(4)
Germany, West (concentrates)	6,497	5,097	6,563	10,300	8,963	7,459
Italy	5,520	4,639	4,521	4,514	3,960	4,910
Norway	1,825	2,257	2,457	3,453	4,120	[3] 3,000
Spain	218	256	310	274	783	[3] 250
Sweden	56	109	----------	----------	----------	----------
Yugoslavia	----------	----------	----------	----------	687	(4)
Asia:						
Ceylon (exports)	10,398	12,437	13,030	12,824	7,782	7,334
China	[3] 4,000	----------	----------	(4)	(4)	(4)
India	1,368	988	1,611	1,603	2,182	(4)
Indochina	6	----------	----------	----------	----------	----------
Japan	7,370	5,664	4,008	4,872	4,650	[3] 3,900
Korea, Republic of	[5] 37,979	40,671	16,382	21,578	15,066	20,629
Taiwan (Formosa)	(4)	(4)	(4)	(4)	700	----------
Africa:						
Egypt	92	----------	----------	----------	----------	(4)
French Morocco	361	72	74	131	21	98
Kenya	3	----------	----------	----------	35	(4)
Madagascar	8,830	9,141	14,013	18,338	18,478	13,325
Mozambique	83	110	----------	240	----------	----------
Southern Rhodesia	2	----------	----------	----------	----------	----------
South-West Africa	1,482	2,264	1,380	2,626	1,184	(4)
Spanish Morocco	87	15	3	----------	17	(4)
Union of South Africa	238	107	244	328	353	375
Australia	291	126	147	135	81	(4)
Total (estimate)	142,400	170,000	160,000	195,000	185,000	180,000

[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] Estimate.
[4] Data not available; estimate by senior author of chapter included in total.
[5] Average for 1944–47 for Korea.

Madagascar.—With 41 mines and over 4,000 workers active in the graphite industry of Madagascar, the productive capacity reached an alltime high early in 1953; but the world demand for flake graphite fell sharply during the year, and except for unusually large deliveries to the United States Government, exports of graphite from Madagascar were below normal. Total production in 1953 was 13,325 metric tons compared with over 18,000 metric tons in each of the two preceding years. Before the Korean War production in Madagascar averaged about 9,000 metric tons; and since many of the new producers on the island were high-cost operators, a sharp drop in the world price was expected to result in a return to the 9,000 metric tons production rate.

Gypsum

By Oliver S. North[1] and Nan C. Jensen[2]

A NEW dollar-volume record was established by the gypsum industry in 1953, mainly on the strength of increases of $13, $4, and $3 million, respectively, in the output of wallboard, lath, and sanded (containing sand, perlite or other aggregate) plasters. Consumption of gypsum products was well above normal during the first part of 1953 but had stabilized by early summer at about 1952 figures.

Demand for wallboard was unusually high in the first 6 months of the year, during which most of the increased output noted above occurred; in the final two quarters production was approximately the same as during the last half of 1952. On the other hand, demand for lath was more nearly even through the year, a few percent higher than in the preceding year. Consumption of sanded (including perlite-premixed) and roof-deck plasters was very high throughout the year.

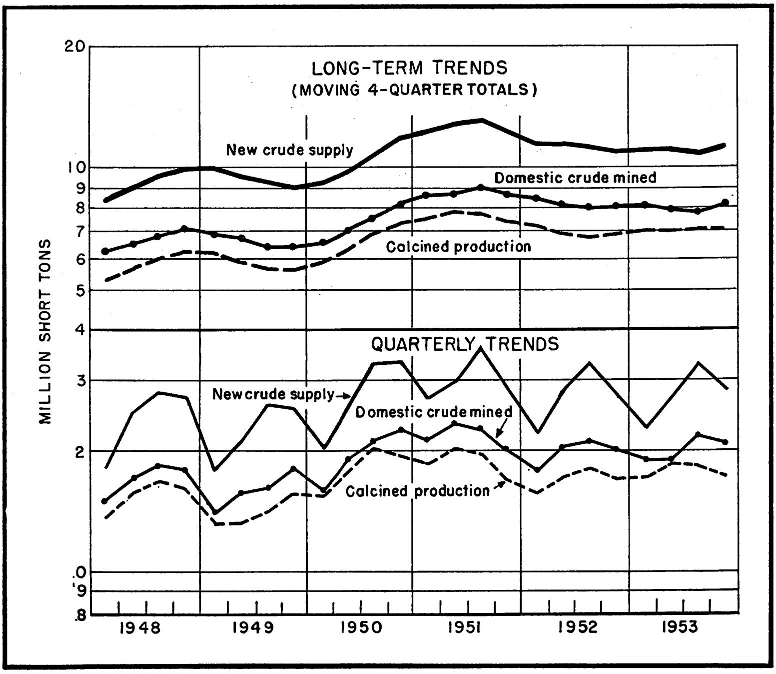

FIGURE 1.—Trends of new crude supply, domestic crude mined, and production of calcined gypsum 1948–53, by quarters.

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

The sharpest declines were a 17-percent decrease in agricultural gypsum tonnage and a 9-percent drop in base-coat plasters. The latter was due to the increase in consumption of sanded and perlite-premixed plasters. The decrease in agricultural gypsum apparently was due to several reasons, one of which was reduction in the subsidies granted under the Agricultural Conservation Program.

At the beginning of 1954 the outlook for the gypsum industry was considered excellent.

TABLE 1.—Salient statistics of the gypsum industry in the United States, 1944–48 (average) and 1949–53

	1944–48 (average)	1949	1950	1951	1952	1953
Active establishments [1]	84	88	87	85	89	94
Crude gypsum: [2]						
Mined short tons	5, 333, 021	6, 608, 118	8, 192, 625	8, 665, 534	8, 415, 300	8, 292, 876
Imported do	1, 464, 925	2, 593, 329	3, 219, 299	3, 436, 927	[3] 3, 087, 884	3, 184, 292
Apparent supply do	6, 797, 946	9, 201, 447	11, 411, 924	12, 102, 461	[3] 11,503, 184	11, 477, 168
Calcined gypsum produced:						
Short tons	[4] 4, 054, 441	5, 767, 163	7, 341, 024	7, 454, 916	6, 874, 432	7, 166, 005
Value	[4] $28,891,827	$45, 455, 419	$60, 479, 573	$65, 761, 032	$59, 696, 410	$66, 668, 981
Gypsum products sold: [5]						
Uncalcined uses:						
Short tons	1, 604, 312	1, 989, 893	2, 218, 286	2, 530, 379	2, 705, 727	2, 656, 446
Value	$5, 286, 291	$7, 127, 497	$7, 911, 988	$9, 413, 098	$9, 616, 780	$9, 844, 330
Industrial uses:						
Short tons	198, 429	211, 635	266, 192	288, 713	252, 216	254, 148
Value	$3, 039, 902	$3, 562, 017	$4, 530, 159	$5, 467, 803	$4, 999, 779	$5, 260, 875
Building uses:						
Value	[3] $95,277,605	[3] $147,610,881	[3] $192,940,452	[3] $220,954,226	[3] $210,307,189	$229, 948, 261
Total value	[3] $103,603,798	[3] $158,300,395	[3] $205,382,599	[3] $235,835,127	[3] $224,923,748	$245, 053, 466
Gypsum and gypsum products:						
Imported for consumption	$1, 682, 353	$2, 851, 289	$3, 584, 152	$3, 813, 892	$3, 694, 975	$4, 792, 191
Exported	$1, 194, 903	$1, 936, 148	$1, 046, 458	$1, 584, 488	$1, 216, 294	$1, 993, 671

[1] Each mine, plant, or combination mine and plant is counted as 1 establishment.
[2] Excludes byproduct gypsum.
[3] Revised figure.
[4] Includes production from small quantity of byproduct gypsum in 1944–46.
[5] Made from domestic, imported, and byproduct gypsum.

DOMESTIC PRODUCTION

Crude.—For the fourth successive year the output of crude gypsum from mines in the United States exceeded 8 million short tons, although the production in 1953 was 1 percent lower than in 1952 and 4 percent lower than in 1951, the record year. Compared to 1952 increased tonnages were mined in Iowa, Nevada, and Texas, while all other separately recorded States and groupings of States showed declines. A total of 61 mines, in 19 States, reported production during the year; of these, 45 were open-pit operations, 14 were underground mines, and 2 were combination pit-underground mines.

Calcined.—Forty-eight plants, with 219 pieces of calcining equipment, were in operation. The quantity of calcined gypsum produced in 1953 was 4 percent higher than in the previous year. Production of calcined gypsum—the form in which most gypsum is utilized—is considered the most accurate overall measure of the industry, as it reflects consumption of both domestic and imported raw material.

TABLE 2.—Crude gypsum mined in the United States, 1951–53, by States [1]

State	Active mines			1951		1952		1953	
	1951	1952	1953	Short tons	Value	Short tons	Value	Short tons	Value
California	10	13	16	1,092,883	$2,602,758	1,236,430	$2,721,134	1,199,489	$2,855,983
Iowa	5	4	4	1,127,705	2,881,150	1,122,409	2,797,704	1,151,692	2,939,654
Michigan	4	4	4	1,566,276	4,402,725	1,487,642	4,200,418	1,446,973	4,091,002
Nevada	5	4	4	643,637	1,811,757	608,284	1,666,938	701,584	1,975,053
New York	5	5	5	1,259,484	4,010,766	1,143,920	3,816,148	987,156	3,507,207
Texas	5	5	5	1,136,824	2,987,890	1,021,161	2,682,019	1,067,854	2,860,633
Other:									
Arizona	1	1	1						
Arkansas	1	1	1	392,863	717,133	446,705	777,975		
Kansas	2	2	2						
Louisiana	1	1	1						
Colorado	3	3	5					586,301	1,323,430
Idaho	1	1	1						
Montana	2	2	2	173,341	559,191	170,457	546,373		
Washington	1	1	1						
Wyoming	1	1	1						
Ohio	2	2	2						
Oklahoma	2	3	3	1,272,521	4,050,731	1,178,292	3,687,342	1,151,827	3,622,111
Utah	3	2	2						
Virginia	1	1	1						
Total	55	56	61	8,665,534	24,024,101	8,415,300	22,896,051	8,292,876	23,175,073

[1] Production of some States is not shown separately, to avoid disclosing individual company operations.

TABLE 3.—Calcined gypsum produced in the United States, 1952–53, by districts

District	1952		1953	
	Short tons	Value	Short tons	Value
New Hampshire, Massachusetts, and Connecticut	247,835	$2,308,999	261,434	$2,569,177
Eastern New York, New Jersey, Pennsylvania, Georgia, and Florida	1,285,101	12,134,418	1,331,302	13,086,768
Ohio, Virginia, Indiana, and Maryland	1,045,248	10,507,203	1,055,610	11,328,596
Western New York	640,956	5,145,257	654,174	5,969,663
Michigan	606,406	4,974,226	660,908	5,718,867
Iowa	721,953	5,382,295	756,783	6,205,931
Kansas and Oklahoma	453,901	3,333,289	448,897	3,519,841
Texas	707,654	5,960,375	730,083	7,020,270
Colorado, Montana, and Utah	243,365	2,336,283	256,980	2,778,613
California and Nevada	922,013	7,614,065	1,009,834	8,471,255
Total	6,874,432	59,696,410	7,166,005	66,668,981

Mine and Calcining-Plant Developments.—Blue Diamond Corp., Los Angeles, Calif., was reported to be expanding the mining and processing facilities at its Blue Diamond, Nev., gypsum mine and products plant. A $2 million program was planned, to increase capacity from 900 tons to 1,300 tons per day.[3]

National Gypsum Co., Buffalo, N. Y., was considering erection of a plant at a newly discovered gypsum deposit in a midwestern State. The location of the deposit was not disclosed.[4]

According to an item in the trade press, Casner Chemical Co. opened a new gypsum mine 75 miles east of El Paso, Tex. The mineral is mined by open-pit methods and trucked 4 miles to a railroad siding. Reserves were estimated at 5 million tons.[5]

[3] Rock Products, Gypsum Expansion: Vol. 56, No. 10, October 1953, p. 78.
[4] Chemical Week, Expansion: Vol. 72, No. 26, June 27, 1953, p. 18.
[5] Mining Congress Journal, Open Texas Gypsum Mine: Vol. 39, No. 4, April 1953, p. 134.

United States Gypsum Co., Chicago, Ill., announced plans for reopening its Eldorado, Okla., mine and plant if suitable rock in sufficient quantity can be found. The plant will produce sheet rock and casting plaster.[6]

CONSUMPTION AND USES

Expenditures for new construction in the United States totaled approximately $34.7 billion in 1953 compared with $32.3 billion in 1952. About 1,100,000 new nonfarm-dwelling units were started during the year—3 percent fewer than in 1952.

The demand for most gypsum building products, particularly high-value lath and wallboard, exceeded that in the previous year, as the decline in number of new housing starts was more than offset by the greater use of gypsum products, larger size of the average housing unit, and increased remodeling and rebuilding of older dwellings. The gypsum industry had little difficulty in meeting this demand. Few major gypsum-plant expansions were undertaken during the year, and there was a widespread belief that a satisfactory balance existed between supply and demand.

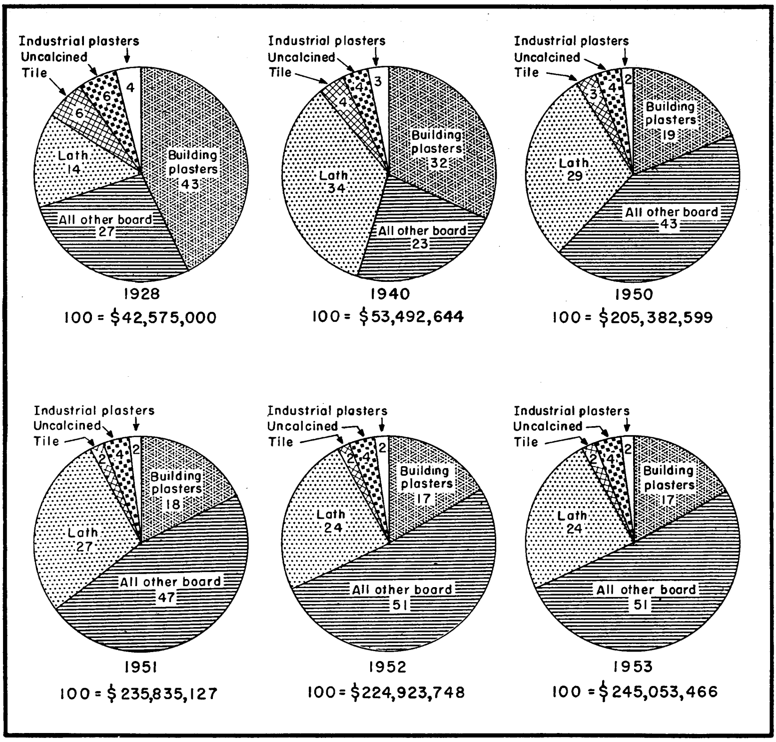

FIGURE 2.—Percentage distribution of total sales value, f. o. b. plant, of gypsum products in 1928, 1940, and 1950–53, by groups of products.

[6] Rock Products, May Reopen Gypsum Plant: Vol. 56, No. 12, December 1953, p. 84.

For the first time, the Bureau of Mines in table 5 of this chapter has compiled separate data on roof-deck plasters and on industrial molding, art, and casting plasters. Also for the first time, lath and wallboard data have been broken down on the basis of thickness; These figures are shown in table 7.

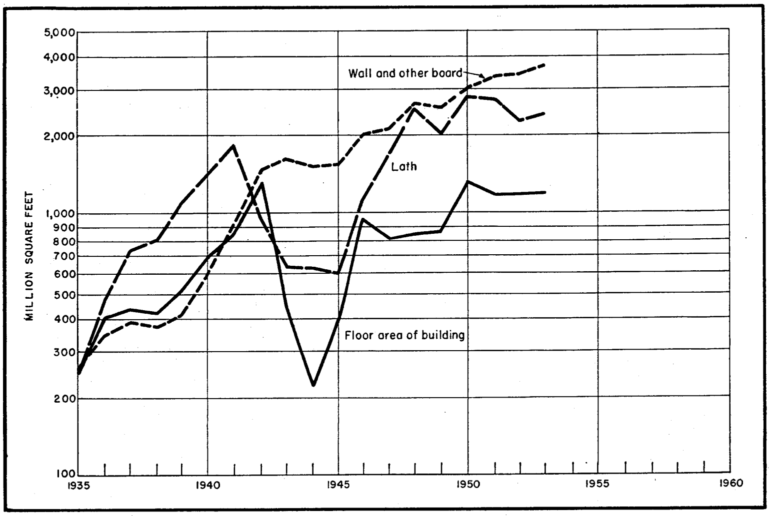

FIGURE 3.—Trends in sales of gypsum lath and wallboard and other boards (includes wallboard, laminated board in terms of component board, formboard, and sheathing), compared with Dodge Corp. figures on combined floor area of residential and nonresidential building, 1935–53.

TABLE 4.—Active calcining plants and equipment in the United States, 1951–53, by States

State	1951			1952			1953		
	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	11	8	5	12	8
Iowa	5	24	4	5	24	4	5	22	4
Michigan	4	20	1	4	20	1	4	20	1
New York	7	22	6	7	22	6	7	22	6
Texas	4	31	1	4	30	1	4	31	1
Other States[2]	25	74	23	25	74	23	23	71	21
Total	50	182	43	50	181	43	48	178	41

[1] Includes rotary and beehive kilns, grinding-calcining units, and hydrocal cylinders.
[2] Comprises calcining plants in 1951–53, as follows: 1 each in Connecticut, Florida, Georgia, Indiana, Maryland, Massachusetts, Montana (2 in 1951–52), New Hampshire, New Jersey, Oklahoma, and Pennsylvania; 2 each in Colorado, Kansas, Nevada, Ohio, Utah (3 in 1951–52), and Virginia.

TABLE 5.—Gypsum products (made from domestic, imported, and byproduct crude gypsum) sold or used in the United States, 1952–53, by uses

Use	1952			1953			Percent of change in—	
	Short tons	Value		Short tons	Value			
		Total	Average		Total	Average	Tonnage	Average value
Uncalcined:								
Portland-cement retarder	1, 815, 489	$6, 232, 230	$3. 43	1, 907, 031	$6, 842, 516	$3. 59	+5	+5
Agricultural gypsum	866, 005	3, 072, 419	3. 55	721, 993	2, 646, 389	3. 67	−17	+3
Other uses [1]	24, 233	312, 131	12. 88	27, 422	355, 425	12. 96	+13	+1
Total uncalcined uses	2, 705, 727	9, 616, 780	3. 55	2, 656, 446	9, 844, 330	3. 71	−2	+5
Industrial:								
Plate-glass and terra-cotta plasters	48, 587	626, 771	12. 90	60, 290	754, 116	12. 51	+24	−3
Pottery plasters	43, 991	811, 609	18. 45	43, 957	824, 381	18. 75	-------	+2
Orthopedic and dental plasters	11, 017	390, 347	35. 43	10, 613	401, 192	37. 80	−4	+7
Industrial molding, art, and casting plasters	(2)	(2)	(2)	69, 560	1, 286, 249	18. 49		
Other industrial uses [3]	148, 621	3, 171, 052	21. 34	69, 728	1, 994, 937	28. 61	−6	+10
Total industrial uses	252, 216	4, 999, 779	19. 82	254, 148	5, 260, 875	20. 70	+1	+4
Building:								
Cementitious:								
Plasters:								
Base-coat	1, 907, 871	26, 596, 087	13. 94	1, 727, 088	24, 815, 667	14. 37	−9	+3
Sanded	177, 679	3, 331, 533	18. 75	300, 603	6, 416, 673	21. 35	+69	+14
To mixing plants	11, 703	126, 243	10. 79	11, 570	127, 185	10. 99	−1	+2
Gaging and molding	176, 957	2, 943, 304	16. 63	168, 539	2, 842. 686	16. 87	−5	+1
Prepared finishes	16, 000	935, 670	58. 48	12, 096	822, 317	67. 98	−24	+16
Roof-deck	(4)	(4)	(4)	289, 177	4, 084, 194	14. 12		
Other [5]	[6] 208, 147	[6] 3, 924, 516	[6] 18. 85	20, 391	1, 483, 528	72. 75	+49	−5
Keene's cement	52, 591	1, 158, 703	22. 03	51, 475	1, 193, 135	23. 18	−2	+5
Total cementitious	[6] 2, 550, 948	[6] 39, 016, 056	[6] 15. 29	2, 580, 939	41, 785, 385	16. 19	+1	+6
Prefabricated:								
Lath	1, 757, 771	54, 402, 346	[7] 23. 48	1, 864, 983	58, 396, 664	[7] 23. 96	[8] +5	+2
Wallboard [9]	2, 964, 381	108, 974, 618	[10] 32. 88	3, 223, 708	121, 630, 254	[10] 33. 66	[8] +9	+2
Sheathing board	123, 310	4, 281, 772	[7] 36. 57	126, 876	4, 366, 801	[7] 36. 52	[8] +2	------
Tile	157, 451	3, 632, 397	[11] 78. 54	153, 617	3, 769, 157	[11] 84. 20	[8] −1	+7
Total prefabricated	5, 002, 913	171, 291, 133	34. 24	5, 369, 184	188, 162, 876	35. 04	[8] +7	+2
Total building uses	-----------	[6] 210, 307, 189	--------	-----------	229, 948, 261	--------	-------	------
Grand total value	-----------	[6] 224, 923, 748	--------	-----------	245, 053, 466	--------	-------	------

[1] Includes uncalcined gypsum sold for use as filler and rock dust, in brewer's fixe, in color manufacture, and for unspecified uses.
[2] Included with "Other industrial uses."
[3] Includes industrial molding, art, and casting plasters (1952), dead-burned filler, granite polishing, and miscellaneous uses.
[4] Included with "Other plasters."
[5] Includes roof-deck and insulating (1952), joint filler, patching and painter's plaster, and unclassified building plasters.
[6] Revised figure.
[7] Average value per thousand square feet.
[8] Percent of change in square footage.
[9] Includes laminated board and formboard.
[10] Average value per thousand square feet of wallboard only.
[11] Average value per thousand square feet of partition tile only.

TABLE 6.—Gypsum board and tile sold or used in the United States, 1944–48 (average) and 1949–53, by types

Year	Lath			Wallboard[1]		
	Thousand square feet	Value		Thousand square feet	Value	
		Total	Average[2]		Total	Average[3]
1944–48 (average)	1, 316, 178	$24, 095, 091	$18. 31	1, 856, 295	$46, 821, 344	$24. 99
1949	2, 015, 638	43, 060, 474	21. 36	2, 439, 121	68, 493, 078	28. 03
1950	2, 793, 620	60, 621, 179	21. 70	2, 901, 947	84, 693, 753	29. 16
1951	2, 756, 278	64, 551, 960	23. 42	3, 243, 676	105, 128, 204	32. 39
1952	2, 317, 191	54, 402, 346	23. 48	3, 312, 543	108, 974, 618	32. 88
1953	2, 437, 481	58, 396, 664	23. 96	3, 606, 868	121, 630, 254	33. 66

Year	Sheathing			Tile[4]		
	Thousand square feet	Value		Thousand square feet	Value	
		Total	Average[2]		Total	Average[5]
1944–48 (average)	105, 672	$2, 918, 431	$27. 62	21, 174	$2, 186, 601	$59. 23
1949	97, 037	3, 267, 935	33. 68	28, 518	3, 286, 264	73. 17
1950	113, 785	3, 850, 763	33. 84	45, 032	4, 992, 467	75. 26
1951	116, 204	4, 240, 084	36. 49	37, 862	4, 715, 009	77. 79
1952	117, 080	4, 281, 772	36. 57	27, 044	3, 632, 397	78. 54
1953	119, 560	4, 366, 801	36. 52	26, 649	3, 769, 157	84. 20

[1] Includes laminated board, in component board footage, and formboard.
[2] Per thousand square feet, f. o. b. producing plant.
[3] Average value per thousand square feet of wallboard, f. o. b. producing plant.
[4] Includes partition, roof, floor, soffit, shoe, and all other gypsum tiles and planks.
[5] Per thousand square feet, f. o. b. producing plant, of partition tile only.

TABLE 7.—Gypsum lath and wallboard sold or used in the United States in 1953, by thicknesses

	Thousand square feet	Short tons	Value	
			Total	Average[1]
Lath:				
⅜ inch[2]	2, 416, 675	1, 843, 409	$57, 771, 746	$23. 91
½ inch	20, 806	21, 574	624, 918	30. 04
Total	2, 437, 481	1, 864, 983	58, 396, 664	23. 96
Wallboard:				
¼ inch	102, 534	59, 487	2, 834, 189	27. 64
⅜ inch[3]	1, 941, 427	1, 528, 220	62, 049, 294	31. 96
½ inch	1, 478, 651	1, 533, 034	53, 045, 666	35. 87
⅝ inch	41, 815	57, 452	2, 037, 875	48. 74
Total	3, 564, 427	3, 178, 193	119, 967, 024	33. 66

[1] Per thousand square feet, f. o. b. producing plant.
[2] Includes a small amount of ¼-inch lath.
[3] Includes a small amount of 5/16-inch wallboard.

STOCKS

Producers reported stocks of crude gypsum totaling 1,529,000 short tons on hand December 31, 1953, compared with 1,689,000 tons on the same date of the preceding year and 1,547,000 tons at the end of 1951.

PRICES

According to reports from producers, the average value of crude gypsum mined was $2.79 per short ton compared with $2.72 in 1952 and $2.77 in 1951. The values of nearly all gypsum products were higher in 1953 than in 1952. The highest percentage increases in average value were those of prepared finishes and sanded plaster, up 16 and 14 percent, respectively. Other marked increases were noted in the average values of the miscellaneous industrial plasters (including molding, art, and casting plasters), orthopedic and dental plasters, and tile. Lath and wallboard each increased 2 percent in average value, while base-coat plaster was up 3 percent.

FOREIGN TRADE[7]

Imports of crude gypsum into the United States in 1953 increased to 3,184,000 short tons—3 percent more than in 1952. Canada supplied 89 percent of the total quantity imported, or about one-fourth of the apparent United States supply. Imports of crude gypsum from all other countries that supply this mineral to the United States increased. Over five times as much crude gypsum was imported from the Dominican Republic in 1953 as in 1952. Increases of imports of crude gypsum from Jamaica and Mexico were 62 and 16 percent, respectively.

The value of prefabricated gypsum products exported from the United States in 1953 more than doubled the 1952 figure, although it was less than the value of exports of those products in 1949.

TABLE 8.—Gypsum and gypsum products imported for consumption in the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Year	Crude (including anhydrite)		Ground		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	Short tons	Value			
1944–48 (average)	1,464,924	$1,554,665	368	$9,201	108	$3,237	36	$912	$81,791	$32,547	$1,682,353
1949	2,593,329	2,693,824	613	14,209	209	8,036	------	-------	55,569	79,651	2,851,289
1950	3,219,299	3,276,707	716	15,787	237	7,900	1	173	61,444	222,141	3,584,152
1951	3,436,927	3,535,747	576	16,929	301	12,308	3	441	97,858	150,609	3,813,892
1952	[2]3,087,884	3,246,143	605	20,821	249	11,379	3	193	189,478	226,961	3,694,975
1953	3,184,292	4,288,589	598	18,685	290	12,423	(3)	2	181,421	291,071	4,792,191

[1] Includes imports of jet manufactures, which are believed to be negligible.
[2] Revised figure.
[3] Less than 1 ton.

TECHNOLOGY

The Oklahoma Highway Commission was conducting field checks and laboratory tests on a 3-mile section of road in which anhydrite was used. According to the reports, the road had been in satisfactory use for 5 years.[8] For many years gypsum companies have been seeking

[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.
[8] Rock Products, Gypsum Roads?: Vol. 56, No. 7, July 1953, p. 94.

TABLE 9.—Crude gypsum (including anhydrite) imported for consumption in the United States, 1951–53, by countries

[U. S. Department of Commerce]

Country	1951		1952		1953	
	Short tons	Value	Short tons	Value	Short tons	Value
Canada	3,094,070	$3,162,601	[1] 2,806,799	$2,917,999	2,832,077	$3,914,879
China	1	160				
Dominican Republic	6,685	23,874	2,240	8,000	11,672	31,384
Jamaica	22,563	65,471	35,784	102,963	58,099	87,427
Mexico	313,608	283,641	243,061	217,181	282,444	254,899
Total	3,436,927	3,535,747	[1] 3,087,884	3,246,143	3,184,292	4,288,589

[1] Revised figure.

TABLE 10.—Gypsum and gypsum products exported from the United States, 1944–48 (average) and 1949–53

[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		
1944–48 (average)	16,030	$346,918	17,480,368	$575,348	$272,637	$1,194,903
1949	17,567	423,478	53,313,138	1,336,269	176,401	1,936,148
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

[1] Effective Jan. 1, 1949, calcined gypsum not separable from crude, crushed, or calcined.

a large-tonnage use for the anhydrite produced in gypsum-mining operations, and the industry may be expected to watch with considerable interest the outcome of this investigation.

A new and economical method of applying gypsum to the soil to counteract alkaline conditions is said to be practiced in west Texas. Rock gypsum is dumped into irrigation water, which dissolves it and carries it to the fields.[9]

A patent was issued on a special cement designed for wallboard joints and surfaces and consisting of deadburned gypsum, dextrin, clay, mica, asbestos, and portland cement.[10]

It is reported that an improved wet process for calcining gypsum imparts increased strength and density to the finished product by reducing the quantity of water used to produce a mortar. Gypsum is heated in an aqueous solution of a metallic salt—preferably calcium chloride—vapor-pressure depressant. When the gypsum is converted to hemihydrate the product is washed in boiling water, dried in a 212°–350° F. temperature range, and ground to desired fineness.[11]

A British firm was reported to be planning the erection of a full-scale retort for the production of sulfur and sulfur dioxide from the large deposits of anhydrite in the Billingham area. Although the sulfur

[9] Rock Products (news item), vol. 56, No. 7, July 1953, p. 33.
[10] Riddell, W. C., and Kirk, G. B. (assigned to Kaiser Gypsum Co., Oakland, Calif.), Cementitious Compositions: U. S. Patent 2,662,024, Dec. 8, 1953.
[11] Chemical Engineering, Stronger Gypsum Plaster: Vol. 60, No. 4, April 1953, pp. 380, 382.

shortage had ended, the company considered it desirable from a long-range standpoint to take steps toward increasing the utilization of anhydrite as an alternate to imported Frasch sulfur.[12]

A report was published on the setting of gypsum plaster.[13] The report described some of the theories and earlier work by investigators in this field. Experimental evidence derived from this investigation corroborated the work of those in the past who pointed to a colloidal mechanism involved in the initial set rather than the formation and intergrowth of a crystalline hydration product. The latter mechanism was said to be the principal cause of final set or hardness of the system.

Investigations by the California Division of Mines show that celestite and gypsum are usually associated in bedded lacustrine deposits in southern California.[14]

Thermodynamic calculations show that gypsum is converted to anhydrite plus water below 14° C. in the presence of a saturated salt solution. Anhydrite will be precipitated from a concentrated solution of sea water above 34° C., while gypsum will begin to precipitate at temperatures below 34°. Factors said to govern the depth to which gypsum will be found in nature include temperature gradient, composition of ground waters, and ratio of lithostatic to hydrostatic pressure acting on the deposit.[15]

An article published in Japan described the preparation of dies for precision casting from gypsum mixed with such refractory materials as sand, silica, tridymite, and particularly cristobalite.[16] The refractory material is said to compensate for the volume changes that take place in gypsum at its dehydration temperature.

Patents issued during the year by the United States Patent Office covered the use of plaster of paris as a base in which television transmitter-tube wires may be embedded in the manufacture of "a photosensitive mosaic target for image orthicons" [17] the use of gypsum for manufacturing ammonium sulfate [18]; and a continuous process for preparing gypsum slurry.[19]

Deposits of gypsiferous rocks northeast of Anchorage, Alaska, were described.[20] The beds are of hydrothermal origin. The 6 largest deposits were mapped, and indicated reserves were estimated at 311,000 tons, with an additional 348,000 tons inferred. The gypsum is mixed with large percentages of other materials, such as quartz, alunite, and clay.

[12] Chemical Week, Next Step; Sulfur From Anhydrite: Vol. 73, No. 22, Nov. 28, 1953, pp. 65–66.

[13] Fischer, H. C., The Setting of Gypsum Plaster: ASTM Bull. 192, September 1953, pp. 43–47.

[14] Durrell, C., Geological Investigations of Strontium Deposits in Southern California: California Dept. of Nat. Resources, Div. of Mines, Spec. Rept. 32, 1953, pp. 5–48.

[15] Macdonald, G. J. F., Anhydrite-Gypsum Equilibrium Relations: Am. Jour. Sci., vol. 251, No. 12, December 1953, pp. 884–898.

[16] Ito, S., Teraoka, I., and Yoshihama, S., Gypsum for Precision Casting: Gypsum Lime (Tokyo, Japan), vol. 1, 1953 (English summary), pp. 513–518.

[17] Teal, G. K. (assigned to Bell Telephone Laboratories, Inc., New York, N. Y.), Preparation of Two-Sided Mosaic: U. S. Patent 2,650,191, Aug. 25, 1953.

[18] Ogilvie, R. S. (assigned to Phillips Petroleum Co., Bartlesville, Okla.), Production and Recovery of Ammonium Sulfate: U. S. Patent 2,653,077, Sept. 22, 1953.

[19] Zimmerman, R. F., and Hoge, J. H. (assigned to Hoge, Warren, Zimmerman Co., Cincinnati, Ohio), Process of Continuously Preparing a Gypsum Slurry: U. S. Patent 2,625,381, Jan. 13, 1953.

[20] Eckhardt, R. A., Gypsiferous Deposits on Sheep Mountain, Alaska: Geol. Survey Bull. 989–C, 1953, pp. 39–60.

TABLE 11.—World production of gypsum, by countries[1], 1944-48 (average) and 1949-53 in metric tons[2]

[Compiled by Helen L. Hunt]

Country[1]	1944-48 (average)	1949	1950	1951	1952	1953
North America:						
Canada	1,721,131	2,854,999	3,429,332	3,563,745	3,224,042	3,481,115
Cuba[3]	13,000	13,880	15,500	30,000	30,000	30,000
Dominican Republic	7,415	18,157	----------	21,238	12,863	18,589
Jamaica	[4] 7,112	12,193	23,369	27,173	45,621	75,282
United States	4,838,010	5,994,752	7,432,186	7,861,199	7,634,192	7,523,131
South America:						
Argentina	[3] 107,000	(5)	(5)	(5)	(5)	(5)
Brazil	[3] 50,000	50,857	[3] 51,000	----------	----------	----------
Chile	58,720	60,304	65,509	68,938	[3] 70,000	70,000
Colombia	[3] 6,700	2,120	3,771	4,886	4,885	8,500
Ecuador	[4] 410	486	434	138	39	----------
Peru	43,471	37,419	31,917	30,890	31,896	28,355
Venezuela[6]	2,066	3,042	2,050	1,404	152	(5)
Europe:						
Austria	14,297	36,189	42,300	[7] 119,365	[7] 187,540	[7] 229,946
Bulgaria[3]	5,000	5,000	5,000	5,000	5,000	5,000
Finland	[3] 1,900	(5)	(5)	----------	----------	----------
France	1,531,240	2,143,157	1,991,009	2,016,859	[3] 2,000,000	[3] 2,000,000
Germany, West[8]	166,220	594,400	733,711	814,945	529,111	623,961
Greece	1,316	730	820	17,949	19,000	(5)
Ireland	36,359	67,268	82,668	86,391	74,646	(5)
Italy	238,115	447,647	488,794	578,205	[3] 600,000	600,000
Luxembourg	17,546	19,569	17,846	12,320	5,072	9,452
Poland	9,777	26,361	32,824	(5)	(5)	(5)
Portugal	29,042	43,060	36,034	29,993	39,613	46,371
Spain	1,230,570	1,293,552	2,251,831	1,821,676	1,596,032	1,046,584
Sweden	92	----------	----------	----------	----------	----------
Switzerland	108,200	[3] 80,000	[3] 80,000	120,000	(5)	125,000
United Kingdom:						
Great Britain	1,660,373	2,144,272	2,241,711	2,321,065	2,433,135	[3] 2,600,000
Northern Ireland	14	----------	----------	173	----------	----------
Yugoslavia	[3] 8,000	(5)	(5)	15,749	17,362	44,487
Asia:						
Ceylon	66	187	----------	417	686	(5)
China[3]	45,000	(5)	60,000	70,000	80,000	100,000
Cyprus (exports)	9,782	25,788	65,485	23,171	56,553	105,286
India	68,303	142,190	209,678	206,880	417,307	[3] 567,000
Iran	[3] [9] 120,000	[3] [10] 378,000	[3] [10] 378,000	[3] 120,000	120,000	[3] 130,000
Iraq[3]	140,000	250,000	250,000	250,000	250,000	250,000
Israel	[3] 13,000	[3] 12,000	23,623	[3] 20,000	[3] 25,000	[3] 23,000
Japan	86,465	117,123	114,505	200,640	200,645	271,101
Pakistan	[3] 13,500	15,896	16,927	22,791	29,663	32,717
Philippines	164	2,710	2,883	399	----------	----------
Syria[11]	[3] 1,500	1,400	2,000	8,170	5,500	750
Taiwan (Formosa)	[9] 2,306	2,939	1,968	2,055	1,800	1,910
Thailand (Siam)	118	154	336	79	----------	----------
Africa:						
Algeria	27,915	31,881	46,097	82,000	53,200	90,600
Anglo-Egyptian Sudan	1,713	1,496	----------	183	1,451	(5)
Angola	[12] 300	[12] 2,504	[12] 1,952	[12] 3,047	[12] 3,650	5,550
Belgian Congo	----------	----------	[3] 7,190	3,955	3,955	6,545
Egypt	89,752	6,909	155,902	112,056	141,854	186,000
French Morocco	16,259	36,130	620	7,695	7,955	14,370
Kenya	529	181	610	83	1,619	855
Tanganyika	----------	----------	----------	----------	503	1,727
Tunisia	12,429	22,066	23,064	24,385	23,369	22,800
Union of South Africa (sales and exports)	70,768	88,232	103,707	124,979	148,911	152,449
Oceania:						
Australia	171,398	315,302	340,869	370,195	356,946	332,456
New Caledonia	6,991	17,119	15,200	15,777	5,181	----------
Total (estimate)[1]	14,060,000	19,000,000	22,700,000	24,700,000	24,300,000	24,500,000

[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] Estimate.
[4] Average for 1 year only, as 1948 was first year of production.
[5] Data not available; estimate by senior author of chapter included in total.
[6] Production in Government quarries only; beginning in 1951 no longer under Government control.
[7] Includes anhydrite.
[8] Crude production estimates for 1949-51 based on calcined figures.
[9] Average for 1946-48.
[10] Year ended March 20 of year following that stated.
[11] Some pure, some 80 percent gypsum and 20 percent limestone.
[12] Exports.

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WORLD REVIEW

Australia.—Gypsum deposits and processing practices in Australia were described.[21] Reserves are estimated at 800 million tons.

Belgian Congo.—The only production of gypsum in Belgian Congo was reported to have been from the Kapiri mine. The material was used as cement retarder at the Lubudi cement plant. The CICO cement plant in Bas Congo apparently imported its gypsum requirements.[22]

Canada.—Recent exploration activities in the gypsum-producing areas of Nova Scotia were reported to indicate future developments of interest in that industry. Approximately 80 percent of the output of gypsum in Canada is produced in Nova Scotia.[23]

National Gypsum Co. was reported to be developing a large gypsum deposit 30 miles northwest of Halifax. It is believed that the present gypsum quarries operated by the company near Dingwall will be closed when the new deposit can be fully exploited.[24]

The subsidiary of a major United States producer of gypsum announced plans for constructing a gypsum-products plant in Montreal. The same company was said to have underway at its Guelph, Ontario, plant an expansion program designed to increase production 40 percent.[25]

The Government-built gypsum products plant at Humbermouth, Newfoundland, was operated by a Crown corporation, although the Provincial Government contemplated its sale to private industry. The plant manufactures plaster, lath, and wallboard.[26]

Columbia Gypsum Products, Ltd., is reported to control three commercial gypsum deposits in the Stanford Range of the Rocky Mountains, British Columbia. The company is now quarrying a deposit near Windermere, B. C., from which it has taken 130,000 tons of crude gypsum since beginning operations in midsummer 1950.[27]

Cyprus.—The Gypsum & Plasterboard Co., Ltd., a subsidiary of Hellenic Mining Co., Ltd., completed erection of a modern plaster and plasterboard plant at Vasiliko. Appreciable quantities of gypsum products were consumed locally, and more was exported.[28]

Dominican Republic.—Several United States gypsum companies have expressed interest in importing crude gypsum from the extensive beds under development 25 miles west of Barahona, and some negotiations have taken place. Most offers so far have been made on a

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[21] Willington, C. M., Gypsum Resources of South Australia: South Australia Dept. Min., Min. Review (Adelaide), No. 92, 1950 (pub. 1953), pp. 167–192.
King, D., Lake Fowler Gypsum Deposit: South Australia Dept. Min., Min. Review (Adelaide), No. 92, 1950 (pub. 1953), pp. 60-67.
Johns, R. K., Gypsum Deposits at Rotten Lake in the Renmark District: South Australia Dept. Min., Min. Review (Adelaide), No. 94, 1951 (pub. 1953), pp. 52–57.
Jackson, N., The Manufacture of Plaster of Paris From Cooke Plains Gypsum: South Australia Dept. Min., Min. Review (Adelaide), No. 94, 1951 (pub. 1953), pp. 174–175. Manufacture of Plaster of Paris From Seed Gypsum Using a Rotary Kiln: South Australia Dept. Min., Min. Review (Adelaide), No. 94, 1951 (pub. 1953), pp. 175–180.
Solomon, M., Gypsum Deposits Near Port Broughton and Tichera: South Australia Dept. Min., Min. Review (Adelaide), No. 95, 1951 (pub. 1953), pp. 93–95.

[22] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 5, November 1953, p. 63.

[23] Canadian Mining and Metallurgical Bulletin (Montreal), Gypsum: No. 498, October 1953, p. 662.

[24] Pit and Quarry, New Gypsum Rock Deposit to Be Developed by National: Vol. 46, No. 6, December 1953, p. 117.

[25] Rock Products, Canadian Gypsum Plant: Vol. 56, No. 7, July 1953, p. 49.

[26] Pit and Quarry, 2 Plants in Newfoundland Launched by Government for Private Operation: Vol. 45, No. 9, March 1953, p. 93.

[27] Cummings, J. M., The Windermere Gypsum Deposit: Western Miner and Oil Review (Vancouver), vol. 26, No. 11, November 1953, pp. 80–81.

[28] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 4, October 1953, pp. 59–60.

dockside-purchase basis. It is claimed that the Barahona gypsum is of high quality.[29]

Hungary.—A large deposit of gypsum reportedly has been found in northern Hungary near Rudabanya, 20 miles north of Miskolc. This discovery is said to be of great interest to the cement industry of Hungary, which has been forced to import its requirements of portland-cement retarder from East Germany and Rumania.[30]

India.—Production and consumption of gypsum in India were at record highs in 1953, as the State-owned ammonium sulfate plant at Sindri, Bihar, reached near-capacity operation. It was estimated that production of gypsum in 1953 exceeded 558,000 long tons compared with 411,000 in 1952 and 204,000 in 1951. The bulk of India's gypsum output was used in manufacturing ammonium sulfate fertilizer and as portland-cement retarder. Other uses were as a conditioner for barren alkali land, in pottery and paints, for building construction, and miscellaneous.[31]

The Geological Survey of India announced that its investigations indicated an additional 10 million tons of gypsum reserves in Rajasthan bringing that State's estimated reserves to approximately 65 million tons. The Survey's systematic exploration of all known gypsum deposits, begun in 1947, is still in progress.[32]

[29] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 3, March 1953, pp. 33-34.
[30] Engineering and Mining Journal (news item), vol. 154, No. 10, October 1953, p. 204.
[31] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 1, January 1954, pp. 40–42.
[32] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 4, October 1953, p. 60.

Iodine

By Joseph C. Arundale [1] and Flora B. Mentch [2]

IODINE has been recovered from such diverse sources as seaweed, iodine minerals associated with nitrate deposits, and waste oil-well brines. It is one of the most versatile of mineral commodities; it has been a major factor in the advance of chemical science, is essential in human and animal nutrition and medication, and is an important raw material and tool of industry.

DOMESTIC PRODUCTION

During World War I iodine was recovered from seaweed on the Pacific coast. Production of iodine from brines was started in 1928, when the Jones Chemical Co., a subsidiary of Dow Chemical Co., began commercial output from brines in Louisiana. By 1930 General Salt Co., Dow Chemical Co., and Deepwater Chemical Co. were producing substantial quantities of iodine from California brines. General Salt Co. discontinued its iodine operations a few years later. In 1932 the Jones Chemical Co. was producing in California; the following year the name of the firm was changed to Io-Dow Chemical Co., and its Louisiana operation was abandoned. Dow Chemical Co. took over the business of this subsidiary in 1939.

Iodine was produced in the United States in 1953 only in California. Dow Chemical Co. at Seal Beach and Deepwater Chemical Co. at Compton recover iodine from waste oil-well waters. Because of the small number of producers, the Bureau of Mines is not at liberty to publish statistics on domestic production. A substantial portion of requirements is supplied by domestic output.

CONSUMPTION AND USES

The crude iodine of commerce usually contains over 99 percent iodine. However, little is consumed in this form; most is either resublimed to greater purity or converted to one or more of the various iodine compounds. Potassium iodide is the principal compound produced; but hundreds of other inorganic and organic compounds are made, and these have numerous and varied uses in industry, agriculture, and medicine.

Probably the most widely known use of iodine is as antiseptic tincture of iodine. However, it is used in salt to prevent human goiter and in stock feeds and supplements to prevent various diseases and ailments. Several hundred (a partial list) iodine pharmaceuticals and

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[2] Statistical assistant.

TABLE 1.—Crude iodine consumed in the United States in 1952–53

Compound manufactured	1952			1953		
	Number of plants	Crude iodine consumed		Number of plants	Crude iodine consumed	
		Pounds	Percent of total		Pounds	Percent of total
Resublimed iodine	5	78,222	7	6	149,405	13
Potassium iodide	10	768,554	65	10	796,953	68
Sodium iodide	6	64,332	5	6	55,791	5
Other inorganic compounds	8	29,785	3	8	37,012	3
Organic compounds	13	232,981	20	14	131,261	11
Total	[1] 25	1,173,874	100	[1] 25	1,170,422	100

[1] A plant producing over 1 product is counted but once in arriving at total.

their therapeutic applications have been described in a bulletin issued by the Chilean Iodine Educational Bureau, Stone House, Bishopsgate, London (with offices at 120 Broadway, New York, N. Y.).[3]

PRICES

According to Oil, Paint and Drug Reporter the price of crude iodine was cut substantially in June 1953. Prices of iodine and iodine compounds were quoted as follows: Crude iodine, in kegs, $1.84 to $2.04 per pound from January through May, and $1.30 per pound the remainder of the year; resublimed iodine, U. S. P., bottles, drums, at $2.55 to $2.78 for January through March, $2.80 to $2.82 from May through August, and $2.55 for September through December; potassium iodide, drums, at $2.15 to $2.20 per pound from January through March, $2.40 to $2.42 from April through August, and $2.15 per pound for September through December; sodium iodide, U. S. P., bottles, drums, at $2.69 per pound for January through March and $2.80 to $2.92 from April through December; ammonium iodide, N. F., jars, was quoted at $4.01 to $4.13 per pound from January through March and $4.26 to $4.38 for April through December.

FOREIGN TRADE[4]

Crude iodine is imported into the United States from Chile and Japan.

TABLE 2.—Crude iodine imported for consumption in the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Year	Pounds	Value	Year	Pounds	Value
1944–48 (average)	1,032,810	$1,226,835	1951	852,107	$1,320,328
1949	489,999	719,758	1952	791,208	1,362,909
1950	724,858	1,055,946	1953	957,638	1,606,024

[3] Chilean Iodine Educational Bureau, Iodine Pharmaceuticals: London, 1952, 78 pp.
[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.—Iodine, iodide, and iodates exported from the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Year	Pounds	Value	Year	Pounds	Value
1944–48 (average)	342,890	$587,886	1951	320,165	$612,556
1949	268,925	501,055	1952	120,789	264,952
1950	456,847	784,578	1953	274,690	452,387

TECHNOLOGY

Iodine has been used successfully to trace the movement of oil-field flood water. In applying this method an iodine compound was introduced into the injection water and, by chemical analysis of the waters of producing wells, the researchers were able to trace the progress of the flood front.[5]

Studies were made on the germicidal efficiency of iodine as an emergency disinfectant for drinking water. It was reported that iodine would destroy all types of disease-causing organisms. Several advantages over chlorinous disinfectants were claimed.[6]

Numerous iodine-containing compositions were tested to find the most suitable emergency field-water disinfectant. Tablets of the following composition were found to satisfy most of the requirements for such a disinfectant: 20 mg. of tetraglycine hydroperiodide, 90 mg. of disodium dihydrogen pyrophosphate, and 5 mg. of talc. These tablets are said to dissolve in less than 1 minute at room temperature and liberate about 8 mg. of elemental iodine per tablet. This will treat 1 liter of most natural waters in 10 minutes to produce a safe and palatable drinking water.[7]

The operation of the potassium iodide plant of Dow Chemical Co. at Seal Beach, Calif., was described in an article.[8] In this plant elemental iodine is reacted with caustic potash in an old-fashioned cast-iron bathtub. Water is driven off in an evaporator, and the mixed potassiom iodide and iodate crystals are heated to 600° C. until the mass is fused, thereby converting all the material to the iodide. These crystals then are dissolved in steam condensate. Barium iodide is used to remove sulfates. The solution is neutralized and heavy metal salts are precipitated with hydrogen sulfide. After filtration the potassium iodide solution is boiled to produce a saturated solution of the iodide. After cooling, the mother liquor is removed under vacuum and the potassium iodide recovered.

Comprehensive bibliographies on the research being conducted on iodine and other aspects of the subject are contained in the bulletin, Iodine Abstracts and Reviews, published preiodically by Chilean Iodine Educational Bureau, Inc., 120 Broadway, New York, N. Y.

[5] Oil and Gas Journal, New Flood Tracers: Vol. 52, No. 25, Oct. 26, 1953, p. 60.
[6] Chang, Shih Lu, and Morris, J. Carrell, Elemental Iodine as a Disinfectant for Drinking Water: Ind. and Eng. Chem., vol. 45, No. 5, May 1953, pp. 1009–1012.
[7] Morris, J. Carrell, Chang, Shih Lu, Fair, Gordon M., and Conant, G. H. Jr., Disinfection of Drinking Water Under Field Conditions: Ind. and Eng. Chem., vol. 45, No. 5, May 1953, pp. 1013–1015.
[8] Chemical Week, Two Men and a Tub: Vol. 73, No. 23, December 5, 1953, pp. 77–78, 80, 83.

WORLD REVIEW

Canada.—Imports of crude iodine into Canada during 1953 totaled 114,700 pounds valued at C$186,485, of which 10,073 pounds came from Chile and 104,593 pounds came from the United States.[9]

Indonesia.—The only active producer of iodine in Indonesia is the N. V. Semarangsche Administratie Maatschappy, of Djalan Purwodinatan Tengah 10/12, Semarang, which operates the N. V. Jodium Onderneming Watudakon with a concession near Modjokerto, East Java. In July 1953 this firm had 8 operating wells and produced 18,244 cubic meters of iodine-bearing brine. This was refined into 1,117 kg. of cuprous iodide; stocks at the end of July were 8,174 kg. This firm makes potassium iodide, sodium iodide, ammonium iodide, iodoform, and resublimed iodine.

A review of the iodine industry in Indonesia may be found in The Geology of Indonesia (vol. II, Economic Geology, edited by R. W. von Bemmelen, pp. 185–190, Government Printing Office, The Hague, 1949).

Japan.—The iodine industry in Japan was described in detail in the Iodine chapter of Bureau of Mines Minerals Yearbook, 1952.

United Kingdom.—The Board of Trade announced that, effective December 17, 1953, iodine may be imported from any country without a separate import license.[10]

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[9] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 5, May 1954, p. 41.
[10] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 2, February 1954, p. 58.

Iron Ore

By Jachin M. Forbes [1]

THE YEAR 1953 marked the end of a long period of virtual self-sufficiency in iron ore for the United States, although domestic sources could still supply all requirements if necessary during an emergency occurring within the next few years. The long-term trend of expanding consumption, as well as diminishing domestic reserves of easily obtained high-grade ore, has fostered development of large, new sources in Canada, South America, and Africa. Some of the new sources were supplying iron ore in 1953, and more will contribute to the supply in 1954. Thus 1953 domestic production and shipment of iron ore, which were the largest ever recorded, are likely to stand as the peak levels until treatment of taconite and other low-grade ores has reached economic and technologic maturity.

It should be noted that the availability of new foreign ore provides the time necessary for orderly development of feasible methods for utilizing low-grade domestic ores on an enormous scale.

DOMESTIC PRODUCTION

The steel strike of June–July 1952 undoubtedly continued to influence iron-ore production through the first half of 1953. Demand through June supported near-capacity output of steel, and although the business outlook grew less encouraging, and steel production began to decline at midyear, it was still necessary to build enough stocks of ore in the yards of those furnaces dependent upon Great Lakes transportation to support possible full production through the winter. Thus, production and shipments were high through October and declined abruptly in November as the stocks reached adequate levels.

Crude ore (mine product before any treatment to eliminate waste constituents) increased 22 percent above 1952 and 3 percent above 1951, the previous record-high production. Hematite increased proportionately and was 81 percent of the total compared with 79 percent in 1952. Brown ore dropped from 8 to 6 percent and magnetite less than 1 percent. These percentages of crude ore do not indicate actual production of hematite, limonite, and magnetite; the tonnages given include large quantities of gangue material, which was partly eliminated by treatment to improve the quality of the ore.

[1] Commodity-industry analyst.

TABLE 1.—Salient statistics of iron ore in the United States, 1944–48 (average) and 1949–53

	1944–48 (average)	1949	1950	1951	1952	1953
Iron ore (usable;[1] less than 5 percent Mn):						
Production by districts:						
Lake Superior..gross tons..	74,427,344	68,494,123	79,627,294	93,946,990	77,094,762	95,655,105
Southeastern........do....	7,118,294	7,601,822	7,507,508	8,587,408	7,623,779	7,691,745
Northeastern........do....	3,695,212	3,863,833	4,474,834	5,180,959	4,426,378	5,161,813
Western.............do....	3,717,601	4,441,671	5,860,755	8,181,465	8,030,331	8,868,658
Undistributed (byproduct ore)......gross tons..	527,994	535,998	574,969	[2] 607,850	[2] 742,754	617,448
Total.............do....	89,486,445	84,937,447	98,045,360	116,504,672	97,918,004	117,994,769
Production, by types of product:						
Direct........gross tons..	68,609,522	63,970,016	70,309,322	85,281,923	70,358,493	82,163,882
Concentrates........do....	16,674,778	16,412,639	22,810,818	25,708,840	22,037,106	29,161,642
Sinter..............do....	3,674,151	4,018,794	4,350,251	4,945,278	4,918,264	6,051,797
Byproduct material (pyrites cinder and sinter) gross tons..	527,994	535,998	574,969	568,631	604,141	617,448
Total.............do....	89,486,445	84,937,447	98,045,360	116,504,672	97,918,004	117,994,769
Production, by types of ore:						
Hematite.....gross tons..	81,794,267	76,262,577	87,156,235	101,530,954	83,515,561	102,553,404
Brown ore...........do....	1,245,076	1,545,595	2,615,402	3,014,761	2,729,524	2,238,236
Magnetite...........do....	5,918,737	6,593,277	7,698,754	11,390,326	11,068,778	12,585,681
Byproduct material (pyrites cinder and sinter) gross tons..	527,994	535,998	574,969	568,631	604,141	617,448
Total.............do....	[3] 89,486,445	84,937,447	98,045,360	116,504,672	97,918,004	117,994,769
Shipments...........do....	89,499,830	84,687,275	97,764,410	116,230,052	97,972,584	117,821,981
Value....................	$286,195,731	$381,515,831	$487,990,404	$634,728,583	$596,306,850	$796,732,998
Average value per ton at mine..................	$3.18	$4.50	$4.99	$5.46	$6.09	$6.76
Stocks at mines Dec. 31 gross tons..	5,245,755	5,333,660	5,725,569	5,599,466	5,528,295	5,706,430
Imports.............do....	3,075,273	7,391,291	8,281,237	10,139,678	9,760,625	11,074,035
Value....................	$13,152,761	$36,707,534	$43,968,426	$59,520,046	[4] $82,854,506	$96,811,527
Exports..........gross tons..	2,323,837	2,424,775	2,550,738	4,328,910	[4] 5,122,644	4,251,364
Value....................	$8,620,328	$14,653,817	$15,716,509	$30,996,784	[4] $37,403,973	$32,410,237
Consumption..gross tons..	90,977,980	89,218,498	106,610,273	114,837,112	100,640,636	122,124,661
Manganese-bearing ore (5 to 35 percent Mn):						
Shipments......gross tons..	1,195,636	962,853	971,069	1,092,825	900,909	974,546
Value....................	$3,686,194	$4,040,155	$4,609,432	$5,385,986	[4] $5,116,985	$6,946,862

[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 371 tons of carbonate ore (siderite).
[4] Revised figure.

Open-pit mines produced 79 percent of the crude ore, with the remaining 21 percent from underground operations. Distribution of the crude ore indicated that ore for concentration was 48 percent of the total, and 52 percent went direct to consumers. The pronounced trend toward increasing beneficiation continued and will soon equal half of the total.

The number of States producing iron ore in 1953 increased to 21 from 18 in 1952. Colorado, Montana, and South Dakota reported small tonnages that were used in making cement and paint; Puerto Rico ceased production in 1952. Minnesota continued as the leading State, with 104,343,000 long tons or 67 percent of all domestic crude-iron-ore output. Michigan was second with 9 percent and Alabama third with 7 percent. New York produced 6 percent; Utah 3 percent; Texas 2 percent; and California, New Jersey, Pennsylvania, and Wisconsin slightly over 1 percent each. Eleven other States together produced 2 percent of the total. Tables 2, 3, and 4 show crude-ore production and shipments by States, type of ore, open-pit or underground methods, and distribution direct to consumers and to beneficiation plants.

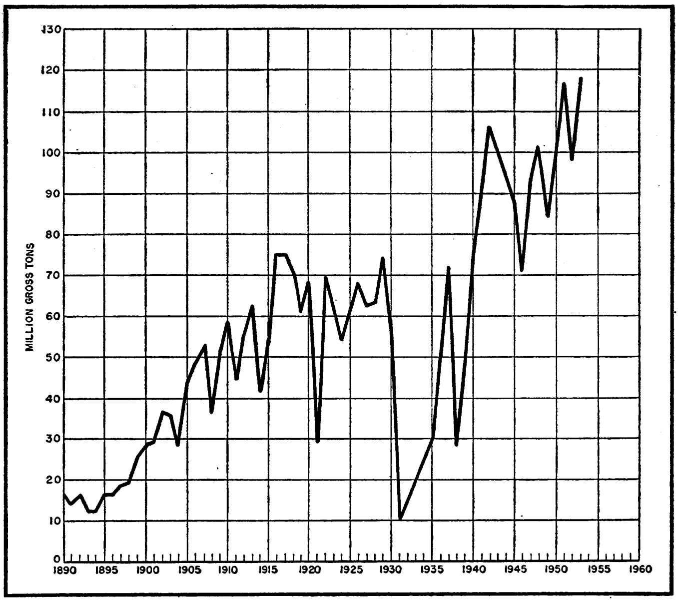

FIGURE 1.—Production of iron ore in the United States, 1890–1953.

TABLE 2.—Crude iron ore mined in the United States, 1952–53, 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
1952						
Alabama	[1] 40	6,273,538	4,970,934		11,244,472	3
Arkansas	1			600	600	18
California	3			[2] 1,516,373	1,516,373	9
Georgia	[1] 13	200	1,687,332		1,687,532	7
Michigan	41	11,994,915			11,994,915	2
Minnesota	171	80,163,188	677,171	602,394	81,442,753	1
Missouri	[1] 5	580,648	177,700		758,348	13
Nevada	12	169,332		742,752	912,084	12
New Jersey	5			1,318,599	1,318,599	11
New Mexico	5			7,793	7,793	17
New York	6	(3)		[3] 7,267,202	7,267,202	4
Pennsylvania	1			1,596,191	1,596,191	8
Tennessee	3	47	[4] 46,197		[4] 46,244	16
Texas	4		2,417,864		2,417,864	6
Utah	6			[2] 4,060,003	4,060,003	5
Virginia	1		(4)		(4)	
Wisconsin	2	1,495,109			1,495,109	10
Wyoming	1	484,945			484,945	14
Puerto Rico	1			138,613	138,613	15
Total	321	[3] 101,161,922	9,977,198	[3] 17,250,520	128,389,640	
Percent of total		78.8	7.8	13.4	100.0	
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
Puerto Rico						
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	

[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.

Usable ore (from mines and beneficiating plants) production and shipments during 1953 were only slightly (1 percent each) above the 1951 totals but established new record highs. However, comparison with 1952 indicated increases of 21 and 20 percent, respectively. Hematite constituted 87 percent of the total compared with 85 percent in 1952 and 87 percent in 1951. Magnetite was 11 percent and brown ore 2 percent in 1953. Byproduct ore (obtained as a residue of burned pyrites) remained less than 1 percent. As with crude ore, it should be noted that the tonnages shown in table 7 under "Types of ore" include not only some gangue minerals but also other iron minerals, inasmuch as production from individual deposits is reported as the predominant type of ore. All iron deposits include more than one mineral of iron, owing to alteration by weathering or other influences.

Direct-shipping grades declined from 72 percent of total usable production in 1952 to 70 percent in 1953. Beneficiated ore, including byproduct cinder and sinter, other sinter produced at mines, and concentrates not further treated, totaled 35,831,000 tons to account for the remaining 30 percent. Sinter and concentrates totaling 35,213,000 tons were derived from 74,430,000 tons of crude ore, a concentration ratio of 2.11 compared with similar ratios of 2.15 in 1952 and 2.19 in 1951.

The Lake Superior district supplied 81 percent of all usable ore (excluding byproduct ore) in 1953 and regained the proportionate level of 1950 and 1951 after dropping back to 79 percent in 1952 as a result of the steel strikes. Southeastern States again lagged behind Western States; the percentages were 7 and 8, respectively. Northeastern States produced 4 percent.

Minnesota furnished 68 percent of all usable ore, slightly more than its percentage of the crude ore. Michigan, virtually all of whose output is from underground mines, produced almost the same tonnage as in 1951 and supplied 12 percent of the total as in 1952 and 1951. Alabama ranked third, with 6 percent; Utah fourth, 4 percent; New York fifth, 3 percent; and all other States produced less than 2 million tons each. Together, these 16 other States produced 7 percent of the usable ore.

TABLE 3.—Crude iron ore mined in the United States, 1952–53, by States and mining methods, in gross tons

(Exclusive of ore containing 5 percent or more manganese)

State	1952			1953		
	Open pit	Underground	Total	Open pit	Underground	Total
Alabama	5,263,769	5,980,703	11,244,472	3,975,618	6,994,697	10,970,315
Arkansas		600	600		254	254
California	1,516,373		1,516,373	1,627,357		1,627,357
Colorado				900		900
Georgia	1,687,532		1,687,532	937,531		937,531
Michigan	1,038,261	10,956,654	11,994,915	1,977,690	12,348,384	14,326,074
Minnesota	77,789,725	3,653,028	81,442,753	100,417,224	3,925,151	104,342,375
Missouri	389,806	368,542	758,348	223,482	432,641	656,123
Montana				6,709		6,709
Nevada	912,084		912,084	426,753		426,753
New Jersey		1,318,599	1,318,599		1,558,384	1,558,384
New Mexico	7,793		7,793	7,525		7,525
New York	4,375,790	2,891,412	7,267,202	5,436,909	3,254,486	8,691,395
Pennsylvania	564,696	1,031,495	1,596,191	231,406	1,544,118	1,775,524
South Dakota				1,060		1,060
Tennessee	[1] 46,244		[1] 46,244	[1] 70,281		[1] 70,281
Texas	2,417,864		2,417,864	3,963,529		3,963,529
Utah	4,060,003		4,060,003	4,838,983		4,838,983
Virginia	(1)		(1)	(1)		(1)
Wisconsin		1,495,109	1,495,109	45,127	1,711,023	1,756,150
Wyoming		484,945	484,945	51,724	603,373	655,097
Puerto Rico	138,613		138,613			
Total	100,208,553	28,181,087	128,389,640	124,239,808	32,372,511	156,612,319
Percent of total	78.1	21.9	100.0	79.3	20.7	100.0

[1] Small tonnage mined in Virginia included with Tennessee.

TABLE 4.—Crude iron ore shipped from mines in the United States, 1952–53, by States and disposition, in gross tons

(Exclusive of ore containing 5 percent or more manganese)

State	1952			1953		
	Direct to consumers	To beneficiation plants	Total	Direct to consumers	To beneficiation plants	Total
Alabama	5,089,437	6,156,421	11,245,858	4,443,123	6,520,920	10,964,043
Arkansas		600	600	254		254
California	1,463,239		1,463,239	1,697,652		1,697,652
Colorado				900		900
Georgia	38,221	1,649,311	1,687,532	28,982	908,549	937,531
Michigan	11,710,737	253,599	11,964,336	13,134,853	712,539	13,847,392
Minnesota	44,798,372	36,812,301	81,610,673	54,355,738	49,924,037	104,279,775
Missouri		758,348	758,348		656,123	656,123
Montana				6,709		6,709
Nevada	911,657		911,657	444,081		444,081
New Jersey	166,962	1,147,862	1,314,824	177,475	1,370,235	1,547,710
New Mexico	7,793		7,793	7,525		7,525
New York	58,473	7,206,929	7,265,402	85,854	8,606,141	8,691,995
Pennsylvania		1,595,256	1,595,256		1,703,696	1,703,696
South Dakota				1,060		1,060
Tennessee	[1] 6,229	39,900	[1] 46,129	[1] 5,951	64,000	[1] 69,951
Texas		2,417,864	2,417,864		3,963,529	3,963,529
Utah	3,990,505		3,990,505	4,617,288		4,617,288
Virginia	(1)		(1)	(1)		(1)
Wisconsin	1,485,845		1,485,845	1,655,331		1,655,331
Wyoming	484,945		484,945	654,285		654,285
Puerto Rico	138,613		138,613			
Total	70,351,028	58,038,391	128,389,419	81,317,061	74,429,769	155,746,830
Percent of total	54.8	45.2	100.0	52.2	47.8	100.0

[1] Small tonnage mined in Virginia included with Tennessee.

TABLE 5.—Iron ore mined in the United States, 1952–53, by mining districts and varieties, in gross tons

(Exclusive of ore containing 5 percent or more manganese)

Variety of ore	Lake Superior district	Southeastern States	Northeastern States	Western States	Total
1952					
Crude ore:					
Hematite	93,653,212	6,273,785	(1)	1,234,925	[1] 101,161,922
Brown ore	[2] 677,171	6,704,463		2,595,564	9,977,198
Magnetite	602,394		[1] 10,181,992	6,327,521	[1,3] 17,250,520
Total	94,932,777	12,978,248	[1] 10,181,992	10,158,010	[3] 128,389,640
Usable iron ore:					
Hematite	76,441,769	6,186,910	(1)	886,882	[1] 83,515,561
Brown ore	[2] 476,242	1,436,869		816,413	2,729,524
Magnetite	176,751		[1] 4,426,378	6,327,036	[1,3] 11,068,778
Total	77,094,762	7,623,779	[1] 4,426,378	8,030,331	[3] 97,313,863
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

[1] Small tonnage of hematite included with magnetite to avoid disclosure of individual company operations.
[2] Produced in Fillmore County, Minn.; not in the true Lake Superior district.
[3] Total includes 138,613 tons Puerto Rican ore in 1952.

Average iron content of all domestic iron ore was 50.44 percent compared with 50.27 in 1952 and 50.79 in 1951. The Minnesota average increased to 50.31 percent compared with 50.16 percent in 1952.

In table 8 values are shown for those States having over 3 producers and where the output of 1 producer does not predominate. These values are for ore at the mine before transportation costs. Table 9 shows production of crude and usable ore by States and counties, with the number of mines in each county. However, as regards brown ore, the number of mines is more nearly the number of producers, inasmuch as one operator may extract ore from a number of ore banks or pits in the clay formation and report the operation as one mine.

Table 10 gives cumulative production of iron ore from the six ranges of the United States Lake Superior region. The Mesabi range will soon have supplied 2 billion tons of high-grade iron ore, and the region is close to the 3 billion-ton level. These figures illustrate a record of production that the new large sources in Canada and Venezuela will have difficulty in matching. Average analyses of Lake Superior ore, as shown in table 11, indicate slightly higher silica content and lower manganese content, with other constituents about normal for 1953. In addition to the tonnages shown in table 10 for the Lake Superior ranges, 217,760 tons of brown-ore concentrates was mined in Fillmore County, Minn., which is not considered a part of the true Lake Superior district. Manganese-bearing ore containing 5 percent or more manganese and considered by the trade as a special grade of iron ore totaled 1,013,000 tons, and 1,043,000 tons was shipped. Including these tonnages, the Lake Superior district produced 96,668,000 tons and shipped 96,544,000.

Of the 325 active mines in 1953, 43 are listed individually with crude-ore production exceeding 1 million tons each, 8 more than were listed in this group in 1952. Fifteen mines were new in the million-ton list, and 7 mines listed in 1952 either dropped out or lost their identity through combination with other operations. Together, the million-ton mines supplied 60 percent of all crude ore and 61 percent of all usable ore, excluding byproduct ore. Fifty-one mines producing 500,000 to 1,000,000 tons each accounted for 21 and 20 percent, respectively, of crude and usable ore. In the 100,000 to 500,000-ton group, 106 mines furnished 17 percent of both the crude and usable ore. The largest number of mines, 125 with less than 100,000 tons, produced only 2 percent of crude and usable ore.

Among the million-ton mines, 28 were in Minnesota, 4 in New York, 3 each in Alabama and Utah, and 1 each in California, Michigan, Pennsylvania, Texas, and Wisconsin; 34 were open pits, 6 were underground, and 3 combined open-pit and underground operations. Hematite predominated as the ore mineral in 33 of the million-ton mines and magnetite in 9 mines; 1 operation produced mixed limonite-carbonate ore from brown-ore deposits.

TABLE 6.—Iron ore produced in the United States, 1952–53, by States and types of product, in gross tons

(Exclusive of ore containing 5 percent or more manganese)

State	1952					1953				
	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	5,084,612	990,896	1,164,840	7,240,348	37.76	4,451,288	1,092,173	1,918,918	7,462,379	37.97
Arkansas			115	115	52.17	254			254	58.66
California	1,516,373			1,516,373	56.16	1,627,357			1,627,357	53.64
Colorado						900			900	48.50
Georgia	38,221		331,038	369,259	41.53	28,982		181,682	210,664	43.48
Michigan	11,741,316		68,629	11,809,945	51.06	13,613,535		199,806	13,813,341	50.96
Minnesota	44,628,318	781,459	18,379,931	63,789,708	50.16	54,430,622	1,121,052	24,533,940	80,085,614	50.31
Missouri			268,218	268,218	51.57			274,693	274,693	53.59
Montana						6,709			6,709	50.01
Nevada	912,084			912,084	59.44	426,753			426,753	63.11
New Jersey	177,232		529,723	706,955	62.38	236,034		640,134	876,168	61.82
New Mexico	7,793			7,793	56.38	7,525			7,525	56.33
New York	67,645	2,367,693	293,878	2,729,216	62.49	76,682	2,899,888	287,803	3,264,373	62.75
Pennsylvania		641,020	349,187	990,207	58.03		778,561	242,711	1,021,272	57.51
South Dakota						1,060			1,060	38.00
Tennessee	[2] 6,229		7,943	[2] 14,172	41.39	[2] 5,951		12,751	[2] 18,702	34.00
Texas		137,196	643,604	780,800	45.41		160,123	869,204	1,029,327	47.68
Utah	4,060,003			4,060,003	53.97	4,838,983			4,838,983	54.15
Virginia	(2)			(2)		(2)			(2)	
Wisconsin	1,495,109			1,495,109	52.81	1,756,150			1,756,150	53.04
Wyoming	484,945			484,945	48.20	655,097			655,097	49.96
Puerto Rico	138,613			138,613	58.00					
Total mined ore	70,358,493	4,918,264	22,037,106	97,313,863	50.17	82,163,882	6,051,797	29,161,642	117,377,321	50.36
Byproduct ore: [3]										
Delaware, Tennessee, Virginia		604,141		604,141	66.39		617,448		617,448	65.91
Grand total	70,358,493	5,522,405	22,037,106	97,918,004	50.27	82,163,882	6,669,245	29,161,642	117,994,769	50.44

[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, 1952–53, by States and varieties, in gross tons

(Exclusive of ore containing 5 percent or more manganese)

State	1952				1953			
	Hematite	Brown ore	Magnetite	Total	Hematite	Brown ore	Magnetite	Total
Alabama	6,186,663	1,053,685	-----	7,240,348	6,736,109	726,270	-----	7,462,379
Arkansas	-----	-----	115	115	254	-----	-----	254
California	-----	-----	1,516,373	1,516,373	10,000	-----	1,617,357	1,627,357
Colorado	-----	-----	-----	-----	-----	900	-----	900
Georgia	200	369,059	-----	369,259	250	210,414	-----	210,664
Michigan	11,809,945	-----	-----	11,809,945	13,813,341	-----	-----	13,813,341
Minnesota	63,136,715	476,242	176,751	63,789,708	79,341,313	217,760	526,541	80,085,614
Missouri	232,605	35,613	-----	268,218	239,830	34,863	-----	274,693
Montana	-----	-----	-----	-----	-----	-----	6,709	6,709
Nevada	169,332	-----	742,752	912,084	-----	-----	426,753	426,753
New Jersey	-----	-----	706,955	706,955	-----	-----	876,168	876,168
New Mexico	-----	-----	7,793	7,793	-----	-----	7,525	7,525
New York	(1)	-----	[1] 2,729,216	[1] 2,729,216	(1)	-----	[1] 3,264,373	[1] 3,264,373
Pennsylvania	-----	-----	990,207	990,207	-----	-----	1,021,272	1,021,272
South Dakota	-----	-----	-----	-----	1,060	-----	-----	1,060
Tennessee	47	[2] 14,125	-----	[2] 14,172	-----	[2] 18,702	-----	[2] 18,702
Texas	-----	780,800	-----	780,800	-----	1,029,327	-----	1,029,327
Utah	-----	-----	4,060,003	4,060,003	-----	-----	4,838,983	4,838.983
Virginia	-----	(2)	-----	(2)	-----	(2)	-----	(2)
Wisconsin	1,495,109	-----	-----	1,495,109	1,756,150	-----	-----	1,756,150
Wyoming	484,945	-----	-----	484,945	655,097	-----	-----	655,097
Puerto Rico	-----	-----	138,613	138,613	-----	-----	-----	-----
Total	[1] 83,515,561	2,729,524	[1] 11,068,778	97,313,863	[1] 102,553,404	2,238,236	[1] 12,585,681	117,377,321
Byproduct ore: [3] Delaware, Tennessee, Virginia	-----	-----	-----	604,141	-----	-----	-----	617,448
Grand total	[1] 83,515,561	2,729,524	[1] 11,068,778	97,918,004	[1] 102,553,404	2,238,236	[1] 12,585,681	117,994,769

[1] Small tonnage of hematite included with magnetite to avoid disclosure of individual company operations.
[2] Small tonnage mined in Virginia included with Tennessee.
[3] Cinder and sinter obtained from pyrites treated in, but not necessarily mined in, States indicated.

TABLE 8.—Shipments of iron ore in the United States in 1953, 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	4,428,070	1,092,173	1,925,887				7,446,130	$55,640,338
Arkansas	254						254	(2)
California	1,678,637			18,975		40	1,697,652	(2)
Colorado					900		900	3,825
Georgia	28,982		230,982				259,964	1,100,725
Michigan	13,105,192		177,913		29,661		13,312,766	94,691,612
Minnesota	54,355,738	1,080,413	25,097,519				80,533,670	517,850,509
Missouri			274,693				274,693	(2)
Montana				6,709			6,709	45,083
Nevada	437,371					6,710	444,081	2,647,859
New Jersey	177,475		633,128	5,302			815,905	10,114,970
New Mexico	1,614			5,911			7,525	(2)
New York	85,854	2,858,465	381,421	4,135	3,376	[3] 81,608	3,414,859	36,346,279
Pennsylvania		778,561	242,265				1,020,826	(2)
South Dakota	1,060						1,060	(2)
Tennessee			12,751		[4] 5,951		[4] 18,702	[4] 160,799
Texas		159,672	854,645		620		1,014,937	(2)
Utah	4,606,534			4,417		6,337	4,617,288	26,496,950
Virginia					(4)		(4)	(4)
Wisconsin	1,655,331						1,655,331	(2)
Wyoming	654,285						654,285	(2)
Undistributed								45,392,280
Total	81,216,397	5,969,284	29,831,204	45,449	40,508	94,695	117,197,537	790,491,229
Byproduct ore: [5] Delaware, Tennessee, Virginia		624,444					624,444	6,241,769
Grand total	81,216,397	6,593,728	29,831,204	45,449	40,508	94,695	117,821,981	796,732,998

[1] Exclusive of sinter produced at consuming plants.
[2] Values that may not be shown separately are combined as "Undistributed."
[3] Small tonnage used as earth pigments included with "Miscellaneous."
[4] Small tonnage mined in Virginia included with Tennessee.
[5] Cinder and sinter obtained from pyrites treated in, but not necessarily mined in, States indicated.

TABLE 9.—Iron ore mined in the United States in 1953, 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
labama:			
Blount	1		
Butler	4	665,600	133,230
Calhoun	1		
Cherokee	1		
Franklin	6	2,003,800	400,683
Jefferson	10	7,339,415	6,736,109
Pike	3	53,200	10,652
St. Clair	1		
Shelby	1	908,300	181,705
Talladega	1		
Tuscaloosa	1		
Total	[1] 30	10,970,315	7,462,379
Arkansas: Nevada	1	254	254
California:			
Riverside	1	1,570,925	1,570,925
San Bernardino	2	56,392	56,392
Shasta	1	40	40
Total	4	1,627,357	1,627,357
Colorado: San Miguel	1	900	900
Georgia:			
Bartow	5		
Polk	6	937,531	210,664
Walker	1		
Total	[1] 12	937,531	210,664
Michigan:			
Baraga	1	124,615	124,615
Dickinson	2	260,684	43,814
Gogebic	9	3,764,448	3,468,585
Iron	15	4,515,824	4,515,824
Marquette	14	5,660,503	5,660,503
Total	41	14,326,074	13,813,341
Minnesota:			
Crow Wing	20	3,969,375	2,898,325
Fillmore	1	326,012	217,760
Itasca	40	32,470,614	15,974,274
Morrison	1		
St. Louis	120	67,576,374	60,995,255
Total	182	104,342,375	80,085,614
Missouri:			
Butler	1		
Douglas	1	72,100	11,986
Howell	2		
Oregon	1		
Ozark	1	95,600	19,746
Shannon	1		
St. Francois	2	488,423	242,961
Wayne	1		
Total	[1] 10	656,123	274,693
Montana: Broadwater	1	6,709	6,709
Nevada:			
Churchill	1		
Douglas	1		
Eureka	1	133,277	133,277
Humboldt	1		
Nye	1		
Ormsby	1		
Pershing	2	293,476	293,476
Total	8	426,753	426,753
New Jersey:			
Morris	3		
Passaic	1	1,558,384	876,168
Warren	1		
Total	5	1,558,384	876,168
New Mexico:			
Grant	2	7,525	7,525
Lincoln	2		
Total	4	7,525	7,525
New York:			
Clinton	1	4,727,986	1,982,790
Essex	3		
Oneida	1	3,963,409	1,281,583
St. Lawrence	1		
Total	6	8,691,395	3,264,373
Pennsylvania: Lebanon	1	1,775,524	1,021,272
South Dakota: Pennington	1	1,060	1,060
Tennessee: Monroe	1	[2] 70,281	[2] 18,702
Texas:			
Cass	1		
Cherokee	1	3,963,529	1,029,327
Morris	1		
Total	3	3,963,529	1,029,327
Utah:			
Box Elder	8	4,838,983	4,838,983
Iron			
Virginia: Pulaski	1	(2)	(2)
Wisconsin:			
Florence	1	45,127	45,127
Iron	2	1,711,023	1,711,023
Wyoming: Platte	2	655,097	655,097
Grand total	325	156,612,319	117,377,321

[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, 1854–1953, by ranges, in gross tons

(Exclusive after 1905 of ore containing 5 percent or more manganese)

Year	Marquette	Menominee	Gogebic	Vermilion	Mesabi	Cuyuna	Total
1854-1948	247,795,664	220,539,812	261,463,087	81,469,969	1,603,909,204	40,102,567	2,455,280,303
1949	4,392,732	3,483,375	4,756,474	1,381,327	52,551,346	1,826,711	68,391,965
1950	5,085,500	4,068,458	5,238,781	1,580,217	60,838,025	2,480,843	79,291,824
1951	5,617,935	4,864,831	4,978,369	1,806,818	73,574,908	2,651,724	93,494,585
1952	4,668,550	4,168,465	4,468,039	1,573,748	59,370,538	2,369,180	76,618,520
1953	5,785,118	4,604,765	5,179,608	1,643,039	75,324,236	2,900,579	95,437,345
Total	273,345,499	241,729,706	286,084,358	89,455,118	1,925,568,257	52,331,604	2,868,514,542

TABLE 11.—Average analyses of total tonnages (bill-of-lading weights) of all grades of iron ore from all ranges of Lake Superior district, 1944–48 (average) and 1949–53

[Lake Superior Iron Ore Association]

Year	Gross tons	Content (natural), percent				
		Iron	Phosphorus	Silica	Manganese	Moisture
1944-48 (average)	75,017,482	51.21	0.090	8.84	0.74	11.17
1949	68,531,664	50.39	.096	9.72	.78	11.12
1950	79,150,079	50.38	.092	9.85	.77	11.11
1951	93,549,414	50.25	.090	9.87	.77	11.22
1952	77,225,818	50.49	.111	10.05	.77	10.78
1953	95,438,743	50.37	.090	10.25	.75	10.90

TABLE 12.—Beneficiated iron ore shipped from mines in the United States, 1925–29 (average) and 1930–53, 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				

TABLE 13.—Iron-ore mines in the United States in 1953, 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	9,277,379	9,276,467
Rouchleau	do	Virginia	do	do	6,784,704	6,702,297
Hull Rust	do	Hibbing	do	do	4,184,256	3,950,841
Benson	New York	Star Lake	Adirondack	do	3,957,611	1,278,207
Mountain Iron	Minnesota	Mountain Iron	Mesabi	do	3,372,513	2,779,579
Mahoning	do	Hibbing	do	do	3,279,428	3,279,428
King	do	Coleraine	do	do	3,252,478	1,897,352
Wenonah	Alabama	Bessemer	Birmingham	Underground	3,249,675	3,248,266
Lone Star	Texas	Daingerfield	East Texas	Open pit	3,092,899	681,076
Monroe	Minnesota	Chisholm	Mesabi	do	3,046,652	3,046,652
Spruce	do	Eveleth	do	Combined	2,808,374	2,726,711
Canton	do	Biwabik	do	Open pit	2,651,057	2,651,057
Gross Marble	do	Marble	do	do	2,607,634	1,334,431
Mather	Michigan	Ishpeming	Marquette	Underground	2,239,899	2,239,899
Holman Cliffs	Minnesota	Taconite	Mesabi	Open pit	2,234,159	971,299
Gilbert	do	Gilbert	do	do	2,128,291	2,065,524
Patrick	do	Nashwauk	do	do	1,972,958	900,194
Hill-Trumbull	do	Marble	do	do	1,917,763	651,878
Iron Mountain	Utah	Cedar City	Iron Springs	do	1,837,027	1,837,027
Cornwall-Lebanon	Pennsylvania	Lebanon	Cornwall	Combined	1,775,524	1,021,272
Pyne	Alabama	Bessemer	Birmingham	Underground	1,636,000	1,145,237
Eagle Mountain	California	Desert Center	Eagle Mountain	Open pit	1,570,925	1,570,925
Canisteo	Minnesota	Coleraine	Mesabi	do	1,498,177	777,518
Buckeye	do	do	do	do	1,473,293	697,416
New Bed Harmony & Old Bed	New York	Mineville	Adirondack	Underground	1,458,867	990,686
Embarrass	Minnesota	Biwabik	Mesabi	Open pit	1,366,257	1,366,257
Chateaugay	New York	Lyon Mountain	Adirondack	Combined	1,364,655	360,225
MacIntyre	do	Tahawus	do	Open pit	1,347,293	537,560
Danube	Minnesota	Bovey	Mesabi	do	1,304,214	793,985
Hill Annex	do	Calumet	do	do	1,226,119	583,591
Olson	do	Nashwauk	do	do	1,213,828	512,514
Section 18	do	Keewatin	do	do	1,149,081	1,033,332
Carlz No. 2	do	do	do	do	1,129,872	782,400
Montreal	Wisconsin	Montreal	Gogebic	Underground	1,126,144	1,126,144
Hawkins	Minnesota	Nashwauk	Mesabi	Open pit	1,110,141	422,626
Desert Mound	Utah	Cedar City	Iron Springs	do	1,098,683	1,098,683
Harrison	Minnesota	Nashwauk	Mesabi	do	1,065,120	327,835
Kevin	do	Cooley	do	do	1,060,095	381,339
Muscoda	Alabama	Bessemer	Birmingham	Underground	1,050,631	1,049,540
Susquehanna	Minnesota	Hibbing	Mesabi	Open pit	1,050,340	796,296
Mary Ellen	do	Biwabik	do	do	1,032,070	502,016
Enterprise	do	Virginia	do	do	1,026,270	1,026,270
Blowout	Utah	Cedar City	Iron Springs	do	1,009,854	1,009,854
Output of 43 mines producing more than 1,000,000 tons of crude ore each					94,038,210	71,431,706
Output of 51 mines producing 500,000 to 1,000,000 tons of crude ore each					32,990,491	23,613,493
Output of 106 mines producing 100,000 to 500,000 tons of crude ore each					26,029,857	19,810,277
Output of 125 mines producing under 100,000 tons of crude ore each					3,553,761	2,521,845
Grand total United States (325 mines)					156,612,319	117,377,321

CONSUMPTION AND USES

In accordance with record-high production and imports, domestic consumers used more iron ore than in any year before 1953. Table 14 shows a total of 122,125,000 long tons consumed, which exceeds the previous high total in 1951 by 6 percent. Unlike domestic production, consumption may be expected to continue expanding as the Nation's industrial plant grows with increasing population and a rising standard of living. The crude-steel capacity of 124.3 million short tons, as of January 1, 1954, could use as much as 140 million long tons of iron ore (mostly in blast furnaces producing pig iron for steel furnaces) in 1 year, assuming an adequate supply of scrap. Even larger tonnages would be needed should insufficient quantities of scrap be available.

In 1953 blast furnaces consumed 94,170,000 long tons of iron ore, excluding grades containing 5 percent or more manganese and including siliceous grades used in making silvery pig iron. Also included is a small tonnage employed in manufacturing ferroalloys to adjust the iron content to meet standard specifications. The tonnage used in steel furnaces was of a lump quality having a high density, with high iron and low silica content. This type of ore is of premium grade and is used as a vehicle for oxygen, which combines with carbon and other elements in the hot metal, eliminating impurities when the oxides pass off as gas or slag constituents. Open-hearth lump ore must be heavy enough to sink through the slag blanket into the molten metal and low enough in silica not to require additional limestone in maintaining a basic slag.

Steel furnaces used only 6 percent of the total, and less than 1 percent was used in making cement, paint, and for miscellaneous purposes. The tonnage used in making sinter (17 percent) eventually was consumed in iron and steel furnaces as shown in table 15.

Sinter.—Agglomerated iron ore, including sinter made in moving-bed continuous machines and Greenawalt batch machines, nodules made in rotary kilns, extruded and pressed briquets, and heat-treated pellets balled in rotating drums, totaled 25,797,000 long tons in 1953 compared with 20,289,000 tons in 1952. The 27-percent increase was more than can be shown in comparison with 1951, when 22,643,000 tons was made to establish the previous record-high tonnage. Iron-bearing materials consumed in manufacturing sinter included 20,727,000 tons of iron-ore fines and concentrates, 2,300 tons of manganiferous ore, 7,674,000 tons of blast-furnace flue dust, 731,000 tons of mill cinder and roll scale, and 639,000 tons of pyrite cinder. The total, 29,773,000 tons, resulted in a conversion yield of 87 percent. Agglomerating plants at mines in 5 States produced 6,589,000 tons, 26 percent of the total; and plants at blast furnaces and custom in 15 States produced 19,208,000 tons, or 74 percent.

TABLE 14.—Consumption of iron ore in the United States in 1953, by States and uses, in gross tons

(Exclusive of ore containing 5 percent or more manganese)

State	Metallurgical uses				Miscellaneous uses			Total
	Iron blast furnaces	Steel furnaces	Sintering plants	Ferroalloy furnaces	Cement	Paint	Other	
Alabama	7,712,250	113,214	1,510,696	481	70,006	-------	-------	9,406,647
California	—	—	—	-------	43,484	(2)	40	—
Colorado	3,417,989	577,876	2,532,184	-------	(2)	-------	-------	6,577,910
Utah	—	—	—	-------	(2)	-------	6,337	—
Illinois	9,796,041	546,156	472,912	-------	191	(2)	-------	10,815,300
Indiana	11,643,664	1,061,716	1,281,515	-------	-------	-------	-------	13,986,895
Kentucky	1,043,439	92,173	-------	-------	-------	-------	-------	1,135,612
Maryland	—	—	—	—	—	—	—	—
Massachusetts	6,872,179	659,541	1,310,661	-------	(2)	-------	-------	8,842,381
Michigan	—	—	—	—	—	—	—	—
Minnesota	1,073,154	100,315	1,080,413	-------	-------	-------	-------	2,253,882
New Jersey	-------	-------	-------	-------	-------	(2)	-------	(2)
New York	5,159,598	479,384	4,106,714	179,553	11,129	(2)	(2)	9,936,378
Ohio	19,461,411	1,154,796	3,058,027	158,045	4,048	(2)	-------	23,836,327
Pennsylvania	23,693,343	1,996,631	5,196,220	29,454	9,802	34,214	-------	30,959,664
Tennessee	179,268	-------	-------	-------	14,249	-------	-------	193,517
Texas	972,271	18,237	177,868	-------	24,983	-------	-------	1,193,359
West Virginia	2,777,597	19,132	-------	-------	(2)	-------	-------	2,796,729
Undistributed [3]	-------	-------	-------	-------	45,669	56,073	88,318	190,060
Total	93,802,204	6,819,171	20,727,210	367,533	223,561	90,287	94,695	122,124,661

[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, Kansas, Louisiana, Missouri, Montana, Oregon, South Dakota, Virginia, and Washington; for paint, Kansas and Virginia; and a small tonnage from Nevada used as ship ballast and in making refractories.

TABLE 15.—Production and consumption of sinter in the United States in 1953, by States, in gross tons

State	Sinter produced	Sinter consumed	
		In blast furnaces	In steel furnaces
Alabama	1,469,194	1,705,376	57,982
California, Colorado, Utah	2,438,006	2,443,778	-------
Delaware	105,530	-------	-------
Illinois	923,164	967,011	272,489
Indiana	1,989,121	2,041,232	182,769
Maryland, Kentucky, Tennessee, West Virginia	1,402,989	1,491,571	33,219
Michigan	779,896	756,976	-------
Minnesota	1,121,052	-------	-------
New York	4,645,171	1,984,231	25,147
Ohio	3,712,704	4,405,397	497,611
Pennsylvania	7,049,857	8,055,406	553,749
Texas	160,123	159,672	-------
Total	25,796,807	24,010,650	1,622,966

STOCKS

Mine stocks of usable iron ore, shown in table 16, increased slightly above those at the end of 1952. Michigan's total was highest (44 percent), inasmuch as the underground mines build stocks after shipments recess for the winter. Minnesota was the second largest holder, with 33 percent, and New York reduced its stockpiles during the year to 268,000 tons, about the level of Wisconsin's 247,000 tons. Utah increased stocks from 204,000 tons to 426,000 at the end of the year, probably as a result of reduced consumption in the last 6 months.

Consuming plants held iron ore and sinter totaling 45,242,000 tons on December 31 compared with 43,131,000 tons a year earlier. Ore on Lake Erie docks at the end of the year was 7,671,000 tons compared with 6,116,000 tons at the end of 1952, according to the Lake Superior Iron Ore Association. Thus, total stocks at mines, mills, and docks were 58,619,197 tons, an increase of 3,843,732 tons during the year. Sinter included in these totals carries recycled materials, such as flue dust, mill cinder, and roll scale.

TABLE 16.—Stocks of usable iron ore at mines, Dec. 31, 1952–53, by States, in gross tons

State	1952	1953	State	1952	1953
Alabama	51, 864	68, 113	Pennsylvania	6, 250	6, 696
California	160, 678	90, 383	Texas	101, 860	113, 857
Georgia	49, 300		Utah	204, 403	426, 098
Michigan	2, 016, 419	2, 516, 994	Wisconsin	146, 264	247, 083
Minnesota	2, 328, 925	1, 880, 869	Wyoming		812
Nevada	21, 931	5, 347			
New Jersey	22, 304	82, 567	Total	5, 528, 295	5, 706, 430
New York	418. 097	267, 611			

PRICES

The average value per long ton of iron ore f. o. b. mines was $6.76 in 1953 compared with $6.09 in 1952 and $5.46 in 1951. Table 17 gives the average value at mines of the different types of product and varieties of ore for each of the producing States, except where there are fewer than three shippers of a certain class of ore in a State and where permission has not been given to publish the value. These data are taken directly from statements of producers and probably represent the commercial selling prices only approximately. Usually the delivered cost is given less transportation costs to the consuming plant. In the Lake Superior district the mine value is the Lake Erie price less freight from mines to lower Lake ports. This value appears to be applied also to ore that is not sold on the open market. A discussion of price computation for Lake Superior iron ores was published.[2]

Prices of Lake Superior Iron Ore.—Decontrol of prices for iron ore by the Office of Price Stabilization became effective February 12, 1953, and new base prices effective from that date were: Mesabi non-Bessemer and High-Phosphorus, $9.70 per long ton; Mesabi Bessemer, $9.85; Old Range non-Bessemer, $9.95; Old Range Bessemer, $10.10; and Lake Superior open-hearth lump ore, $10.95. The increase of $0.65 per ton in the base price included $0.37 of costs formerly paid by the purchaser. Thus, the actual increase to the purchaser was $0.28 per ton. These prices held until July 1, when a further increase of $0.20 per ton went into effect. At the end of 1953, Lake Erie base prices were: Mesabi non-Bessemer and High-Phosphorus, $9.90 per ton; Mesabi Bessemer, $10.05; Old Range non-Bessemer, $10.15; Old Range Bessemer, $10.30; and open-hearth lump ore, $11.15. These

[2] Ross, H. U., Computation of Iron Ore Prices: Canadian Min. Jour., vol. 74, No. 3, March 1953, pp. 73–79.

prices were for ore delivered at lower Lake ports, carrying 51.5 percent natural iron content with 0.045 percent (max.) phosphorus (dry) for Bessemer grades; ores exceeding 0.18 percent phosphorus (dry) are classified as High-Phosphorus. Premiums and penalties are applied for variations in analyses and physical structure.

For Pittsburgh consumers the average value for Mesabi-range ore without respect to grade was \$6.41 (average value at the mines) plus \$5.28 (transportation charges plus Federal tax), or \$11.69 per long ton. This value applies more closely to the non-Bessemer grades, which constitute the bulk of the tonnage shipped.

TABLE 17.—Average value per gross ton of iron ore at mines in the United States, 1952–53

(Exclusive of ore containing 5 percent or more manganese)

State	1952							1953						
	Direct			Concentrates				Direct			Concentrates			
	Hematite	Brown ore	Magnetite	Hematite	Brown ore	Magnetite	Sinter	Hematite	Brown ore	Magnetite	Hematite	Brown ore	Magnetite	Sinter
Mined ore:														
Alabama	\$5.04	----	----	\$5.86	\$5.71	----	(1)	\$7.31	----	----	\$7.22	\$5.35	----	(1)
Colorado	----	----	----	----	----	----	----	----	\$4.27	----	----	----	----	----
Georgia	(1)	\$2.63	----	----	4.75	----	----	(1)	2.49	----	----	4.45	----	----
Michigan	6.46	----	----	6.38	----	----	----	7.11	----	----	6.94	----	----	----
Minnesota	5.83	----	----	5.94	(1)	(1)	(1)	6.34	----	----	6.50	----	(1)	(1)
Montana	----	----	----	----	----	----	----	----	----	\$6.72	----	----	----	----
New Jersey	----	----	(1)	----	----	\$9.41	----	----	----	(1)	----	----	\$12.23	----
New York	----	----	(1)	(1)	----	7.74	\$12.80	----	----	(1)	(1)	----	7.13	\$11.28
Pennsylvania	----	----	----	----	----	(1)	(1)	----	----	----	----	----	(1)	(1)
South Dakota	----	----	----	----	----	----	----	(1)	----	----	----	----	----	----
Utah	----	----	\$3.77	----	----	----	----	----	----	5.74	----	----	----	----
Other States [2]	5.29	9.98	6.27	8.72	4.13	4.40	(1)	6.05	13.16	6.85	8.04	3.79	----	(1)
Average, all States	5.87	3.66	4.91	5.98	5.30	9.17	10.14	6.53	6.05	6.26	6.57	4.48	10.27	12.56
Byproduct ore: [3]														
Delaware														
Tennessee	----	----	----	----	----	----	8.64	----	----	----	----	----	----	10.00
Virginia														

[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

Great Lakes.—The 1953 navigation season opened early, with prospects for a record-high movement of ore, which eventually totaled 95,844,000 long tons, including manganiferous ores and Canadian tonnages (according to the Lake Superior Iron Ore Association). The next largest tonnage over the Lakes in one season was in 1942, when 92,077,000 tons were moved. The first ore cargo of the 1953 season left Duluth March 29 on the *Henry C. Frick* of the Pittsburgh Steamship Division's fleet, and favorable weather permitted 8,635,000 tons to be moved by May 1, 1953. Shipments in November declined rapidly with a number of ships taken out of service before the close of shipping, and no ore moved over the Lakes in December.

The fleet of bulk carriers operating on the Great Lakes now includes

36 vessels added since World War II, 9 of which began operating in 1953. These were:[3]

McKee Sons, 9,000-horsepower turbine, Amersand S. S. Corp.
J. L. Mauthe, 7,000-horsepower turbine, Interlake S. S. Co.
Ernest T. Weir, 7,000-horsepower turbine, National Steel Corp.
Reserve, 7,000-horsepower turbine, Columbia Transportation Co.
Armco, 7,000-horsepower turbine, Columbia Transportation Co.
William Clay Ford, 7,000-horsepower turbine, Ford Motor Co.
John I. Boland, 7,000-horsepower turbine, American S. S. Co.
Richard M. Marshall, 5,000-horsepower turbine, Great Lakes S. S. Co.
E. B. Barber, 3,000-horsepower turbine, Algoma Central S. S. Co., Ltd.

Six more vessels had been built or were to be ready for operation in 1954. These included:[4]

Scott Misener, 10,000-horsepower turbine, Colonial S. S. Ltd.
T. R. McLagan, 8,500-horsepower turbine, Canada S. S. Lines.
Hull 871 (not named), 8,500-horsepower turbine, National Steel Corp.
Hull 418 (not named), 7,700-horsepower turbine, American S. S. Co.
Georgian Bay, 4,500-horsepower turbine, Canada S. S. Lines.
Paterson, 3,000-horsepower turbine, N. M. Paterson Sons Ltd.

The entire fleet of ore carriers consisted of 276 vessels having a trip capacity of 3,150,000 tons compared with 285 vessels and 3,194,000 tons a year earlier, indicating that 18 old vessels were retired during 1953.

Overseas.—Prospects of increased movement of iron ore and other minerals from overseas through United States ports has caused the construction of new ore docks and unloading equipment, as well as a number of special large-capacity carriers. At Baltimore, the Bethlehem Steel Co. dock adjacent to the Sparrow's Point plant is the largest on tidewater and capable of unloading 9,200 tons an hour. Baltimore & Ohio Railroad has a new dock, of 2,000-tons-per-hour capacity, which was put into service in 1951; the Canton Railroad has an ore pier of 2,000 tons per hour with an additional 1,000 tons to be added; and the Western Maryland Railway Ore Pier at Port Covington has a capacity of 2,000 tons per hour. Altogether, the Maryland facilities total 15,200 tons per hour, and municipal authorities have plans for an additional pier.

Philadelphia is building a new pier for ore handling to supplement its present facilities, Mobile is preparing for increasing ore tonnages, and other facilities exist at Newport News, Boston, and Charleston. Vessels loaded to shallow drafts can proceed to docks at the United States Steel Corp. new Fairless Works, but the Delaware River channel must be deepened to accommodate the large, new, ore carriers being constructed for the iron-ore trade.

Indicating the trend toward large ore carriers are two ships under construction. *Hulls 471 and 1841*, for the M. A. Hanna Co., being built in England, will be 630 feet long, beam 87 feet, depth 45 feet, 6 inches, and horsepower 13,750 (turbine) and will have an estimated capacity of 32,000 deadweight tons. Two much larger ships are under construction in Japan for Universal Tankships, Inc.: *Hulls 36 and 38* will be 756 feet long, beam 116 feet, depth 56 feet, horsepower 16,500 (twin-screw turbine) and will have an estimated deadweight capacity of 60,000 tons.[5]

[3] Skillings Mining Review, vol. 42, No. 43, Jan. 30, 1954, p. 18.
[4] Work cited in footnote 3.
[5] Work cited in footnote 3, p. 45.

Freight Rates.—Total charges from the Mesabi range to Pittsburgh were $5.1306 per long ton in 1953 compared with $4.9806 in 1952. The increase of $0.15 per ton was in vessel rates, effective April 15, 1953. Component charges were $1.1799 per ton for freight rates from Mesabi mines to Duluth, including $0.1495 dock-handling charges, $1.18 per ton vessel rates (including $0.23 unloading charges), and $2.1207 rail freight rates from Lake Erie ports to the Pittsburgh-Wheeling district (including $0.1495 dock-handling charges). Thus, the total included $0.5290 handling charges and $4.6016 rail and vessel rates. In addition, the Federal 3-percent transportation tax applies to rail, vessel, and handling charges, with exceptions for ore going to dock stockpiles and handling at private docks.

FOREIGN TRADE [6]

Iron ore imported for consumption in the United States reached a new high total of 11,074,000 long tons from 19 foreign countries in 1953. Average value increased $0.25 per ton to $8.74 compared with an increase of $2.62 per ton from 1951 to 1952 and a 5-year average value between 1944–48 of $4.28 per ton. Such values are based on declarations at the port of exit, exclusive of boat-loading charges. Chile again was the largest supplier, with 21 percent of the total. Sweden, Venezuela, and Canada followed closely, with 19, 18, and 17 percent, respectively. Peru was a new source that supplied 844,000 tons or 8 percent of the total. Liberia supplied 6 percent and Brazil only 4 percent after 10 percent in 1952. Brazilian imports were influenced by strong demand and higher prices offered by European consumers. Seven percent of the total imports were supplied by 12 other countries, among which British West Africa (Sierra Leone), Cuba, and Mexico were prominent. Small tonnages from Costa Rica, Denmark, Iran, and the United Kingdom included pigment-grade natural iron oxides and other iron ores for experimental purposes.

In addition to the imports noted above, Canada continues to supply byproduct iron ore obtained as a residue from burned pyrites used in making sulfuric acid. The tonnage has been small but is expected to increase to about 1 million tons per year as a result of facilities under construction by the International Nickel Co.

Canada and Japan were the only recipients of iron ore from the United States in 1953, except 1 ton exported to the Philippines. The tonnage to Japan decreased sharply in 1953 as a result of increased supplies from British Columbia, the Philippines, and South Asia (see below).

The second table on world trade in iron ore (No. 21) shows the tonnages for 1951. Total exports increased from 41,242,000 metric tons to 54,701,000 tons in 1951 or 33 percent. This follows the general rise in production of ore and metal in that year. Venezuela entered the trade pattern as a supplier to the United States, and Japan more than doubled its receipts, with new ore from the United States and increased tonnages from India, Goa, Malaya, and the Philippines. The United Kingdom greatly increased its tonnage from Canada, and there were smaller increases from Brazil, France, Sweden, and Algeria. Sweden increased its exports to all countries, as did France. New Caledonia apparently was unable to maintain its exports to Australia.

[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.—Iron ore imported for consumption in the United States, 1944–48 (average) and 1949–53, by countries, in gross tons

[U. S. Department of Commerce]

Country	1944-48 (average)		1949		1950		1951		1952		1953	
	Gross tons	Value	Gross tons	Value	Gross tons	Value	Gross tons	Value	Gross tons	Value	Gross tons	Value
Algeria	175,777	$804,352	415,501	$2,349,746	494,342	$2,917,910	446,273	$2,919,490	66,008	$518,994	21,150	$273,888
Argentina	4	27	20	24,809								
Belgium-Luxembourg	244	820										
Brazil	76,294	389,244	351,134	2,281,797	701,329	4,732,136	1,037,828	8,921,991	1,010,919	[1] 14,938,163	458,282	6,386,308
British West Africa	8,300	72,583	59,548	395,034	192,669	1,615,728	255,817	1,586,940	217,760	1,108,055	231,600	1,305,910
Canada	912,589	4,440,860	1,615,803	10,742,201	} 1,852,508	12,728,135	1,961,990	14,399,135	1,822,038	[1] 13,884,030	1,840,983	16,058,457
Newfoundland-Labrador	3,100	12,400										
Chile	1,120,907	3,019,240	2,627,007	6,891,016	2,606,557	6,821,829	2,767,207	8,587,746	1,861,575	8,240,661	2,363,401	12,347,510
Colombia	2	7										
Costa Rica									449	1,005	3,076	4,588
Cuba	69,212	325,380	11,589	24,763	29,000	61,770	4,223	29,926	87,536	882,684	196,676	1,853,185
Denmark											123	4,408
Dominican Republic									18,408	197,943	80,401	947,442
Egypt			7,500	88,650								
France	2,602	14,863			500	1,550						
French Morocco	4,578	24,303										
Greece	200	600										
Iran	900	40,800	1,500	90,000	3,000	180,000	1,500	60,000	2,972	165,755	2,953	205,053
Italy	1,993	13,198										
Liberia	(2)	17	30	105	(2)	51	110,123	552,694	572,485	3,156,561	710,290	5,764,548
Mexico	63,863	140,543	169,823	284,557	190,958	475,299	169,563	506,482	114,309	356,845	241,636	1,048,617
Netherlands			7,114	64,026								
Norway	32,264	189,972										
Peru	3	12									844,481	5,955,545
Philippines	832	5,776	5,250	51,816	3,600	36,000						
Spain	1,291	13,369	9,200	78,658			74,306	599,350	4,600	33,482	10,690	139,764
Spanish Africa	1,700	9,775			39,680	250,717	8,750	62,335				
Sweden	575,749	3,491,754	2,027,155	12,893,385	2,047,250	13,511,874	2,522,011	16,920,468	2,111,100	24,504,292	2,097,522	27,207,210
Tunisia	20,630	105,760	82,815	424,076	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
United Kingdom	452	27,195	302	22,895	751	27,050	446	28,837	690	23,369	444	24,011
Venezuela							635,416	3,780,692	1,845,776	14,610,871	1,949,618	17,026,862
Total	3,075,273	13,152,761	7,391,291	36,707,534	8,281,237	43,968,426	10,139,678	59,520,046	9,760,625	[1] 82,854,506	11,074,035	96,811,527

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

TABLE 19.—Pyrites cinder [1] imported for consumption in the United States, 1944–48 (average) and 1949–53, by countries, in gross tons

[U. S. Department of Commerce]

Country	1944–48 (average)		1949		1950		1951		1952		1953	
	Gross tons	Value	Gross tons	Value	Gross tons	Value	Gross tons	Value	Gross tons	Value	Gross tons	Value
Belgium-Luxembourg	(2)	$18										
Canada	8,603	26,160	7,588	$27,601	15,735	$58,260	8,675	$34,758	11,149	$48,028	12,053	$54,172
France	140	148										
Italy	(2)	2										
Total	8,743	26,328	7,588	27,601	15,735	58,260	8,675	34,758	11,149	48,028	12,053	54,172

[1] Byproduct iron ore.
[2] Less than 1 ton.

TABLE 20.—Iron ore exported from the United States, 1944–48 (average) and 1949–53, by countries of destination, in gross tons

[U. S. Department of Commerce]

Destination	1944–48 (average)		1949		1950		1951		1952		1953	
	Gross tons	Value	Gross tons	Value	Gross tons	Value	Gross tons	Value	Gross tons	Value	Gross tons	Value
Australia	(1)	$91	12	$3,109	7	$2,748	4	$1,439	4	$1,918		
Brazil							4	326				
Canada	2,311,569	8,507,936	2,168,763	12,312,318	2,550,712	15,709,693	3,340,170	21,734,997	3,790,253	24,507,789	3,853,579	$28,094,069
Canal Zone	2	45	9	200			4	138	7	212		
French Morocco	20	990										
Gold Coast					1	463						
Japan	12,174	109,218	251,791	2,293,560			987,814	9,245,943	[2] 1,332,379	[2] 12,893,934	397,784	4,316,048
Mexico	18	206					46	127				
Netherlands	5	343	75	5,804								
Norway			75	788			854	11,129				
Philippines			4,047	36,806	7	639	5	485	1	120	1	120
United Kingdom	(1)	12	3	1,232	11	2,966	9	2,200				
Other countries	49	1,487										
Total	2,323,837	8,620,328	2,424,775	14,653,817	2,550,738	15,716,509	4,328,910	30,996,784	[2] 5,122,644	[2] 37,403,973	4,251,364	32,410,237

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

TABLE 21.—World trade in iron ore in 1951, in thousand metric tons

[Compiled by Berenice B. Mitchell and John E. McDaniel]

Exports by countries of origin	Fe, percent	Production	Exports	Exports by Countries of Destination: North America: Canada	North America: United States	Europe: Belgium-Luxembourg	Europe: Germany, West	Europe: Sarr	Europe: United Kingdom	Europe: Other European	Asia: Japan
North America:											
Canada	55	4,246	2,926	------	1,982	------	137	------	704	------	103
Cuba	34	17	9	------	9	------	------	------	------	------	------
Mexico	68	460	224	------	224	------	------	------	------	------	------
United States	49	118,375	4,398	3,394	------	------	------	------	[1]	------	1,004
South America:											
Brazil	68	2,407	1,320	113	1,075	25	------	------	94	13	------
Chile	64	3,252	2,687	------	2,687	------	------	------	------	------	------
Venezuela	64	1,270	646	------	646	------	------	------	------	------	------
Europe:											
Austria	32	2,370	181	------	------	15	166	------	------	------	------
Belgium-Luxembourg	28	5,704	203	------	------	------	178	------	------	25	------
France	33	35,201	15,832	------	------	8,895	349	5,994	380	214	------
Germany, West	27	12,923	69	------	------	------	------	40	[1]	29	------
Greece	49	53	86	------	------	------	------	------	------	86	------
Italy	29	553	71	------	------	------	71	------	------	------	------
Norway	65	332	269	------	------	------	[2] 175	------	2	92	------
Spain	45	2,389	1,550	------	61	49	362	------	770	308	------
Sweden	60	15,383	14,992	8	2,580	1,923	4,563	------	3,561	2,357	------
Switzerland	31	86	100	------	------	------	72	------	------	28	------
Yugoslavia	45	581	281	------	------	------	103	------	51	127	------
Asia:											
Hong Kong	45	164	171	------	------	------	------	------	------	------	171
India	53	3,716	200	------	------	18	18	------	------	71	93
Malaya	45	860	793	------	------	------	------	------	18	------	775
Philippines	54	903	938	------	------	------	------	------	------	------	938
Portuguese India	55	436	285	------	------	------	15	------	------	------	270
Africa:											
Algeria	52	2,823	2,842	------	455	180	65	------	1,494	648	------
French Morocco	45	533	545	------	------	------	37	------	285	223	------
Sierra Leone	60	1,204	1,204	------	35	247	272	------	650	------	------
Spanish Morocco	67	937	968	------	9	20	15	------	432	492	------
Tunisia	53	923	911	3	137	------	79	------	491	201	------
Oceania: Australia	60	2,475	------	------	------	------	------	------	------	------	------
Other countries:	[3]	[4] [5] 73,424	[3]	------	------	------	------	------	------	------	------
Total		[4] 294,000	54,701	3,518	9,900	11,372	6,677	6,034	8,932	4,914	3,354

[1] Less than 500 tons.
[2] Including approximately 1,500 tons for East Germany.
[3] Data not available.
[4] Estimate.
[5] Includes 48,000,000 tons produced in U. S. S. R. and 15,014,000 tons produced in the United Kingdom.

TECHNOLOGY AND INDUSTRIAL DEVELOPMENT

Voluminous literature and publicity given to taconite development on the Mesabi range in recent years may have tended to obscure a significant and similar activity in Michigan.

In some parts of the Michigan ranges, particularly in the west end of the Marquette range, intrusive granites in past geologic ages have changed the character of the ore in the iron formation. The metamorphosed ores include a banded type locally called jaspillite, which is predominantly nonmagnetic and contains specular hematite, a steel-gray iron mineral that breaks into flaky particles. For some time it has been known that such ores respond favorably to concentration by flotation. Until recently, however, no attempt has been made to use this method for commercial production. In 1945 the Bureau of

Mines published a report which concluded that anionic flotation methods were promising for iron ores but impracticable for red ores carrying slimes.[7] A later report dealt with experiments on specular hematite and offered suggestions for further investigations.[8] In 1949 Cleveland-Cliffs Iron Co. erected a modern research laboratory at Ishpeming, Mich., which had for a prime objective the development of feasible means to concentrate the nonmagnetic lean ores of the area. Experiments developed several technically feasible methods, and flotation was chosen for use in a commercial operation.

Cleveland-Cliffs Iron Co., with Ford Motor Co., formed the Humboldt Mining Co. and was building a flotation plant near Humboldt, Mich., to be completed early in 1954. The mine also is named Humboldt, and the iron formation bears the same name. Thus, reference to the development as the "Humboldt Project" is more than appropriate. Plans call for a mill adjacent to the mine with a three-stage crushing unit serving the flotation plant. No agglomeration facilities for the concentrates were planned, inasmuch as Ford's sintering plant can accommodate the 200,000-ton output capacity of the first unit. However, with additional facilities to be installed by 1955 doubling the capacity at Humboldt and another 400,000 tons planned for the Republic mine, the agglomeration problem will require additional equipment.

Eight hundred thousand tons of fine-size flotation concentrates per year is a big step toward utilization of the Nation's large reserves of nonmagnetic low-grade ores. It may be that information developed by the Humboldt Project will provide the necessary technical data and impetus to hasten commercial exploitation of nonmagnetic taconites, as well as ferruginous sandstones. The preliminary program at Humboldt was described.[9]

In connection with the beneficiation of Mesabi nonmagnetic taconites, results of investigations at Battelle Memorial Institute were published during the year.[10] A four-step process is proposed, which includes:

(1) Drying and heating the finely ground ore to reaction temperature (600° to 750° F.).

(2) Gaseous reduction (750° to 840° F.) of the natural hematite to artificial magnetite in a specially designed furnace or oven.

(3) Controlled reoxidation (up to 930° F.) of the artificial magnetite to artificial gamma hematite (which also is magnetic and the reaction generates heat to be recovered in step 4 and utilized in step 1 thus reducing costs for gas).

(4) Cooling of the hematite and using the recovered heat in step 1.

In operation the process would continue with conventional magnetic separation equipment to be followed by agglomeration of the fine-size concentrates. The feature distinguishing this process from other magnetic roasting methods is step 3, and the necessary requirement for the crude ore is enough iron in the form of hematite to support a cyclic heat operation between steps 4 and 1, thus reducing fuel requirements to those required for partial reduction in step 2. This

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7 Clemmer, J. B., Clemmons, B. H., Rampacek, C., Williams, M. F., Jr., and Stacey, R. H., Beneficiation of Iron Ores by Flotation: Bureau of Mines Rept. of Investigations 3799, 1945, 42 pp.

8 Iverson, H. G., Flotation of Gray Iron Ores From the Talladega Area, Ala.: Bureau of Mines Rept. of Investigations 4570, 1949, 18 pp.

9 Erck, L. J., and Johnson, E. B., Marquette Range Low-Grade Ores: Skillings Mining Review, vol. 42, No. 5, May 9, 1953, pp. 1–2.

10 Stephens, F. M., Langston, B., and Richardson, A. C., Reduction-Oxidation Process for the Treatment of Taconites: Transactions, 36th Conference, AIME Blast-Furnace, Coke-Oven and Raw Materials Committee, Buffalo, N. Y., 1953, pp. 53–81.

saving may or may not prove to be sufficient for a competitive operation in the near future, but certainly the process is an important advance in a promising direction.

RESERVES

Data in Tables 22 and 23 represent taxable and State-owned reserves. New tonnages are added each year, resulting from revised estimates as well as the progress of exploration. The totals given most certainly will be greatly exceeded by eventual production.

TABLE 22.—Iron-ore reserves in Michigan, Jan. 1, 1945–49 (average) and 1950–54, in gross tons

[Michigan Department of Conservation]

Range	1945–49 (average)	1950	1951	1952	1953	1954
Gogebic	31, 659, 072	29, 098, 914	33, 466, 792	34, 162, 005	[1] 31, 467, 972	28, 606, 915
Marquette	59, 794, 704	65, 109, 601	68, 323, 382	65, 119, 690	[1] 64, 943, 858	65, 364, 095
Menominee	51, 062, 411	55, 594, 843	60, 136, 726	62, 940, 226	62, 188, 665	60, 086, 244
Total Michigan	142, 516, 187	149, 803, 358	161, 926, 900	162, 221, 921	[1] 158, 600, 495	154, 057, 254

[1] Revised figure.

TABLE 23.—Unmined iron-ore reserves in Minnesota, May 1, 1944–48 (average) and 1949–53, in gross tons

[Minnesota Department of Taxation]

	1944–48 (average)	1949	1950	1951	1952	1953
Mesabi	948, 990, 789	900, 959, 665	912, 226, 039	893, 007, 833	854, 280, 596	839, 732, 761
Vermilion	11, 529, 088	12, 196, 016	12, 498, 639	11, 660, 302	12, 390, 557	12, 989, 074
Cuyuna	54, 915, 352	37, 308, 274	42, 977, 068	41, 415, 581	43, 472, 578	43, 983, 246
Total Lake Superior district (taxable)	1, 015, 435, 229	950, 463, 955	967, 701, 746	946, 083, 716	910, 143, 731	896, 705, 081
Fillmore County	162, 468	547, 744	582, 820	908, 996	574, 908	607, 500
Morrison County			88, 286	44, 300	15, 000	
Aitkin County					850, 000	850, 000
State ore (not taxable)	13, 586, 515	2, 435, 729	2, 642, 853	2, 643, 033	2, 486, 297	117, 197
Total Minnesota	1, 029, 184, 212	953, 447, 428	971, 015, 705	949, 680, 045	914, 069, 936	898, 279, 778

EMPLOYMENT

Preliminary data on the average number of workers in iron-ore mines and mills indicate a decrease from 31,800 to 31,400 in 1953; total man-hours increased 7 percent to 67,960,000. Output of usable iron ore per man-hour increased to 1.742 tons compared with 1.551 in 1952 and 1.549 in 1951.

Production figures used above and in table 24 include manganiferous ore from the Lake Superior district, which is considered a special grade of iron ore.

TABLE 24.—Employment at iron-ore mines and beneficiating plants, quantity and tenor of ore produced, and average output per man in 1952, by districts and States [1]

District and State	Employment					Production									
	Average number of men employed	Time employed				Crude ore (gross tons)	Usable ore			Average per man (gross tons)					
		Average number of days	Total manshifts	Man-hours			Gross tons	Iron contained		Crude ore		Usable ore			
				Average per shift	Total			Gross tons	Natural (percent)	Per shift	Per hour	Per shift	Per hour	Iron contained	
														Per shift	Per hour
Lake Superior: [1]															
Michigan	} 8,870	248	2,199,159	8.03	17,667,824	13,509,752	13,324,782	6,828,384	51.25	6.143	0.765	6.059	0.754	3.105	0.386
Wisconsin															
Minnesota	14,138	259	3,657,596	8.02	29,345,471	82,294,873	64,613,288	32,314,467	50.01	22.500	2.804	17.666	2.202	8.835	1.101
Total	23,008	255	5,856,755	8.03	47,013,295	95,804,625	77,938,070	39,142,851	50.22	16.358	2.038	13.307	1.658	6.683	.833
Southeastern States:															
Alabama	4,862	204	994,221	8.10	8,049,071	11,244,472	7,240,348	2,733,751	37.76	11.310	1.397	7.282	.900	2.750	.340
Georgia	103	225	23,186	9.57	221,930	1,687,532	369,259	153,353	41.53	72.782	7.604	15.926	1.664	6.614	.691
Tennessee [2]	6	224	1,344	9.00	12,100	46,244	14,172	5,838	41.19	34.408	3.822	10.545	1.171	4.344	.482
Total	4,971	205	1,018,751	8.13	8,283,101	12,978,248	7,623,779	2,892,942	37.95	12.739	1.567	7.483	.920	2.840	.349
Northeastern States:															
New Jersey	550	269	147,836	7.85	1,161,051	1,318,599	706,955	441,010	62.38	8.919	1.136	4.782	.609	2.983	.380
New York	} 1,869	288	537,586	8.00	4,300,703	8,863,393	3,719,423	2,280,284	61.31	16.487	2.061	6.919	.865	4.242	.530
Pennsylvania															
Total	2,419	283	685,422	7.97	5,461,754	10,181,992	4,426,378	2,721,294	61.48	14.855	1.864	6.458	.810	3.970	.498
Western States:															
California	} 350	228	79,673	8.00	637,379	2,428,457	2,428,457	1,393,770	57.39	30.480	3.810	30.480	3.810	17.494	2.187
Nevada															
Arkansas	} 132	272	35,900	8.18	293,483	758,948	268,333	138,388	51.57	21.141	2.586	7.474	.914	3.855	.472
Missouri															
New Mexico	} 251	189	47,319	8.00	378,552	2,425,657	788,593	358,943	45.52	51,262	6.408	16.665	2.083	7.586	.948
Texas															
Utah	} 669	232	155,194	7.96	1,236,115	4,544,948	4,544,948	2,424,994	53.36	29.286	3.677	29.286	3.677	15.626	1.962
Wyoming															
Total	1,402	227	318,086	8.00	2,545,529	10,158,010	8,030,331	4,316,095	53.75	31.935	3.991	25.246	3.155	13.569	1.696
Total 1952 [2]	31,800	248	7,879,014	8.03	63,303,679	129,261,488	98,157,171	49,153,578	50.36	16.406	2.042	12.458	1.551	6.239	.776

[1] Includes manganese-bearing ore in the Lake Superior district.
[2] Man-hour data for Virginia and Puerto Rico are not available and are therefor excluded from all totals; however, production data for Virginia is included with Tennessee and for Puerto Rico (138,613 tons of crude and usable ore) are included with total production.

WORLD REVIEW

CANADA[11]

Iron-ore production in Canada during 1953 exceeded 5 million tons for the first time. The year also was one of extensive development activities that will result in further increased output, until Canada becomes a major world producer. Production (shipments, 5,805,000 long tons) increased 23 percent over 1952 and came from mines in British Columbia, Newfoundland, and Ontario.

British Columbia.—Argonaut Mining Co., Ltd., and Texada Mines, Ltd., continued to produce magnetite concentrates from the Iron Hill mine on Vancouver Island and the Prescott, Lake, and Paxton mines on Texada Island. Virtually all output was for the Japanese trade. The Iron Hill mine shipped 554,000 long tons, averaging 55.9 percent iron, to Japan, with 60 tons additional to domestic users. The 3 mines on Texada Island shipped 333,000 tons averaging 55.67 percent iron, 1.4 percent sulfur, and 0.26 percent copper, all to Japan. Both companies continued exploration for new deposits and extension of reserves.

TABLE 25.—World production of iron ore, by countries,[1] 1944–48 (average) and 1949–53, in thousand metric tons [2]

[Compiled by Pearl J. Thompson]

Country [1]	1944–48 (average)	1949	1950	1951	1952	1953
North America:						
Canada	2,317	3,334	3,271	4,246	4,783	5,898
Cuba	26	12	12	17	101	229
Mexico	305	363	420	460	523	547
United States	90,923	86,301	99,619	118,375	99,490	119,889
Total North America	94,000	90,000	103,000	123,000	105,000	126,600
South America:						
Argentina [3]	39	40	40	54	60	80
Brazil	837	1,888	1,987	2,407	3,044	3,145
Chile [4]	1,425	2,597	2,976	3,252	2,209	2,165
Peru	------	------	------	------	------	1,001
Venezuela	------	------	198	1,270	1,970	2,296
Total South America [3]	2,000	4,500	5,000	7,000	7,000	8,700
Europe:						
Austria	1,176	1,488	1,859	2,370	2,653	2,757
Belgium	52	42	46	79	135	99
Bulgaria [3]	[5] 3	20	27	43	60	92
Czechoslovakia	1,153	[3] 1,600	[3] 1,784	[3] 1,962	[3] 2,315	[3] 2,500
France	16,948	31,428	30,016	35,201	40,716	42,368
Germany:						
East [3]	} 6,536	250	386	592	852	1,250
West		9,112	10,883	12,923	15,404	14,619
Greece	3	------	5	53	137	86
Hungary	234	339	368	[3] 400	[3] 450	[3] 500
Italy	286	554	476	553	790	933
Luxembourg	2,391	4,137	3,845	5,625	7,245	7,170
Norway	146	275	298	332	769	1,182
Poland	469	700	790	901	1,027	1,345
Portugal	------	(6)	------	21	89	123
Rumania [3]	165	324	395	478	654	661
Spain	1,484	1,876	2,088	2,389	2,863	2,956
Sweden	8,045	13,729	13,611	15,383	16,949	17,128
Switzerland	74	70	55	86	107	105
U. S. S. R.[3] [7]	22,000	35,000	44,000	48,000	50,000	55,000
United Kingdom	13,416	13,612	13,171	15,014	16,493	16,072
Yugoslavia	[3] 468	825	826	581	676	795
Total Europe [3]	75,000	115,000	125,000	143,000	160,000	167,700

See footnotes at end of table.

[11] Information in this section is principally from Buck, W. Keith, A Survey of the Iron Ore Industry in Canada During 1953: Canada Department of Mines and Technical Surveys, Mines Branch, Ottawa, Mar. 5, 1954, 20 pp.

TABLE 25.—World production of iron ore, by countries,[1] 1944–48 (average) and 1949–53, in thousand metric tons[2]—Continued

Country [1]	1944–48 (average)	1949	1950	1951	1952	1953
Asia:						
China [3]	2,661	500	2,000	3,000	4,000	5,000
Hong Kong	------	60	172	164	130	125
India	2,402	2,854	3,005	3,716	3,989	3,617
Indochina	22	------	------	------	------	------
Japan [8]	1,470	794	927	1,168	1,394	1,541
Korea:						
North	918 (North and Republic of)	(9)	(9)	(9)	(9)	(9)
Republic of		------	------	------	17	19
Malaya	5	9	507	860	1,072	1,080
Philippines	[3] 64	370	599	903	1,170	1,218
Portuguese India	1	151	131	436	494	[10] 863
Thailand (Siam)	1	------	3	6	3	8
Turkey	134	211	234	226	482	506
U. S. S. R.	(7)	(7)	(7)	(7)	(7)	(7)
Total Asia [3]	8,000	5,000	7,600	10,500	13,000	14,000
Africa:						
Algeria	1,417	2,538	2,573	2,823	3,096	3,388
French Guinea	------	------	------	------	------	399
French Morocco	118	357	323	533	651	506
Liberia	------	------	------	171	904	[10] 1,316
Northern Rhodesia	------	2	------	------	6	2
Sierra Leone	809	1,107	1,185	1,159	1,183	1,390
Southern Rhodesia	6	51	57	52	65	63
Spanish Morocco	799	893	951	937	934	986
Tunisia	301	712	758	923	977	1,057
Union of South Africa	963	1,242	1,189	1,421	1,759	1,971
Total Africa	4,000	7,000	7,000	8,000	10,000	11,000
Oceania:						
Australia	1,982	1,484	2,403	2,475	2,954	3,352
New Caledonia	12	------	15	------	3	------
Total Oceania	2,000	1,500	2,400	2,500	3,000	3,000
Total (estimate)	185,000	223,000	250,000	294,000	298,000	331,000

[1] In addition to countries listed, Egypt and Madagascar report production of iron ore in past years, but quantity produced is believed insufficient to affect estimate of world total.
[2] This table incorporates a number of revisions of data published in previous Iron Ore chapters.
[3] Estimate.
[4] Production of Tofo mines.
[5] Average for 1947–48.
[6] Less than 500 tons.
[7] U. S. S. R. in Asia included with U. S. S. R. in Europe.
[8] Includes iron sand production as follows: 1949, 33,120 tons; 1950, 101,544; 1951, 255,984 tons; 1952, 322,008 tons; and 1953, 437,868 tons.
[9] Data not available; estimate by author of chapter included in total.
[10] Exports.

Labrador-Quebec.—At the end of 1953 Iron Ore Co. of Canada had nearly completed tracklaying from Seven Islands to the deposits' terminal near Knob Lake. It was planned to continue tracklaying in cold weather, with completion scheduled in February 1954. Ballasting and other work necessary before using the railroad to bring in mining equipment would wait for warmer weather, but it was expected that first shipments of ore would be made before the end of July 1954. The new townsite near Knob Lake was under construction, with about 20 residences occupied by staff families. It will be named Schefferville after the Bishop of Labrador. The ore docks and yards at Seven Islands were nearing completion, as were the two power sites at Menihek and St. Marquerite Dams.

Prospecting and exploration for new discoveries of commercial iron ore deposits continued in Labrador and Quebec, with a number of companies active in 1953:

Quebec Labrador Development Co., Ltd., holds an exploration license covering about 500 square miles along the Kaniapiskua River northwest of Knob Lake in New Quebec. An aerial magnetometer survey revealed anomalies, and a drilling program was started.

Canadian Javelin Foundries & Machine Work, Ltd. (and the Newfoundland & Labrador Corp.), holds concessions in southwest Labrador in the Wabush Lake area. Exploration by field parties of geologists and mining engineers continues for direct-shipping-grade ore after having located formations of possible concentrating grade.

Great Mountain Iron Corp. holds a group of 12 mining claims near Fort McKensie, New Quebec, which were being explored by geological and magnetometer surveys.

Fort Chimo Mines, Ltd., released part of its concession north of Knob Lake and south of Ungava Bay but retained some areas for further exploration.

Fenimore Iron Mines, Ltd., sank 12,714 feet of diamond-drill holes in the siderite deposit now called Gossan Hill. Another prospect, also in the Leaf Lake area south of Ungava Bay, was drilled, but no results have been released for either program.

Norancon Exploration Quebec, Ltd., holds concessions north of Knob Lake, which were mapped in detail and investigated by surface prospecting.

Atlantic Iron Ore, Ltd., holds concessions for exploration in the area of Hope's Advance Bay on the west shore of Ungava Bay and in the vicinity of Ford Lake southwest of Knob Lake.

International Iron Ore Co., Ltd., holds an exploration license for 600 square miles along the west shore of Ungava Bay north of Payne Bay.

Hollinger (Quebec) Exploration Co., Ltd., holds claims covering the titaniferous magnetite deposit at Marybelle Lake, Saguenay County, Quebec.

Canadian Cliffs, Ltd., explored holdings near Lake Albanel and in the Temiscamie River area.

M. J. O'Brien, Ltd., was active in the vicinity of Lake Albanel, with aerial magnetometer surveys.

United States Steel Corp. continued drilling and prospecting in the area of Lake Matonipi.

Quebec Cobalt & Exploration, Ltd., surveyed holdings about 175 miles north and west of Seven Islands.

Chemical Lime, Ltd., leased the old Bristol mine from Trent River Iron, Ltd. Results of the former holder's exploration will be studied for economic possibilities.

Gravemetric Surveys, Ltd., in addition to work for other companies, explored holdings of its own in two areas of Quebec.

New Concord Development Corp., Ltd., holds iron prospects in several areas of Quebec.

Bellechase Mining Corp., Ltd., holds 2 groups of claims covering about 2,400 acres in the Mount Wright area of Quebec.

Although most of these 17 companies have found iron formations with material of possible concentrating grade, no information has been published to indicate the discovery of commercial-size deposits of direct-shipping grade.

Newfoundland.—Dominion Wabana Mines, Ltd., shipped 2,400,000 long tons of ore from its mines under Conception Bay, with shaftheads and surface facilities on Bell Island. This tonnage, very close to the goal of 2.5 million tons, went to furnaces at Sidney, Nova Scotia, the

United Kingdom, and West Germany. An average analysis of Wabana ore lists:

	Percent		Percent
Iron	51.26	Manganese oxide	0.17
Silica	11.46	Magnesia	.61
Sulfur	.04	Titanic acid	.37
Phosphorus	.88	Carbon dioxide	2.13
Lime	3.13	Combined water	2.52
Alumina	4.93		

Ontario.—In the Michipicoten area, Algoma Ore Properties, Ltd., shipped 1,166,000 tons of sinter, of which 391,000 tons went to Algoma Steel Corp., Ltd., furnaces at Sault Ste, Marie and 775,000 tons to the Lower Lake area. All production came from the Helen and Victoria mines.

In the Atikokan area, Steep Rock Iron Mines, Ltd., shipped 1,302,000 tons, of which a final 640,000 tons came from the Errington open pit, 20,000 tons from the new Errington underground operation, and 642,000 tons from the Hogarth open pit.

Exploration and development in Ontario for new sources were almost as widespread as in Labrador and Quebec. Bethlehem Steel Corp. had nearly completed facilities and stripping at its new Marmora mine and anticipated first shipments in 1954. Caland Ore Co., Ltd., prepared to develop the "C" ore body at Steep Rock, and 12 other firms were prospecting or investigating iron-ore prospects. These included Nipiron Mines, Ltd., Steel Co. of Canada, Ltd., Canada Iron Mining, Ltd., Trent River Iron, Ltd., Algoma Ore Properties, Ltd., Dominion Gulf Co., North Range Mining Co., Jalore Mining Co., Ltd., Canadian Cliffs, Ltd., Head of the Lakes Iron, Ltd., McMarmac Red Lake Gold Mines, Ltd., and Calmor Mines, Ltd.

The International Nickel Co. announced intentions to construct facilities for treating pyrrhotite concentrate which would yield up to 1 million tons of byproduct iron ore annually.

OTHER COUNTRIES

Brazil.—United States imports of iron ore from Brazil dropped from 1,038,000 long tons in 1951 and 1,011,000 tons in 1952 to only 458,000 tons in 1953. The decline was associated with price increases and heavy purchases by European consumers. The European market, however, did not sustain the higher prices. Prices quoted in E&MJ Mineral and Metal Markets reached a high of $18.40 per metric ton f. o. b. Brazilian port but declined to $13.75 per ton in October and was $14.00 at the end of the year.

Chile.—Production of iron ore in Chile during 1953 about equaled that of 1952, although the output of the Tofo mine declined slightly. Relatively small tonnages of independent production not included in table 25 was exported to the United States and West Germany. El Tofo, whose output declined sharply in 1952 more as a result of a strike than because of the transfer of shipping to the Venezuelan trade as reported in Minerals Yearbook 1952, is expected to be exhausted of good ore in about 3 years. The new mine, El Romeral, is expected to be ready for production by the end of 1954.[12]

French West Africa.—First shipments from the newly developed Conakry deposits of Compagnie Minière de Conakry left for Belgium

[12] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 3, September 1953, pp. 22–23.

early in 1953, followed by initial shipments to United Kingdom on April 9.[13] Production for the year reached 399,000 metric tons.

The Fort Gouraud deposit in a northwest corner of French Mauretania near Sebkha d'Idjil was explored further, and plans for development were being worked out. The deposit is a large one, but the problem of transportation presents unusual difficulties. Port Etienne is the nearest French port; however, to use this exit the railroad from the deposits would have to be built around the right-angle southeast corner of Spanish Rio De Oro or take an hypotenuse route across Rio De Oro with the permission of the Spanish Government. The other alternative and shortest route would be directly across Rio De Oro to Villa Cisneros.

Peru.—The first shipment of iron ore from the Marcona deposit was made in April to the United States Steel Corp. Fairless works at Morristown, Pa. During a remarkably short development period of about 4 months, mining, crushing, screening, and loading equipment was brought in and installed as well as a highway and port facilities constructed.[14] The project was assisted by an Export-Import Bank loan of $2,500,000. Production in 1953 reached 984,703 long tons, and receipts in the United States totaled 844,481 tons. Average analysis was: Iron 61.66 percent, sulfur 0.165 percent, phosphorus 0.054 percent, silica 4.64 percent, alumina 1.13 percent, and moisture 0.78 percent.

Near the end of 1953 Republic Steel Corp. obtained an exploration option on lands holding iron-ore prospects in the Acari River region in south Peru near the coast. It was expected to find ore averaging over 65 percent iron with virtually no moisture. Diamond drilling will begin early in 1954.[15]

Sweden.—Strong demand for Swedish iron ore in recent years has supported an extensive expansion program by Trafik AB, Grangesberg-Oxelosund, which operates the Kiruna, Malmberget, and Grangesberg deposits. The program is near completion, and Swedish production has increased steadily from an average output over the 5 years, 1944–48, of 8,045,000 metric tons to 17,128,000 tons in 1953. Several descriptive articles concerning iron mining in Sweden appeared during 1953.[16]

Venezuela.—Cerro Bolivar, the major iron deposit of the Orinoco Mining Co. (U. S. Steel Corp. subsidiary) was ready to begin shipments at the end of 1953. Shipments are scheduled at 2 million tons the first year.[17] Facilities at Puerto Ordaz were described and history of the development recounted in articles released in October.[18]

Production from El Pao, operated by the Iron Mines Co. of Venezuela (subsidiary of Bethlehem Steel Corp.), in its fourth year of operation, was 2,296,000 metric tons, an increase of 17 percent over 1952.

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[13] Metal Bulletin (London), No. 3771, Feb. 24, 1953, p. 16
American Metal Market, vol. 60, No. 73, Apr. 17, 1953, p. 1.

[14] Marcona-Four Months from Plan to Production: Eng. and Min. Jour., vol. 155, No. 1, January 1954.
Mining World, Marcona Equips Peru Iron Mine and Ships First Ore in 90 Days: Vol. 16, No. 2, February 1954.

[15] American Metal Market, vol. 60, No. 247, Dec. 24, 1953.

[16] Mining Journal (London), Methods and Equipment Used at the Grangesberg Mine, Sweden (one of a series): Vol. 241, No. 6167, Oct. 30, 1953, pp. 500–501.
Mine & Quarry Engineering (London), Stoping at Gangesberg: Vol. 19, No. 11, November 1953, pp. 410–415.
Metal Bulletin (London), Sweden's Iron and Steel Industry: Special Issue, March 1953.

[17] Mining Engineering, vol. 5, No. 12, December 1953, pp. 1188–1189.

[18] Millard, L. O., Ore Handling and Crushing System for Orinoco Mining Co., Puerto Ordaz, Venezuela: Trans. ASCE Construction Division, New York, October 1953.
Wanamaker, Wm. W., The Development of Iron-Ore Deposits in Venezuela by the Orinoco Mining Co. Trans. ASCE Construction Division, New York, N. Y., October 1953.

Iron and Steel

By James C. O. Harris[1]

PRODUCTION of steel ingots and castings in the United States in 1953 reached an alltime high of 111.6 million net tons and a monthly production record of 10.2 million tons was set in March. For the first time since Pearl Harbor steel supply exceeded demand, and this point was not reached until the third quarter. Blast-furnace operations, staying well above 90 percent of capacity until December when there was a decrease to 86 percent, produced a record total of 74.8 million net tons of pig iron.

With plant additions to make 6.4 million tons of open-hearth and 366 thousand tons of electric and Bessemer steel, annual capacity reached a new high of 124,330,000 net tons on December 31, 1953, according to the American Iron and Steel Institute.

The automotive industry was the largest consumer of steel products in 1953, receiving 14.7 million tons or 19 percent of the 77,472,000 net tons of domestic steel shipments. Total sales, amounting to 7,328,040 units, an increase of 32-percent over 1952, were comprised of 6,121,787 passenger cars, 1,202,196 trucks, and 4,057 coaches.

The construction industry received 12 percent of the steel shipments in 1953. Construction of new dwellings (houses and apartments) declined slightly in 1953, with an estimated 1,102,500 units started during the year compared with 1,127,000 in 1952. The total new construction during the year was valued at $34.8 billion, compared with $32.6 billion in 1952 and absorbed 9.9 million tons of steel products.

The container industry used 9 percent (6,051,000 tons) more steel in 1953 than in 1952. Railroads received 4.8 million net tons of steel products compared with 4.0 million tons in 1952. Shipbuilding requirements and steel exports were the lowest since 1950. Steel for export decreased markedly from 1952, according to the United States Department of Commerce. Thirty-four of the 43 exported steel-product combinations listed in table 20 decreased. Steel ingots, blooms, billets, slabs, and sheet bars decreased from 732,185 net tons to 89,620. Galvanized iron and steel sheets, storage tanks, and unfabricated structural shapes showed the greatest increase.

Average weekly hours worked per employee in the steel industry totaled 40.5 in 1953 compared with 41.1 in 1951 and 39.7 in 1952, the year of the steel strike. The average number of employees was 560,000, with a high of 572,000 in August and a low of 535,000 in December. The average hourly wage earned per worker was $2.16 compared with $1.98 in 1952 and $1.89 in 1951. The average value f. o. b. mill of all steel products, computed from figures supplied by the Bureau of the Census, was 6.789 cents per pound in 1953. There were price increases in May, June, and July and a decrease in December.

[1] Commodity-industry analyst.

TABLE 1.—Salient statistics of iron and steel in the United States, 1944–48 (average) and 1949–53, in net tons

	1944–48 (average)	1949	1950	1951	1952	1953
Pig iron:						
Production	55, 494, 074	53, 323, 142	64, 499, 983	70, 277, 938	61, 308, 424	74, 853, 319
Shipments	55, 551, 216	52, 919, 019	64, 626, 146	70, 250, 379	61, 234, 790	74, 162, 829
Imports	58, 636	99, 804	804, 799	1, 066, 513	[1] 380, 200	589, 825
Exports	73, 396	81, 309	6, 813	6, 555	14, 085	18, 837
Steel:[2]						
Production of ingots and castings:						
Open hearth:						
Basic	73, 054, 918	69, 742, 110	85, 661, 651	92, 387, 447	82, 143, 400	99, 827, 729
Acid	790, 976	506, 693	600, 858	779, 071	703, 039	646, 094
Bessemer	4, 229, 739	3, 946, 656	4, 534, 558	4, 890, 946	3, 523, 677	3, 855, 705
Electric	3, 820, 470	3, 782, 717	6, 039, 008	7, 142, 384	6, 797, 923	7, 280, 191
Total	81, 896, 103	77, 978, 176	96, 836, 075	105, 199, 848	93, 168, 039	111, 609, 719
Capacity, annual, as of January 1	93, 304, 568	96, 120, 930	99, 392, 800	104, 229, 650	108, 587, 670	117, 547, 470
Percent of capacity	87. 8	81. 1	97. 4	100. 9	85. 8	94. 9
Production of alloy steel:						
Stainless	541, 562	455, 093	832, 309	933, 730	930, 164	1, 049, 077
Other than stainless	7, 711, 905	5, 442, 476	7, 737, 796	9, 190, 857	8, 204, 587	9, 279, 117
Total	8, 253, 467	5, 897, 569	8, 570, 105	10, 124, 587	9, 134, 751	10, 328, 194
Shipments of steel products:						
For domestic consumption	56, 011, 865	54, 586, 039	69, 665, 819	76, 164, 539	64, 732, 412	77, 472, 162
For export	3, 836, 378	3, 517, 971	2, 566, 473	2, 764, 411	3, 271, 200	2, 679, 731
Total	59, 848, 243	58, 104, 010	72, 232, 292	78, 928, 950	68, 003, 612	80, 151, 893

[1] Revised figure. [2] American Iron and Steel Institute.

GOVERNMENT REGULATIONS

All controls on iron and steel were revoked during 1953. Orders M–1, governing steel mills as to production of steel mill products, and M–6A, governing receipt and distribution of steel mill products by distributors, were revoked July 1, 1953 at the time the National Production Authority was dissolved. No. 9M–80, requiring all processors and melters to prepare and submit to NPA melting or processing schedules and reports on their inventories of these materials, was transferred to Business and Defense Services Administration and subsequently revoked November 1, 1953.

PRODUCTION AND SHIPMENTS OF PIG IRON

Domestic production of pig iron, exclusive of ferroalloys, was 74.9 million net tons in 1953, 22 percent greater than in 1952 and 7 percent above 1951. Production increased in all States and shipments in all States except Massachusetts. Although 1953 was a record year for pig-iron production, 50 furnaces were out of blast at the end of the year compared with 11 at the end of 1952 and 9 at the end of 1951. During the latter half of 1953 the steel-operating rate decreased more rapidly than blast-furnace operations, accounting for a record high of 2.8 million net tons of pig-iron stocks. Pig-iron production in 1953 consumed 100,324,000 net tons of domestic iron and manganiferous ore and 5,976,000 tons of foreign ores, with 73 percent of the imports coming from Chile, Venezuela, and Canada. Peru, a new source for the United States, suppled 392,300 net tons. Blast furnaces also

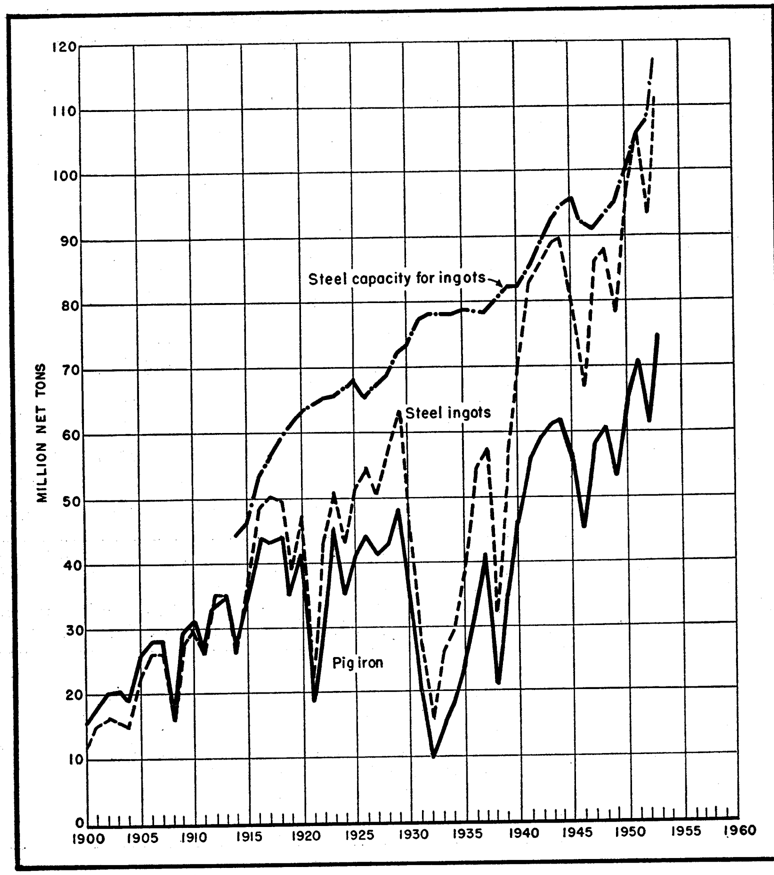

FIGURE 1.—Production of pig iron and steel ingots (1900-53) and steel-ingot capacity (1914-53) in the United States.

consumed 26,892,000 tons of sinter and 11,384,000 tons of miscellaneous iron-bearing materials. In addition to the above raw materials, 2,306,287 tons of home scrap and 465,193 tons of flue dust were used.

Shipments of pig iron increased 21 percent in quantity and 25 percent in value over 1952. The figures in table 4 cover total shipments, which consist predominantly of molten iron transferred to steel furnaces on the site. Values for merchant pig iron are included; however, the average value per ton of pig iron is lower than the market prices published in trade journals because handling charges, selling commissions, freight costs, and other related items are not considered. The term "shipped" is applied to materials involved in interdepartmental transfers within plants, upon which value is placed for bookkeeping purposes, as well as to actual sales.

Metalliferous Materials Used.—The production of pig iron in 1953 required 133,191,839 net tons of iron ore, sinter, and manganiferous iron ore; 4,061,186 tons of mill cinder and roll scale; 4,623,160 tons of open-hearth and Bessemer slags; 2,544,665 tons of purchased scrap;

TABLE 2.—Pig iron produced and shipped in the United States, 1952–53, by States

State	Produced		Shipped from furnaces			
	1952 (net tons)	1953 (net tons)	1952		1953	
			Net tons	Value	Net tons	Value
Alabama	4, 172, 583	4, 663, 278	4, 108, 562	$185, 300, 714	4, 669, 388	$217, 756, 777
California	977, 121	1, 095, 118	974, 953	177, 409, 364	1, 085, 223	222, 456, 852
Colorado, Texas, Utah	2, 624, 715	3, 514, 837	2, 644, 168		3, 408, 758	
Illinois	5, 484, 209	6, 582, 114	5, 461, 716	263, 873, 529	6, 531, 839	325, 582, 535
Indiana	6, 594, 197	8, 349, 930	6, 603, 756	318, 029, 698	8, 372, 193	412, 683, 336
Kentucky	545, 417	790, 206	545, 417	(1)	790, 206	(1)
Maryland	2, 948, 210	3, 760, 809	2, 946, 157	(1)	3, 753, 407	(1)
Massachusetts	124, 897	151, 215	137, 963	(1)	126, 763	(1)
Michigan	2, 083, 677	2, 501, 953	2, 130, 969	(1)	2, 471, 789	(1)
Minnesota	604, 334	667, 074	600, 589	(1)	643, 513	(1)
New York	4, 067, 393	4, 807, 157	4, 025, 323	198, 482, 363	4, 697, 782	237, 030, 016
Ohio	12, 273, 225	15, 147, 940	12, 265, 698	584, 460, 102	15, 025, 152	742, 881, 582
Pennsylvania	16, 890, 004	20, 718, 641	16, 870, 493	829, 288, 945	20, 503, 705	1, 039, 285, 525
Tennessee, West Virginia	1, 918, 442	2, 103, 047	1, 919, 026	(1)	2, 083, 111	(1)
Undistributed [1]				408, 564, 615		497, 770, 509
Total	61, 308, 424	74, 853, 319	61, 234, 790	2, 965, 409, 330	74, 162, 829	3, 695, 447, 132

[1] Data that may not be shown separately because they would reveal individual company operations are combined as "Undistributed."

TABLE 3.—Foreign iron ore and manganiferous iron ore consumed in the manufacture of pig iron in the United States, 1952–53, by sources of ore, in net tons

Source	1952	1953	Source	1952	1953
Africa	435, 607	306, 733	Peru		392, 321
Brazil	378, 610	166, 345	Sweden	633, 724	449, 964
Canada	959, 256	1, 091, 020	Venezuela	1, 031, 891	1, 255, 097
Chile	1, 841, 327	2, 007, 143	Unclassified	58, 012	96, 333
Cuba	44, 313	54, 173			
India	615		Total	5, 520, 938	5, 975, 728
Mexico	137, 583	156, 599			

TABLE 4.—Pig iron shipped from blast furnaces in the United States, 1952–53, by grades [1]

Grade	1952			1953		
	Net tons	Value		Net tons	Value	
		Total	Average		Total	Average
Foundry	2, 674, 827	$122, 952, 546	$45. 97	2, 401, 634	$115, 285, 076	$48. 00
Basic	48, 378, 353	2, 343, 116, 271	48. 43	60, 494, 864	3, 019, 648, 231	49. 92
Bessemer	6, 728, 619	328, 589, 203	48. 83	7, 291, 289	365, 522, 455	50. 13
Low-phosphorus	303, 494	16, 655, 961	54. 88	282, 896	15, 926, 537	56. 30
Malleable	2, 965, 932	144, 951, 694	48. 87	3, 505, 160	169, 624, 571	48. 39
All other (not ferroalloys)	183, 565	9, 143, 655	49. 81	186, 986	9, 440, 262	50. 49
Total	61, 234, 790	2, 965, 409, 330	48. 43	74, 162, 829	3, 695, 447, 132	49. 83

[1] Includes pig iron transferred directly to steel furnaces at same site.

and 154,860 tons of other materials—an average of 1.931 tons of metalliferous materials (exclusive of home scrap and flue dust) per ton of pig iron made.

Alabama furnaces used hematite from the Birmingham district, Missouri, and the Lake Superior region, brown ores from Alabama and Georgia, and byproduct ore from Tennessee. Imported iron ores used were from Brazil and Sweden and foreign manganese-bearing ores from Africa and Brazil.

Blast furnaces at Fontana, Calif., used iron ore from the Eagle Mountain mine, Riverside County, Calif.

Pueblo, Colo., furnaces (Colorado Fuel & Iron Corp.) used iron ore from Wyoming and Utah.

Eighty-two percent of the iron ore used at Sparrows Point, Md., came from Chile and Venezuela. Other foreign sources were Sweden and Mexico; African manganiferous ores were also used.

In addition to the Lake Superior ore used in Pennsylvania, iron ore was used from Africa, Brazil, Cuba, Dominican Republic, Norway, Peru, Sweden, and Venezuela. A small quantity of manganiferous ore from Africa was also used.

Blast furnaces in Illinois, Indiana, Ohio, and West Virginia used iron and manganiferous ores coming mostly from the Lake Superior region of the United States and Canada. Some ore from Africa, Brazil, and Peru was also used.

The Everett, Mass., blast furnace used iron ore from Newfoundland and Spain, 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, as well as some ore from Liberia and manganiferous ores from Minnesota. The Troy furnace consumed magnetite from Chateaugay mine at Lyon Mountain, N. Y., and manganiferous ore from South America. Texas furnaces used brown ores from east Texas and Mexican iron ores; manganese ore from Mexico and Africa was also used.

Utah furnaces used iron ore from Iron County, Utah, and manganiferous ore from Nevada and Utah.

TABLE 5.—Number of blast furnaces (including ferroalloy blast furnaces) in the United States, December 31, 1952–53

[American Iron and Steel Institute]

State	Dec. 31, 1952			Dec. 31, 1953		
	In blast	Out of blast	Total	In blast	Out of blast	Total
Alabama	19	2	21	17	4	21
California	2		2	2	1	3
Colorado	4		4	3	1	4
Illinois	22		22	17	5	22
Indiana	22	1	23	20	3	23
Kentucky	3		3	3		3
Maryland	8		8	9		9
Massachusetts		1	1	1		1
Michigan	7		7	6	1	7
Minnesota	3		3	3		3
New York	17		17	14	3	17
Ohio	50	1	51	41	12	53
Pennsylvania	74	6	80	62	16	78
Tennessee	3		3	2	1	3
Texas	2		2	2		2
Utah	5		5	3	2	5
Virginia	1		1	1		1
West Virginia	5		5	4	1	5
Total	247	11	258	210	50	260

TABLE 6.—Iron ore and other metallic materials consumed and pig iron produced in the United States, 1952–53, by States, in net tons

State	Metalliferous materials consumed					Pig iron produced	Materials consumed per ton of pig iron made			
	Iron and manganiferous iron ores		Sinter	Miscellaneous [1]	Total		Ores	Sinter	Miscellaneous	Total
	Domestic	Foreign								
1952										
Alabama	7, 734, 858	93, 493	1, 743, 039	133, 990	9, 705, 380	4, 172, 583	1. 876	0. 418	0. 032	2. 326
California	952, 606		612, 356	172, 227	1, 737, 189	977, 121	. 975	. 627	. 176	1. 778
Colorado, Texas, Utah	3, 160, 945	131, 675	1, 400, 063	139, 492	4, 832, 175	2, 624, 715	1. 255	. 533	. 053	1. 841
Illinois	9, 607, 782		794, 510	861, 417	11, 263, 709	5, 484, 209	1. 752	. 145	. 157	2. 054
Indiana	10, 898, 052	61, 790	1, 480, 004	695, 179	13, 135, 025	6, 594, 197	1. 662	. 225	. 105	1. 992
Kentucky	849, 905		90, 397	128, 122	1, 068, 424	545, 417	1. 558	. 166	. 235	1. 959
Maryland	355, 085	3, 590, 849	522, 458	635, 510	5, 103, 902	2, 948, 210	1. 338	. 177	. 215	1. 731
Massachusetts	168, 977	57, 083		8, 583	234, 643	124, 897	1. 810		. 069	1. 879
Michigan	2, 946, 089		631, 896	390, 499	3, 968, 484	2, 083, 677	1. 414	. 303	. 188	1. 905
Minnesota	1, 091, 608			158, 239	1, 249, 847	604, 334	1. 806		. 262	2. 068
New York	5, 082, 100	53, 790	1, 873, 408	651, 463	7, 660, 761	4, 067, 393	1. 263	. 460	. 160	1. 883
Ohio	17, 388, 909	643, 759	3, 932, 175	2, 030, 875	23, 995, 718	12, 273, 225	1. 469	. 320	. 166	1. 955
Pennsylvania	21, 087, 233	719, 858	7, 382, 109	2, 893, 234	32, 082, 434	16, 890, 004	1. 291	. 437	. 171	1. 899
Tennessee, West Virginia	2, 718, 235	168, 641	143, 195	144, 512	3, 174, 583	1, 918, 442	1. 505	. 075	. 075	1. 655
Total	84, 042, 384	5, 520, 938	20, 605, 610	9, 043, 342	119, 212, 274	61, 308, 424	1. 461	. 336	. 147	1. 944
1953										
Alabama	8, 615, 911	35, 797	1, 910, 021	225, 421	10, 787, 150	4, 663, 278	1. 855	. 410	. 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

[1] Does not include recycled materials.

PRODUCTION OF STEEL

Steel production increased 20 percent in 1953 over 1952, with a capacity increase during the year of 6,808,000 net tons or 6 percent more than the 117,547,000 tons as of January 1, 1953. Of the total tonnage of steel ingots produced in the United States in 1953, 90 percent was made in open-hearth furnaces compared with 89 percent in 1952 and 88 percent in 1951; 7 percent was made in electric furnaces, unchanged since 1951; and 3 percent in Bessemer converters compared with 4 percent in 1952 and 5 percent in 1951 and 1950.

In 1953, 37 percent of the domestic steel was produced in the Pittsburgh-Youngstown district, 22 percent in the Chicago district, and 20 percent in the Eastern district compared with 39, 21, and 19 percent, respectively, in 1952. The percentage of steel production in Cleveland-Detroit, Western, and Southern districts remained the same as in 1952—10, 6, and 5 percent, respectively.

Steel-production data used by the Bureau of Mines are furnished by the American Iron and Steel Institute. The output from steel foundries that do not produce steel ingots is not included in the production data.

Alloy Steel.—Alloy-steel data include steels in which the minimum of the range specified in 1 or more of the elements named exceeds the following percentages: Manganese, 1.65 percent; silicon, 0.60 percent; copper, 0.60 percent; or aluminum, boron, chromium, cobalt, columbium, molybdenum, nickel, titanium, tungsten, vanadium, zirconium, and other alloying elements, any added percent.

The 1953 steel production includes 10,328,194 net tons of alloy steel, a 13-percent increase over 1952, representing 9 percent of total steel output compared with 10 percent in 1952 and 1951.

The production of stainless steel, which represented 10 percent of alloy-steel output, had its first million-ton year with the production of 1,049,000 net tons of ingots. The production of austenitic stainless steel, AISI 300 series, decreased 1 percent from the 1952 output, while ferritic and martensitic, AISI 400 series, increased 30 percent over 1952. The production of AISI type 430, which is widely used for automobile trim, increased 43 percent over 1952. The output of type

TABLE 7.—Steel capacity, production, and percentage of operations, in the United States, 1944–48 (average) and 1949–53, 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
1944–48 (average)	93, 304, 568	73, 845, 894	4, 229, 739	3, 820, 470	81, 896, 103	87.8
1949	96, 120, 390	70, 248, 803	3, 946, 656	3, 782, 717	77, 978, 176	81.1
1950	99, 392, 800	86, 262, 509	4, 534, 558	6, 039, 008	96, 836, 075	97.4
1951	104, 229, 650	93, 166, 518	4, 890, 946	7, 142, 384	105, 199, 848	100.9
1952	108, 587, 670	82, 846, 439	3, 523, 677	6, 797, 923	93, 168, 039	85.8
1953	[1]117,547,470	100, 473, 823	3, 855, 705	7, 280, 191	111, 609, 719	94.9

[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.

501, 502, and other high-chromium heat-resisting steel, included in the stainless-steel production figures, decreased 31 percent from 1952. Boron-steel production decreased 29 percent from 1952, indicating a sharp decline of the use of boron in steel. The percentages of alloy steel produced in basic open-hearth, acid open-hearth, and electric furnaces were 64, 2, and 34 percent, respectively, remaining the same as in 1952.

Metalliferous Materials Used.—Scrap and pig iron used in steel furnaces in 1953 totaled 124.9 million net tons. The percentage of each used was 47 and 53, respectively, compared with 49 and 51 in 1952. In addition, steel furnaces used 4,178,000 tons of domestic

TABLE 8.—Open-hearth steel ingots and castings manufactured in the United States, 1944–48 (average) and 1949–53, by States, in net tons [1]

[American Iron and Steel Institute]

State	1944–48 (average)	1949	1950	1951	1952	1953
New England States	425, 549	381, 763	485, 007	535, 014	436, 993	489, 967
New York and New Jersey	3, 982, 198	4, 020, 711	4, 820, 177	5, 271, 387	[2] 4, 521, 685	[2] 5, 771, 684
Pennsylvania	21, 985, 550	19, 759, 983	24, 610, 259	26, 977, 599	24, 224, 361	28, 805, 249
Ohio	13, 586, 677	12, 215, 389	15, 200, 938	16, 842, 144	14, 759, 616	17, 570, 814
Indiana	10, 020, 889	9, 099, 413	11, 055, 043	11, 888, 961	10, 414, 109	13, 818, 187
Illinois	5, 927, 339	5, 886, 460	6, 831, 337	7, 271, 633	6, 508, 525	7, 735, 397
Other States	17, 917, 692	18, 885, 084	23, 259, 748	24, 379, 780	21, 981, 150	26, 282, 525
Total	73, 845, 894	70, 248, 803	86, 262, 509	93, 166, 518	82, 846, 439	100, 473, 823

[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 in "Other States."

TABLE 9.—Bessemer-steel ingots and castings manufactured in the United States 1944–48 (average) and 1949–53, by States, in net tons [1]

[American Iron and Steel Institute]

State	1944–48 (average)	1949	1950	1951	1952	1953
Ohio	1, 900, 852	1, 760, 006	2, 000, 294	2, 208, 456	1, 922, 776	2, 326, 983
Pennsylvania	1, 375, 653	1, 174, 866	1, 293, 746	1, 345, 297	751, 297	689, 814
Other States	953, 234	1, 011, 784	1, 240, 518	1, 337, 193	849, 604	838, 908
Total	4, 229, 739	3, 946, 656	4, 534, 558	4, 890, 946	3, 523, 677	3, 855, 705

[1] Includes only that portion of steel for castings produced in foundries by companies manufacturing steel ingots. See table 7.

TABLE 10.—Steel electrically manufactured in the United States, 1944–48 (average) and 1949–53, in net tons [1]

[American Iron and Steel Institute]

Year	Ingots	Castings	Total [2]	Year	Ingots	Castings	Total [2]
1944–48 (average)	3, 729, 324	91, 146	3, 820, 470	1951	7, 043, 366	99, 018	7, 142, 384
1949	3, 687, 077	95, 640	3, 782, 717	1952	6, 703, 734	94, 189	6, 797, 923
1950	5, 927, 509	111, 499	6, 039, 008	1953	7, 226, 030	54, 161	7, 280, 191

[1] Includes only that portion of steel for castings produced in foundries operated by companies manufacturing steel ingots. See table 7.
[2] Includes a very small quantity of crucible steel.

TABLE 11.—Alloy-steel ingots and castings manufactured in the United States, 1944–48 (average) and 1949–53, by processes, in net tons [1]

[American Iron and Steel Institute]

Process	1944–48 (average)	1949	1950	1951	1952	1953
Open hearth:						
Basic	5,639,646	4,192,344	5,738,067	6,585,635	5,807,191	6,599,038
Acid	232,786	105,550	123,253	238,034	218,867	185,341
Crucible } Electric	2,381,035	1,599,675	2,708,785	3,300,918	3,108,693	3,543,815
Total	8,253,467	5,897,569	8,570,105	10,124,587	9,134,751	10,328,194

[1] Includes only that portion of steel for castings produced in foundries operated by companies manufacturing steel ingots. See table 7.

iron ore and 3,457,000 tons of foreign ore; the latter originated in Africa, Brazil, Chile, Dominican Republic, Mexico, Peru, Sweden, Venezuela, and Cuba, with small tonnages from Canada and Puerto Rico. Also used was 1,817,772 tons of sinter made from both foreign and domestic ores.

Iron ore is employed both as a part of the charge and as a source of oxygen in the refining process. The ore for the first use is termed "charge ore" and for the second "feed ore." The characteristics required of charge and feed ores are similar—hard lump structure, high iron content, and freedom from fines.

TABLE 12.—Metalliferous materials consumed in steel furnaces in the United States, 1944–48 (average) and 1949–53, in net tons

Year	Iron ore		Sinter	Manganese ore		Pig iron	Ferro-alloys	Iron and steel scrap
	Domestic	Foreign		Domestic	Foreign			
1944–48 (average)	3,828,895	471,468	1,179,359	2,246	5,269	48,300,126	1,326,000	43,904,104
1949	3,152,797	1,107,625	1,051,746	1,231	3,033	46,502,503	950,000	40,428,214
1950	3,495,862	1,799,089	1,310,471	2,877	1,335	56,269,610	1,320,000	51,091,581
1951	3,774,770	2,369,165	1,701,404	660	2,847	61,750,383	1,470,000	57,087,329
1952	3,511,221	2,275,868	1,614,512	15	1,935	53,491,734	1,461,000	52,217,060
1953	4,178,398	3,459,075	1,817,722	3,742	575	65,839,018	1,700,000	59,100,900

CONSUMPTION OF PIG IRON

Consumption of pig iron in 1953 increased 21 percent over the 1952 figure. Pig iron, a product of the blast furnace, is a semiraw material; except for a small quantity used in direct casting it moves to steelmaking or ironmelting furnaces for refining, alone or mixed with other ingredients. In 1953, 88 percent of the pig iron went to steelmaking furnaces (open-hearth, Bessemer, and electric) to be processed into steel, 4 percent was used to make direct castings, and 8 percent was consumed in ironmaking furnaces. The percentage changes that occurred in 1953 compared with 1952 consumption of pig iron are as follows: Open-hearth increased 24 percent; Bessemer increased 9 percent; and cupola, the major iron-furnace consumer, increased 1 percent. There was little change in other consumers.

TABLE 13.—Consumption of pig iron in the United States, 1950–53, by type of furnace

Type of furnace or equipment	1950		1951		1952		1953	
	Net tons	Percent of total	Net tons	Percent of total	Net tons	Percent of total	Net tons	Percent of total
Open-hearth	50,946,134	78.5	56,055,103	78.5	49,374,315	80.2	61,306,565	82.1
Bessemer	5,169,835	8.0	5,551,149	7.8	3,998,751	6.5	4,351,117	5.8
Electric	153,641	.2	144,131	.2	118,668	.2	181,336	.3
Cupola	6,059,188	9.3	6,559,800	9.2	5,438,294	8.8	5,549,522	7.4
Air	---	---	---	---	---	---	---	---
Brackelsberg	334,613	.5	400,267	.5	317,500	.5	313,054	.4
Crucible	1,190	(1)	243	(1)	152	(1)	268	---
Puddling	3,168	(1)	---	---	---	---	---	---
Direct castings	2,275,349	3.5	2,703,624	3.8	2,303,281	3.8	3,005,882	4.0
Total	64,943,118	100.0	71,414,317	100.0	61,550,961	100.0	74,707,744	100.0

[1] Less than 0.05 percent.

TABLE 14.—Consumption of pig iron in the United States, 1945–49 (average) and 1950–53 by States and districts

State and district	1945–49 (average)		1950		1951 [1]	1952 [1]	1953 [1]
	Consumers	Net tons	Consumers	Net tons	Net tons	Net tons	Net tons
Connecticut	58	83,021	54	75,868	83,101	60,598	63,436
Maine	15	11,251	13	9,657	9,647	4,072	5,928
Massachusetts	99	186,439	101	218,931	231,897	165,324	174,513
New Hampshire	16	5,620	16	4,190	4,762	4,607	3,503
Rhode Island	12	30,756	15	41,223	57,792	46,842	49,432
Vermont	13	8,913	13	8,783	17,331	14,643	8,974
Total New England	213	326,000	212	358,652	404,530	296,086	305,786
New Jersey	78	[2] 325,776	73	274,116	295,182	244,320	200,572
New York	178	2,673,682	163	3,060,001	3,416,408	3,128,013	3,689,763
Pennsylvania	386	15,791,488	347	18,315,008	20,314,328	17,026,406	20,608,854
Total Middle Atlantic	642	18,790,946	583	21,649,125	24,025,918	20,398,739	24,499,189
Illinois	213	4,446,860	204	5,465,752	5,948,201	4,893,725	6,055,031
Indiana [3]	134	6,417,818	132	7,480,127	8,339,759	7,044,738	[3] 8,928,835
Michigan	173	[4] 2,630,944	171	3,687,724	3,605,019	3,294,753	3,811,411
Ohio [3]	316	10,681,549	283	11,667,857	13,230,964	11,650,525	[3] 14,641,399
Wisconsin	120	(4)	123	295,792	341,120	278,670	258,786
Total East North Central	956	24,177,171	913	28,597,252	31,465,063	27,162,411	33,695,462
Iowa	54	96,983	54	101.702	152,275	101,833	89,467
Kansas	24	17,101	21	16,887	10,395	6,682	12,378
Nebraska	11		10				
Minnesota	59	431,588	59	542,101	620,166	506,084	518,930
North Dakota	1	323	2				
South Dakota	1		2				
Missouri	52	86,427	45	86,939	103,115	80,995	77,075
Total West North Central	202	632,422	193	747,629	885,951	695,594	697,850
Delaware	7	(2)	6	3,666,178	3,871,880	3,144,907	3,919,420
District of Columbia	2	[5] 3,172,278	1				
Maryland	22		18				
Florida	16	43,737	13	86,243	79,929	60,528	65,111
Georgia	51		49				
North Carolina	47	24,043	52	30,658	29,946	27,194	22,644
South Carolina	16	7,727	16	11,424	21,521	12,911	10,501
Virginia	52	[6] 221,430	49	1,952,608	1,929,435	1,862,646	1,933,541
West Virginia	25	1,422,856	22				
Total South Atlantic	238	4,892,071	226	5,747,111	5,932,711	5,108,186	5,951,217

See footnotes at end of table.

TABLE 14.—Consumption of pig iron in the United States, 1945–49 (average) and 1950–53 by States and districts—Continued

State and district	1945–49 (average)		1950		1951 [1]	1952 [1]	1953 [1]
	Consumers	Net tons	Consumers	Net tons	Net tons	Net tons	Net tons
Alabama	70	3, 092, 421	79	3, 777, 495	3, 902, 199	3, 527, 809	4, 163, 931
Kentucky	24	(5)	22				
Mississippi	8	1, 887	8	973, 876	1, 041, 910	845, 718	1, 055, 604
Tennessee	53	(6)	51				
Total East South Central	155	3, 094, 308	160	4, 751, 371	4, 944, 109	4, 373, 527	5, 219, 535
Arkansas	4		5				
Louisiana	12	6, 474	11	7, 280	13, 981	11, 961	12, 464
Oklahoma	10		15				
Texas	38	155, 598	45	356, 724	578, 593	418, 964	568, 161
Total West South Central	64	162, 072	76	364, 004	592, 574	430, 925	580, 625
Arizona							
Nevada	4	963	3	1, 520	866	144	195
New Mexico							
Colorado	28	1, 257, 547	25	1, 766, 874	1, 864, 848	1, 776, 397	2, 506, 885
Utah							
Montana			3	207	276	181	243
Idaho	6	1, 245	2	167	689	504	235
Wyoming			2	4			
Total Mountain	38	1, 259, 755	35	1, 768, 772	1, 866, 679	1, 777, 226	2, 507, 558
California	119	586, 166	105	937, 740	1, 271, 574	1, 288, 561	1, 233, 898
Oregon	27	24, 526	24	21, 462	25, 208	19, 706	15, 357
Washington	33		28				
Total Pacific	179	610, 692	157	959, 202	1, 296, 782	1, 308, 267	1, 249, 255
Undistributed [3]							1, 267
Total United States	2, 687	53, 945, 437	2, 555	64, 943, 118	71, 414, 317	61, 550, 961	74, 707, 744

1 Consumption for 1951–53 from sample canvasses; therefore, exact number of consumers by States not available.
2 Delaware included with New Jersey.
3 Small tonnage of pig iron in Indiana and Ohio, not separable, included with "Undistributed".
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 given in the accompanying table is compiled from producers' reports to the Bureau of Mines. The figures represent value f. o. b. blast furnaces and do not include the value of ferroalloys. The average value for all grades of pig iron at furnaces was $49.83 in 1953 compared with $48.43 in 1952. Table 17 has been changed to cover the weighted average f. o. b. value of all grades of steel. This table in previous years covered prices of 10 major carbon-steel products as published by The Iron Age.

TABLE 15.—Average value of pig iron at blast furnaces in the United States, 1944–48 (average) and 1949–53, by States, per net ton

State	1944–48 (average)	1949	1950	1951	1952	1953
Alabama	$24.57	$35.79	$39.00	$43.87	$45.10	$46.63
California, Colorado, and Utah	27.77	42.92	44.52	48.50	50.83	51.14
Illinois	27.28	41.69	42.77	46.53	48.31	49.85
Indiana	28.02	41.26	42.43	46.59	48.16	49.29
New York	25.32	43.81	42.68	48.01	49.31	50.46
Ohio	27.85	40.92	42.38	45.67	47.65	49.44
Pennsylvania	27.25	43.04	43.09	47.08	49.16	50.69
Other States [1]	27.47	44.59	44.73	47.98	48.70	49.79
Average	27.21	42.05	42.85	46.75	48.43	49.83

[1] Comprises Kentucky, Maryland, Massachusetts, Michigan, Minnesota, Tennessee, Texas, Virginia, and West Virginia.

TABLE 16.—Average monthly prices per net ton of chief grades of pig iron, 1952–53

[Metal Statistics, 1954]

Month	Foundry pig iron at Birmingham furnaces		Foundry pig iron at Valley furnaces		Bessemer pig iron at Valley furnaces		Basic pig iron at Valley furnaces	
	1952	1953	1952	1953	1952	1953	1952	1953
January	$43.64	$45.88	$46.87	$49.11	$47.32	$49.55	$46.43	$48.66
February	43.64	45.88	46.87	49.11	47.32	49.55	46.43	48.66
March	43.64	45.88	46.87	49.11	47.32	49.55	46.43	48.66
April	43.64	45.88	46.87	49.11	47.32	49.55	46.43	48.66
May	43.64	45.88	46.87	49.11	47.32	49.55	46.43	48.66
June	43.64	45.88	46.87	49.11	47.32	49.55	46.43	48.66
July	44.04	47.21	47.28	50.45	47.72	50.89	46.83	50.00
August	45.88	47.21	49.11	50.45	49.55	50.89	48.66	50.00
September	45.88	47.21	49.11	50.45	49.55	50.89	48.66	50.00
October	45.88	47.21	49.11	50.45	49.55	50.89	48.66	50.00
November	45.88	47.21	49.11	50.45	49.55	50.89	48.66	50.00
December	45.88	47.21	49.11	50.45	49.55	50.89	48.66	50.00
Average	44.61	46.54	47.84	49.78	48.29	50.22	47.39	49.33

FOREIGN TRADE [2]

Imports and exports of pig iron both increased in 1953; but steel exports decreased, and imports increased. Canada and Australia supplied 82 percent of the pig-iron imports. Exports of pig iron totaled 18,837 net tons ($1,073,776), of which Canada and the United Kingdom received 84 percent.

Steel sheets (uncoated), tinplate and terneplate, and casing and line pipe headed the principal export list. Structural iron and steel, sheets and plates, and pipes and tubes made up 59 percent of the major imports.

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

TABLE 17.—F. o. b. value of steel mill products in the United States, 1951–53, in cents per pound[1]

Product	1951				1952				1953			
	Carbon	Alloy	Stainless	Average	Carbon	Alloy	Stainless	Average	Carbon	Alloy	Stainless	Average
Ingots	3.985	6.803	19.272	4.408	4.124	6.963	17.632	4.425	3.881	7.577	21.889	4.383
Semifinished shapes and forms					4.253	7.363	22.154	4.864	4.550	7.647	21.595	5.138
Plates	4.427	10.448	43.439	4.822	4.567	11.163	59.022	5.052	4.893	11.787	56.437	5.405
Sheets and strips	5.499	11.014	40.417	6.321	5.536	11.558	42.463	6.418	5.790	11.646	43.585	6.675
Tin-mill products	7.662			7.662	7.780			7.780	7.849			7.849
Structural shapes and piling	4.251	(2)		4.251	4.399	5.764		4.430	4.672	5.585		4.683
Bars	5.222	9.986	45.035	6.583	5.376	10.090	46.715	6.741	5.794	10.721	50.133	7.164
Rails and railway-track material	4.585			4.585	4.728			4.728	5.024			5.024
Pipes and tubes	7.325	13.961	116.768	7.908	7.620	15.539	135.589	8.434	7.966	15.831	124.170	8.790
Wire and wire products	8.509	22.503	54.645	9.038	8.744	20.621	63.935	9.426	9.367	25.725	62.485	10.072
Other rolled and drawn products	6.510	10.615	49.563	7.307	6.033	17.281	45.820	7.981	6.481	17.573	47.510	8.459
Average total steel	5.629	10.308	40.419	6.245	5.772	10.590	44.853	6.468	6.058	11.223	44.881	6.789

[1] Computed from figures supplied by Bureau of the Census.
[2] Included in "Other rolled and drawn products."

TABLE 18.—Pig iron imported for consumption in the United States, 1944–48 (average) and 1949–53, by countries, in net tons

[U. S. Department of Commerce]

Country	1944–48 (average)	1949	1950	1951	1952	1953
North America:						
Canada	7,195	12,270	195,807	220,094	[1] 288,722	305,256
Mexico	2,451					
South America:						
Argentina	(2)					
Brazil	110			33,936		
Chile			7,583	57,241	2,577	
Europe:						
Austria	3,885	5,145	56,635	82,628	11,071	
Belgium-Luxembourg	6,630	15,688	8,086	16,605	3,045	
Finland						168
France	3,575	340	37,640	37,323	343	
Germany	4,912	2,383	225,132	331,244	[3] 16,203	[3] 3,539
Italy	1,000			123	1	
Netherlands	9,546	20,527	243,434	99,189	12,735	18,475
Norway	6,680	146	5,364	15,352	[1] 6,369	2,692
Poland	1,493					
Spain				34,048	25,224	4,665
Sweden	266	436	14,798	43,822	2,096	56,633
Turkey				36,587	622	
U. S. S. R.	272					
United Kingdom	2,021	193	2,816	3,957		
Asia: India	3,220	23,077	7,168	34,158		12,659
Africa:						
Southern Rhodesia						6,606
Union of South Africa			336	20,206		
Oceania: Australia	5,380	19,599			11,192	179,132
Total: Net tons	58,636	99,804	804,799	1,066,513	[1] 380,200	589,825
Value	$2,919,775	$4,591,779	$26,237,334	$49,169,985	[1]$19,846,695	$25,967,435

[1] Revised figure.
[2] Less than 1 ton.
[3] West Germany.

TABLE 19.—Major iron and steel products imported for consumption in the United States, 1951–53

[U. S. Department of Commerce]

Products	1951		1952		1953	
	Net tons	Value	Net tons	Value	Net tons	Value
Semimanufactures:						
Steel bars:						
Concrete reinforcement bars	138,534	$14,818,748	[1] 130,477	[1] $13,850,685	107,818	$8,203,852
Solid or hollow, n. e. s.	246,489	25,027,123	[1] 103,431	[1] 13,954,601	98,963	10,236,975
Hollow and hollow drill steel	944	270,536	588	241,121	539	182,154
Iron slabs, blooms, or other forms	5	765	110	12,488		
Bar iron	695	108,286	208	45,187	174	42,614
Wire rods, nail rods, and flat rods up to 6 inches in width	122,009	12,094,127	[1] 44,404	5,636,629	65,418	6,939,265
Boiler and other plate iron and steel, n. e. s.	585,529	74,073,926	143,837	17,466,883	132,984	15,914,998
Steel ingots, blooms, and slabs	40,227	3,019,220	8,195	1,500,626	48,536	4,167,762
Billets, solid or hollow	99,401	8,470,562	[1] 53,266	[1] 6,284,020	85,151	9,994,140
Die blocks or blanks, shafting, etc.	1,142	274,858	827	486,591	421	118,851
Circular saw plates	35	25,260	14	11,672	17	16,362
Sheets of iron or steel, common or black and boiler or other plate iron or steel	71,542	10,308,898	29,699	3,768,689	325,090	43,733,940
Sheets and plates and steel, n. s. p. f.	36,461	4,499,488	11,068	1,106,692	2,968	379,153
Tinplate, terneplate, and taggers' tin	445	88,213	2,550	530,076	419	79,079
Total semimanufactures	1,343,458	153,080,010	[1] 528,674	[1] 64,895,960	868,498	100,009,145

[1] Revised figure.

TABLE 19.—Major iron and steel products imported for consumption in the United States, 1951–53—Continued

[U. S. Department of Commerce]

Products	1951		1952		1953	
	Net tons	Value	Net tons	Value	Net tons	Value
Manufactures:						
Structural iron and steel	459, 919	$46, 914, 054	[1] 319, 455	$35, 957, 687	458, 555	$39, 909, 272
Rails for railways	11, 026	561, 766	3, 687	236, 444	2, 005	137, 393
Rail braces, bars, fishplates, or splice bars and tie plates	118	9, 343	641	40, 264	1, 041	83, 925
Pipes and tubes:						
Cast-iron pipe and fittings	6, 932	733, 645	5, 308	675, 862	3, 818	454, 307
Other pipes and tubes	239, 798	40, 005, 096	274, 066	64, 506, 357	237, 804	53, 305, 392
Wire:						
Barbed	7, 245	1, 082, 260	26, 252	3, 981, 349	16, 089	1, 865, 856
Round wire, n. e. s	26, 977	3, 793, 165	9, 217	1, 535, 857	17, 494	2, 383, 102
Telegraph, telephone, etc., except copper, covered with cotton jute, etc	860	325, 594	[1] 217	262, 266	171	190, 297
Flat wire and iron or steel strips	41, 219	8, 808, 230	7, 194	3, 708, 208	33, 915	7, 423, 996
Rope and strand	4, 346	1, 426, 796	[1] 3, 377	[1] 1, 316, 523	4, 341	1, 605, 001
Galvanized fencing wire and wire fencing	1, 466	185, 472	[1] 1, 697	[1] 247, 195	3, 442	365, 695
Hoop or band iron or steel, for baling	14, 547	1, 436, 478	7, 324	1, 049, 706	13, 703	1, 452, 575
Hoop, band and strips, or scroll iron or steel, n. s. p. f	71, 705	7, 459, 013	[1] 20, 288	[1] 2, 232, 007	32, 543	3, 005, 487
Nails	56, 419	7, 795, 986	18, 520	3, 030, 927	40, 244	5, 385, 895
Castings and forgings, n. e. s	3, 235	1, 020, 793	[1] 4, 693	[1] 1, 362, 923	6, 325	1, 835, 340
Total manufactures	945, 812	121, 557, 691	[1] 701, 936	[1] 120, 143, 575	871, 490	119, 403, 533
Grand total	2, 289, 270	274, 637, 701	[1] 1, 230, 610	[1] 185, 039, 535	1, 739, 988	219, 412, 678

[1] Revised figure.

TABLE 20.—Major iron and steel products exported from the United States, 1951–53

[U. S. Department of Commerce]

Products	1951		1952 [1]		1953 [1]	
	Net tons	Value	Net tons	Value	Net tons	Value
Semimanufactures:						
Steel ingots, blooms, billets, slabs, and sheet bars	134, 527	$11, 971, 343	732, 185	$66, 321, 638	89, 620	$8, 140, 371
Iron and steel bars and rods:						
Iron bars	2, 941	499, 453	1, 479	216, 940	519	166, 770
Concrete reinforcement bars	44, 426	4, 820, 793	93, 186	10, 382, 546	53, 354	5, 574, 688
Other steel bars	150, 436	21, 117, 654	[2] 164, 960	[2] 26, 091, 506	122, 828	18, 767, 586
Wire rods	4, 148	481, 320	29, 681	3, 312, 103	9, 489	1, 232, 367
Iron and steel plates, sheets, skelp, and strips:						
Plates, including boiler plate, not fabricated	160, 542	19, 322, 830	232, 075	27, 025, 828	201, 765	24, 871, 357
Skelp iron and steel	107, 878	8, 946, 310	124, 497	11, 407, 272	98, 717	8, 672, 578
Iron and steel sheets, galvanized	68, 087	12, 515, 185	64, 045	12, 389, 082	110, 590	20, 423, 943
Steel sheets, black, ungalvanized	525, 081	80, 998, 187	[2] 601, 003	[2] 92, 271, 322	517, 802	79, 862, 020
Iron sheets, black	14, 050	1, 773, 745	(3)	(3)	(3)	(3)
Strip, hoop, band, and scroll iron and steel:						
Cold-rolled	52, 625	13, 903, 833	59, 862	15, 308, 477	42, 527	12, 185, 977
Hot-rolled	60, 589	7, 899, 601	69, 765	9, 094, 492	51, 535	6, 725, 892
Tinplate and terneplate	558, 664	113, 562, 793	599, 160	116, 325, 825	514, 797	94, 690, 106
Total semimanufactures	1, 883, 994	297, 813, 047	[2] 2, 771, 898	[2] 390, 147, 031	1, 813, 543	281, 313, 655

See footnotes at end of table.

TABLE 20.—Major iron and steel products exported from the United States 1951–53—Continued

[U. S. Department of Commerce]

Products	1951		1952 [1]		1953 [1]	
	Net tons	Value	Net tons	Value	Net tons	Value
Manufactures—steel-mill products:						
Structural iron and steel:						
Water, oil, gas, and other storage tanks, complete and knocked-down material	33, 304	$8, 796, 908	[2] 38, 067	[2] $10, 227, 578	69, 508	$16, 359, 762
Structural shapes:						
Not fabricated	232, 035	22, 466, 923	[2] 192, 202	[2] 19, 117, 977	234, 600	24, 533, 010
Fabricated	77, 136	23, 535, 603	[2] 83, 281	[2] 21, 226, 028	61, 604	19, 322, 396
Plates, sheets, fabricated, punched, or shaped	13, 015	3, 621, 664	16, 081	4, 265, 933	16, 606	4, 684, 843
Metal lath	4, 684	1, 326, 342	2, 693	788, 648	1, 936	691, 173
Frames, sashes, and sheet piling	13, 182	2, 136, 551	8, 780	1, 671, 974	12, 241	2, 362, 973
Railway-track material:						
Rails for railways	105, 599	8, 755, 167	168, 101	14, 906, 465	190, 903	18, 991, 036
Rail joints, splice bars, fish-plates, and tie plates	33, 779	4, 411, 717	50, 265	7, 099, 749	51, 557	6, 945, 446
Switches, frogs, and crossings	2, 514	733, 539	6, 622	2, 079, 720	2, 552	959, 837
Railroad spikes	8, 319	1, 466, 060	8, 955	1, 376, 618	4, 935	808, 372
Railroad bolts, nuts, washers, and nut locks	1, 673	463, 363	2, 064	584, 415	1, 741	481, 086
Tubular products:						
Boiler tubes	18, 205	5, 299, 047	36, 798	9, 946, 893	40, 676	10, 225, 487
Casing and line pipe	463, 137	70, 412, 183	502, 611	[2] 81, 275, 642	416, 534	72, 331, 971
Seamless black and galvanized pipe and tubes, except casing, line and boiler, and other pipes and tubes	17, 196	3, 785, 263	[2] 27, 339	[2] 5, 900, 410	32, 207	6, 176, 106
Welded black pipe and tubes	68, 415	11, 096, 062	[2] 51, 406	[2] 8, 853, 874	36, 701	6, 326, 737
Welded galvanized pipe and tubes	44, 005	8, 736, 989	45, 426	8, 919, 059	38, 861	7, 287, 613
Malleable-iron screwed pipe fittings	4, 489	3, 554, 624	3, 805	3, 156, 293	2, 854	2, 217, 071
Cast-iron pressure pipe and fittings	38, 545	4, 594, 174	[2] 43, 387	[2] 6, 172, 820	26, 554	3, 913, 996
Cast-iron soil pipe and fittings	10, 712	2, 083, 057	9, 874	1, 722, 738	8, 458	1, 479, 446
Iron and steel pipe and fittings, n. e. c	54, 576	25, 242, 245	[2] 49, 609	[2] 28, 622, 886	49, 616	26, 568, 565
Wire and manufactures:						
Barbed wire	13, 900	2, 159, 062	6, 663	1, 018, 347	3, 519	564, 137
Galvanized wire	15, 741	3, 070, 636	19, 578	[2] 4, 349, 990	10, 159	2, 393, 379
Iron and steel wire, uncoated	54, 574	10, 197, 841	58, 262	9, 735, 093	25, 639	4, 854, 034
Wire rope and strand	18, 040	8, 200, 077	[2] 15, 564	[2] 7, 284, 225	13, 224	6, 208, 285
Woven-wire fencing and screen cloth	12, 933	4, 910, 328	6, 512	[4] 3, 277, 644	4, 006	[4] 2, 096, 509
All other	38, 004	12, 168, 578	33, 141	[2] 10, 322, 111	29, 289	9, 188, 940
Nails and bolts, iron and steel, n. e. c.:						
Wire nails	8, 737	1, 534, 790	6, 990	1, 960, 237	3, 960	1, 641, 394
All other nails, including tacks and staples	5, 520	2, 241, 352	3, 316	1, 634, 850	2, 277	1, 151, 451
Bolts, machine screws, nuts, rivets, and washers, n. e. c.	21, 594	13, 530, 637	25, 672	17, 383, 888	17, 326	13, 499, 554
Castings and forgings:						
Horseshoes, muleshoes, and calks	568	107, 699	(5)	(5)	(5)	(5)
Iron and steel, including car wheels, tires, and axles	110, 869	20, 195, 167	118, 269	24, 153, 477	102, 785	22, 800, 403
Total manufactures	1, 545, 000	290, 833, 648	[2] 1, 641, 333	[2] 319, 035, 582	1, 512, 828	297, 065, 012
Advanced manufactures:						
House-heating boilers and radiators	----------	1, 709, 679	----------	3, 581, 725	----------	5, 614, 357
Oil burners and parts	----------	8, 333, 848	----------	7, 364, 653	----------	8, 252, 306
Tools (iron and steel chief value)	----------	42, 999, 558	----------	47, 086, 743	----------	41, 916, 336
Total advanced manufactures	----------	53, 043, 085	----------	58, 033, 121	----------	55, 782, 999

[1] Due to changes in classifications some data not strictly comparable to earlier years.
[2] Revised figure.
[3] Effective January 1, 1952, data included with steel sheets, black, ungalvanized.
[4] Includes wire cloth as follows—1952: $1,542,736 (12,667,342 square feet); 1953: $1,060,693 (7,394,124 square feet); weight not available.
[5] Effective January 1, 1952, not separately classified.

TECHNOLOGY

During 1953 experiments were conducted at the Bureau of Mines Pittsburgh Station covering recarburization, decarburization, and desulfurization by pneumatic injection of various materials into the molten steel bath of a 2-ton open-hearth furnace.

Recarburization.—The operators of either cold-metal or hot-metal shops are likely to encounter soft (low-carbon) melts. To make a good-quality steel and meet the carbon specification these heats must be recarburized or diverted to a lower carbon grade of lower quality standards. The conventional method of adding carbon is by the addition of liquid or cold pig iron, which results in an overcharged furnace. This excess molten steel, along with its portion of the added alloys, above the ladle capacity is lost in the slag pot as scrap. Also, the operators of cold-metal shops—the 70-odd furnace plants across the country that have no molten iron available—must add and melt cold pig iron to recarburize. To these operators a soft melt means a great sacrifice of furnace time and temperature.

On a pilot-plant scale the problem of soft melts has been solved by pneumatically injecting materials (coke, anthracite, graphite, and charcoal), rich in fixed carbon, with compressed air directly into the metal bath (weighing 1½ to 2 tons) through a graphite tube. Approximately 1 percent of the bath weight in carbon is injected by 1 cubic foot of air per pound of material, and the injection is completed in 1 minute. Metal, slag, and carbon are mixed well by the air stream, and the reactions are complete in 5 minutes or less. By this means, material containing 70 percent or more fixed carbon is added, and much of the remaining constituents introduced passes off as gases. Since the usual desired melt for most heats is about 0.50 percent carbon, there is no significant increase in bath volume by this method. The heat required to maintain the bath temperature at the desired level above the liquids temperature for this injection is much less than when cold pig iron is used because the 90-odd percent iron contained in cold pig iron is not introduced to be heated up.

Carburization of the metal effected with byproduct coke, anthracite, or graphite averages 56 percent of the fixed carbon injected when the initial metal contained 0.3 to 1.0 percent carbon before the blow. At carbon levels less than 0.3 percent or greater than 1.0 percent the carbon recovery decreases rapidly—the former because of the high oxygen content of the metal and slag which reacts with the carbon and liberates it as a gas and the latter because of the lower rate of solution of carbon in the metal. Of the carburizing materials used, graphite proved the best, but its cost is probably too high for commercial use. A close second is anthracite which has been washed and sized to Buckwheat No. 4 and No. 5, and its cost is much less than that of graphite. Both materials are high in fixed carbon and low in volatile matter, ash, and sulfur and are free-flowing granular particle shape. Byproduct coke was inferior because of its high sulfur and ash content, which required a simultaneous injection of lime to prevent sulfur pickup. Use of ferrosilicon before anthracite gives better recovery of carbon and better temperature control.

Decarburization.—The process of decarburization with oxygen has been well established, but its heavy fuming creates undesirable atmospheric conditions. By using a carefully controlled oxygen-iron oxide feed the fumes are reduced considerably. Nitrogen is a good decarburizer, but there is no pickup in temperature, as with oxygen. Bureau of Mines engineers are working on this problem, using different materials and dust collectors.

Desulfurization.—Elimination of sulfur is one of the most serious problems in the steel industry. It enters molten open-hearth steel through pig iron, scrap, limestone, dolomite, and fluorspar and is absorbed from flame gases. Even with the best control of raw materials and fuels, high sulfur heats are not uncommon. Compared with phosphorus removal, sulfur elimination is inefficient and time consuming. Calcium carbide injected with compressed air into the open-hearth bath at Pittsburgh enabled sulfur to be removed rapidly during the refining period and also at high carbon levels, with an acidic slag corresponding to the runoff slag produced by hot-metal practice.

Blast Furnace.—The iron and steel industry was engaged in abating smoke, dust, and dirt produced by its furnaces. The No. 3 blast furnace at the Monessen works of the Pittsburgh Steel Co. was equipped during the year with gas-cleaning equipment of the electrostatic type and new slag-handling methods to prevent the release of fumes or obnoxious odors during the granulating process. One unit combines coke-oven and blast-furnace gases into a usable uniform fuel. Besides eliminating smoke with this system, there is a daily saving of 1,000 tons of coal, using the fuel produced.[3]

A blast-furnace gas-cleaning plant was installed at the Duquesne works of United States Steel Corp. during the year. This plant is the first of its kind and was designed particularly to eliminate the dust peculiar to ferromanganese operations. The unit includes 5 electrostatic precipitators having a combined capacity of 135,000 c. f. m. Auxiliary equipment includes facilities for handling and disposing of the dust. The flue dust contained about 18 percent manganese and was stockpiled. Economical methods for recovery of the manganese are now being studied. In addition to a cleaner atmosphere at this plant, boiler operation improved due to clean gas.[4]

A new development during the year for blast-furnace gas-cleaning precipitators was a solenoid-actuated magnetic impulse system which reportedly cleans precipitators in 60-second cycles.[5]

Another operating procedure reported on during the year was that of blowing in a blast furnace through the iron notch. It is claimed that, by this procedure, the time of returning a banked furnace to 80-percent normal blast has been reduced from 72 hours to 30.[6]

Low-Shaft Blast Furnace.—The experimental low-shaft blast furnace, built at Liège, Belgium was blown in, in the middle of 1953. This 80-ton-per-day iron furnace was built to utilize low-grade ore and fuels less costly than metallurgical coke and is designed to use an oxygen blast enriched up to 50 percent. In addition to raw materials studies, high-top pressure techniques and metal refining will be tested. The project is sponsored by the International Com-

[3] Madsen, I. E., Developments in the Iron and Steel Industry During 1953: Iron and Steel Eng., vol. 31, No. 1, January 1954, pp. 120–156.
[4] Steel, vol. 133, No. 5, August 3, 1953, p. 106.
[5] Work cited in footnote 3.
[6] Steel, vol. 132, No. 22, June 1, 1953, pp. 120, 122, 126.

mittee for Research on the Low-Shaft Furnace, which is composed of members from seven European countries and the United States.[7]

Electric Furnaces vs. Open-Hearth Furnaces.—In 1953 there were a number of studies concerned with the comparative cost of electric and open-hearth furnaces and the production of carbon steel in large basic electric furnaces. Throughout the war-years 1942–45 the quantity of carbon steels produced in electric furnaces was between 15 and 20 percent of the total electric-furnace steel production. In 1946 this figure rose to 36 percent, and from 1947 to 1953 it ranged between 52 and 60 percent. This increase, plus the fact that electric steelmaking capacity has increased from 2.6 million net tons in 1942 to 10.5 million by the end of 1953, shows the trend toward carbon steel production in the electric furnace. A technical report presented during the year predicted that, by 1975, 30 percent of the carbon steel produced in this country will be made in electric furnaces.[8]

The many improvements and developments in electric furnace steelmaking since World War II have placed them on a competetive basis with open hearths. The most important of these were the swing roof, high rates of energy input, and increased furnace size, which contribute toward an increased tonnage per hour and lower current consumption. A study by the Battelle Memorial Institute [9] shows that capital cost of electric furnaces is only 60 percent of the cost of open hearths; that the cold-charge process (scrap and pig iron) favors electric furnaces in cost; and, with the 50 percent hot metal-50 percent scrap process, the annual return with electric furnaces is equal to or greater than open hearths. Some other advantages of electric furnaces are:

(1) Flexibility; they can be put into production or withdrawn at will while the roofs and other brickwork of open-hearths tend to fall in.

(2) The annual down time for electric furnaces is about 15 days compared with 30 days for open hearths.

(3) The metallic yield is about 2 percent greater than with open hearths.

(4) Electric furnaces give better control of sulfur.

In favor of the open hearths is the fact that most of these furnaces in the United States are either comparatively new or have been modernized. It is, therefore, unlikely that they will be taken out of service within the next 20 to 25 years. However, much future expansion will probably be in electric furnaces because of their lower investment cost.

The largest electric furnaces in the world were under construction for McLouth Steel Corp., Detroit, Mich. These 2 furnaces are 24 feet, 6 inches, in diameter and are equipped with 25,000 kv.-a. transformers which have heat exchangers to increase their rating to 33,000 kv.-a. The 200-ton furnaces will use blown metal from a basic converter equipped with surface oxygen-blowing equipment.[10]

Induction Stirring.—A number of papers were given on induction stirring for electric arc furnaces. The stirrer was invented and

[7] Iron and Coal Trades Review, vol. 158, No. 4451, July 31, 1953, pp. 253–258.
[8] Steel, vol. 133, No. 17, Oct. 26, 1953, p. 120.
[9] Battelle Memorial Institute, Comparative Economics of Open-Hearth and Electric Furnaces for Production of Low-Carbon Steel: Columbus, Ohio, 1953, p. 45.
[10] Steel, vol. 133, No. 8, Aug. 24, 1953, p. 86.

developed by ASEA (Allmanna Venska Elektriska Aktiebolaget) in Sweden in 1936 under the guidance of L. Dryfus. Stirrers were installed in Sweden in 1939, 1947, and 1948. The last two are still operating, but the 1939 stirrer has been taken out of service because of operating difficulties. In October 1952 the first stirrer, built by the Elliott Co., Ridgway, Pa., was placed in operation at Canton, Ohio, by the Timken Roller Bearing Co. on a 100-ton, top-charge, electric-arc furnace. The stirrer has been described as a segment of the stator of a gigantic induction motor. In principle the stirrer works as an induction motor, in which the molten bath acts as the rotor. The power supply is a very low frequency—1 cycle or less per second—which gives a metal surface speed of about 1 to 2 feet per second.

Some advantages of induction stirring follow:

(1) Saving in furnace time, largely because of faster slag-metal reactions and faster melting of scrap that hangs on the furnace sides by undercutting it with molten metal.

(2) A much easier slagging-off operation.

(3) A more uniform temperature in all parts of the mass, as well as more rapid distribution of alloying elements.

(4) Lower final sulfur levels.

(5) Improved steel surface quality.[11]

Linz-Donawitz Process.—A new process for producing steel by top-blowing molten pig iron in a solid-bottom basic converter with oxygen has been developed in Austria. It has been named the Linz-Donawitz process after the towns in which the two steel plants employing this process are located. High-purity oxygen at 4 to 12 atmospheres pressure is blown through a water-cooled copper nozzle placed vertically about 10 inches above the melt. The charge of the 30-ton converter consists of pig iron, scrap (15 percent), and limestone. Metallic recovery runs 90 percent and the slag volume 12 to 15 percent (at 11 to 18 percent Fe). Analyses of the deep-drawing-quality steel produced are 0.030 percent maximum nitrogen and less than 0.035 percent phosphorus.[12]

Planetary Mill.—Hot-rolled steel strip is being produced on the first planetary hot mill at Willenhall, England. The mill consists of 2 assemblies, each consisting of a number of 2-inch-diameter planetary rolls equally spaced around the circumference of a 20-inch backup roll. The backup rolls are driven by a 900-hp. constant-speed motor operating at 500 r. p. m. Immediately following the planetary rolls is a two-high planishing stand, which further reduces the thickness and gives a flat, hot-rolled finish to the surface. It is claimed that a reduction of up to 90 percent can be achieved in 1 pass. Another planetary mill is under construction for Atlas Steels, Ltd., Welland, Ontario, Canada.[13]

In the tinplate field, the Mellon Institute has developed an organic coating, which when applied to sheet steel may be a satisfactory re-

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[11] Malmlow, Eric G., The Development of Induction Stirring: Pres. at AIME Electric Furnace Conference, Cincinnati, Ohio, Dec. 2-4, 1953.
Walther, Harry F., Induction Stirring Provides Better Control of Operating Techniques: Pres. at AIME Electric Furnace Conference, Cincinnati, Ohio, Dec. 2-4, 1953.

[12] United Nations, Some Important Developments During 1953 in Iron and Steel Technology: Geneva, January 1954, pp. 12-15.

[13] Work cited in footnote 12, pp. 27-29.

placement for tinplate in the manufacture of containers for food and other products.[14]

Research sponsored by the United States Department of Agriculture has resulted in the development of another possible substitute for palm oil in tinplate manufacture. This new oil, which is made from byproduct grease of the packing industry, may compete with the beef-tallow-base material substitute developed by American Iron and Steel Institute. It is claimed that consumption of this oil per base box will be much lower than the oil made from tallow, although its production cost will be higher.

WORLD PRODUCTION

World production of steel and pig iron in 1953 reached a new high of 236 and 169 million tons, respectively—a 10-percent increase for both items over 1952.

The United States, the Schuman Plan countries, and Russia were, consecutively, first, second, and third in both steel and pig-iron production. United States steel production was 43 percent of world production compared with 40 percent in 1952 and 45 percent in 1951.

Canada.—The expansion program of the Canadian steel industry, which started 6 years ago, has been completed, except for a few small projects. During this period steelmaking capacity has increased over 40 percent to a new high of 5 million net tons by the end of 1953.

The Steel Co. of Canada (Stelco) plans to construct, in 1954, a new sintering plant that will cost $3.6 million and will replace the 27-year-old plant now in operation at Hamilton. Daily production is expected to exceed 1,500 gross tons, or 4 times that of the present plant. Sinter produced will be used as a partial replacement for blast-furnace ore and for "feed" ore in open-hearth furnaces.

Among other improvements, Stelco introduced a new gas called "HNX" into use in its annealing furnaces for cold-rolled strip before tinning. This gas, composed mostly of nitrogen with a small quantity of hydrogen, is produced by controlled burning of coke oven gas. HNX, which is similar to deoxidizing gases used in annealing furnaces in the United States, chemically removes surface oxides from cold-rolled strip, leaving a superior surface for tinning.

Atlas Steel, Ltd, Hamilton, producer of stainless and other alloy steels, completed trial rolling of its new stainless-steel strip mill early in December. Commercial production was scheduled for the first quarter of 1954. The company was completing the construction of a continuous casting machine. Also under construction was a pipe- and tube-forming machine of the Yeder type, which was expected to begin production in January 1954.

In June Dominion Foundry & Steel Co. of Canada (Hamilton) confirmed the fact that the company had purchased the rights to use the Brassert process for making steel, which involves surface blowing molten pig iron in a converter with high-purity oxygen. The installation of equipment (imported from Germany) was proceeding according to schedule, and production was expected to begin in April 1954.

[14] Mellon Institute, 40th Annual Report: Feb. 28, 1953, p. 44.

TABLE 21.—World production of pig iron (including ferroalloys), by countries,[1] 1944–48 (average) and 1949–53, in thousand metric tons [2]

[Compiled by Berenice B. Mitchell]

Country [1]	1944–48 (average)	1949	1950	1951	1952	1953
North America:						
Canada	1,829	2,138	2,266	2,557	2,643	2,869
Mexico [3]	228	356	227	254	238	265
United States	51,942	49,775	60,210	65,745	57,507	70,025
Total	54,000	52,300	62,700	68,600	60,400	73,200
South America:						
Argentina	11	[4] 18	20	28	27	35
Brazil	391	512	729	776	816	879
Chile	12	19	109	240	270	286
Total	500	550	900	1,000	1,100	1,200
Europe:						
Austria	396	838	886	1,051	1,175	1,321
Belgium	2,072	3,749	3,695	4,847	4,774	4,217
Czechoslovakia [4]	1,241	1,808	1,971	2,070	2,318	2,781
Denmark	14	39	51	33	36	36
Finland	75	101	63	102	97	80
France	3,821	8,412	7,838	8,839	9,876	8,759
Germany:						
East	4,929 (East and West)	246	335	340	651	1,068
West		7,140	9,473	10,697	12,877	11,654
Hungary	260	428	482	[4] 506	[4] 575	760
Italy	[5] 299	445	573	1,049	1,206	1,309
Luxembourg	1,494	2,372	2,499	3,157	3,076	2,722
Netherlands	202	434	454	525	539	593
Norway	138	234	227	245	273	270
Poland	744	1,365	1,488	[4] 1,577	[4] 1,782	[4] 2,299
Rumania [4]	108	275	335	350	390	450
Saar	746	1,582	1,684	2,364	2,544	2,382
Spain	523	634	680	679	787	822
Sweden	784	860	837	906	1,114	1,004
Switzerland	18	[4] 32	34	40	40	41
Trieste	([5])	31	65	40	87	84
U. S. S. R.[4]	10,248	16,700	19,500	22,500	25,000	28,000
United Kingdom	7,857	9,653	9,818	9,859	10,900	11,354
Yugoslavia	100	202	226	262	288	281
Total [4]	36,100	57,600	63,200	72,000	80,400	82,300
Asia:						
China [4]	606	317	1,022	1,300	2,000	2,400
India	1,484	1,637	1,687	1,853	1,883	1,805
Japan	1,037	1,602	2,299	3,227	3,585	4,653
Korea, North [4]	154	50	23	20	20	20
Taiwan (Formosa)	3	2	6	6	7	4
Thailand	------	------	8	9	[4] 2	5
Turkey	84	116	116	166	196	215
U. S. S. R.	([6])	([6])	([6])	([6])	([6])	([6])
Total [6]	3,400	3,700	5,200	6,600	7,700	9,100
Africa:						
Southern Rhodesia	[7] 17	28	34	32	39	[4] 40
Union of South Africa	574	708	733	805	1,129	1,223
Total	600	750	800	850	1,200	1,300
Australia	1,140	1,046	1,336	1,352	1,560	1,864
Grand total (estimate)	95,800	116,000	134,000	150,000	152,000	169,000

[1] Pig iron is also produced in Belgian Congo and Indonesia, but the quantity produced is believed insufficient to affect estimate of world total.
[2] This table incorporates a number of revisions of data published in previous 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 1 year only, as 1948 was first year of production.

TABLE 22.—World production of steel ingots and castings, by countries, 1944–48 (average) and 1949–53, in thousand metric tons [1]

[Compiled by Berenice B. Mitchell]

Country	1944–48 (average)	1949	1950	1951	1952	1953
North America:						
Canada	2,607	2,894	3,070	3,237	3,359	3,733
Mexico	231	332	333	388	601	[2] 447
United States [3]	74,294	70,740	87,848	95,435	84,520	101,250
Total	77,132	73,966	91,251	99,060	88,480	105,430
South America:						
Argentina [2]	112	180	200	250	280	300
Brazil	328	615	789	843	896	980
Chile	21	32	56	178	246	313
Colombia [2]	3	10	10	10	10	------
Peru [2]	6	10	10	10	10	10
Total	[2] 470	847	1,065	1,291	1,442	1,603
Europe:						
Austria	273	835	947	1,028	1,058	1,284
Belgium	2,096	3,849	3,777	5,069	5,051	4,445
Czechoslovakia [2]	2,015	2,762	3,011	3,312	3,577	4,200
Denmark	36	76	123	161	176	180
Finland	92	114	102	133	151	147
France	4,432	9,152	8,652	9,835	10,868	9,996
Germany:						
East	5,771 (East and West)	603	995	1,552	1,893	2,177
West		9,156	12,121	13,506	15,806	15,420
Greece [2]	5	23	26	30	34	40
Hungary	507	849	1,022	[2] 1,234	[2] 1,396	[2] 1,500
Ireland [2]	6	16	16	16	20	20
Italy	[4] 1,278	2,026	2,323	3,007	3,474	3,452
Luxembourg	1,396	2,272	2,451	3,077	3,002	2,659
Netherlands	148	428	490	554	685	860
Norway	52	74	81	88	98	110
Poland	1,187	2,305	2,515	2,792	3,180	3,600
Rumania [2]	202	459	558	646	698	719
Saar	810	1,757	1,898	2,603	2,823	2,684
Spain	634	684	807	831	1,008	894
Sweden	1,210	1,369	1,437	1,504	1,666	1,764
Switzerland	93	124	130	144	156	157
Trieste	(4)	29	39	56	61	46
U. S. S. R. [2]	13,860	23,000	27,000	31,500	35,000	38,500
United Kingdom	13,059	15,803	16,554	15,889	16,682	17,892
Yugoslavia	[5] 189	401	428	434	452	525
Total [2]	49,351	78,166	87,503	99,001	109,015	113,271
Asia:						
China [2]	208	100	550	1,000	1,860	2,350
India	[6] 1,326	1,374	1,461	1,524	1,604	1,531
Japan	2,246	3,111	4,838	6,502	6,988	7,662
Korea:						
Korea, Republic of	[2] 50 (Republic of and North Korea)	8	4	1	1	1
North Korea [2]		32	40	40	30	40
Pakistan	(6)	5	3	3	7	11
Thailand	------	------	5	6	[2] 4	[2] 1
Turkey	80	103	90	135	162	170
U. S. S. R.	(7)	(7)	(7)	(7)	(7)	(7)
Total	3,910	4,733	6,991	9,211	10,656	11,766
Africa:						
Belgian Congo	------	------	------	(8)	1	4
Egypt [2]	5	10	10	10	10	20
Southern Rhodesia	5	18	22	28	35	40
Union of South Africa	544	632	755	948	1,203	1,241
Total	554	660	787	986	1,249	1,305
Australia	1,381	1,149	1,448	1,457	1,668	2,082
Total (estimate)	133,000	160,000	189,000	211,000	213,000	236,000

[1] This table incorporates a number of revisions of data published in previous Iron and Steel chapters.
[2] Estimate.
[3] Data from American Iron and Steel Institute. Excludes production of castings by companies that do not produce steel ingots.
[4] Trieste included with Italy.
[5] Average for 1945–48.
[6] Pakistan included with India.
[7] U. S. S. R. in Asia included with U. S. S. R. in Europe.
[8] Less than 500 tons.

A new method was developed by General Engineering Co. of Toronto to heat billets for forging and steel shapes for heat treatment by electric induction heating, using first low- and then high-frequency currents. It is claimed that initial capital costs are lower than for other heating methods and that the rapidity with which billets are heated greatly reduces scale loss.

Another important development in the alloy-steel industry was the purchase in April 1953 of the London, Ontario, mill, formerly Quality Steels (Canada), Ltd., by Vanadium-Alloys Steel, Canada, Ltd. The mill is being renovated, at a cost of $1 million, to roll and forge tool steel for the Canadian market.[15]

India.—On December 22, 1953, the Government of India signed a cooperative agreement with the German machine firm, Demag, and the Krupp Steel Works of Essen for the installation of a third steel plant in India. The plant is to be designed to produce 500,000 tons of steel ingots annually and will cost $150 million. Future plans call for expansion to 1 million tons capacity, with an additional estimated cost of $75 million. The contribution of the German firms will include a preliminary survey to determine a suitable location and the erection and initial operations of the plant. According to the original plans, the plant was to be completed within 4 years, and the combine was to continue in its consultant capacity 3 years more without additional payment. The plant was intended to produce categories of steel in short supply in India, particularly plate and and other flat products. The unit cost of production of this plant, when expanded to 1 million tons was expected to compare favorably with that of other Indian steel plants. It was indicated that the plant would be at Rourkela in Orissa, as recommended by the German experts.[16]

Mexico.—The year 1953 saw a number of expansions and improvements in the Mexican iron and steel industry. Altos Hornos de Mexico, S. A., of Monclova, added a hot-metal mixer, one additional open hearth, soaking pits, a new finishing mill, a complete new automatic cleaning and pickling installation for sheets, and some additional tinpots. The company also began to construct a new 800-ton-per-day blast furnace, which was scheduled for completion in May 1954.

Hojalata y Lámina, S. A., of Monterrey, completed, at a cost of $5 to $6 million, a new and modern rolling mill, including soaking pits, for producing plates, sheets, and strip. Two electric furnaces to produce steel from sponge iron and scrap were also installed by this company.

Cía. Fundidora de Fierro y Acero de Monterrey, S. A., the largest steel mill in Mexico, awarded a contract for constructing a new merchant mill costing over $6 million. All equipment was to be supplied by American manufacturers, and construction was scheduled for completion early in 1955.

Aceros Ecatepec, S. A., in the outskirts of Mexico City, completed a new steel mill, in the middle of 1953, with an annual capacity of 25,000 tons. This plant operates an electric furnace, using only scrap for ingot production, and rolls bars and bar-mill shapes. The com-

[15] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 5, May 1954, pp. 14–15.
[16] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 1, January 1954, p. 14.

pany also plans to double its steel capacity and to install two electric furnaces for producing pig iron from iron ore.

Tubos de Acero de Mexico, near Vera Cruz, began to construct a seamless-steel-tube plant to cost approximately $10 million. Reportedly, it was to have an annual capacity of 50,000 tons, and operations were scheduled for 1954. Steel ingots to operate this mill will be obtained from outside Mexico, probably the United States or Europe.

In addition to the above, there were many important improvements and additions to a number of smaller steel plants. Barras y Perfiles, S. A., Laminadora Kreimerman, S. A., Aceros Industriales, and Tuberias Aspe, S. A., each installed electric furnaces. Equipment for the manufacture of welded pipe was installed by Tuberias Aspe, S. A., and Acero Estructural. The manufacture of steel spring wire was begun by Productos de Alambre la Mexicana, S. A.[17]

Pakistan.—Pakistan's iron and steel industry is composed of iron and steel foundries and rerolling mills. There are no blast furnaces. Virtually all materials required, including coke, pig iron and scrap, and semifinished steel for rerolling are imported. Two 5-ton electric steel furnaces and rolling mills, with a total annual capacity of 12,000 tons, are operating in Lahore. In addition, there are 32 rerolling mills, mainly in Karachi and Lahore, with a capacity of about 70,000 tons a year.[18]

Construction of a modern rerolling mill for structural steel, with an annual capacity of 45,000 tons, was nearly completed at the end of the year. The plant, 15 miles from Karachi, was being built by Pakistan Industries, Ltd. During the last quarter of 1953 the Krupp Steel Works of Essen began a survey of Pakistan's iron and steel industry in the Inuval area of Punjab. It will submit a plan for a pilot plant for producing 15,000 tons of steel ingots a year. Production was scheduled to begin by the end of 1954. Krupp will also draw up plans for a large steel plant to produce 300,000 tons of steel ingots and 50,000 tons of pig iron annually. Such a plant would supply much of Pakistan's steel needs of 350,000 tons annually.[19]

Spain.—The Empresa Nacional Siderugica, Government-owned Spanish enterprize, awarded a contract amounting to $28 million to a British company for the supply and installation of the bulk of equipment for a projected iron and steel plant in Aviles, Province of Oviedo.[20]

The plant, with an annual raw-steel capacity of 600,000 metric tons, will have the following equipment: 2 small sintering plants, 60 coke ovens, 1 blast furnace with a daily capacity of 1,000 metric tons, 1 600-ton mixer, 3 300-ton open-hearths, 1 20-ton electric furnace, and rolling mills for the production of rails, structurals, billets and sheet bar.[21]

Sweden.—In 5 years Sweden's steel-ingot capacity has increased from 1.3 million to over 2 million tons. The large increases in output have occurred in merchant carbon grades rather than specialty steels.

[17] U. S. Embassy, Mexico, D. F., State Dept. Dispatch 1337, Feb. 16, 1954.
Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 4, April 1954, pp. 15–17.
[18] United Nations, European Steel Exports and Steel Demands in Non-European Countries: Geneva, 1953, p. 161.
[19] Chemical and Engineering News, vol. 31, No. 47, Nov. 23, 1953, p. 4896.
[20] U. S. Department of Commerce, Foreign Commerce Weekly, vol. 49, No. 11, Mar. 16, 1953, p. 7.
[21] Metal Bulletin, No. 3832, Oct. 6, 1953, p. 15.

Three iron works, Domnarvet (Stora Kopparbergs Bergslag), Norrbottens Jarnvek, and Fagersta, have effected most of the increase. At these plants ingot capacity has risen by 300,000, 350,000, and 100,000 tons, respectively. These increases are based on coke pig iron, which is processed into steel by Thomas converters or by electric furnaces used in conjunction with converters. In an effort to overcome the high cost of charcoal pig iron Swedish steelmakers have been giving more attention to the possibilities offered by sponge iron. They have successfully used sponge iron to replace both charcoal pig iron and scrap in electric and acid open-hearth furnaces. It is claimed that, by using sponge iron, crude steel can be produced at approximately the same cost as pig iron made with charcoal. About seven sponge-iron works are operating in Sweden.[22]

Of special interest during the year was expansion of the Domnarfvet steel rolling mill from 200,000 to 400,000 metric tons. Expansion of the company heavy-plate mill from 70,000 to 125,000 tons was expected to be completed during the summer of 1954.[23]

EUROPEAN COAL AND STEEL COMMUNITY

The steel industry of Europe's six-nation Coal and Steel Community produced 40 million metric tons of steel in 1953 compared with 42 million in 1952. In spite of the drop in production, the Community went ahead with its plans to increase steelmaking capacity to 50 million tons by 1957 or 1958. The planned capacity increase is to cost about $500 million.[24]

To attain higher productivity, plans call for (1) modernization, by replacing obsolete installations with up-to-date modern equipment, the operation of which will save in labor cost as well as in the consumption of fuel and raw materials and also improve the quality of products; (2) coordination, by eliminating bottlenecks in all processes from raw materials to the finished product; (3) standardization of production and specialization of plants—new markets call for concentration of orders, simplifying specializations, and limitation of ranges of products of individual plants.[25]

At the end of 1953 the first European common market had been a reality for 11 months for coal, iron ore, and scrap and 8 months for steel. During the year the main restrictions covering customs duties, quotas, foreign currency regulations, and the main discriminating practices, dealing prices and transportation conditions, were abolished.

Customs Duties.—Custom duties on steel were suspended, but France increased the price of some categories of imported coal to bring them up to the same level as home-produced coal. These increases have been abolished for coal coming from any other country of the Community.

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[22] American Metal Market, vol., 60, No. 224, Nov. 20, 1953, pp. 1, 3.
Iron and Coal Trades Review (London) vol. 167, No. 4466, p. 1132.

[23] U. S. Embassy, Stockholm, Sweden, State Department Dispatch 1025, Annual Report for 1953, Apr. 1, 1954.

[24] American Metal Market, vol. 60, No. 242, Dec. 17, 1953, p. 3.

[25] Report on the Situation of the Community at the Beginning of 1954, pp. 42–44.

TABLE 23.—Production and capacity increase, planned and attained, in the European Coal and Steel Community, by type of product, in thousand metric tons [1]

	Production in 1952	Increases in capacity				Increase in relation to production in 1952 (percent)
		Attained in 1953	Under way on Dec. 31, 1953	To be started in 1954	Totals	
Pig iron	34,740	1,255	2,267	1,478	5,000	14.0
Steels:						
Basic Bessemer	22,987	1,462	1,460	1,003	3,925	17.0
Open-hearth	15,198	1,913	1,539	351	3,803	25.0
Electric and other	3,628	158	425	285	868	24.0
Total	41,813	3,533	3,424	1,639	8,596	20.5
Finished products:						
Railway material	1,440					
Heavy sections	2,712	100	250	150	500	8.0
Semis for tubes	2,136					
Light sections	10,176	400	1,300	600	2,300	23.0
Wire	2,844		1,200	100	1,300	45.0
Strip	2,076	180	600	260	1,040	50.0
Plates over 3 mm	4,284	400	1,800	560	2,760	62.0
Plates and sheets under 3 mm	2,844	720	1,300	680	2,700	95.0
Total	28,512	1,800	6,450	2,350	10,600	37.0

[1] Second General Report on the Activities of the Community, Apr. 11, 1954, p. 147.

Quantitative Restrictions.—Quantitative restrictions were numerous with respect to imports and exports. Almost all countries used a system of permits to cover imports and exports of coal; the Benelux countries applied a system of import and export permits to steel; France, in principle, prohibited the imports of steel and controlled its export; France also limited exports of iron ore; and exports of iron and steel scrap, with a few exceptions, were forbidden in the six countries of the Community. All these restrictions have been abolished.

Foreign Currency.—All foreign currency restrictions covering transfer from one country to another within the Community have been abolished. For example, if a French ship-building yard wishes to buy thick steel plate from West Germany, marks can be obtained without any limitations.

Dual Prices.—Before creation of the common market, German thick steel plate sold for $106 on the home market but was invoiced at $135 to Italy. The export price of Belgian thick steel plate to The Netherlands was $120, while home price was $94.50. French steel was exported to Germany at prices comparable with German prices, which were considerably higher than in France. Since establishment of the common market all these dual price discriminations have disappeared. In regard to prices of steel exported from the Community, the High Authority has taken steps to fix prices although it advocates free competition.

Transportation.—There were also numerous inequities in transportation, which usually occurred in increases of export and import transportation charges. For example, the iron-ore transportation cost per ton from Sancy, France, to Ougrée, Belgium, was 4 francs per kilometer, while within France from Sancy to Agincourt it was only

2.20 francs. Inequities of this type have been abolished. The transportation cost from Sancy to Agincourt was increased 4 percent and from Sancy to Ougrée decreased 8 percent.[26]

In the field of research the High Authority has undertaken a survey of progress in technical research, and it plans, among other things, to improve coordination between research centers and to speed the movement of experimental processes to industrial application. The first three fields of research proposed were: The influence of the properties of coke on the operation of blast furnaces; the improvement of refractory materials; and the influence of rolling temperatures on the quality of the products. In addition to the above, the improvement of basic Bessemer steel by the use of oxygen was examined, and the operation of blast furnaces under pressure was to be studied.[27]

[26] Work cited in footnote 25, pp. 11–31.
[27] Second General Report on the Activities of the Community Apr. 11, 1954, pp. 125–26.

Iron and Steel Scrap

By James E. Larkin [1]

SCRAP and pig iron consumed during 1953 increased 16 percent compared with 1952, when a prolonged strike depressed demand to establish a record 2 percent above the previous one, set in 1951. Scrap use (7,321,291 short tons) in March set a new record month, followed by a total of 7,050,310 short tons during May, which became the second highest month. After all previous records in the use of scrap had been broken during 1953, it is interesting to note that the lowest non-strike month since July 1950 was December 1953. The use of pig iron in both March and May 1953 was larger than in the previous record month (October 1952). The 6,577,422 short tons used in March established a new record. Total stocks of ferrous scrap held by consumers fluctuated slightly during the first 5 months of the year and reached a low for the year at the end of June. During the last 6 months stocks continued to fluctuate but by the end of the year had reached the highest quantity on record and were 4 percent greater than at the beginning of the year. Despite the 4-percent increase in stocks from the beginning to the end of the year, they were equivalent to only a 34-day supply at the 1953 average daily consumption rate of 211,316 short tons.

GOVERNMENT CONTROL

Office of Price Stabilization removed ceiling prices on iron and steel scrap, effective 12:01 a. m. February 13. National Production Authority did not discontinue immediately the compulsory reporting of stocks, production, consumption, and shipments of iron and steel scrap, but by May 31 the Bureau of the Census had been ordered to discontinue the collection of data on Form NPAF–33 from manufacturers and railroads. Dealers, brokers, and automobile wreckers were the next to be affected by cancellation of the compulsory reporting of their transactions, when, on June 30, the Bureau of the Census discontinued Form NPAF–32. This form was for use by NPA and the Bureau of Mines, with the Bureau of the Census acting as a distribution and collection agency. Data from this form were compiled and published in monthly releases by the Bureau of Mines. Since it had collected these data before NPA was established, the Bureau of Mines resumed the dealers', brokers', and automobile wreckers' canvass with the month of October. A simplified form (6–1072–M) was designed for use in compiling data on stocks, receipts, and shipments of the scrap dealers on a voluntary basis.

Legislation authorizing the functions of NPA expired June 30, 1953; however, some controls were revoked before this agency was terminated. On March 30, NPA revoked Order M–64, which re-

[1] Commodity-industry analyst.

quired the reporting of rails, axles, and cast-iron car wheels under which these materials were allocated, making it no longer necessary to apply to NPA for use authorization covering these materials. Order M–20 was officially revoked on April 15; this order required segregation of certain alloy scrap, restricted inventories of consumers and dealers, and made statistical reporting mandatory. All NPA restrictions on shipments and consumption of ferrous scrap were removed accordingly. However, the collection of data on Form M21C (Monthly Survey of Iron and Steel Foundries, Blast Furnaces, and Steel-Ingot Producers) from the consumers of iron and steel scrap continued to be collected on a sample basis by the Bureau of Mines and Bureau of the Census.

On October 16, 1953, the United States Department of Commerce announced that quota limitations for iron and steel scrap export would be eliminated for the fourth quarter. Thereafter, scrap of any grade from any part of the United States could be exported to certain nations with a license under the following conditions: Applicants must have accepted orders for the scrap and made certification that the scrap is available.

CONSUMPTION

Of the 1953 consumption of ferrous scrap and pig iron for all purposes, 77,131,000 short tons or 51 percent was scrap. Total scrap was consumed in 1953 at an average monthly rate of 6,428,000 short tons, 12 percent greater than the average monthly rate of total scrap for 1952. The increased use of ferrous scrap was accompanied by an increased demand for pig iron during 1953; the total for the year was 21 percent greater than during the previous year. The average monthly consumption rate of pig iron was 6,226,000 short tons compared with 5,129,000 in 1952.

The 20-percent increase over 1952 in the output of steel ingots and castings established an alltime high in steel production and required the melting of a record quantity of ferrous materials. The quantities used in steelmaking furnaces (open-hearth, Bessemer, and electric) were 59,101,000 short tons of scrap and 65,839,000 short tons of pig iron, increases of 13 and 23 percent, respectively, over the quantity of these materials used during 1952. There were some strikes and work stoppages throughout the year but none as serious as the strikes during the previous year. January and March were record-breaking months in steel production; accordingly, records were established in the use of ferrous materials in these furnaces.

The proportions of scrap and pig iron used in steel furnaces in 1953 were 47 percent scrap and 53 percent pig iron compared with 49 and 51 percent, respectively, in 1952. The charge of scrap and pig iron used in iron foundries, mainly cupola furnaces, comprised 66 percent scrap and 34 percent pig iron compared with 65 and 35 percent, respectively, in 1952.

The use of scrap and pig iron increased 12 and 21 percent, respectively, in 1953 compared with 1952. Consumption of scrap increased in all but the West North Central district and pig iron in all but the Pacific Coast district. There was a noticeably greater quantity of scrap than pig iron used in the New England, West North Central, West South Central, and Pacific Coast districts. These districts together used 10 percent of the total scrap and 4 percent of the pig iron consumed in 1953 compared with 11 and 4 percent, respectively, in 1952. The United States as a whole used 3 percent more scrap than pig iron in 1953 compared with 12 percent in 1952. The average ratio of scrap to pig iron in these 4 districts was 2.7:1, whereas the United States average was 1.03:1.

TABLE 1.—Salient statistics of ferrous scrap and pig iron in the United States, 1952–53

	1952 (short tons)	1953 (short tons)	Change from 1952 (percent)
Stocks, December 31: Ferrous scrap and pig iron at consumers' plants:			
Total scrap	6,902,314	7,148,766	+4
Pig iron	1,964,087	2,797,555	+42
Total	8,866,401	9,946,321	+12
Consumption: Ferrous scrap and pig iron charged to—			
Steel furnaces: [1]			
Total scrap	52,217,060	59,100,900	+13
Pig iron	53,491,734	65,839,018	+23
Total	105,708,794	124,939,918	+18
Iron furnaces: [2]			
Total scrap	15,642,031	16,779,591	+7
Pig iron	8,059,227	8,868,726	+10
Total	23,701,258	25,648,317	+8
Miscellaneous uses [3] and ferroalloy production: Total scrap	1,164,033	1,250,011	+7
All uses:			
Total ferrous scrap	69,023,124	77,130,502	+12
Pig iron	61,550,961	74,707,744	+21
Grand total	130,574,085	151,838,246	+16
Imports of scrap (including tinplate scrap)	153,674	172,171	+12
Exports of scrap:			
Iron and steel	[4] 337,573	297,905	−12
Tinplate, circles, strips, cobbles, etc	15,137	18,637	+23
Average prices per gross ton:			
Scrap:			
No. 1 Heavy-Melting, Pittsburgh [5]	$42.78	$40.99	−4
No. 1 Cast Cupola, Chicago [5]	$45.18	$42.73	−5
For export	[4] $39.69	$39.70	
Pig iron, f. o. b. Valley furnaces: [5]			
Basic	$53.08	$55.25	+4
No. 2 Foundry	$53.75	$55.75	+4

[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] Iron Age.

Open-hearth furnaces continued to be the largest consumers of ferrous scrap and pig iron, their consumption increasing over that in 1952 by 6,671,000 tons of scrap and 11,932,000 tons of pig iron. Open-hearth consumption composed 64 percent of the total scrap in 1953 compared with 62 percent in 1952. Pig-iron consumption in open hearths represented 82 percent of the total pig iron consumed compared with 80 percent in 1952.

Cupola-furnace consumption in 1953 was as follows: Scrap used in this type of furnace was 14 percent of the total scrap consumed compared with 15 percent in 1952; pig iron 7 percent compared with 9 percent in 1952.

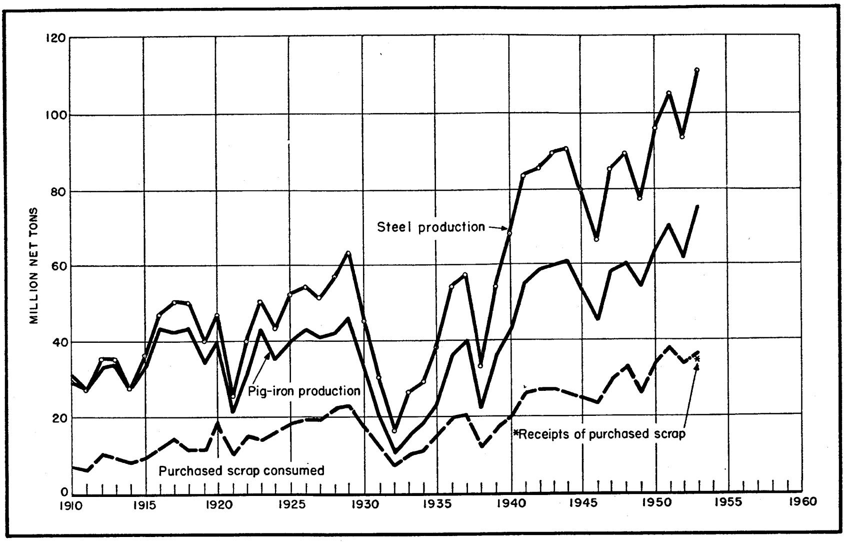

FIGURE 1.—Consumption of purchased scrap in the United States, 1910–52, and output of pig iron and steel, 1910–53. Figures on consumption of purchased scrap for 1910–32 are from State of Minnesota vs. Oliver Iron Mining Co., et al., Exhibits, vol. 5, 1935, p. 328; those for 1933–34 are estimated by authors; and those for 1935–52 are based on Bureau of Mines records. Data for 1953 represent receipts of purchased scrap by consumers, based on Bureau of Mines records. Data on steel output from the American Iron and Steel Institute.

Bessemer converters consumed 6 percent of the pig iron and 0.4 percent of the scrap, respectively, the same as in the previous year.

Electric furnaces consumed 12 percent of the total scrap, or 1 percent less than in 1952, and 0.2 percent of the pig iron, unchanged from the 3 previous years.

TABLE 2.—Ferrous scrap and pig iron consumed in the United States and percent of total derived from scrap and pig iron, 1952–53, by districts

District	1952			1953		
	Total consumed (short tons)	Percent of total consumed		Total consumed (short tons)	Percent of total consumed	
		Scrap	Pig iron		Scrap	Pig iron
New England	1,236,665	76.1	23.9	1,248,012	75.5	24.5
Middle Atlantic [1]	41,041,327	50.3	49.7	47,769,843	48.7	51.3
East North Central [1]	58,421,271	53.5	46.5	69,161,210	51.3	48.7
West North Central	3,015,357	76.9	23.1	2,885,376	75.8	24.2
South Atlantic [1]	9,697,148	47.3	52.7	11,030,021	46.0	54.0
East South Central [1]	7,862,325	44.4	55.6	9,179,200	43.1	56.9
West South Central	1,624,508	73.5	26.5	1,958,372	70.4	29.6
Rocky Mountain	3,230,628	45.0	55.0	4,103,534	38.9	61.1
Pacific Coast [1]	4,369,445	70.1	29.9	4,417,201	71.7	28.3
Undistributed [1]	75,411	100.0	----------	85,477	98.5	1.5
Total	130,574,085	52.9	47.1	151,838,246	50.8	49.2

[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, 1952–53, by types of furnace, in short tons

Type of furnace or equipment	Total scrap	Pig iron	Total scrap and pig iron
1952			
Open-hearth	42,997,467	49,374,315	92,371,782
Bessemer	246,770	3,998,751	4,245,521
Electric	8,972,823	118,668	9,091,491
Cupola	10,168,735	5,438,294	15,607,029
Air	1,199,019	317,500	1,516,519
Crucible	126	152	278
Blast	4,274,151		4,274,151
Direct castings		2,303,281	2,303,281
Ferroalloy	339,759		339,759
Miscellaneous	824,274		824,274
Total	69,023,124	61,550,961	130,574,085
1953			
Open-hearth	49,668,274	61,306,565	110,974,837
Bessemer	276,020	4,351,117	4,627,132
Electric	9,156,606	181,336	9,337,940
Cupola	10,634,168	5,549,522	16,183,699
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

TABLE 4.—Proportion of scrap and pig iron used in furnaces in the United States, 1952–53, in percent

Type of furnace	1952		1953	
	Scrap	Pig iron	Scrap	Pig iron
Open-hearth	46.5	53.5	44.8	55.2
Bessemer	5.8	94.2	6.0	94.0
Electric	98.7	1.3	98.1	1.9
Cupola	65.2	34.8	65.7	34.3
Air	79.0	21.0	79.3	20.7
Crucible	45.3	54.7	33.3	66.7
Blast	100.0		100.0	

CONSUMPTION BY DISTRICTS AND STATES

During 1953 iron and steel scrap was consumed in all 48 States and the District of Columbia, with increases in all areas except the West North Central district. The use of pig iron in all but the Pacific Coast district was greater during 1953 than in 1952. 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 24 (the same percentage for 4 consecutive years), Ohio 17, Indiana 10, and Illinois 9 compared with 18, 9, and 10, respectively, during 1952.

TABLE 5.—Consumption of ferrous scrap and pig iron in the United States in 1953, 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	48, 650, 706	61, 104, 228	109, 754, 934	1, 017, 568	202, 337	1, 219, 905				49, 668, 274	61, 306, 565	110, 974, 839
Bessemer	244, 356	4, 348, 075	4, 592, 431	27, 605	2, 603	30, 208	4, 059	439	4, 498	276, 020	4, 351, 117	4, 627, 137
Electric	7, 370, 724	136, 819	7, 507, 543	1, 565, 909	27, 477	1, 593, 386	219, 973	17, 040	237, 013	9, 156, 606	181, 336	9, 337, 942
Total steelmaking furnaces	56, 265, 786	65, 589, 122	121, 854, 908	2, 611, 082	232, 417	2, 843, 499	224, 032	17, 479	241, 511	59, 100, 900	65, 839, 018	124, 939, 918
Cupola	664, 517	649, 654	1, 314, 171	669, 097	177, 893	846, 990	9, 300, 554	4, 721, 975	14, 022, 529	10, 634, 168	5, 549, 522	16, 183, 690
Air	39, 131	15, 941	55, 072	305, 616	75, 201	380, 817	852, 300	221, 912	1, 074, 212	1, 197, 047	313, 054	1, 510, 101
Crucible	22	12	34				112	256	368	134	268	402
Blast [3]	4, 948, 242		4, 948, 242							4, 948, 242		4, 948, 242
Direct castings		1, 738, 860	1, 738, 860					1, 267, 022	1, 267, 022		3, 005, 882	3, 005, 882
Ferroalloy							373, 172		373, 172	373, 172		373, 172
Miscellaneous	270, 149		270, 149				606, 690		606, 690	876, 839		876, 839
Total: 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
1952	53, 789, 334	55, 139, 586	108, 928, 920	4, 037, 324	514, 284	4, 551, 608	11, 196, 466	5, 897, 091	17, 093, 557	69, 023, 124	61, 550, 961	130, 574, 085

[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, 1949–53, 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:				
1949	765,448	−29.9	283,337	−17.4
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
Middle Atlantic:				
1949	16,047,293	−18.4	17,731,194	−15.1
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
East North Central:				
1949	24,856,801	−15.8	23,869,383	−9.9
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
West North Central:				
1949	1,752,051	−15.1	571,453	−13.6
1950	2,111,712	+20.5	747,629	+30.8
1951 [1]	2,645,897	+25.3	885,951	+18.5
1952 [1]	2,319,763	−12.3	695,594	−21.5
1953 [1]	2,187,526	−5.7	697,850	+.3
South Atlantic:				
1949	3,859,328	−8.3	4,818,855	+1.8
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	5,078,804	+10.7	5,951,217	+16.5
East South Central:				
1949	2,924,319	−16.6	3,913,460	−11.6
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	3,959,665	+13.5	5,219,535	+19.3
West South Central:				
1949	685,162	−15.1	204,333	−14.1
1950	1,003,466	+46.5	364,004	+78.1
1951 [1]	1,301,441	+29.7	592,574	+62.8
1952 [1]	1,193,583	−8.3	430,925	−27.3
1953	1,377,747	+15.4	580,625	+34.7
Rocky Mountain:				
1949	1,224,953	−8.4	1,365,795	−13.8
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
Pacific Coast:				
1949	2,222,868	−19.4	688,955	−6.6
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
Undistributed:				
1951 [1]	81,397			
1952 [1]	75,411			
1953 [1]	84,210		1,267	
United States 1944–48 (average)	58,570,527		55,505,517	
1949	54,338,223	−16.4	53,446,765	−11.0
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

[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 1953, 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	328,555	0.4	63,436	0.1	391,991	0.3
Maine	11,757	(2)	5,928	(2)	17,685	(2)
Massachusetts	455,470	.6	174,513	.2	629,983	.4
New Hampshire	19,396	(2)	3,503	(2)	22,899	(2)
Rhode Island	105,952	.2	49,432	.1	155,384	.1
Vermont	21,096	(2)	8,974	(2)	30,070	(2)
Total New England	942,226	1.2	305,786	.4	1,248,012	.8
New Jersey [1]	698,366	.9	200,572	.3	898,938	.6
New York [1]	4,065,687	5.3	3,689,763	4.9	7,755,450	5.1
Pennsylvania	18,506,601	24.0	20,608,854	27.6	39,115,455	25.8
Total Middle Atlantic	23,270,654	30.2	24,499,189	32.8	47,769,843	31.5
Illinois	7,251,208	9.4	6,055,031	8.1	13,306,239	8.8
Indiana [1]	7,753,735	10.1	8,928,835	12.0	16,682,570	11.0
Michigan	6,305,347	8.2	3,811,411	5.1	10,116,758	6.6
Ohio [1]	13,347,091	17.3	14,641,399	19.6	27,988,490	18.4
Wisconsin	808,367	1.0	258,786	.3	1,067,153	.7
Total East North Central	35,465,748	46.0	33,695,462	45.1	69,161,210	45.5
Iowa	461,644	.6	89,467	.1	551,111	.3
Kansas and Nebraska	99,551	.1	12,378	(2)	111,929	.1
Minnesota, North Dakota, and South Dakota	696,107	.9	518,930	.7	1,215,037	.8
Missouri [1]	930,224	1.2	77,075	.1	1,007,299	.7
Total West North Central	2,187,526	2.8	697,850	.9	2,885,376	1.9
Delaware, District of Columbia, and Maryland	2,908,179	3.8	3,919,420	5.3	6,827,599	4.5
Florida and Georgia	289,051	.4	65,111	.1	354,162	.3
North Carolina	45,730	(2)	22,644	(2)	68,374	(2)
South Carolina	17,792	(2)	10,501	(2)	28,293	(2)
Virginia and West Virginia [1]	1,818,052	2.4	1,933,541	2.6	3,751,593	2.5
Total South Atlantic	5,078,804	6.6	5,951,217	8.0	11,030,021	7.3
Alabama [1]	2,495,028	3.2	4,163,931	5.6	6,658,959	4.4
Kentucky, Mississippi, and Tennessee	1,464,637	1.9	1,055,604	1.4	2,520,241	1.6
Total East South Central	3,959,665	5.1	5,219,535	7.0	9,179,200	6.0
Arkansas, Louisiana, and Oklahoma	142,908	.2	12,464	(2)	155,372	.1
Texas	1,234,839	1.6	568,161	.8	1,803,000	1.2
Total West South Central	1,377,747	1.8	580,625	.8	1,958,372	1.3
Arizona, Nevada, and New Mexico	73,350	.1	195	(2)	73,545	.1
Colorado and Utah	1,496,998	2.0	2,506,885	3.3	4,003,883	2.6
Montana	20,913	(2)	243	(2)	21,156	(2)
Idaho and Wyoming	4,715	(2)	235	(2)	4,950	(2)
Total Rocky Mountain	1,595,976	2.1	2,507,558	3.3	4,103,534	2.7
California	2,574,840	3.3	1,233,898	1.7	3,808,738	2.5
Oregon [1] and Washington	593,106	.8	15,357	(2)	608,463	.4
Total Pacific Coast	3,167,946	4.1	1,249,255	1.7	4,417,201	2.9
Undistributed [1]	84,210	.1	1,267	(2)	85,477	.1
Total United States:						
1953	77,130,502	100.0	74,707,744	100.0	151,838,246	100.0
1952	69,023,124	100.0	61,550,961	100.0	130,574,085	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 1953 totaled 111.0 million short tons, an increase of 20 percent over 1952 and 7 percent over 1951, establishing a record high. Consumption of ferrous materials (scrap and pig iron) and the production of ingots and castings in open-hearth furnaces during 1953 increased 20 and 21 percent, respectively, over 1952. The use of pig iron in this type of furnace was the largest on record, exceeding 1951, the previous record year, by 9 percent; it was 24 percent greater than 1952. The open-hearth furnace melt in 1953 consisted of 45 percent scrap and 55 percent pig iron compared with 47 and 53 percent, respectively, in 1952. The 45 percent scrap used in the open-hearth furnace melt is the lowest on record.

Pennsylvania continued to be the leading State in the use of open-hearth scrap, followed by Ohio, Indiana, and Illinois; these States have maintained the same order since 1936.

TABLE 8.—Consumption of ferrous scrap and pig iron in open-hearth furnaces in the United States in 1953, 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	405,360	115,477	520,837
Total: 1953	405,360	115,477	520,837
1952	394,140	104,314	498,454
Middle Atlantic:			
New Jersey and New York	3,005,257	3,445,962	6,451,219
Pennsylvania	14,066,093	17,935,307	32,001,400
Total: 1953	17,071,350	21,381,269	38,452,619
1952	14,855,257	17,419,941	32,275,198
East North Central:			
Illinois	4,177,054	4,510,519	8,687,573
Indiana	6,769,578	8,607,952	15,377,530
Michigan and Wisconsin	2,122,907	2,567,416	4,690,323
Ohio	8,502,774	10,811,633	19,314,407
Total: 1953	21,572,313	26,497,520	48,069,833
1952	18,304,187	21,101,110	39,405,297
West North Central: Minnesota and Missouri	930,037	514,136	1,444,173
Total: 1953	930,037	514,136	1,444,173
1952	960,742	478,633	1,439,375
South Atlantic:			
Delaware and Maryland	2,367,314	3,432,757	5,800,071
Georgia and West Virginia	1,489,854	1,622,003	3,111,857
Total: 1953	3,857,168	5,054,760	8,911,928
1952	3,498,200	4,236,184	7,734,384
East South Central: Alabama and Kentucky	1,932,153	3,918,799	5,850,952
Total: 1953	1,932,153	3,918,799	5,850,952
1952	1,622,927	3,051,990	4,674,917
West South Central: Oklahoma and Texas	762,614	454,643	1,217,257
Total: 1953	762,614	454,643	1,217,257
1952	561,708	249,569	811,277
Rocky Mountain: Colorado and Utah	1,280,034	2,293,945	3,573,979
Total: 1953	1,280,034	2,293,945	3,573,979
1952	1,146,173	1,619,938	2,766,111
Pacific Coast: California and Washington	1,857,245	1,076,016	2,933,261
Total: 1953	1,857,245	1,076,016	2,933,261
1952	1,654,133	1,112,636	2,766,769
Total United States: 1953	49,668,274	61,306,565	110,974,839
1952	42,997,467	49,374,315	92,371,782

Bessemer Converters.—The 4.6 million short tons of ferrous raw materials used in Bessemer converters in 1953 represents an increase of 9 percent over 1952; the production of ingots in these furnaces also increased 9 percent. The greatest increase in the metallic charge in the Bessemer furnaces was in scrap, which increased 12 percent. The ratio of scrap to total metal charge was 1:17, unchanged from 1952. For the second consecutive year Ohio was the principal consumer of converter scrap and, following the usual pattern, was the largest consumer of pig iron in this type of furnace.

TABLE 9.—Consumption of ferrous scrap and pig iron in Bessemer converters in the United States in 1953, 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	2,427	323	2,750
Pennsylvania	99,913	804,239	904,152
Total: 1953	102,340	804,562	906,902
1952	91,435	933,689	1,025,124
East North Central and West North Central:			
Illinois	5,008	295,566	300,574
Minnesota and Missouri	7,860	4	7,864
Ohio	131,765	2,597,958	2,729,723
Total: 1953	144,633	2,893,528	3,038,161
1952	115,075	2,428,223	2,543,298
South Atlantic: Delaware, Maryland, and West Virginia	24,451	652,858	677,309
Total: 1953	24,451	652,858	677,309
1952	34,698	636,630	671,328
East South Central and West South Central: Alabama, Louisiana, and Texas	4,193	157	4,350
Total: 1953	4,193	157	4,350
1952	5,079	190	5,269
Rocky Mountain and Pacific Coast: Colorado and Washington	403	12	415
Total: 1953	403	12	415
1952	483	19	502
Total United States: 1953	276,020	4,351,117	4,627,137
1952	246,770	3,998,751	4,245,521

Electric Steel Furnaces.—The melt of ferrous scrap and pig iron used in electric furnaces in 1953 totaled 9,338,000 short tons, a 3-percent increase over 1952. The ratio of scrap to pig iron used in the electric furnace was 50 : 1 compared with 76 : 1 in 1952. Consumption of scrap in the electric furnaces increased in 5 of the 9 districts, the largest increase occurring in the South Atlantic district. The Middle Atlantic and East North Central areas continued to melt the largest quantity of scrap in electric furnaces, consuming 76 percent of the total.

TABLE 10.—Consumption of ferrous scrap and pig iron in electric steel furnaces in the United States in 1953, 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	16,733	532	17,265
Massachusetts	31,768	1,182	32,950
Total: 1953	48,501	1,714	50,215
1952	54,906	1,603	56,509
Middle Atlantic:			
New Jersey	41,797	1,691	43,488
New York	187,364	2,159	189,523
Pennsylvania	1,811,299	20,241	1,831,540
Total: 1953	2,040,460	24,091	2,064,551
1952	1,970,125	23,158	1,993,283
East North Central:			
Illinois	1,341,420	107,268	1,448,688
Indiana	98,780	1,988	100,768
Michigan	1,153,834	3,682	1,157,516
Ohio	2,148,875	26,012	2,174,887
Wisconsin	169,733	3,605	173,338
Total: 1953	4,912,642	142,555	5,055,197
1952	4,953,217	76,681	5,029,898
West North Central:			
Iowa, Kansas, and Nebraska	71,153	1,265	72,418
Minnesota	9,201	265	9,466
Missouri	157,665	1,120	158,785
Total: 1953	238,019	2,650	240,669
1952	211,004	4,779	215,783
South Atlantic:			
Delaware, District of Columbia, and Maryland	103,197	1,761	104,958
Florida and Georgia	131,674	109	131,783
North Carolina, Virginia, and West Virginia	79,943	358	80,301
Total: 1953	314,814	2,228	317,042
1952	215,299	3,236	218,535
East South Central:			
Alabama	97,569	40	97,609
Kentucky	306,971		306,971
Tennessee	34,129	597	34,726
Total: 1953	438,669	637	439,306
1952	357,459	2,050	359,509
West South Central:			
Arkansas, Louisiana, and Oklahoma	45,898	1,271	47,169
Texas	242,398	2,601	244,999
Total: 1953	288,296	3,872	292,168
1952	284,066	4,425	288,491
Rocky Mountain: Arizona, Colorado, Nevada, and Utah	30,520	273	30,793
Total: 1953	30,520	273	30,793
1952	38,314	649	38,963
Pacific Coast:			
California	567,315	2,898	570,213
Oregon	151,099	108	151,207
Washington	126,271	310	126,581
Total: 1953	844,685	3,316	848,001
1952	888,433	2,087	890,520
Total United States: 1953	9,156,606	181,336	9,337,942
1952	8,972,823	118,668	9,091,491

Cupolas.—Figures released by the Bureau of Mines and the Bureau of the Census, United States Department of Commerce, indicate that shipments of gray-iron castings in 1953 increased 7 percent over 1952. Accordingly, consumption for scrap and pig iron for cupolas increased 4 percent over 1952; scrap increased 5 percent and pig iron 2 percent. The charge to cupolas consisted of 66 percent scrap and 34 percent pig iron compared with 65 and 35 percent, respectively, in 1952.

Michigan continued to be the leading State in consumption of scrap in cupola furnaces, using 25 percent of the total.

TABLE 11.—Consumption of ferrous scrap and pig iron in cupola furnaces in the United States in 1953, by districts and States, in short tons

District and State	Total scrap	Pig iron	Total scrap and pig iron
New England:			
Connecticut	125,173	54,280	179,453
Maine	11,757	5,929	17,686
Massachusetts	200,665	82,128	282,793
New Hampshire	13,115	1,640	14,755
Rhode Island	35,495	21,305	56,800
Vermont	21,096	8,974	30,070
Total: 1953	407,301	174,256	581,557
1952	413,453	174,709	588,162
Middle Atlantic:			
New Jersey	362,781	161,317	524,098
New York	403,550	208,986	612,536
Pennsylvania	739,522	340,314	1,079,836
Total: 1953	1,505,853	710,617	2,216,470
1952	1,546,865	822,597	2,369,462
East North Central:			
Illinois	1,033,933	368,990	1,402,923
Indiana [1]	517,782	277,582	795,364
Michigan	2,670,765	1,231,472	3,902,237
Ohio [1]	1,129,231	551,838	1,681,069
Wisconsin	489,762	222,662	712,424
Total: 1953	5,841,473	2,652,544	8,494,017
1952	5,140,146	2,316,014	7,456,160
West North Central:			
Iowa	238,662	85,410	324,072
Kansas	52,730	7,894	60,624
Nebraska	16,904	4,419	21,323
Minnesota, North Dakota, and South Dakota	133,638	33,620	167,258
Missouri	184,825	40,433	225,258
Total: 1953	626,759	171,776	798,535
1952	752,581	203,039	955,620
South Atlantic:			
Delaware and Maryland	89,716	75,513	165,229
Florida	4,994	2,155	7,149
Georgia	28,252	19,453	47,705
North Carolina	44,050	22,492	66,542
South Carolina	15,549	10,501	26,050
Virginia	204,987	54,166	259,153
West Virginia	20,346	47,711	68,057
Total: 1953	407,894	231,991	639,885
1952	417,945	220,410	638,355
East South Central:			
Alabama	618,663	893,536	1,512,199
Kentucky and Mississippi	141,050	192,947	333,997
Tennessee	293,157	213,616	506,773
Total: 1953	1,052,870	1,300,099	2,352,969
1952	1,011,890	1,318,138	2,330,028

TABLE 11.—Consumption of ferrous scrap and pig iron in cupola furnaces in the United States in 1953, by districts and States, in short tons—Continued

District and State	Total scrap	Pig iron	Total scrap and pig iron
West South Central:			
Arkansas	1,790	820	2,610
Louisiana	3,857	818	4,675
Oklahoma	20,199	6,172	26,371
Texas	174,295	105,981	280,276
Total: 1953	200,141	113,791	313,932
1952	250,116	173,789	423,905
Rocky Mountain:			
Arizona and New Mexico	33,714	144	33,858
Colorado	67,679	31,767	99,446
Utah	81,992	61,461	143,453
Idaho and Wyoming	3,142	235	3,377
Montana	11,279	243	11,522
Total: 1953	197,806	93,850	291,656
1952	196,596	80,881	277,477
Pacific Coast:			
California	323,333	90,326	413,659
Oregon	30,291	3,718	34,009
Washington	37,555	5,287	42,842
Total: 1953	391,179	99,331	490,510
1952	439,143	128,717	567,860
Undistributed: [1] 1953	2,892	1,267	4,159
Total United States: 1953	10,634,168	5,549,522	16,183,690
1952	10,168,735	5,438,294	15,607,029

[1] Some scrap and pig iron consumption in Indiana and Ohio—not separable—are included with "Undistributed."

Air Furnaces.—The total charge of scrap and pig iron in air furnaces in 1953 was slightly less than during 1952. Apparently no Brackelsberg furnaces were used in the United States during the year. The use of scrap and pig iron separately decreased slightly from 1952. The East North Central district continued to lead in the use of air furnace scrap, owing largely to the large consumption in Ohio.

Crucible and Puddling Furnaces.—The consumption of scrap and pig iron in crucible furnaces was negligible during 1953, 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 the blast furnace charge and in 1953 consisted of 133,191,839 short tons of iron ore, sinter, and manganiferous ore; 4,061,186 tons of mill cinder and roll scale; 4,623,160 tons of open-hearth and Bessemer slag; and 154,860 tons of miscellaneous materials.

Consumption of scrap in blast furnaces was 16 percent greater than in 1952. The proportion of scrap used to pig iron produced was 6.6 percent compared with 6.9 percent in 1952.

TABLE 12.—Consumption of ferrous scrap and pig iron in air furnaces in the United States in 1953, by districts and States, in short tons

District and State	Total scrap	Pig iron	Total scrap and pig iron
New England:			
Connecticut	28,979	7,621	36,600
Massachusetts and New Hampshire	16,131	5,349	21,480
Rhode Island	5,698	1,163	6,861
Total: 1953	50,808	14,133	64,941
1952	45,449	15,277	60,726
Middle Atlantic:			
New Jersey	3,515	2,773	6,288
New York	52,465	16,758	69,223
Pennsylvania	148,760	55,399	204,159
Total: 1953	204,740	74,930	279,670
1952	210,245	78,052	288,297
East North Central:			
Illinois	179,396	48,195	227,591
Indiana	140,168	38,355	178,523
Michigan	106,368	16,070	122,438
Ohio	365,434	73,064	438,498
Wisconsin	85,136	25,290	110,426
Total: 1953	876,502	200,974	1,077,476
1952	875,709	199,181	1,074,890
West North Central: Iowa, Minnesota, and Missouri	13,062	7,750	20,812
Total: 1953	13,062	7,750	20,812
1952	14,472	9,141	23,613
South Atlantic and West South Central:			
Delaware, North Carolina, and West Virginia	18,829	9,167	27,996
Texas	19,399	2,575	21,974
Total: 1953	38,228	11,742	49,970
1952	36,679	12,234	48,913
Pacific Coast: California	13,707	3,525	17,232
Total: 1953	13,707	3,525	17,232
1952	16,465	3,615	20,080
Total United States: 1953	1,197,047	313,054	1,510,101
1952	1,199,019	317,500	1,516,519

TABLE 13.—Consumption of ferrous scrap in blast furnaces in the United States in 1953, 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	480,625	Alabama	375,239
Pennsylvania	1,580,139	Kentucky, Maryland, Tennessee, Texas, and West Virginia	557,535
Total: 1953	2,060,764	Total: 1953	932,774
1952	1,687,679	1952	849,940
East North Central and West North Central:		Rocky Mountain and Pacific Coast:	
Illinois	316,441	California, Colorado, and Utah	41,754
Indiana	197,894	Total: 1953	41,754
Michigan and Minnesota	412,178	1952	27,173
Ohio	986,437		
Total: 1953	1,912,950	Total United States: 1953	4,948,242
1952	1,709,359	1952	4,274,151

USE OF SCRAP IN FERROALLOY PRODUCTION

The ferroalloy plants operating electric furnaces or aluminothermic units during 1953 used 10 percent more scrap than in 1952.

Scrap used in blast furnaces in the manufacture of ferroalloys is included with blast furnaces in this chapter.

TABLE 14.—Consumption of ferrous scrap by ferroalloy producers in the United States, in 1953, by districts, in short tons

District	Total scrap	District	Total scrap
Middle Atlantic: [1]		East South Central:	
Total: 1953	32,438	Total: 1953	55,485
1952	45,222	1952	26,976
East North Central: [1]		Pacific Coast:	
Total: 1953	19,278	Total: 1953	4,173
1952	16,360	1952	4,813
West North Central:		Undistributed: [1]	
Total: 1953	178,587	Total: 1953	80,968
1952	170,579	1952	75,411
South Atlantic:		Total United States:	
Total: 1953	2,243	1953	373,172
1952	398	1952	339,759

[1] Some scrap consumption in the Middle Atlantic and East North Central districts—not separable—is included with "Undistributed."

MISCELLANEOUS USES

Scrap consumed in 1953 for miscellaneous purposes, such as rerolling, nonferrous metallurgy, and as a chemical agent, amounted to 1.1 percent of the total consumption compared with 1.2 percent during the previous year. The quantity so used increased 6 percent over that used for similar purposes in 1952.

TABLE 15.—Consumption of ferrous scrap in miscellaneous uses in the United States in 1953, by districts and States, in short tons

District and State	Total scrap	District and State	Total scrap
New England: Connecticut and Massachusetts	16,033	South Atlantic:	
		Georgia	1,019
		Virginia and West Virginia	41,927
Total: 1953	16,033	Total: 1953	42,946
1952	15,860	1952	41,378
Middle Atlantic:		East South Central and West South Central: Alabama and Texas	61,278
New Jersey [1]	119,545	Total: 1953	61,278
New York	87,534	1952	56,585
Pennsylvania	59,799	Rocky Mountain:	
Total: 1953	266,878	Arizona	32,164
1952	252,509	Colorado, Idaho, and Montana	14,662
East North Central:		Utah	5,855
Illinois	197,956	Total: 1953	52,681
Indiana	29,533	1952	49,235
Michigan and Wisconsin	21,303	Pacific Coast:	
Ohio	63,215	California	48,284
Total: 1953	312,007	Washington	1,451
1952	294,733	Total: 1953	49,735
West North Central:		1952	53,619
Minnesota	615	Undistributed: [1]	351
Missouri [1]	74,315	Total United States: 1953	876,839
Total: 1953	74,930	1952	824,274
1952	60,355		

[1] Some scrap consumed in miscellaneous uses during 1953 in New Jersey and Missouri—not separable—is included with "Undistributed."

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TABLE 16.—Consumers' stocks of ferrous scrap and pig iron on hand in the United States on December 31, 1952, and December 31, 1953, by district and States, in short tons.

District and State	December 31, 1952		December 31, 1953	
	Total scrap	Pig iron	Total scrap	Pig iron
Connecticut	26,778	10,101	34,850	9,671
Maine	1,942	756	3,099	1,366
Massachusetts	86,876	54,484	87,638	101,864
New Hampshire	2,878	281	2,363	663
Rhode Island	10,581	8,153	9,002	5,383
Vermont	8,951	1,338	4,876	1,150
Total New England	138,006	75,113	141,828	120,097
New Jersey [1]	75,323	38,440	68,017	38,098
New York [1]	474,633	116,435	428,527	225,388
Pennsylvania	1,640,646	337,459	1,705,062	511,654
Total Middle Atlantic	2,190,602	492,334	2,201,606	775,140
Illinois	737,569	127,164	798,279	188,220
Indiana [1]	520,117	130,191	672,823	128,603
Michigan	372,412	367,231	378,094	509,722
Ohio [1]	1,124,395	228,170	1,176,841	376,148
Wisconsin	85,660	36,854	66,350	33,797
Total East North Central	2,840,153	889,610	3,092,387	1,236,490
Iowa	60,214	23,700	37,328	18,199
Kansas and Nebraska	14,073	1,090	16,654	1,758
Minnesota, North Dakota, and South Dakota	186,399	21,803	158,123	41,411
Missouri [1]	132,612	35,671	158,959	18,153
Total West North Central	393,298	82,264	371,064	79,521
Delaware, District of Columbia, and Maryland	101,705	12,061	136,991	46,639
Florida and Georgia	20,423	6,540	14,092	3,184
North Carolina	2,210	2,675	2,594	2,296
South Carolina	3,980	2,477	1,515	1,675
Virginia and West Virginia [1]	152,937	24,237	131,417	11,541
Total South Atlantic	281,255	47,990	286,609	65,335
Alabama [1]	136,366	225,371	117,618	203,396
Kentucky, Mississippi, and Tennessee	66,986	55,763	90,864	102,044
Total East South Central	203,352	281,134	208,482	305,440
Arkansas, Louisiana, and Oklahoma	12,270	4,764	20,566	1,728
Texas	172,698	29,983	169,914	66,422
Total West South Central	184,968	34,747	190,480	68,150
Arizona, Nevada, and New Mexico	23,164	309	21,404	188
Colorado and Utah	148,411	18,650	134,500	83,612
Montana	5,383	10	8,211	56
Idaho and Wyoming	3,418	289	2,245	72
Total Rocky Mountain	180,376	19,258	166,360	83,928
Alaska, Washington, and Oregon [1]	102,543	3,724	87,162	4,165
California	363,401	37,913	386,162	59,098
Total Pacific Coast	465,944	41,637	473,324	63,263
Undistributed [1]	24,360		16,626	191
Total United States	6,902,314	1,964,087	7,148,766	2,797,555

[1] Some scrap stocks in Alabama, Indiana, Missouri, New Jersey, New York, Oregon, and West Virginia, also some pig iron stocks in Indiana and Ohio—not separable—are included with "Undistributed."

STOCKS

Complete iron- and steel-scrap stock figures covering 1953 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, 1953, increased 4 percent over those held at the beginning of the year. Stocks of pig iron on December 31, 1953, increased 42 percent over the stocks on hand December 31, 1952.

Suppliers' Stocks.—Stocks of iron and steel scrap in the hands of a combined total of 426 dealers, automobile wreckers, and shipbreakers, as reported voluntarily to the Bureau of Mines, totaled 805,657 short tons on December 31, 1953.

PRICES

All price controls were removed by OPS, effective 12:01 a. m. February 13, 1953. This terminated scrap price controls, which had been in effect since February 7, 1951.

The price of No. 1 Heavy-Melting scrap at Pittsburgh, as reported in the Iron Age Annual Review, January 7, 1954, averaged $40.99 per gross ton in 1953. The basing-point price ceiling of $43.00 per ton, as set by OPS, remained firm until price controls were removed, when it rose immediately to $44.75 in March, falling and rising for the next few months, reaching a high of $46.75 during June. During the last 6 months prices continued to fluctuate, reaching a low in December of $33.10 per ton. Cast-iron scrap dropped from the ceiling price of $49 to an average for the year of $42.82 per gross ton. The lowest price, $36.90 per gross ton, paid for this grade of scrap also was in effect during December.

The composite price of iron and steel scrap, as reported by Iron Age, was $42 per gross ton in January 1953, unchanged from the previous year. Price regulations were removed as of 12:01 a. m. February 13; the average price increased to $44.18 per ton during March and continued rising to a high of $44.60 per ton in July but dropped to $31.33 per ton by the end of December. The average composite price for the year dropped to $39.52 per ton. No. 1 Cast scrap composite price at Chicago was quoted at $46.63 per gross ton at the beginning of the year and rose to a high of $47.20 per ton during March. The prices for this grade of scrap varied from month to month and reached a low point in October of $36.75 per ton. The average price for the year for No. 1 Cast at Chicago was $42.73 per ton. No. 1 Heavy Melting at Chicago was quoted at $41.50 per gross ton in January, but following removal of ceiling price regulations it ranged from a high during March of $43.50 per ton to a low of $31.00 per ton in December. The average price for this grade of scrap for the year was $38.24.

OPS issued amendment 12 to Ceiling Price Regulation 5 (CPR 5), effective January 16, 1953, clarifying the intent of the regulation with respect to the definition of "brokers," changes the basis on which deductions are made from the shipping-point ceiling price for sales of scrap where the purchaser must load the scrap or transfer the scrap from the seller's premises. Ceiling Price Regulation 186, issued January 30, 1953, to become effective February 16, would have regulated ceiling prices on relaying rail and used track accessories; however, as the ceiling price regulation was terminated before the effective date, this regulation never applied.

FOREIGN TRADE[2]

Imports.—Imports of iron and steel scrap, including tinplate, increased 12 percent over the previous year, with the value increasing 8 percent. Of the scrap imported, the largest quantity was received from Canada-Newfoundland-Labrador (76 percent of the total imports), followed by Netherlands Antilles (4 percent) and Australia (4 percent); 16 percent was imported from other countries. Of the total imports, 24 percent was tinplate scrap, mostly from Canada, compared with 31 percent during the previous year.

Exports.—Exports of ferrous scrap from the United States in 1953 showed a 10-percent decrease from 1952 in both tonnage and price. Exports exceeded imports by 84 percent compared with 130 percent (revised) in previous year. The tonnage exported amounted to only 10 percent of the 5-year prewar average (1935–39) of 3,298,000 tons a year; the percentage in 1952 was 11. Tinplate scrap, tinplate circles, strips, cobbles, and terneplate clippings and scrap exported during 1953 were 5 percent of the total exports, with a value of $1,253,000. The same materials in 1952 were 4 percent of the 1952 exports, with a value of $1,388,000.

TABLE 17.—Ferrous scrap imported for consumption in the United States, by countries, 1944–48 (average) and 1949–53, in short tons

[U. S. Department of Commerce]

Country	1944–48 (average)	1949	1950	1951	1952	1953
Algeria	107	548	15,401	22,863	799	790
Australia	4,600	12,469	16,635	12,512	8,755	6,145
Belgium-Luxembourg	1,528	5,731	39,527	1,676	328	
Canada-Newfoundland-Labrador	48,319	71,201	87,981	69,799	55,101	131,371
Canal Zone	4,631	1,824	1,163	10,525	1,141	2,180
Cuba	15,671	10,337	21,242	43,870	22,800	3,012
Denmark	1,162	146	5,006	475	128	
France	223	213	162,090	27,844	258	373
French Morocco	677	1,682	6,586	3,042	2,187	3,778
French West Indies		4,693			1,596	1,381
Germany	45,561	532,850	185,839	63,912		[1] 253
India	739	1,186	325	21,519	13,251	
Japan	13,171	209,519	113,436	31,648	1,259	1,751
Korea	179			8,516	5,741	
Netherlands	1,992	200,486	70,001	19,402	12	77
Netherlands Antilles	4,073	2,128	3,609	4,328	951	7,104
New Zealand	133	1,634	175	7,477	431	318
Norway	23	[2] 308	18	35	2,576	3
Panama	184	1		65	1,913	1,410
Philippines	5,080	75,955	14,253	26,336		51
Switzerland			[2] 28	6,709		
Union of South Africa	1,164	4,461	5,893	6,930	[2] 5,617	2,167
United Kingdom	539	3,257	8,529	6,225	23	4,926
Venezuela	1,542	647		[2] 554	8,385	2,240
Western Pacific Islands		101			6,720	
Other countries	9,474	[2] 9,917	[2] 27,493	[2] 20,596	[2] 13,702	2,841
Total: Short tons	160,772	1,151,294	785,230	416,858	153,674	172,171
Value	$3,252,819	$29,937,798	$18,718,895	$15,013,148	$5,398,570	$5,849,577

[1] West Germany.
[2] Revised figure.

[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 18.—Ferrous scrap exported from the United States, 1944–48 (average) and 1949–53, by countries of destination, in short tons

[U. S. Department of Commerce]

Destination	1944–48 (average)	1949	1950	1951	1952	1953
Argentina	1,175	3,866	1,112	2,597	741	------
Belgium-Luxembourg	12	------	------	316	55	[1] 178
Brazil	580	12	3,225	1,018	296	------
British Malaya	------	------	863	2,487	1,044	361
Canada-Newfoundland-Labrador	97,200	[1] 162,631	81,000	89,632	[1] 195,439	76,762
Chile	2,869	------	------	6	------	------
China	2,019	33	230	------	------	------
Hong Kong	693	1,558	2,547	14	------	121
India	233	808	160	797	1,763	3,205
Italy	52	------	115	473	1,300	171
Japan	------	------	1,605	3,105	4,362	[1] 68,344
Mexico	32,601	[1] 123,624	124,537	[1] 140,304	[1] 136,271	[1] 157,086
Netherlands	70	------	355	1,212	34	27
Philippines	(2)	26	186	81	------	287
Turkey	32	503	95	420	846	624
Union of South Africa	219	25	236	709	28	91
United Kingdom	115	38	------	------	[3] 9,634	9,055
Other countries	1,806	[1] 5,470	698	2,169	897	230
Total: Short tons	139,676	[1] 298,594	216,964	[1] 245,340	[1,3] 352,710	[1] 316,542
Value	$3,590,791	[1] $7,342,886	$6,013,719	[1] $9,094,473	[1,3] $12,500,289	[1] $11,218,916

[1] Includes rerolling materials as follows: 1949, Canada, 37 tons; Mexico, 1,095 tons; other countries, 74 tons; total, 1,206 tons ($50,086); 1951, Mexico, 9,813 tons ($358,146); 1952, Canada, 69 tons; Mexico, 1,217 tons, total, 1,286 tons ($77,287); and 1953, Belgium-Luxembourg, 163 tons; Japan, 5,873 tons; Mexico, 692 tons; total, 6,728 tons ($391,464). Not separately classified before 1949.
[2] Less than 1 ton.
[3] Revised figure.

TABLE 19.—Ferrous scrap imported into and exported from the United States, 1944–48 (average) and 1949–53, by classes

[U. S. Department of Commerce]

Year	Imports			Exports				
	Iron and steel scrap	Tinplate scrap	Total	Iron and steel scrap	Tinplate scrap	Tinplate circles, strips, cobbles, etc.	Terne-plate clippings and scrap	Total
				SHORT TONS				
1944–48 (average)	131,248	29,524	160,772	135,700	166	3,493	317	139,676
1949	1,105,343	45,951	1,151,294	[1] 294,960	------	3,380	254	[1] 298,594
1950	737,749	47,481	785,230	208,355	629	7,819	161	216,964
1951	359,099	57,759	416,858	[1] 229,718	907	14,554	161	[1] 245,340
1952	105,896	47,778	153,674	[1,2] 337,573	3,998	11,139	------	[1,2] 352,710
1953	130,079	42,092	172,171	[1] 297,905	5,818	12,819	------	[1] 316,542
				VALUE				
1944–48 (average)	$2,846,398	$406,421	$3,252,819	$3,208,560	$13,196	$348,804	$20,231	$3,590,791
1949	28,890,519	1,047,279	29,937,798	[1] 6,947,516	------	370,568	24,802	[1] 7,342,886
1950	17,834,543	884,352	18,718,895	5,254,747	39,237	697,755	21,980	6,013,719
1951	13,181,093	1,832,055	15,013,148	[1] 6,815,215	33,498	2,227,549	18,211	[1] 9,094,473
1952	4,053,529	1,345,041	5,398,570	[1,2] 11,112,572	85,828	1,301,889	------	[1,2] 12,500,289
1953	4,734,301	1,115,276	5,849,577	[1] 9,966,375	99,041	1,153,500	------	[1] 11,218,916

[1] Includes rerolling materials as follows: 1949, 1,206 tons valued at $50,086; 1951, 9,813 tons valued at $358,146; 1952, 1,286 tons valued at $77,287; and 1953, 6,728 tons valued at $391,464. Not separately classified before 1949.
[2] Revised figure.

TECHNOLOGY

The use of oxygen-enriched blast mixtures rather than air for blowing Bessemer converters was an outstanding technical development of the year. W. C. Bell, joint director, research and technical development, Stewarts and Lloyds, Ltd., Corby, Northampshire, England, described the methods used at the general meeting of the American Iron and Steel Institute, New York, N. Y., May 27–28.[3]

By the process of oxygen blast, the blowing time is shortened 30 to 40 percent, the rate of output is increased 15 to 20 percent, greater charges of scrap can be carried, and the economic advantage of the basic process is retained. A special method for applying oxygen has been developed in Belgium and Germany. This method uses throughout the blow, or for the major part of it, a mixture of 60 percent oxygen and 40 percent steam. This oxygen-steam mixture is approximately thermally equivalent to air.

Another technical development was the improved handling techniques used at scrap-preparation yards. One of the most modern, that of the Columbia Iron & Metal Co., Girard (Youngstown), Ohio, was described.[4] This yard was planned to serve a large operation; the result was a model yard with minimum length of moves and number of handlings. The yard area was planned specifically for its role in scrap preparation and arranged according to operations that would take place in various sections.

The tracks are laid out in pairs, running north and south, then branching into various lines. Spur tracks connect each pair of tracks; 1 large spurline connects 2 sets of tracks near the weighing house. These tracks serve designated areas where specified operations are performed, such as baling, shearing, and cutting; each is done in separate areas.

The layout was planned to enable the company to move incoming scrap to a particular processing area where it is unloaded by cranes, processed, and reloaded into cars for shipment.

The number of railroad tracks within the yard and the distance between these tracks were planned carefully. In many yards locomotive cranes can operate only on single tracks, on which are the rail cars. This means that a crane with a 55-foot boom cannot completely empty a loaded car, most of which are 55 feet long. With double pairs of tracks the rail cars are located on the outside of the two, away from the storage and processing area to which the scrap is to be transferred. This makes it easier for the cranes to travel back and forth, servicing all cars in the line and emptying them completely with a minimum of effort.

The entire handling operation proceeds on a direct and orderly basis. Because so many overall activities in the yard consist of handling, it was considered imperative to organize both layout and handling with regard to maximum effectiveness, resulting in an effortless operation that utilizes both working and storage area, eliminates manual handling, and greatly increases productivity.

A paper presented at the Youngstown Regional Meeting of the Iron and Steel Engineers, January 25, 1954, described new open-

[3] Steel, vol. 133, No. 1, July 6, 1953, pp. 112, 115, 118, 120.
[4] Waste Trade Journal, vol. 95, No. 3, Apr. 11, 1953, pp. 40, 41.

hearth scrap charging practice.[5] The section of this article titled "Furnace Charging" describes the conditions leading up to the use of hoists for lifting the charging buggies from the ground level to the charging level and the results obtained from this method. According to Barnes:

This charging method has worked out very satisfactorily. Ordinarily the furnaces can be charged as fast as they will take the charge. Some delay occurs occasionally when two adjacent furnaces are charged simultaneously, but it is practically impossible to charge two adjacent furnaces simultaneously by the conventional method. Two charging buggies have been accidentally dropped down the hoist well. One only dropped a few feet. The other went almost to the botton. No serious damage was done in either case. Mechanical, electrical, and hydraulic delays on these units have been very low. Furnace rebuilds can proceed rapidly with no interference due to charging adjacent furnaces.

WORLD REVIEW

A reduction in consumption of scrap in the countries of the European Coal and Steel Community in 1953 was due partly to reduced steel output and partly to reduced scrap input of blast furnaces. In percentage of blast-furnace production, scrap consumed averaged only about 9 percent in the second half of 1953 compared with 11 percent in the first half and 14 percent in 1952. The total scrap consumption in blast furnaces in 1953 was about 2 million tons lower than in 1952. Scrap consumption per ton of steel produced in electric, open-hearth and Thomas furnaces increased somewhat after the summer of 1953; but, due to reduced steel output, total scrap consumption in 1953 was lower.[6]

The lower scrap consumption by the Community expressed itself in lower purchases of commercial scrap. As a result, dealers' stocks of scrap increased substantially in 1953, in addition to the 500,000-ton rise of stocks in steel mills. The quantity of circulating scrap used by the steel industry per ton of produced steel increased in 1953 due to higher rejects caused by greater selectivity of buyers.

The relaxed licensing of exports by the United States Government under the policy announced on October 16 did not result in any substantial imports of United States scrap by the countries of the European Coal and Steel Community.

The low demand for commercial scrap permitted the High Authority of the Community to lower ceiling prices for scrap by $3.00 per ton as from June 15, 1953. At the close of the year, mills in the main steel-producing areas could buy scrap at about $30 per ton for the basic category of scrap, $3.00 below ceiling price.

Bolivia.—The exportation of scrap or used iron and steel was prohibited by a Supreme Decree of February 20, 1953. These commodities were required to be sold locally to foundries, factories, and other "converter" enterprises, through the Metallurgical Department of the Bureau of Mines of the Ministry of National Economy. The decree voided all existing permits issued for exportation of used metallic materials, including those submitted to the various government Customs Offices or covering carloads of material ready for dispatch. The decree stated further that materials that can be industrially converted

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[5] Barnes, H. C., New Open-Hearth Shop at East Works, Middletown Division, Armco Steel Corporation: Iron and Steel Eng., Youngstown Regional Meeting, Jan. 25, 1954, 16 pp.

[6] U. S. Embassy, Luxembourg, State Department Dispatch B-65: Dec. 29, 1953.

into new products must be retained in the country.[7] Data on all stocks were to be submitted to the Ministry of Mines and Petroleum within 45 days from June 16, the date of a Supreme Decree implementing the decree of February 20, 1953. The information contained in the inventory reports was utilized to determine the industrial use of scrap iron and to formulate its export control policy.[8]

Canada.[9]—Indications of a prolonged scrap surplus in Canada prompted the Embassy at Ottawa to inquire of the Steel Division of the Department of Defense Production to what extent scrap dealers were being granted export permits for disposal of offshore scrap accumulations. It was found that export permits were being granted to scrap dealers in hardship cases after careful study of applications but that in every instance offshore scrap offerings were relayed to the Canadian Department of Defense Productions Office in Washington in pursuance of a procedure for first affording consumers in the United States an opportunity to purchase. The bulk of the offshore sales, however, would be Heavy-Melting scrap and would go to the United Kingdom. Export permits were not being issued for bundles, because it was felt they could be absorbed in the domestic market.

The present surplus of scrap was attributed to (1) last year's campaign for scrap accumulation and (2) the prolonged steel strike in the United States during the summer of 1952.

Germany, West.[10]—Scrap stocks in August totaled 394,000 metric tons, an increase of about 63,000 metric tons over the previous month, according to figures issued by the West Germany's Office of Statistics. Export sales totaled 72,000 tons, of which 66,000 metric tons was sent to Italy. Sweden, although not a member of the European Coal and Steel Community, purchased over 2,000 metric tons; during July 25,000 metric tons were exported to countries that are members of the Community.

Imports of scrap rose from 15,000 tons in July to 23,000 tons in August. Steelworks purchased 268,000 tons of scrap during August, and foundries bought 77,000 tons.

India.[11]—The Government of India placed a ceiling of 100,000 tons of iron and steel scrap for export for the period of April to December. Statistical figures furnished by the Iron and Steel Controller showed that exports of scrap for the first quarter of 1953 totaled 168,687 tons. Total exports for 1953 were approximately 270,000 tons compared with 329,604 tons in 1952.

Japan.—According to dispatches from Tokyo, efforts were made to obtain scrap iron in the United States from the San Francisco area. It was reported that 1 steel producer in Japan contracted for imports of 18,000 metric tons of scrap from Guam and another negotiated for 8,000 tons from the Aleutians.[12]

Due to the refusal of collectors in Japan to deliver scrap at established prices some mills experienced an acute shortage of scrap during

[7] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 4, April 1953, p. 18.
[8] Foreign Commerce Weekly, vol. 50, No. 3, July 20, 1953, p. 13.
[9] U. S. Embassy, Ottawa, Canada, State Department Dispatch 1: July 2, 1953.
[10] American Metal Market, vol. 60, No. 186, Sept. 24, 1953, p. 12.
[11] U. S. Consulate, Calcutta, India, State Department Dispatch 906: June 1, 1953.
[12] Waste Trade Journal, vol. 95, No. 13, June 20, 1953, p. 4.

July. Another factor was the decline in scrap shipments from Southeast Asia.[13]

According to the Japan Iron and Steel Federation, stocks of iron and steel scrap decreased to 629,190 metric tons at the end of November, 35,221 tons less than at the end of the previous month. A spokesman for the federation said that the decrease was due to less scrap being collected in Japan. Collections in November totaled 130,269 tons compared with 148,956 tons in October. The total supplies—those imported—collected in Japan and produced in the course of manufacturing iron and steel products, were 417,116 tons in November against 430,221 tons in October.[14]

United Kingdom.[15]—A shortage of scrap iron and steel during May 1953 in South Wales caused a burden on the pig-iron supply, and the relative proportions of these essential basic raw materials had to be revised in relation to materials available. Some furnaces were idle and were unable to resume production until the supply position was improved, whereas others were able to remain in operation on a day-to-day basis. The scrap supply continued to cause anxiety. Demand was far greater than supply, thus minimum needs were all that could be met. Imports offered no relief. Small tonnages of mixed quality comprised the cargoes received at South Wales.

A decision was announced to suspend the national scrap drive at the end of 1953. The drive had been conducted since June 1948, proving worthwhile, but it was felt that a period must be allowed for further accumulation of scrap. The recovery of demolition scrap was to be continued.[16]

Scrap dealers had been able to maintain an improvement in deliveries to the steelworks, whose requirements had increased rapidly. Most of the works had substantial stocks upon which they could draw in case of temporary shortages, but there could be no relaxation in the use of home scrap, and purchases of increased supplies from overseas were to continue.[17]

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[13] American Metal Market, July 29, 1953, p. 3.
[14] American Metal Market, vol. 61, No. 13, Jan. 20, 1954, p. 12.
[15] Metal Bulletin (London), No. 3789, May 1, 1953, p. 29.
[16] American Metal Market, vol. 60, No. 191, Oct. 1, 1953, p. 1.
[17] Iron and Coal Trades Review (London), vol. 167, No. 4471, Dec. 18, 1953, p. 1438.

Jewel Bearings

By Robert D. Thomson [1] and Eleanor V. Blankenbaker [2]

PRODUCTION of jewel bearings in the United States during 1953 was the largest for the industry since 1943. The consumption of blanks and finished jewel bearings declined, but consumption of semifabricated jewel bearings remained about the same. The quantity and value of jewel bearing imports were both less in 1953 than in 1952.

DOMESTIC PRODUCTION

Production of blanks and finished jewel bearings in 1953 increased 217 and 47 percent, respectively. The domestic industry continued to be affected by competition from Swiss jewel bearings of high quality, through lower cost and plentiful supply. Firms at Elgin, Ill.; Waltham and West Lynn, Mass.; Newark, Perth Amboy, and Trenton, N. J.; Woodside, N. Y.; and Lancaster and Morrisville, Pa., reported production of finished jewel bearings. Production of jewel bearings at the Turtle Mountain Ordnance Plant, Rolla, N. Dak., began early in 1953. This plant, under management of the Bulova Watch Co., was established in the interest of national defense to provide a nucleus of labor skilled in the production of jewel bearings and to develop mechanization and efficient manufacturing practices.

TABLE 1.—Salient statistics of the jewel-bearings industry in the United States, 1949–53

[Number of jewel bearings]

	1949	1950	1951	1952	1953
Production:					
Blanks	249, 600	795, 400	1, 200, 503	1, 907, 301	6, 043, 886
Finished jewels [1]	2, 725, 103	3, 327, 206	9, 876, 654	10, 637, 206	15, 666, 908
Consumption:					
Blanks	6, 678, 922	7, 008, 289	11, 415, 514	9, 062, 893	7, 939, 130
Semifabricated jewels	1, 603, 900	3, 331, 500	7, 884, 500	1, 892, 000	1, 900, 000
Finished jewels [1]	68, 322, 111	71, 126, 700	85, 030, 037	77, 311, 999	70, 936, 923
Shipments:					
Blanks	29, 100	85, 400	75, 503	5, 391	8, 189, 821
Semifabricated jewels	1, 771	2, 414	561	1, 439	30, 000
Finished jewels [1]	24, 645, 548	6, 976, 608	14, 031, 386	28, 795, 001	36, 772, 885
Stocks on hand Dec. 31:					
Blanks	7, 684, 765	5, 796, 014	2, 618, 650	4, 327, 957	1, 413, 951
Semifabricated jewels	243, 454	529, 540	710, 479	1, 054, 886	2, 134, 040
Finished jewels [1]	98, 213, 655	107, 432, 348	97, 390, 081	104, 169, 041	97, 545, 593

[1] Includes finished jewels made from glass.

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

CONSUMPTION AND USES

The jewel-bearings industry showed an overall decline in consumption during the year. Consumption of blanks and finished jewels declined 12 and 8 percent, respectively, while consumption of semifabricated jewels remained about the same.

About 41 percent less raw material was reported consumed in producing synthetic sapphire and ruby jewel bearings. Sizable quantities of glass were used in producing the glass vees.

Consumption and shipments of finished jewels, by uses, are shown in table 3. Of the total consumption, instrument rings totaled 31 percent; caps, 14; vees, 13; and endstones and watch rings, 10 percent each. Various jewel-bearings shapes are shown in figure 1.

Forty-one companies in 12 States reported consumption of finished jewel bearings in 1953. About 38 percent of the jewels was consumed by 6 companies in New Jersey and 8 companies in New York and Pennsylvania.

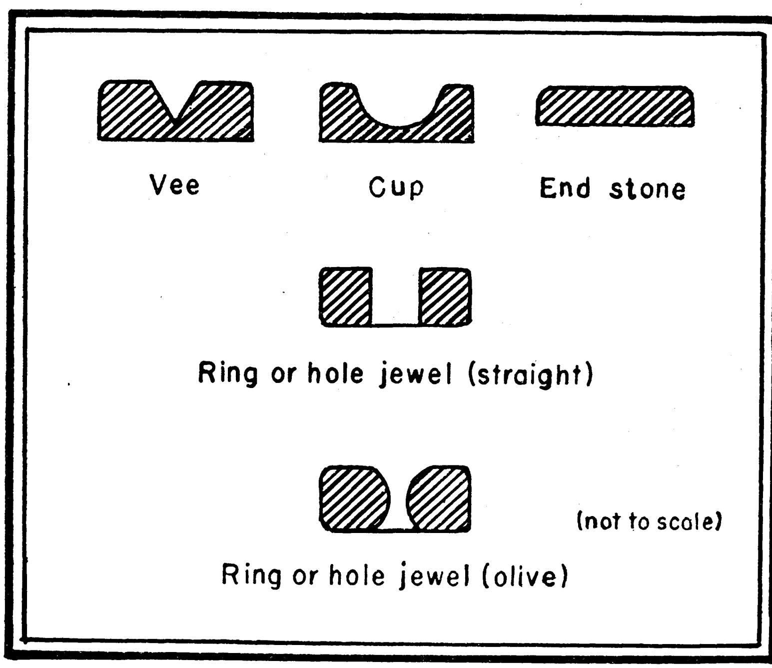

FIGURE 1.—Typical shapes of jewel bearings.

TABLE 2.—Consumption and shipments of raw materials for production of blanks by the jewel-bearings industry in the United States, 1949–53

Type of raw material	Consumption (carats)	Shipments	
		Carats	Value
1949:			
Synthetic sapphire	70, 299	284	$602
Synthetic ruby	20, 550		
Total	90, 849	284	602
1950:			
Synthetic sapphire	37, 845	10, 000	100
Synthetic ruby	4, 300		
Total	42, 145	10, 000	100
Synthetic sapphire rods ... inches	1, 152		
1951:			
Synthetic sapphire	88, 135		
Synthetic ruby	18, 651		
Total	106, 786		
Synthetic sapphire rods ... inches	210		
1952:			
Synthetic sapphire	162, 600		
Synthetic ruby	149, 500	300	120
Other	450		
Total	312, 550	300	120
1953:			
Synthetic sapphire	[1] 170, 892	646	141
Synthetic ruby	[1] 13, 111		
Other	684		
Total	[1] 184, 687	646	141

[1] Partly estimated.

TABLE 3.—Consumption and shipments of finished jewels in the United States, 1953, by uses

Use	Consumption		Shipments	
	Quantity (number of jewels)	Market value	Quantity (number of jewels)	Market value
Vees:				
Glass	6, 702, 462	$957, 578	8, 179, 633	$357, 575
Other	2, 186, 962	356, 035	6, 203, 609	735, 787
Instrument rings	21, 805, 016	1, 340, 316	10, 713, 766	1, 469, 547
Watch rings	7, 027, 528	406, 145	788, 617	88, 310
Cups	6, 460, 485	509, 915	4, 527, 216	403, 729
Endstones	7, 079, 447	165, 918	3, 378, 423	178, 642
Caps	10, 196, 097	439, 450		
Holes	1, 467, 187	109, 101	2, 108	475
Pallet stones	5, 127, 097	163, 857	401, 635	26, 042
Jewel pins	1, 700, 063	50, 623	647, 500	78, 200
Locked stones			1, 869, 000	224, 280
Roller pins	674, 905	17, 008	78	12
Other	509, 674	122, 322	61, 300	36, 644
Total	70, 936, 923	4, 638, 268	36, 772, 885	3, 599, 243

TABLE 4.—Consumption of finished jewel bearings in the United States, 1953, by States

State	Number of consumers	Quantity (number of jewels)
Connecticut	3	2, 186, 505
Massachusetts	6	3, 727, 149
Michigan	2	39, 751
New Hampshire	3	880, 859
New Jersey	4	6, 720, 792
New York and Pennsylvania	8	20, 270, 120
Ohio	5	2, 415, 315
Other States [1]	10	34, 696, 432
Total	41	70, 936, 923

[1] Includes Illinois, Indiana, Minnesota, and Wisconsin.

FOREIGN TRADE [3]

A decrease of 11 percent in quantity and 12 percent in value was reported in 1953 from 1952 for jewel bearings imported for consumption (table 5).

Jewel bearings in the loose form (not assembled in units) are dutiable at 10 percent ad valorem.

TABLE 5.—Jewel bearings (not assembled in units) imported for consumption in the United States, 1944—48 (average) and 1949–53

[U. S. Department of Commerce]

Year	Number	Value	Year	Number	Value
1944–48 (average)	77, 175, 993	$2, 910, 194	1951	92, 396, 053	$3, 965, 983
1949	140, 742, 977	5, 117, 341	1952	98, 021, 914	4, 226, 948
1950	87, 939, 766	3, 737, 979	1953	86, 892, 637	3, 708, 027

TECHNOLOGY

The growth, internal stresses, crystallographic orientation, homogeneity, and hardness of synthetic corundum and a general survey of jewel bearings were discussed.[4]

The properties of synthetic sapphire and glass jewel bearings, standard shapes and sizes, bearing mounts, and uses of jewel bearings were described.[5]

A detailed description of the brushing and tumbling machines for producing chamfered and convex surfaces on jewel bearings [6] and of the flat-grinding, verifying, and flat-polishing machines for producing flat surfaces was published.[7]

A patent for a jewel bearing comprised of three members of a wear-resisting material was issued during the year.[8]

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

[4] Kaspar, J., Synthetic Corundum: Ind. Diamond Rev., vol. 13, No. 148, March 1953, pp. 57–59; No. 149, April 1953, pp. 81–84; and No. 150, May 1953, pp. 102–104.

[5] Cameron, R. P., Jr., Jewel Bearings—Precision Components for Quality Equipment: Product Eng. vol. 24, No. 8, August 1953, pp. 186–191.

[6] Weart, S. A., Production of Chamfered and Convex Surfaces on Jewel Bearings: Ind. Diamond Rev., vol. 13, No. 148, March 1953, pp. 53–56.

[7] Weart, S. A., Production of Flat Surfaces on Jewel Bearings: Ind. Diamond Rev., vol. 13, No. 154, September 1953, pp. 199–201.

[8] Bulvoa, Arde, Jewel Bearing and Method of Making Same: U. S. Patent 2,645,078, July 14, 1953.

Kyanite and Related Minerals

By Brooke L. Gunsallus[1] and Frances P. Uswald[2]

KYANITE, sillimanite, andalusite, dumortierite, topaz, and synthetic mullite are discussed under the heading, Kyanite and Related Minerals, because of similarities in properties and end use. The mullite-forming materials constitute an important type of refractories used in the metallurgical and glass industries. Mullite rarely is found in nature but may be produced by the conversion, at high temperatures, of kyanite and related minerals or by sintering or fusing mixtures of alumina and silica. The resulting products consist of mullite and free silica. As with all refractories, however, correct chemical composition is not the only criterion; correct mineralogical constitution and grain structure also are essential.

Domestic production of crude kyanite increased about 15 percent over 1952 in 1953.

Uncertainty of obtaining high-grade material from India continued to influence kyanite imports. Kyanite imports for consumption decreased 27 percent from 1952 in 1953. The decline in imports was accompanied by an increase in the production of synthetic mullite.

In 1953 no domestic production of other minerals in this group was reported.

The development of synthetic mullite assures the United States of self-sufficiency in raw materials for mullite refractories in the future.

DOMESTIC PRODUCTION

Kyanite was the only natural mullite-forming mineral produced in the United States in 1953.

Kyanite production in the United States in 1953 paralleled that for 1952; all of it was recovered from disseminated ores. The demand for domestic kyanite concentrate is limited. Mullite produced from the concentrate is not suitable for the highest grades of refractories because of small grain size and low density. It is satisfactory for use in refractory cements and for purposes that require a relatively fine-grained material.

The same two companies produced kyanite in the United States in 1953 as in 1952, namely, Commercialores, Inc., 39 Cortlandt St., New York, N. Y., from deposits at Henry Knob near Clover, S. C.; and Kyanite Mining Corp., Cullen, Va., from a property on Baker Mountain near Farmville, Prince Edward County, Va. The total domestic production was about 15 percent greater in 1953 than in 1952. The Bureau of Mines is not at liberty to publish figures on domestic production because there were only two producers.

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

The Kyanite Mining Corp. completed a rebuilding program in the flotation section of its mill which materially improved the flowsheet and almost doubled flotation capacity. After expansion, the company was able to produce about 2,000 tons of kyanite concentrates per month. To produce this quantity of material, almost 20,000 tons of ore is required.[3]

CONSUMPTION AND USES

Domestic consumption of kyanite from foreign and domestic sources and synthetic mullite during 1950, 1951, 1952, and 1953 was about 30,000, 38,000, 40,000, and 45,000 short tons, respectively, exclusive of material purchased for the National Stockpile and electrocast mullite.

Mullite is produced either by calcining natural ores or by synthesis. It is used almost entirely in manufacturing superduty refractories. Although mullite refractories represent only a small percentage of the total tonnage of refractories used in the United States, they occupy an important position in that field because of their relatively high softening points, low coefficients of expansion, and resistance to loads at high temperatures, to thermal shock, and to the corrosive action of certain fluxing agents. Although mullite refractories are relatively expensive, certain industries have found it profitable to use them.

Mullite refractories are employed in the form of brick and shapes or as cements, mortars, plastics, and ramming mixtures. Mullite brick and shapes require in their manufacture a material that converts, after calcining, to a coarse-grained material of low porosity and high strength. Until recently they have been made mostly from massive kyanite imported from India. In some instances the relatively fine-grained domestic mullite is blended with the coarse-grained mullite obtained from imported kyanite in the production of refractory brick and shapes. Domestic kyanite is satisfactory for use in refractory cement and in other uses that require a relatively fine-grained material; such uses compose the major part of the United States consumption of domestic kyanite.

In 1953, as in 1952, about 50 percent of all mullite refractories was used by the metallurgical industry and 40 percent by the glass industry. The remaining 10 percent was used for miscellaneous applications, chiefly in the ceramic industry. In the metallurgical industry the principal use of mullite refractories was in electric furnaces, largely the induction type, for melting brasses and bronzes, copper-nickel alloys, certain steels, and ferroalloys. Other metallurgical applications were in zinc smelting and in gold-refining furnaces. In the glass industry mullite refractories are used mainly in the construction of continuous tanks, especially for the superstructure, and in plungers, rings, and tubes employed for feeding molten glass to the forming machines. In the ceramic industry small quantities of mullite refractories are used for manufacturing kiln furniture (for placing ceramic ware in kilns); in saggers (open-top refractory boxes for protecting ware during firing); and in kiln construction. Small quantities of

[3] Avery, W. M., More Kyanite: Pit and Quarry, vol. 46. No. 4, October 1953, pp. 111–113.

kyanite, without calcination, were used as a source of alumina in glass and as an ingredient of electrical and chemical porcelains and pyrometer tubes.

STOCKS

Stocks of imported kyanite at the end of 1953 were 2,896 short tons compared with 2,844 short tons in 1952.

PRICES

As reported by E&MJ Metal and Mineral Markets for December 1953, quotations on kyanite were as follows: Per short ton, f. o. b., point of shipment, Virginia and South Carolina, 35-mesh, carlots, in bulk, $29, in bags, $32; 200-mesh, in bags, carlots, $40. Quotations on imported kyanite (55- to 59-percent grade) in bags were $60 to $65 per short ton c. i. f. Atlantic ports.

FOREIGN TRADE [4]

Kyanite imported for consumption in 1953 decreased 27 percent compared with 1952. In 1952 the decrease over 1951 was 54 percent which resulted from the increased use of synthetic mullite produced from domestic raw materials.

Data on imports and exports of kyanite and related minerals are shown in table 1. India continued to be the principal supplier in 1953, with 63 percent of the total compared with 53 percent in 1952; Union of South Africa supplied 24 percent in 1953 compared with 16 percent in 1952; Southern British Africa supplied 13 percent in 1953 and none in 1952. Total imports for 1953 decreased 27 percent compared with 1952. As in 1952, 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 concerns utilizing Western Hemisphere raw materials has resulted in the development of synthetic mullite products equal or superior to those derived from high-grade Indian kyanite. Snythetic mullite is manufactured by either sintering or fusing intimate mixtures of siliceous and aluminous materials.

Sintered synthetic mullite, for the most part, is being produced from low-iron siliceous bauxite occurring in the southeastern United States. The largest producer of synthetic mullite from this type of bauxite is The Charles Taylor & Sons, a subsidiary of National Lead Co., Taylor, Ky. The product is made in an old plant that formerly made high-grade fire-clay refractory brick, which was converted to produce mullite refractories from Indian kyanite and synthetic mullite from low-iron siliceous bauxite shipped to Taylor from the Eufaula, Ala., district. The bauxite is ground, screened, pugged with water,

[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 1.—Kyanite imported for consumption and kyanite and allied minerals exported from the United States, 1945–48 (average), and 1949–53

[U. S. Department of Commerce]

Imports

Year and origin	Short tons	Value
1945–48 (average)	13,930	$180,553
1949	12,119	324,856
1950	17,417	587,819
1951	19,570	812,434
1952		
Australia	84	1,999
British East Africa	2,595	101,173
Canada	57	4,598
India	4,835	217,908
Union of South Africa	1,486	64,879
Total 1952	9,057	390,557
1953		
India	4,155	184,293
Southern British Africa	858	22,477
Union of South Africa	1,607	80,919
Total 1953	6,620	287,689

Exports

Year and destination	Short tons	Value
1945–48 (average)	[1] 345	$20,113
1949	1,039	46,725
1940	941	35,750
1951	990	43,762
1952		
Canada	575	22,348
France	60	3,443
Mexico	494	18,706
Total 1952	1,129	44,497
1953		
Canada	586	24,036
Mexico	446	17,365
Total 1953	1,032	41,401

[1] Revised figure.

and extruded as a cylindrical column. The extruded column is cut into slugs, which are set in round down-draft kilns and calcined. The calcined material is crushed, ground, and screened to specifications based on the desired product. The ground material then is bonded and formed by power pressing. A few brick and shapes are handmade. After proper drying the mullite brick and shapes are fired in a tunnel kiln. The synthetic mullite grain produced is comparable in quality and cost to mullite grain processed from massive Indian kyanite.

Plans are being made to calcine low-iron bauxite in rotary kilns by a method similar to that being used to calcine kaolin for the production of high-alumina refractory brick.

The highest quality of synthetic mullite is produced from Bayer-process alumina made from Caribbean bauxite by the fusing process. Although the cost of this type of mullite is much higher than that of other types, industry has found it economical for certain uses.

RESERVES

Reserves of domestic kyanite having the favorable characteristics of high-grade Indian kyanite are negligible. High-grade fibrous kyanite occurs on the slopes of Willis Mountain in western Virginia. Estimates have placed the reserves of high-grade, lump kyanite at about 5,000 short tons, equal to 1 month's supply at the present rate of consumption.

In the opinion of the Federal Geological Survey the kyanite reserves in Virginia, North Carolina, South Carolina, and Georgia are of the order of tens of millions of tons of ore containing 20 to 30 percent kyanite.

The Federal Geological Survey released geological maps of some kyanite deposits in Virginia, North Carolina, and South Carolina.

The development of synthetic mullite appeared to offer the best means for future fulfillment of needs now being served by imported kyanite.

WORLD REVIEW

Africa.—General Refractories, Ltd., of Nyasaland has undertaken an extensive geological survey of the kyanite deposits at N'cheu, and a diamond-drilling program is expected to begin in the near future.[5]

Austria.—Mining operations began during January 1953 in the Wipp Valley of the Tyrol to obtain what is said to be the first kyanite produced in Europe. The estimated tonnage of several deposits is several million metric tons.[6]

Canada.—H. V. Barry of Gatchell, near Sudbury, Ontario, reportedly staked 90 new claims on kyanite outcrops in Street and Loughrin townships, east of Sudbury. Showings were said to indicate that the deposit may contain up to 50 percent kyanite.[7]

India.—What is believed to be one of the largest sillimanite deposits in the world has been located in the Autonomous Khasi and Jaintia Hills district in Assam.[8]

Kenya.—Kenya Kyanite Co. continued to mine kyanite. Most of the production was used to make a calcined product for export.[9]

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5 Mining World, vol. 15, No. 11, October 1953, p. 94.
6 Mining World, vol. 15, No. 3, March 1953, p. 75. Engineering and Mining Journal, vol. 154, No. 9, September 1953, p. 190.
7 Mining World, vol. 15, No. 2, February 1953, pp. 71–72
8 South African Mining and Engineering Journal, Johannesburg, S. A., vol. 64, part 1, No. 3148, June 1953, p. 46.
9 South African Mining and Engineering Journal, Johannesburg, S. A., vol. 64, part 1, No. 3135, March 1953, p. 23.

Lead

By O. M. Bishop[1] and Edith E. den Hartog[2]

TOTAL SUPPLIES well in excess of demand, decreased mine production, increased consumption, and continued high imports were salient features of the domestic lead industry in 1953. Lead supply in 1953 totaled 1,377,000 tons compared with total consumption of 1,202,000 tons; in 1952 supply totaled 1,477,000 tons and consumption 1,131,000 tons, respectively. Plentiful supplies were attributed largely to record mine and smelter production of lead outside of the United States which stimulated exports to the United States and accentuated the market problems of the domestic mining industry. United States imports of recoverable lead were the second highest on record, whereas domestic mine production declined 12 percent and (with the exception of 1946) was the lowest since the depression year 1935. The price of lead ranged from a high of 14.75 cents a pound in early January to a low of 12.00 cents in late April; various fluctuations brought the price to 13.50 cents on September 16, where it remained for the balance of the year. The average price for the year was 13.48 cents compared with 16.47 cents in 1952 and 17.49 cents in 1951.

Lead supply in 1953 consisted of 343,000 tons of recoverable lead from mine production, 487,000 tons of secondary lead recovered from scrap, and 547,000 tons of imports (exclusive of imported scrap, which normally goes to secondary smelting plants and is thus included in the scrap total). The total of 1,377,000 tons was 7 percent under the 1952 supply. Consumption of lead, including that in pigments and chemicals, totaled 1,202,000 tons compared with 1,131,000 tons the preceding year. Producers' stocks of primary refined lead increased from 31,000 to 65,000 tons during the year, and primary antimonial lead stocks increased from 11,000 to 14,000 tons. Smelters' stocks of ores and concentrates and base bullion also increased substantially, whereas consumers' stocks of metal dropped from 123,000 tons to 114,000.

Domestic mine production of recoverable lead declined from 390,000 tons in 1952 to 343,000 tons in 1953. Many mines in the Western and West Central States curtailed production or shut down as a result of low lead and zinc prices. Production during the first half of the year was at a rate of about 30,400 tons a month, or 7 percent below the 1952 annual rate, while output during the last 6 months was at a rate of 26,600 tons a month, or 18 percent below the average monthly yield in 1952. Production in 13 of the 16 principal producing States was lower than in 1952. The largest decreases, on a tonnage basis, were in Utah, Colorado, Arizona,

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Oklahoma, New Mexico, and Missouri. The only States in which lead production increased were Idaho, New York, and Wisconsin.

The total lead content of imports exclusive of scrap declined 11 percent from the alltime high of 1952; the tonnage (547,000), nevertheless, was the second highest on record and created an excess supply that exerted a depressing influence upon domestic mine production.

Because of widespread mine closings and reduced employment in the lead- (and zinc-) mining industry much thought was given to tariff revision through either new legislation or the invoking of the "escape clause" of the Reciprocal Trade Agreements Act; various other proposals were made to restrict imports or provide means of direct or indirect relief to the domestic industry. In July the Tariff Commission, in response to resolutions of the United States Senate Committee on Finance and the House of Representatives Committee on Ways and Means, instituted a general investigation of the lead and zinc industries to determine relevant facts of production, trade, consumption, and competitive position, "including the effect of imports of lead and zinc on the livelihood of American workers." A report of the investigation was published April 20, 1954.[3]

GOVERNMENT REGULATIONS

Although all controls governing the use and distribution of lead had been revoked in May 1952 and lead was removed from the list of scarce materials in June, producers and consumers were required to continue reporting stocks, production, and consumption of lead through June 30, 1953, in order that the National Production Authority could continue its "surveillance of lead supplies and consumption." The Office of Price Stabilization price ceilings on lead and zinc were revoked February 13, 1953.

GOVERNMENT PROGRAMS UNDER DEFENSE PRODUCTION ACT OF 1950

Provisions of the Defense Production Act of 1950 with respect to exploration were carried out by the Defense Minerals Exploration Administration (DMEA) and those with respect to procurement by the Defense Materials Procurement Agency (DMPA).

DEFENSE MINERALS EXPLORATION ADMINISTRATION

Exploration contracts and amendments to existing contracts continued to be made by the DMEA during 1953, but in conformance to a directive issued by the Office of Defense Mobilization no applications were accepted for lead- and zinc-exploration projects after May 15, 1953. The turnabout in lead supplies from scarcity to plenty in the second half of 1952 and the continued accumulation of stocks in the United States as well as abroad in 1953 were considered determining factors in the decision reached by the Office of Defense Mobilization (ODM).

[3] 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 objective of the DMEA—to encourage exploration and increase reserves of strategic and critical minerals and metals, including lead and zinc—was achieved through projects to explore potential domestic ore sources. The Government financed up to 50 percent of the total cost of approved exploration projects for lead and zinc and during calendar year 1953 entered into 30 contracts involving maximum Government participation of $2,068,303.[4] Through December 31, 1953, 193 lead- and zinc-exploration contracts had been executed which authorized a maximum Government participation of $7,614,636. Lead-zinc or lead-zinc-copper exploration contracts in 1953 comprised 17 percent of all DMEA contracts executed and for 40 percent of the funds obligated and through 1953, 32 percent of all contracts and 43 percent of the funds obligated. A list of DMEA contracts for lead and zinc exploration in 1953 is given in the Zinc chapter of this volume.

DEFENSE MATERIALS PROCUREMENT AGENCY

The Defense Materials Procurement Agency program was greatly reduced in early 1953 with respect to lead and zinc as the supply-requirement ratio increased and production-expansion programs put in force in 1951 and 1952 were coming to fruition. On August 14, 1953, the remaining function of DMPA—that of servicing contracts and completing those in negotiation—was transferred to the Emergency Procurement Service (EPS) of General Services Administration (GSA).

The only contract providing for lead-zinc production expansion approved in 1953 was that executed on June 29, 1953, with Chief Consolidated Mining Co., Salt Lake City, Utah. Under this contract the Government advanced Chief Consolidated $283,373 or 25 percent of proposed expenditures for developing the Chief No. 1 and Plutus mines in the Tintic district, Juab County, Utah. The contract was a percentage royalty agreement of 3 years' duration, repayment of the loan to be made on the basis of 5 percent of net smelter returns from ores developed under terms of the contract.

United States assistance in developing foreign lead resources was negligible in 1953. Mutual Security Administration contracts, using counterpart funds, were executed with several foreign companies, but only a few hundred tons of lead was involved.

DOMESTIC PRODUCTION

Statistics on lead output may be prepared on a mine or smelter and refinery basis. Mine-production data, compiled on the basis of lead content in ores and concentrates, adjusted to account for average losses in smelting, are a better measure of domestic output from year to year and are more accurate for showing the geographic distribution of production. Pig-lead output, as reported by smelters and refiners, presents a more precise figure of actual lead recovery but indicates in only 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 ores and concentrates.

[4] Includes funds provided through amendments to contracts previously executed; also includes funds for participation in exploration contracts that were subsequently canceled or terminated upon completion.

TABLE 1.—Salient statistics of the lead industry in the United States, 1944–48 (average) and 1949–53, in short tons

	1944–48 (average)	1949	1950	1951	1952	1953
Production of refined primary lead:						
From domestic ores and base bullion	352,962	404,449	418,809	342,644	383,358	328,012
From foreign ores and base bullion	65,888	72,889	89,505	75,049	89,494	139,879
Total	418,850	477,338	508,314	417,693	472,852	467,891
Recovery of secondary lead	419,857	412,183	482,275	518,110	471,294	486,737
Imports (general):						
Lead in pigs, bars, and old	205,196	289,889	461,827	188,175	523,059	390,510
Lead in base bullion	1,791	2,373	3,488	2,281	389	869
Lead in ores and matte	64,504	107,279	76,520	67,471	104,621	160,929
Exports of refined pig lead	3,890	969	2,735	1,281	1,762	803
Consumption of primary and secondary lead	1,086,523	957,674	1,237,981	1,184,793	1,130,795	1,201,604
Prices (cents per pound):						
New York:						
Average for period	10.76	15.36	13.30	17.49	16.47	13.48
Quotation at end of period	12.41	12.00	17.00	19.00	14.12	13.50
London average for period	10.11	16.95	13.29	20.25	[2] 16.82	11.48
Mine production of recoverable lead [1]	383,573	409,908	430,827	388,164	390,162	342,644
World smelter production of lead	1,361,000	[2] 1,648,000	[2] 1,808,000	[2] 1,764,000	[2] 1,973,000	1,995,000

[1] Includes Alaska.
[2] Revised figure.

The competitive position of the domestic lead and zinc industry with reference to foreign producers in 1952 and part of 1953 was reported[5] April 20, 1954, by the United States Tariff Commission. The report, which was based on all available information including industry hearings and a canvass of domestic lead and zinc mining, milling, smelting and refining companies, revealed that many important changes had taken place in the domestic industry since 1939, when the last Mineral Census was made. One tabulation showed that in 1939 the lead-zinc mines of the United States produced 16,317,000 tons of crude ore with a recoverable metal content of 2.2 percent lead, 2.8 percent zinc, 0.71 and 0.004 ounce per ton of silver and gold, respectively, utilizing 32,283,000 man-hours of labor at $0.62 per hour. The total value of mine or mill products for that year was $62,652,000. A similar tabulation for 1952, covering 89 percent of the national output of recoverable lead and 90 percent of the recoverable zinc, showed striking differences. Reports from 211 firms indicated that in 1952 they produced 22,919,000 tons of crude ore with a recoverable metal content of 1.4 percent lead, 2.5 percent zinc, 0.1 percent copper, and 0.73 and 0.006 ounce of silver and gold, respectively. Man-hours worked by production and related workers in mining and milling this tonnage totaled 43,791,000, paid at an average hourly rate of $1.95. The total mine or mill value of all products was $225,384,000. These figures indicate that wages increased 215 percent in the period 1939 to 1952, tons of ore mined and milled per man-hour increased from 0.51 to 0.52, the recovery of zinc and lead per ton of ore declined 11 and 36 percent, respectively, and the value of products sold per ton of crude ore increased from $3.84 to $9.83, or 156 percent.

Tables from the Tariff Commission report showing the quantity and value of products, principal expenses, hourly earnings, and man-hours worked in lead and zinc mining and milling in the United States

[5] Work cited in footnote 3.

by State or principal region, and the crude ore sold or treated along with the recoverable metal content by State, region, or district in 1952, are given in the Zinc chapter of this volume. Wages, productivity per unit of labor, and grade of ore in 1953 were at essentially the same as in 1952, but the average value of the mine products was estimated by the Bureau of Mines to have dropped about 31 percent to approximately $6.75 per ton.

On the basis of reports to the Tariff Commission, the number of employees engaged in mining and milling lead and zinc ores, which supplied 92 percent of the mine output of lead and 93 percent of the zinc, declined from 23,800 in January 1952 to 16,200 in October 1953, or 32 percent for the period. Employment at primary lead smelters and refineries (exclusive of construction workers) declined from an average of nearly 3,600 in 1952 to an average of 3,300 in the first 10 months of 1953.

In studying the competitive position of the domestic lead-zinc mining industry, the Tariff Commission obtained reports from foreign producers which in 1952 supplied 80 and 61 percent, respectively, of the lead and zinc mined in Canada, 28 and 45 percent of that mined in Mexico, and 68 percent of the combined lead and zinc output of Australia. From these confidential reports the Commission concluded as follows with relation to Canada, the United States, and Mexico:

> * * * that total principal operating expenses, as well as expenses for wages and salaries, are lower *per ton of crude ore* mined in the United States than in Canada and Mexico. This appears to be the case even though average hourly earnings of workers are much lower for operations in Mexico than for those in either Canada or the United States, and are slightly lower for Canada than for the United States. The data also indicate that taxes other than income taxes *per ton of crude ore* mined in Mexico were much higher than in Canada and very much higher than in the United States.
>
> However, when allowance is made for the differences in the average value of the ores mined in the three countries, as affected by differences in the yield of metals obtained from them, the situation with respect to the foregoing comparison of costs is quite different. Notwithstanding apparently higher operating expenses, and higher expenses for salaries and wages, *per ton of crude ore* mined in Canada and Mexico than in the United States, these expenses are lower *per unit of recoverable metal* in Mexico and Canada than in the United States.

MINE PRODUCTION

Domestic mine production of recoverable lead in 1953 declined 12 percent to 343,000 tons and, with the exception of 1946, when production was 335,000 tons, was the lowest since 1935. Many mines in the Western and West Central States curtailed production or shut down as a result of low lead and zinc prices. Production during the first half of the year was at a rate of about 30,400 tons a month—7 percent below the 1952 annual rate—while output during the last 6 months was at a rate of 26,600 tons a month—18 percent below the average monthly yield in 1952. Missouri, with 126,000 tons (37 percent of the total), was again the largest lead-producing State. Idaho and Utah produced 75,000 tons (22 percent) and 42,000 tons (12 percent) of recoverable lead, respectively, and were the second and third ranking States. Production in 13 of the 16 principal producing States was lower than in 1952. The largest decreases, on a tonnage basis, were in Utah, Colorado, Arizona, Oklahoma, New Mexico, and Missouri. Idaho, New York, and Wisconsin were the only States in which lead production increased.

TABLE 2.—Mine production of recoverable lead in the United States, 1944–48 (average) and 1949–53, by States, in short tons

State	1944–48 (average)	1949	1950	1951	1952	1953
Western States and Alaska:						
Alaska	153	51	149	21	1	9
Arizona	24,394	33,568	26,383	17,394	16,520	9,428
California	8,404	10,318	15,831	13,967	11,199	8,664
Colorado	19,123	26,853	27,007	30,336	30,066	21,754
Idaho	75,890	79,299	100,025	76,713	73,719	74,610
Montana	13,180	17,996	19,617	21,302	21,279	19,949
Nevada	7,399	10,626	9,408	7,148	6,790	4,371
New Mexico	6,772	4,652	4,150	5,846	7,021	2,943
Oregon	5	12	17	2	1	5
South Dakota	12	4	------	2	2	10
Texas	59	132	129	43	56	------
Utah	45,939	53,072	44,753	50,451	50,210	41,522
Washington	5,024	6,417	10,334	8,002	11,744	11,064
Wyoming	1	------	------	------	------	------
Total	206,355	243,000	257,803	231,227	228,608	194,329
West Central States:						
Arkansas	9	1	9	33	4	------
Kansas	7,776	9,772	9,487	8,947	5,916	3,347
Missouri	144,981	127,522	134,626	123,702	129,245	125,895
Oklahoma	14,302	19,858	20,724	16,575	15,137	9,304
Total	167,068	157,153	164,846	149,257	150,302	138,546
States east of the Mississippi River:						
Illinois	2,972	3,824	2,729	3,160	4,262	3,391
Kentucky	165	187	66	107	60	52
New York	1,261	1,317	1,484	1,500	1,120	1,435
Tennessee	40	257	113	14	18	9
Virginia	4,351	3,313	3,254	1,508	3,792	2,788
Wisconsin	1,361	857	532	1,391	2,000	2,094
Total	10,150	9,755	8,178	7,680	11,252	9,769
Grand total	383,573	409,908	430,827	388,164	390,162	342,644

The West Central States produced 138,500 tons of recoverable lead in 1953 (8 percent less than in 1952) from the mines of southeastern Missouri and those of the Tri-State district, comprised of southwestern Missouri, north-eastern Oklahoma, and southeastern Kansas.

As in the previous 45 years, the southeastern Missouri lead belt was the major lead-producing district in the United States, furnishing 37 percent of the Nation's total lead production. Although crude-ore production was down about 7 percent, output of lead approximated that in 1952. The chief producer was the St. Joseph Lead Co., operating the company-owned Bonne Terre, Desloge, Federal, and Leadwood mine-mill units in St. Francois County. Ore from the company Doe Run operation was milled at the Federal mill, and a sink-float plant concentrate from the new Hayden Creek mine was concentrated further at the Leadwood mill. The company also operated the Mine La Motte mine-mill unit in Madison County and continued development and construction at its new Indian Creek mine-mill unit in Washington County. The second largest producer was the National Lead Co., operating its Madison County mine-mill unit at Fredricktown.

The Tri-State district produced 13,300 tons of lead in 1953 compared with 27,400 tons in 1952. Crude zinc-lead ore production was 3,480,000 tons or 43 percent less than the 6,140,000 tons mined in 1952. Much of the decline in mine output of lead and zinc in the

Tri-State was attributed to the closure of Eagle-Picher Co. mines and Central mill as a result of a strike beginning June 21 and extending through the remainder of the year. This shutdown alone reduced the total ore treated more than 1,500,000 tons. Curtailment of production at the National Lead Co. Ballard mine-mill unit and its closure in mid-November was another factor in reduced lead output. At the year end approximately 30 mines and 9 mills were operating in the district compared with about 150 mines and 18 mills in January. The recoverable zinc and lead in the ore (recovered as concentrates) was 2.87 and 0.50 percent, respectively, of the ore treated compared with 2.75 and 0.56 percent in 1952. This comparison suggests the limited potentiality of upgrading Tri-State ores to offset lower metal values. The Western States had a combined mine production of 194,300 tons of recoverable lead in 1953 compared with 228,600 tons in 1952. The decline, as elsewhere in the United States, resulted chiefly from low lead-zinc prices that forced curtailments or mine closures as mining of submarginal ores was stopped.

Idaho was the second largest producer of lead in the United States, with 74,600 tons (73,700 tons in 1952). As in other years, the Coeur d'Alene region produced over 90 percent of the State output of lead, with the Bunker Hill, Star, Page, and Morning mines the foremost producers. The Nabob mine (Nabob Silver-Lead Mines, Inc.) closed early in 1953 owing to low metal prices, and Day Mines, Inc., ceased company operation of the Sherman and Tamarack mines, leasing them on a block-leasing system. On October 4 the Morning mine (American Smelting & Refining Co.) was closed after 64 years of continuous operation. A considerable quantity of ore remaining in pillars will be mined before complete abandonment of the underground workings. Numerous exploration and development programs were under way in the Coeur d'Alene region in 1953. Bunker Hill & Sullivan Mining & Concentrating Co. started a $1 million shaft extension and deep-exploration project at its Crescent mine during the year. The Triumph mine in Blaine County was the only major lead-producing mine in Idaho outside the Coeur d'Alene region.

Utah ranked third among lead-producing States, with an output of 41,500 tons—almost 9,000 tons less than in 1952 and the smallest since 1946. The principal producing mines, in order of output, were the United States & Lark property (United States Smelting, Refining & Mining Co.), Chief No. 1 and Eureka Hill mines (Chief consolidated Mining Co.), and Blue Ledge district mine (New Park Mining Co.), West Calumet mine (Combined Metals Reduction Co.), and the Ophir mine (United States Smelting, Refining & Mining Co.). The Park Utah Consolidated and Silver King Coalition mines, closed in 1952, remained inoperative throughout 1953. A 2-week strike in November at the United States & Lark property also reduced output.

Lead output from Colorado mines totaled 21,800 tons in 1953, a 28-percent decline from 1952. The greatest production losses were in San Juan County, where the Shenandoah-Dives mine group and 700-ton mill were closed March 14, and in Lake County, where the Resurrection Mining Co. suspended company operations July 3. Callahan Zinc-Lead Co. Akron-Erie mine in Gunnison County, closed November

1952, remained inoperative throughout 1953. The Eagle mine, Colorado's foremost zinc and fourth most important lead producer in 1953, was closed by a strike from September 1 to November 2.

Lead production in Montana declined 6 percent to 19,900 tons in 1953. The chief production was from Anaconda Copper Mining Co. owned or leased properties in the Butte area and the East Helena slag dump. The Blacktail mine, an open-pit mine in Missoula County, operated by Linton Mines, Inc., was closed in the fall of 1953 because of the low lead price. Begun in 1949, the mine had produced about 500 tons of lead annually. The Jack Waite mine (American Smelting & Refining Co.) in Sanders County maintained a high production level, but the Iron Mountain mine of the Mineral Leasing Co. in Mineral County was closed in July.

Mine output of lead in Washington in 1953 was 11,100 tons, or about 700 tons less than in 1952. The lead was produced chiefly by the Pend Oreille mine of Pend Oreille Mines & Metals Co., the Grandview mine of American Zinc, Lead & Smelting Co., and the Deep Creek mine of Goldfield Consolidated Mines Co. Other lead-producing mines included the Bonanza, the Lead King, Oriole, Johnsburg, Advance, Electric Point, Gladstone, King Tut, Lead Trust, Long Shot, Old Dominion, Red Top, Santiago, United Treasure, Young America, Leo Ray, and Queen mines, all in either Pend Oreille or Stevens County. In late 1953 the Grandview and Pend Oreille mine output was curtailed by reducing the workweek, and beginning in October the Deep Creek activity was limited to development.

Lead output in Arizona in 1953 decreased 43 percent to 9,400 tons, the lowest since 1935. Low lead and zinc prices throughout the year resulted in continued idleness of the San Xavier mine and in suspension of mining lead-zinc ores at the Copper Queen, and a general decline in activity at small-scale mining operations. The chief lead producers of the State in 1953 were the Iron King mine (Shattuck Denn Mining Corp.); Trench unit (American Smelting & Refining Co.); Aravaipa mine (Athletic Mining Co.); Hilltop mine (American Zinc, Lead & Smelting Co.); and Copper Queen mine (Phelps Dodge Corp.).

Lead production from California mines declined 23 percent in 1953 to 8,700 tons. The Darwin group operated by Anaconda Copper Mining Co. in Inyo County was the only large producing unit operating throughout the year, but in early 1953 the New Penn mines produced both zinc and copper concentrates containing recoverable lead. Other producing mines included the Silver Reid, Christmas Gift, Lane, Defense, Modoc, Mimetta Reward, Le Moine, and Lippincott mines in Inyo County; the Alexander mine in Mono County; the Umberci mine in San Bernardino County; the Black Eagle mine in Riverside County; the Green Dragon mine in Siskiyou County; and the Hazel Creek mine in El Dorado County.

The recoverable lead content of Nevada-mined ores in 1953 was 4,400 tons, a 36-percent drop from the 1952 output. The decrease was brought about by low lead-zinc prices, which caused Combined Metals Reduction Co. to divert more of its Caselton mill capacity to manganese-lead-zinc ores at the expense of lead-zinc ores. Other producers of lead included the Bristol mine (Bristol Silver Mines Co.), Lincoln County; and the Ward mine (Walker Corp.), White Pine County.

Output of lead in New Mexico declined 58 percent to 2,900 tons during 1953 owing to closure of all zinc-lead mines not previously closed in 1952. Zinc-lead mines closing during the year included the Kearney mine of New Mexico Consolidated Mines Co. (January 28); the Ground Hog group of American Smelting & Refining Co. (February 23); the Bayard group of the United States Smelting, Refining & Mining Co. (September 30); and the Lynchburg mine of Elayer & Co. (April). The principal lead-producing mines in 1953 were the Bayard zinc-lead group in the Central district, the Portales lead mine in the Hansonburg district, and the Ground Hog zinc-lead mine in the Central district.

Mine production of lead in States east of the Mississippi River was 10,000 tons in 1953, a 13-percent decline from the peak production of 1952. The principal producing areas were the Upper Mississippi Valley district of northwestern Illinois and southwestern Wisconsin (3,688 tons); Wythe County, Va. (2,788 tons); and St. Lawrence County, N. Y. (1,435 tons). The remaining lead production was a byproduct of the southern Illinois-western Kentucky fluorspar-zinc mining district (1,849 tons) and of the zinc-mining area of eastern Tennessee (9 tons).

Northern Illinois and southwestern Wisconsin lead output increased 4 percent and was chiefly from the mines of the Calumet & Hecla, Inc., Vinegar Hill Zinc Co., Inc., Eagle-Picher Co., and the Mifflin Mining Co., operating in Lafayette and Iowa Counties, Wisconsin; and mines of Tri-State Zinc, Inc., and the Eagle-Picher Co., operating in Jo Daviess County, Ill. The Eagle-Picher mine operations in both States were brought to a halt March 31 when fire partly destroyed the company Graham Central mill near Galena, Ill. The damaged mill was repaired; but the mines, which included the Birkett and Andrews in Wisconsin and the Graham and Snyder in Illinois, were not reopened. The Mifflin Mining Co. ceased production January 30 but in March resumed operations for 4 months at the Coker and Bickford mines, Iowa County, Wis.

Lead output of the Illinois-Kentucky fluorspar-zinc district declined 34 percent owing to smaller output by the Ozark-Mahoning Co. plant at Rosiclare, Ill., and to smaller quantities of lead-bearing ores being treated. The Hutson zinc mine in western Kentucky, which also produced lead, was closed January 15 because of low metal prices.

Lead output in New York, chiefly from the Balmat mine of the St. Joseph Lead Co., was 28 percent greater than in 1952, but lead production in Virginia declined 26 percent owing to lower lead content in the ore from the Austinville mine of the New Jersey Zinc Co. Late in 1953 the New Jersey Zinc Co. announced acquisition of the Arminius zinc-lead mine, Louisa County, Va. The property has been unproductive since 1911. The lead output of eastern Tennessee was a byproduct recovered in smelting the zinc concentrates.

The 25 leading lead-producing mines in the United States in 1953, listed in table 4, yielded 78 percent of the total domestic output; the 10 leading mines produced 61 percent and the 4 leading mines 43 percent.

More detailed information on the production of mines and mining districts in the United States appears in volume III of the Yearbook.

TABLE 3.—Mine production of recoverable lead in the United States, 1944–48 (average) and 1949–53, by districts that produced 1,000 tons or more during any year, 1949–53, in short tons

District	State	1944–48 (average)	1949	1950	1951	1952	1953
Southeastern Missouri region.	Missouri	141,719	126,269	133,680	122,318	122,942	125,273
Coeur d'Alene region	Idaho	70,488	74,152	94,697	70,570	67,330	69,885
West Mountain (Bingham).	Utah	24,614	32,600	27,472	29,120	34,328	29,311
Summit Valley (Butte)	Montana	6,465	11,490	15,679	16,630	16,153	16,767
Tri-State (Joplin region)	Kansas, southwestern Missouri, Oklahoma.	25,224	30,883	31,157	26,906	27,356	13,273
Metaline	Washington	3,751	4,030	7,445	5,234	([1])	8,694
Coso (Darwin)	California	5,632	4,928	8,479	7,191	([1])	8,269
Upper San Miguel	Colorado	2,433	5,285	7,780	8,008	7,657	7,440
Park City region	Utah	10,521	8,583	7,538	11,719	7,494	4,735
Big Bug	Arizona	2,076	3,330	4,357	4,035	4,135	4,339
Upper Mississippi Valley	Iowa, northern Illinois, Wisconsin.	1,851	2,046	1,801	1,923	3,532	3,688
Tintic	Utah	5,325	6,676	6,520	5,553	4,279	3,590
Pioche	Nevada	3,927	6,630	6,761	4,751	4,632	3,306
California (Leadville)	Colorado	4,850	5,080	6,392	5,996	5,624	3,072
Austinville	Virginia	4,269	3,313	3,254	1,508	3,792	2,788
Rush Valley & Smelter (Tooele County).	Utah	3,587	2,953	1,393	2,674	2,595	2,753
Warm Springs	Idaho	2,102	2,339	2,648	3,086	3,455	2,583
Red Cliff	Colorado	950	1,600	2,110	4,274	3,980	2,500
Northport (Aladdin)	Washington	447	342	237	937	([1])	2,165
Harshaw	Arizona	1,472	1,546	1,931	1,668	1,921	2,104
Pioneer (Rico)	Colorado	2,383	1,388	1,138	2,231	2,230	1,871
Kentucky-Southern Illinois.	Kentucky, southern Illinois.	2,648	2,822	1,526	2,516	2,790	1,849
Creede	Colorado	362	1,162	1,422	1,167	1,513	1,696
Bayhorse	Idaho	1,569	1,073	1,679	1,732	1,091	1,484
Central	New Mexico	4,039	2,479	2,315	3,133	4,486	1,460
St. Lawrence County	New York	1,261	1,317	1,484	1,497	1,120	1,435
Sneffels	Colorado	([1])	1,064	866	1,094	1,044	1,307
Animas	do	2,437	2,935	3,069	3,963	3,464	1,212
Eagle	Montana	638	1,024	1,013	([1])	733	1,179
Ophir	Utah	479	1,089	948	712	999	1,157
Breckenridge	Colorado	101	308	347	246	499	1,056
Hansonberg	New Mexico	24	131	451	753	847	1,031
Bossburg	Washington	599	2,011	2,640	1,768	([1])	168
Battle Mountain	Nevada	92	1,290	564	[2] 351	907	1
Old Hat	Arizona	4,835	6,788	5,980	4,241	3,913	--------
Pima (Sierritas, Papago, Twin Buttes).	do	2,726	4,232	2,996	2,834	1,864	--------
Heddleston	Montana	2,458	2,335	930	1,398	1,251	--------
Warren (Bisbee)	Arizona	9,692	13,865	7,790	1,606	1,828	--------
Magdalena	New Mexico	1,790	1,162	926	1,004	1,046	--------
Aravaipa	Arizona	575	1,271	1,498	1,294	865	--------
Tomichi	Colorado	863	1,221	645	761	739	--------
Ten Mile	do	1,415	3,671	910	6	8	--------
Resting Springs	California	([1])	([1])	([1])	([1])	([1])	--------

[1] Figure not shown to avoid disclosure of individual company operations.
[2] Revised figure.

TABLE 4.—Twenty-five leading lead-producing mines in the United States in 1953, in order of output

Rank	Mine	District	State	Operator	Type of ore
1	Federal	Southeastern Missouri	Missouri	St. Joseph Lead Co	Lead.
2	United States & Lark	West Mountain (Bingham)	Utah	U. S. Smelting, Refining & Mining Co	Lead-zinc.
3	Bunker Hill	Yreka	Idaho	Bunker Hill & Sullivan Mining & Concentrating Co	Do.
4	Leadwood	Southeastern Missouri	Missouri	St. Joseph Lead Co	Lead.
5	Butte Hill mines and dumps	Summit Valley (Butte)	Montana	Anaconda Copper Mining Co	Lead-zinc.
6	Mine La Motte	Southeastern Missouri	Missouri	St. Joseph Lead Co	Lead.
7	Desloge	do	do	do	Do.
8	Bonne Terre	do	do	do	Do.
9	Page	Yreka	Idaho	American Smelting & Refining Co	Lead-zinc.
10	Darwin group	Coso	California	Anaconda Copper Mining Co	Do.
11	Star	Hunter	Idaho	Sullivan Mining Co	Do.
12	Pend Oreille	Metaline	Washington	Pend Oreille Mines & Metals Co	Do.
13	Morning	Hunter	Idaho	American Smelting & Refining Co	Do.
14	Treasury Tunnel-Black Bear	Upper San Miguel	Colorado	Idarado Mining Co	Do.
15	Iron King	Big Bug	Arizona	Shattuck-Denn Mining Co	Do.
16	Dayrock	Placer Center	Idaho	Day Mines, Inc	Lead.
17	Chief	Tintic	Utah	Chief Consolidated Mining Co	Lead-zinc.
18	Park Galena-Mayflower	Park City region	do	New Park Mining Co	Do.
19	Combined Metals group	Pioche	Nevada	Combined Metals Reduction Co	Do.
20	Grandview	Metaline	Washington	American Zinc-Lead Smelting Co	Do.
21	Resurrection	Leadville	Colorado	Resurrection Mining Co	Do.
22	Smuggler Union	Upper San Miguel	do	Telluride Mines, Inc	Do.
23	Frisco	Lelande	Idaho	American Smelting & Refining Co	Do.
24	West Calumet	Rush Valley	Utah	Calumet Mining Co	Do.
25	Triumph, North Star	Warm Springs	Idaho	Triumph Mining Co	Do.

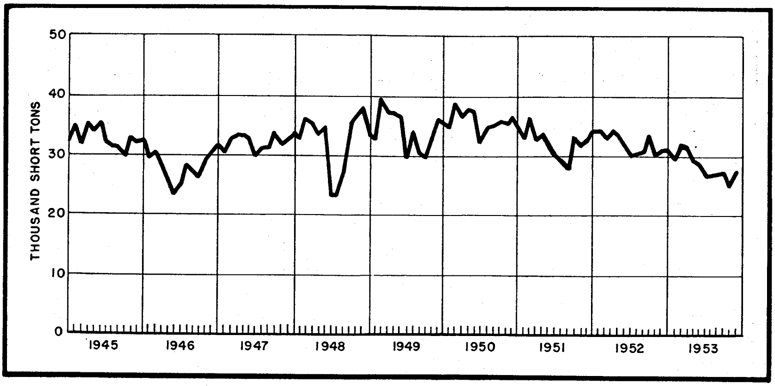

FIGURE 1.—Mine production of recoverable lead in the United States, 1945–1953, by months.

TABLE 5.—Mine production of recoverable lead in the United States,[1] 1952–53, by months, in short tons

Month	1952	1953	Month	1952	1953
January	34,551	31,073	August	30,454	26,531
February	34,601	29,861	September	30,633	26,934
March	33,637	31,780	October	33,853	27,225
April	34,724	31,490	November	30,152	25,154
May	34,087	29,507	December	31,178	27,455
June	32,202	28,797			
July	30,090	26,837	Total	390,162	342,644

[1] Includes Alaska.

SMELTER AND REFINERY PRODUCTION

Pig (refined) lead produced in the United States is derived from three principal sources—domestic mine production, imports of foreign ores and base bullion, and scrap materials (treated largely at secondary smelters)—and is recovered at primary refineries that treat ore, base bullion, and small quantities of scrap and at secondary plants that process scrap exclusively. Of the 13 primary lead plants in the United States, 6 combine smelting and refining operations, 5 produce only base bullion (containing approximately 98 percent lead plus gold and silver, and small quantities of other impurities recovered from the ores smelted), and 2 confine their activities to refining. Refined lead and antimonial or "hard" lead may be produced by both primary and secondary plants. Because of the large quantity of hard lead, such as battery scrap, melted at secondary smelters, the output from this type of operation is principally antimonial lead. Statistics on the production of refined lead and alloys at secondary plants are given in the Secondary Lead section of this chapter.

The 11 primary smelters in operation in 1953 consumed 475,000 short tons (lead content) of primary materials in the form of ores and concentrates, of which 69 percent was of domestic and 31 percent of foreign origin. Total consumption was 5 percent less than in 1952 but 9 percent above consumption in 1951.

ACTIVE LEAD SMELTERS AND REFINERIES

Primary lead smelters and refineries operating in the United States in 1953 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).

Bunker Hill & Sullivan Mining & Concentrating Co. completed a $3 million modernization program at its lead smelter. New installations included a crushing and fine-grinding plant, a charge-preparation and pelletizing plant, and a 202-foot smokestack.

Four companies operated five slag-fuming plants in 1953 to recover zinc and some lead from lead slags.

A list of the companies and plant locations follows:

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.

The new slag-fuming plant [6] at the Selby lead smelter, which began operation April 20, 1953, was described in the technical press. The plant has capacity to recover 10,000 tons of zinc annually from lead slags.

REFINED LEAD

Primary refineries in the United States produced 472,000 short tons of refined lead in 1953, a 1-percent decrease from the 476,000 tons produced in 1952.

Of the 467,900 tons of refined lead derived from primary sources, 70 percent came from domestic ores and base bullion and the remainder from imported ores and bullion (81 and 19 percent, respectively, 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.

[6] Engineering and Mining Journal, Slag-Fuming at Selby: Vol. 154, No. 12, December 1953, pp. 95–97.

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TABLE 6.—Refined lead produced at primary refineries in the United States, 1944–48 (average) and 1949–53, by source material, in short tons

Source	1944–48 (average)	1949	1950	1951	1952	1953
Refined lead:						
From domestic ores and base bullion	352,962	404,449	418,809	342,644	383,358	328,012
From foreign ores	64,523	71,413	86,241	71,984	89,092	139,711
From foreign base bullion	1,365	1,476	3,264	3,065	402	168
Total from primary sources	418,850	477,338	508,314	417,693	472,852	467,891
From scrap	11,704	23,230	5,455	3,893	3,070	4,211
Total refined lead	430,554	500,568	513,769	421,586	475,922	472,102
Average sales price per pound	$0.107	$0.158	$0.135	$0.173	$0.161	$0.131
Total calculated value of primary refined lead [1]	$88,964,000	$150,840,000	$137,245,000	$144,522,000	$153,247,000	$123,691,000

[1] Excludes value of refined lead produced from scrap at primary refineries.

TABLE 7.—Refined primary lead produced in the United States, 1944–48 (average) and 1949–53, by source material and country of origin, in short tons

Source	1944–48 (average)	1949	1950	1951	1952	1953
Domestic ore and base bullion	352,962	404,449	418,809	342,644	383,358	328,012
Foreign ore:						
Australia	12,902	6,465	6,984	9,056	5,888	19,886
Canada	6,159	3,317	7,892	7,986	7,113	26,673
Europe	8	30		17	454	199
Mexico	4,071	8,477	5,992	3,620	2,344	5,876
South America	18,433	29,163	38,770	36,849	48,625	50,828
Other foreign	22,950	23,961	26,603	14,456	24,668	36,249
Total	64,523	71,413	86,241	71,984	89,092	139,711
Foreign base bullion:						
Australia	93	1,382	2,427	2,815		
Mexico	1,160	36	435	27	70	42
South America	53	58	402	75	177	126
Other foreign	59			148	155	
Total	1,365	1,476	3,264	3,065	402	168
Total foreign	65,888	72,889	89,505	75,049	89,494	139,879
Grand total	418,850	477,338	508,314	417,693	472,852	467,891

ANTIMONIAL LEAD

Production of 62,400 tons of antimonial lead at primary refineries in 1953 was 7 percent above 1952 production, with all 5 plants contributing to the increase. Distribution of antimonial lead production at primary refineries in 1949–53 by source material, is shown in table 8, as is also the average antimony content.

Although antimonial lead is an important byproduct of the refining of base bullion, the quantity derived from this source is only a small part of total domestic output. The major production is recovered from smelting antimonial lead scrap at secondary smelters. Production data from lead-smelting plants treating scrap materials exclusively are summarized in the following section.

TABLE 8.—Antimonial lead produced at primary lead refineries in the United States, 1944–48 (average) and 1949–53

Year	Production (short tons)	Antimony content		Lead content by difference (short tons)			
		Short tons	Percent	From domestic ore	From foreign ore	From scrap	Total
1944–48 (average)	70, 343	4, 559	6. 7	15, 232	7, 218	43, 334	65, 784
1949	41, 402	3, 385	8. 2	692	4, 620	32, 705	38, 017
1950	57, 959	4, 504	7. 8	10, 728	4, 344	38, 383	53, 455
1951	65, 309	4, 416	6. 7	17, 372	9, 218	34, 303	60, 893
1952	58, 203	4, 392	7. 5	12, 993	5, 673	35, 145	53, 811
1953	62, 373	4, 537	7. 3	10, 366	10, 721	36, 749	57, 836

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 1953 totaled 486,700 tons, a 3-percent increase over the 471,300 tons recovered in 1952. Lead reclaimed as metal and in alloys again exceeded domestic mine production as it had in the preceding 7 years. Data on lead recovered in 1949–53, 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, 1944–48 (average) and 1949–53, in short tons

	1944–48 (average)	1949	1950	1951	1952	1953
As refined metal:						
At primary plants	11, 704	23, 230	5, 455	3, 893	3, 070	4, 211
At other plants	74, 952	129, 396	123, 858	165, 023	137, 032	122, 363
Total	86, 656	152, 626	129, 313	168, 916	140, 102	126, 574
In antimonial lead:						
At primary plants	43, 335	32, 705	38, 383	34, 303	35, 145	36, 749
At other plants	172, 279	140, 037	187, 257	195, 660	187, 806	199, 806
Total	215, 614	172, 742	225, 640	229, 963	222, 951	236, 555
In other alloys	117, 587	86, 815	127, 322	119, 231	108, 241	123, 608
Grand total:						
Short tons	419, 857	412, 183	482, 275	518, 110	471, 294	486, 737
Value	$96,065,459	$130,249,828	$130,214,250	$179,266,060	$151,756,668	$127, 525, 094

LEAD PIGMENTS

The principal lead pigments are litharge, white lead, red lead, sublimed lead, leaded zinc oxide, and orange mineral. These products are manufactured for the most part from metal, but some ore and concentrates are converted directly into pigments. Details of the production of lead pigments are given in the Lead and Zinc Pigments and Zinc Salts chapter of this volume.

CONSUMPTION AND USES

Domestic lead consumption (including lead in lead ore consumed directly in the manufacture of lead pigments and salts) totaled 1,202,000 tons in 1953, an increase of 6 percent over consumption in 1952. Of the total consumed, 795,000 tons was refined soft lead (including both primary and secondary refined lead), 278,000 tons was contained in antimonial lead (the greater part of which was secondary), 26,000 tons in white-metal scrap, 43,000 tons in percentage metals, 27,000 tons in copper-base scrap, and 24,000 tons in drosses and residues; and 9,000 tons was recovered from ore in leaded zinc oxide. About 42 percent of all lead consumed was used in metal products, 30 percent in storage batteries, 11 percent in pigments, 14 percent in chemicals (including tetraethyl lead), and 3 percent in miscellaneous uses. Production of the 3 largest lead-consuming items—batteries, tetraethyl fluid, and cable covering—took 30.5, 13.5, and 12 percent, respectively, or 56 percent of all lead consumed in 1953. Although aluminum, polyethylene, and neoprene have replaced lead cable sheathing in some uses, lead continues to be favored because of high corrosion resistance, flexibility, the ease with which it may be jointed, and its very considerable salvage value. Lead consumed for cable covering increased 3 percent to 147,000 short tons, the largest quantity so consumed since 1948. Lead consumed in manufacturing tetraethyl lead was 10 percent above 1952 and 93 percent greater than in 1948.

TABLE 10.—Consumption of lead in the United States, 1952–53, by products, in short tons

	1952	1953
Metal products:		
Ammunition	36,182	45,147
Bearing metals	36,545	38,591
Brass and bronze	25,807	26,203
Cable covering	142,571	146,565
Calking lead	45,150	48,236
Casting metals	18,017	12,906
Collapsible tubes	10,095	11,583
Foil	2,124	4,410
Pipes, traps, and bends	29,465	28,693
Sheet lead	28,697	30,476
Solder	72,664	78,743
Terne metal	1,812	3,200
Type metal	27,413	26,729
Total metal products	476,542	501,482
Storage batteries:		
Antimonial lead	187,506	191,753
Lead oxides	163,424	175,822
Total storage batteries	350,930	367,575
Pigments:		
White lead	22,943	17,775
Red lead and litharge	76,742	88,649
Pigment colors	12,839	12,859
Other [1]	9,775	10,307
Total pigments	122,299	129,590
Chemicals:		
Tetraethyl lead	146,723	162,443
Miscellaneous chemicals	3,996	6,976
Total chemicals	150,719	169,419
Miscellaneous uses:		
Annealing	5,084	5,280
Galvanizing	2,002	2,029
Lead plating	1,037	987
Weights and ballast	7,660	8,244
Total miscellaneous uses	15,783	16,540
Other, unclassified uses	14,522	16,998
Grand total	1,130,795	1,201,604

[1] Includes lead content of leaded zinc oxide production.

TABLE 11.—Consumption of lead in the United States 1952–53, by months, in short tons [1]

Month	1952	1953	Month	1952	1953
January	97,503	96,377	August	105,729	109,943
February	92,527	92,121	September	107,728	105,565
March	88,664	103,336	October	108,841	104,716
April	83,719	104,816	November	96,509	89,944
May	82,714	101,282	December	93,614	85,474
June	87,679	108,534			
July	85,568	99,496	Total	1,130,795	1,201,604

[1] Includes lead content of leaded zinc oxide production.

TABLE 12.—Consumption of lead in the United States in 1953, by classes of product and types of material, in short tons

	Soft and antimonial lead	Scrap, percentage metal, drosses, etc.	Total
Metal products	385,439	116,043	501,482
Storage batteries	366,152	1,423	367,575
Pigments	120,037		120,037
Chemicals	169,419		169,419
Miscellaneous	16,279	261	16,540
Unclassified	15,568	1,430	16,998
Total	1,072,894	119,157	[1] 1,192,051

[1] Excludes 9,553 tons of lead contained in leaded zinc oxide.

STOCKS

Producers' Stocks.—Lead stocks, as reported by the American Bureau of Metal Statistics, are shown in table 13. Stocks of refined and antimonial lead include metal held by all primary refiners and by some of the refiners of secondary metal who produce soft lead. Despite decreased supply and increased consumption in 1953 compared with 1952, supply continued to outstrip demand and exceeded consumers' requirements by 173,000 tons. In consequence, stocks of lead in raw material, in process, and in finished form increased 31 percent to 196,000 tons, approximately the same as at the close of 1949.

TABLE 13.—Stocks of lead at smelters and refineries in the United States at end of year, 1944–48 (average) and 1949–53, in short tons

[American Bureau of Metal Statistics]

	1944–48 (average)	1949	1950	1951	1952	1953
Refined pig lead	27,348	61,329	28,894	18,518	31,405	65,036
Antimonial lead	7,044	9,095	6,725	6,821	12,155	16,116
Total	34,392	70,424	35,619	25,339	43,560	81,152
Lead in base bullion—						
At smelters and refineries	8,351	16,364	11,993	11,315	17,583	17,920
In transit to refineries	4,536	3,696	4,959	3,909	3,105	2,867
In process at refineries	15,976	15,561	15,341	15,700	19,759	26,713
Total	28,863	35,621	32,293	30,924	40,447	47,500
Lead in ore and matte and in process at smelters	87,066	95,481	69,757	67,817	65,771	67,688
Grand total	150,321	201,526	137,669	124,080	149,778	196,340

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. Bureau reports indicated stocks of 65,000 tons of refined lead at these plants on December 31, 1953, compared with 31,400 tons on January 1. Stocks of antimonial lead at primary plants increased from 11,000 tons to 14,400 during the year. Stocks of ore and concentrates (lead content) also increased, rising from 34,000 tons to 44,000; inventories of base bullion at refineries that receive bullion and smelters that produce bullion for shipment to refineries, increased from 13,500 tons to 18,200.

Consumers' Stocks.—Consumers' stocks of lead decreased 7 percent in 1953. Stocks on January 1 totaled 123,000 tons, changed very little through the first 4 months of the year, increased to 139,000 tons by the end of June, and thereafter declined gradually to 114,000 tons on December 31. Consumers' stocks of refined lead, antimonial lead, unmelted white-metal scrap, and lead in copper-base scrap decreased 6, 27, 7, and 9 percent, respectively, increases being reported in percentage metals and drosses.

TABLE 14.—Consumers' stocks of lead in the United States at end of year, 1949–53, 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
1949	64, 542	16, 837	2, 957	5, 405	2, 087	5, 439	97, 267
1950	87, 285	27, 737	5, 406	6, 446	1, 558	11, 452	139, 884
1951	56, 731	28, 221	3, 140	7, 054	1, 429	6, 185	102, 760
1952	80, 888	20, 309	3, 877	6, 191	2, 282	8, 983	122, 530
1953	75, 801	14, 867	3, 607	7, 921	2, 083	9, 484	113, 763

PRICES

The market price for common lead, New York, was 14.75 cents a pound for the first few days of the year, the highest quotation of the year. On January 7 the price dropped to 14.50 cents a pound, and subsequent decreases brought it to 12.00 cents, the low point of the year, on April 20. On April 29 it advanced again to 12.50 cents and then six ¼-cent advances raised the quotation to 14.00 cents on July 23. On September 16 there was a ½-cent decrease to 13.50 cents, and the price remained there through December 31.

The London free lead market was in operation throughout the year. Quotations ranged from a high of £105 per long ton (equivalent to 13.11 cents per pound computed on the base of 279.75 cents per pound) on January 5 to a low of £73 per long ton (9.12 cents per pound) on April 22. The average monthly quoted price of common lead is given in table 15. Comparison of the New York and London prices shows that for the year the New York price was 2 cents a pound higher.

TABLE 15.—Average monthly and yearly quoted prices of lead at St. Louis, New York, and London, 1951–53, in cents per pound [1]

Month	1951			1952			1953		
	St. Louis	New York	London [2]	St. Louis	New York	London [3]	St. Louis	New York	London [4]
January	16.80	17.00	17.00	18.80	19.00	21.73	13.99	14.19	12.51
February	16.80	17.00	17.00	18.80	19.00	21.10	13.30	13.50	11.86
March	16.80	17.00	17.00	18.80	19.00	20.82	13.20	13.40	11.46
April	16.80	17.00	20.00	18.72	18.92	20.43	12.44	12.64	10.34
May	16.80	17.00	20.00	15.53	15.73	17.18	12.55	12.75	10.32
June	16.80	17.00	20.00	15.06	15.26	16.26	13.21	13.41	11.14
July	16.80	17.00	21.45	15.80	16.00	16.53	13.48	13.68	11.71
August	16.80	17.00	22.49	15.80	16.00	16.30	13.80	14.00	11.98
September	16.80	17.00	22.49	15.80	16.00	16.27	13.54	13.74	11.68
October	18.72	18.92	21.87	14.20	14.40	[4] 11.28	13.30	13.50	11.59
November	18.80	19.00	21.88	13.98	14.18	[4] 11.69	13.30	13.50	11.82
December	18.80	19.00	21.84	13.92	14.12	[4] 12.20	13.30	13.50	11.34
Average	17.29	17.49	20.25	16.27	16.47	16.82	13.28	13.48	11.48

[1] St. Louis: Metal Statistics, 1954, p. 525. New York: Metal Statistics, 1954, p. 519. London: E&MJ Metal and Mineral Markets and Quin's Metal Handbook.
[2] Conversion of English quotations into American money based on average rates of exchange recorded by Federal Reserve Board.
[3] Revised.
[4] 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 12 percent from the 1952 total to 552,000 tons; nevertheless, the quantity was the second highest on record. The large surplus of lead in the United States in 1952 and 1953 was brought about principally by the influx of foreign metal. Of the total lead imported in 1953, 385,000 tons (70 percent) was in the form of pigs and bars, and 161,000 tons (29 percent) was lead contained in ores, flue dust, and matte. Mexico supplied 37 percent, Australia 18 percent, Peru 14 percent, and Yugoslavia and Canada 13 percent of the pigs and bars. Of the lead contained in ores, flue dust, and matte 24 percent came from Canada, 20 percent from Peru, 19 percent from the Union of South Africa, 13 percent from Australia, and 12 percent from Bolivia.

TABLE 16.—Total lead imported into the United States in ore, matte, base bullion, pigs, bars, and reclaimed, by countries, 1944–48 (average) and 1949–53, in short tons [1]

[U. S. Department of Commerce]

Country	1944–48 [2] (average)	1949	1950	1951 [3]	1952 [3]	1953
Ore and matte:						
Africa	4,391	31,373	19,713	10,673	22,656	32,473
Australia	13,876	8,983	9,792	7,423	8,932	20,706
Bolivia	6,296	24,098	13,336	15,989	18,473	18,984
Canada (including Newfoundland and Labrador)	22,992	10,326	9,452	7,239	[3] 12,030	39,242
Chile	2,902	3,395	2,605	1,945	3,197	3,341
El Salvador	51	333	417	286	126	----------
Guatemala	5	2,827	325	3,169	4,721	5,391
Honduras	13	465	412	381	595	1,090

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 United States Department of Commerce.

TABLE 16.—Total lead imported into the United States in ore, matte, base bullion, pigs, bars, and reclaimed, by countries, 1944–48 (average) and 1949–53, in short tons [1]—Continued

Country	1944–48 [2] (average)	1949	1950	1951 [2]	1952 [2]	1953
Ore and matte—Continued						
Mexico	2,101	8,388	2,846	2,525	[3] 2,497	3,443
Peru	10,007	14,970	16,010	16,946	[3] 28,213	32,842
Philippines	8	279	949	789	2,446	2,980
Other countries	1,862	1,842	663	106	735	437
Total ore and matte	64,504	107,279	76,520	67,471	[3] 104,621	160,929
Base bullion:						
Australia		2,246	2,263	2,234		
Guatemala			232		266	736
Japan			921			
Mexico	1,546	25				
Peru	166	102	72	47	123	133
Other countries	79				(4)	
Total base bullion	1,791	2,373	3,488	2,281	389	869
Pigs and bars:						
Africa	117	280		2,279	6,670	9,706
Australia	12,725	17,192	22,009	13,598	82,800	70,348
Belgium-Luxembourg	1,782	212	166	331	1,785	2,017
Bolivia					635	220
Burma	469	1,414				
Canada (including Newfoundland and Labrador)	31,097	56,432	107,673	56,959	104,531	49,000
Germany		8,333	8,643	738	[5] 6,052	[5] 4,006
Italy	4,270	3,419				
Japan	3,032	2,108	5,712			
Mexico	113,132	126,398	220,767	36,987	198,872	140,751
Netherlands	365	219	484		2,747	1,981
Peru	25,783	34,626	31,988	31,528	42,169	52,216
Spain	331		440		5,509	
United Kingdom	85	341	49	299	4,216	1,148
Yugoslavia	802	23,436	43,855	36,311	53,997	51,826
Other countries	482	830	2	2	737	1,852
Total pigs and bars	194,472	275,240	441,788	179,032	510,720	385,071
Reclaimed, scrap, etc.:						
Africa	164	479				17
Australia	2,084	2,971	1,061	2,175	924	2,666
Belgium-Luxembourg	197	329	13			202
Burma		205			203	
Canada (including Newfoundland and Labrador)	4,548	1,856	1,317	1,730	6,047	371
Canal Zone	132	384	319	228	858	205
Chile	15			84		
France	(4)	289		88		
Germany		663	290			
Italy	475	346				
Jamaica	9	89	51	252	101	28
Japan	1,067	2,765	14,769	470	345	21
Mexico	337	845	934	2,089	872	98
Netherlands	492	599	4	18	454	502
Panama	55	92	80	234	300	138
Peru				159	297	59
Philippines	555	1,144	99	114	96	
Venezuela	(4)	8	106	668	196	
Western Pacific Islands			6	81	282	43
Yugoslavia	130				345	103
Other countries	464	1,585	990	753	1,019	986
Total reclaimed, scrap, etc	10,724	14,649	20,039	9,143	12,339	5,439
Grand total	271,491	399,541	541,835	257,927	[3] 628,069	552,308

[1] Data are "general imports," that is, include lead imported for immediate consumption plus material entering the country under bond.
[2] In addition to data shown "flue dust or fume containing lead and zinc, and other minerals or metals (lead content)," imported as follows—1944–48 (average): 100 tons; 1951: 13 tons; 1952: 40 tons.
[3] Revised figure.
[4] Less than 1 ton.
[5] West Germany.

TABLE 17.—Lead imported for consumption in the United States, 1944–48 (average) and 1949–53, by classes [1]

[U. S. Department of Commerce]

Year	Lead in ores, flue dust, and mattes, n. s. p. f.		Lead in base bullion		Pigs and bars		Sheets, pipe, and shot		Not otherwise specified (value)	Total value
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value		
1944–48 (average)	56, 620	$6, 426, 912	2, 559	$733, 473	191, 634	$36, 364, 443	66	$39, 111	$20, 117	$46, 075, 679
1949	121, 848	34, 397, 026	1, 133	374, 954	272, 437	80, 148, 110	178	101, 084	29, 830	119, 054, 978
1950	95, 068	21, 045, 414	1, 148	193, 356	434, 410	104, 340, 645	207	78, 111	78, 690	129, 613, 215
1951	31, 359	8, 278, 266	------	---------	179, 021	63, 682, 071	255	123, 377	174, 265	74, 528, 528
1952	107, 581	32, 755, 497	2, 951	1, 137, 813	510, 718	165, 018, 991	11	8, 446	221, 779	[2]202, 354, 782
1953	67, 030	15, 214, 084	742	294, 058	379, 119	95, 285, 223	178	58, 291	242, 925	111, 919, 578

[1] In addition to quantities shown (value included in total values), "reclaimed, scrap, etc.," imported as follows—1944–48 (average): 10,712 tons, $2,424,653; 1949: 14,076 tons, $4,003,974; 1950: 22,524 tons, $3,876,999; 1951: 8,020 tons, $2,183,240; 1952: Revised figures, 11,358 tons, $3,198,844; 1953: 3,660 tons, $824,997; and "flue dust or fume containing lead and zinc and other minerals or metals (lead content)," imported as follows—1944–48 (average): 100 tons, $66,970; 1951: 13 tons, $87,309; 1952: 40 tons, $13,412; 1949–50, 1953: None. Figures include lead received by the Government and held in stockpiles but exclude imports for manufacture in bond and export, which are classified as "imports for consumption" by the U. S. Department of Commerce.

[2] Revised figure.

TABLE 18.—Miscellaneous products containing lead, imported for consumption in the United States, 1944–48 (average) and 1949–53

[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
1944–48 (average)	174	111	$149, 884	10, 510	9, 756	$2, 089, 876
1949	281	127	459, 236	5, 861	5, 207	2, 255, 909
1950	4, 345	2, 744	2, 814, 264	12, 518	10, 582	3, 431, 650
1951	1, 533	988	1, 494, 792	9, 128	8, 663	3, 845, 671
1952	[1] 1, 540	[1] 990	[1] 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

[1] Revised figure.

Exports.—Exports of pigs and bars totaled less than 1,000 tons in 1953. Export restrictions imposed under the Export Control Act of 1940 remained in effect throughout 1953.

TABLE 19.—Total lead exported from the United States in ores, matte, base bullion, pigs, bars, anodes, and scrap, by destinations, 1944–48 (average) and 1949–53, in short tons [1]

[U. S. Department of Commerce]

Destination	1944–48 (average)	1949	1950	1951	1952	1953
Ore, matte, base bullion:						
Belgium-Luxembourg	20	—	132	—	—	—
Canada	2	1,616	1	557	836	1,038
Total ore, matte, base bullion	22	1,616	133	557	836	1,038
Pigs, bars, and anodes:						
Belgium-Luxembourg	—	76	—	37	—	—
Brazil	240	126	47	62	433	76
Canada	14	14	306	138	40	32
Canal Zone	12	15	19	24	18	1
Chile	67	40	35	107	193	18
Colombia	27	60	123	42	10	21
Cuba	62	68	61	48	52	28
Denmark	—	131	—	—	—	—
Ecuador	2	15	15	—	84	—
El Salvador	3	34	96	35	23	2
Honduras	5	29	6	14	10	3
India	28	4	—	11	4	—
Pakistan	—	—	569	—	—	—
Philippines	8	53	306	17	78	405
Turkey	17	7	—	—	280	—
United Kingdom	—	—	67	—	—	—
Uruguay	9	69	734	424	231	—
Venezuela	45	148	95	62	67	41
Other countries	3,354	80	256	260	239	176
Total pigs, bars, and anodes	3,893	969	2,735	1,281	1,762	803
Scrap:						
Belgium-Luxembourg	(2)	362	—	31	—	—
Canada	(2)	95	41	203	20	27
Germany	(2)	—	264	145	—	[3] 39
Japan	(2)	—	—	195	—	640
Lebanon	(2)	11	—	—	—	—
United Kingdom	(2)	279	1,271	20	55	2,000
Total scrap	(2)	747	1,576	594	75	2,706
Grand total	3,915	3,332	4,444	2,432	2,673	4,547

[1] In addition, foreign lead in pigs and bars was reexported as follows: 1944–48 (average) 117 tons; 1949—86 tons; 1950—53 tons; 1951—none; 1952—2 tons; 1953—799 tons.
[2] Not separately classified.
[3] West Germany.

Tariff.—The duties on pig lead and lead in ores and concentrates remained at 1$\frac{1}{16}$ cents and $\frac{3}{4}$ cent per pound, respectively, in 1953.

Because of widespread mine closures and reduced employment in the lead- (and zinc-) mining industry much thought was given to tariff revision through either new legislation or the invoking of the "escape clause" of the Reciprocal Trade Agreements Act, and various other proposals were made to restrict imports or provide other means of direct or indirect aid to the domestic industry. On July 29, 1953, the Tariff Commission, in response to resolutions of the United States Senate Committee on Finance and the House of Representatives Committee on Ways and Means, instituted a general investigation of the lead and zinc industries to determine all relevant facts of production, trade, consumption, and competitive position including the effect of imports of lead and zinc on the livelihood of American workers. A report of the investigation was submitted April 20, 1954.[8]

[8] Work cited in footnote 3.

TABLE 20.—Lead articles: United States rates of duty imposed under Tariff Act of 1930, in specified years, 1930–54

[United States Tariff Commission]

Item	Tariff rate in— 1930	1945	1948	1951	1954
	Cents per pound; percent ad valorem				
Par. 72:					
Lead pigments:					
Litharge	2½ cents	2¼ cents [1]	2¼ cents [2]	1¼ cents [3]	1¼ cents.
Orange mineral	3 cents	2½ cents [4]	2 cents [2]	2 cents	2 cents.
Red lead	2¾ cents	2¼ cents [1]	1⅞ cents [2]	1⅞ cents	1⅞ cents.
White lead	2½ cents	2 1/10 cents [5]	2 1/10 cents [2]	1 1/20 cents [3]	1 1/20 cents.
All pigments containing lead, dry or in pulp, or ground in or mixed with oil or water, n. s. p. f.:					
In chief value of suboxide of lead	30 percent	3 cents, 15 percent min., 30 percent max.[6]	3 cents, 15 percent min., 30 percent max.[2]	3 cents, 15 percent min., 30 percent max.	3 cents, 15 percent min. 30 percent max.
Other	30 percent	20 percent [1]	20 percent [2]	20 percent	20 percent.
	Cents per pound of lead content				
Par. 391: Lead-bearing ores, flue dust, and mattes of all kinds.	1½ cents	¾ cents [7]	¾ cents [8]	1½ cents [9] ¾ cents [3]	¾ cents.[10]
Par. 392:					
Lead bullion or base bullion, lead pigs and bars, lead dross, reclaimed lead, scrap lead, type metal, antimonial lead, and antimonial scrap lead.	2⅛ cents	1 1/16 cents [7] [11]	1 1/16 cents [8] [11]	2⅛ cents [9] [11] 1 1/16 cents [3] [11]	1 1/16 cents.[10]
Babbitt metal and solder	2⅛ cents	1 1/16 cents [7]	1 1/16 cents	2⅛ cents [9] 1 1/16 cents [3]	1 1/16 cents.
Alloys or combinations of lead, n. s. p. f.	2⅛ cents	1 1/16 cents [7]	1 1/16 cents	2⅛ cents [9] 1 1/16 cents [3]	1 1/16 cents.
	Cents per pound				
Lead in sheets, pipe, shot, glaziers' lead, and lead wire.	2⅜ cents	2⅜ cents	2⅜ cents	1 5/16 cents [3]	1 5/16 cents.

[1] Trade agreement with the United Kingdom, effective Jan. 1, 1939, through Dec. 31, 1947.
[2] General Agreement on Tariffs and Trade (GATT) (Geneva), effective Jan. 1, 1948.
[3] GATT (Torquay), effective June 6, 1951.
[4] Trade agreement with France, effective June 15, 1936, through Dec. 31, 1947.
[5] Trade agreement with Belgium, effective May 1, 1935, through Dec. 31, 1947.
[6] Trade agreement with Switzerland, effective Feb. 15, 1936.
[7] Trade agreement with Mexico, effective Jan. 30, 1943, through Dec. 31, 1950.
[8] Duty suspended from June 20, 1948, to June 30, 1949, inclusive (Public Law 725, 80th Cong.).
[9] Trade agreement with Mexico terminated, effective Jan. 1, 1951; the rate of duty reverted to the statutory rate provided under the Tariff Act of 1930.
[10] Duty suspended from Feb. 12, 1952, to June 25, 1952, inclusive (Public Law 257, 82d Cong.).
[11] Duty on scrap lead was suspended for virtually the entire period from Mar. 14, 1942, to June 30, 1952, inclusive (Public Law 497, 77th Cong.; Public Law 384, 80th Cong; Public Law 613, 80th Cong.; Public Law 869, 81st Cong.; Public Law 66, 82d Cong.).

TECHNOLOGY

During 1953 the Bureau of Mines published the following reports of investigation relating to lead:

4945. Browning, James S., and Clevenger, Clinton B., Process for Beneficiating Great Gossan Lead Ores, Carroll County, Va.; 14 pp.
4953. Townsend, James W., Investigation of Lead-Zinc Deposits at the Harrington-Hickory Mine, Beaver County, Utah; 2 pp.
5014. Popoff, C. C., Lead-Zinc Deposits of the Dunkelberg District, Granite County, Mont.; 41 pp.

Geological Survey publications relating to lead and issued in 1953 are:

Circular 213. Harrison, J. E., and Leonard, B. F., Preliminary Report on the Jo Reynolds Area, Lawson-Dumont District, Clear Creek County, Colo.; 9 pp.
Circular 231. Agnew, A. F., Flint, A. E., and Allingham, J. W., Exploratory Drilling Program of the United States Geological Survey for Evidences of Zinc-Lead Mineralization in Iowa and Wisconsin; 37 pp.
Circular 242. Luttrell, G. W., Bibliography of United States Geological Survey Publications on Lead and Zinc; 18 pp.
Circular 271. Stieff, L. R., Stern, T. W., and Milkey, R. G., A Preliminary Determination of the Age of Some Uranium Ores of the Colorado Plateaus by the Lead-Uranium Method; 19 pp.
Professional Paper 235. Behre, Charles H., Jr., Geology and Ore Deposits of the West Slope of the Mosquito Range; 176 pp.
Bulletin 998–B. Gault, H. R., Rossman, D. L., Flint, G. M., Jr., and Ray, R. G., Some Zinc-Lead Deposits of the Wrangell District, Alaska; 43 pp.
Bulletin 998–C. Robinson, G. D., and Twenhofel, W. S., Some Lead-Zinc and Zinc-Copper Deposits of the Ketchikan and Wales Districts, Alaska; pp. 59–83.

Articles on new methods and techniques in mining and milling published during the year were:

Tomkinson, E. R., Sinking Iron King's No. 7 Shaft: Min. Cong. Jour., vol. 39, No. 10, October, pp. 36, 37.
Mining World, Iron King Uses Close Control: Vol. 15, No. 2, February, pp. 26–29. How Bunker Hill Stair Step Block Caves Low-Dip Lead-Zinc Ore Body in Quartzite: Vol. 15, No. 8, July, pp. 57–59. National Lead Company Driving 16- by 14-Foot Crosscut, 2,250 Feet to Velie Swalley: Vol. 15, No. 6, May, pp. 38, 39. Eureka Corporation Found It—A Way to Adapt Oil-Well Methods to Mine Exploration: Vol. 15, No. 9, August, pp. 40–43.
Doyle, W. R., Steel Rail Sets at Resurrection: Min. Cong. Jour., vol. 39, No. 10, October, pp. 49–52, 65.
Kinney, L. M., Trackless Mining at Pend Oreille: Vol. 29, No. 11, November, pp. 28, 29, 105.
Huttl, J. B., New Oxide Lead Unit for Darwin: Eng. and Min. Jour., vol. 154, No. 3, March, pp. 81–83.
Stockett, Norman A., Developments in Mining Practice in Southeast Missouri: Min. Cong. Jour., vol. 39, No. 4, April, pp. 84–87.
Bain, C. K., St. Joseph Lead's Indian Creek Development: Min. Eng., vol. 5, No. 9, September, pp. 899–904.
Allen, V. C., Mechanization at an Upper Mississippi Valley Zinc-Lead Mine: Bull. Inst. Min. and Met., vol. 63, No. 556, March, pp. 261–269.

A number of articles relating to secondary lead smelting appeared in the technical press during 1953. One describes the secondary plant [9] of the George Sall Metals Co. in Philadelphia, Pa., which features pneumatic conveying, automatic weighing, flexibility in casting, and use of seasonal gas. The plant produces ingots from lead, aluminum, brass, and zinc scrap. Another describes the layout and operation of the Pennsylvania Smelting & Refining Co. lead plant,[10] Philadelphia, Pa.

Some other articles concerning metallurgical processes and product development published in 1953 were:

Schumacher, E. E., Ultra-Pure Metals Produced by Zinc-Melting Technique: Jour. Met., vol. 5, No. 11, November, pp. 1428–1429.

Chemical Engineering and Mining Review (Melbourne, Australia), Electrodeposition of Léad on Steel, by the Broken Hill Associated Smelters Pty., Ltd: Vol. 46, No. 2, November 10, pp. 49, 50.

Metal Industry (London), Antimonial Lead Alloys–I: Vol. 82, No. 14, April 3, p. 268. Antimonial Lead Alloys–II: Vol. 82, No. 16, April 17, p. 304.

American Institute of Electrical Engineers, Tellurium Alloy Lead Sheath for Power Cable: Tech. Paper 54–7, October, 11 pp.

WORLD REVIEW

World mine production of lead in 1953 established an alltime high of 1,900,000 metric tons, a gain of about 3 percent over the previous record set in 1952. Lead ores are mined in many countries (approximately 53 in 1953), but 5—United States, Australia, Mexico, Canada, and U. S. S. R.—have furnished about three-fifths of the total output in recent years. World smelter production also attained a new record in 1953—1,810,000 metric tons. On a smelter basis, there were approximately 33 lead-producing countries in 1953; the same principal producers on a mine basis supplied virtually the same percentage of the total world smelter output. Annual world mine production by countries for 1949–53, insofar as statistics are available, is given in table 21; world smelter production for the same years is given in table 22.

World smelting and refining facilities outside of the United States are listed in table 23.

[9] Fadden, W. J. Jr., New Plant for Secondary Smelting: Eng. and Min. Jour., vol. 154, No. 11, December 1953, pp. 72–77.

[10] Wakesberg, S. B., Orderliness is the Keynote at This Lead-Smelting Plant: Waste Trade Jour., vol. 97, No. 3, April 10, 1954, pp. 44, 45.

TABLE 21.—World mine production of lead, by countries, 1944–48 (average) and 1949–53, in metric tons [1]

[Compiled by Pauline Roberts]

Country	1944–48 (average)	1949	1950	1951	1952	1953
North America:						
Canada	170,611	144,945	150,317	143,544	153,170	177,618
Cuba	13	47	12	----	----	----
Guatemala	438	3,154	3,000	3,300	4,200	7,066
Honduras	29	449	279	454	538	[2] 989
Mexico	189,438	220,763	238,078	225,468	246,027	221,549
Salvador [3]	40	530	530	470	100	----
United States [4]	347,970	371,860	390,838	352,135	353,947	310,840
South America:						
Argentina	19,925	16,000	[3] 20,000	[3] 20,000	18,000	15,400
Bolivia (exports) [4]	12,782	26,311	31,176	30,558	28,291	23,788
Brazil	[3] 495	2,000	4,000	3,500	2,800	3,000
Chile	1,978	2,859	3,318	7,801	[3] 4,000	[3] 3,200
Ecuador	279	380	229	30	114	114
Peru	50,807	65,357	62,118	82,350	98,069	122,900
Europe:						
Austria	2,433	4,297	4,440	4,522	5,503	5,150
Bulgaria [3]	4,500	10,000	10,000	10,000	10,000	(5)
Czechoslovakia	[3] 2,000	(5)	(5)	(5)	(5)	(5)
Finland	146	130	142	216	216	217
France	6,498	10,004	12,430	10,074	11,815	11,530
Germany:						
East [3]	[6] 1,375	2,500	2,500	2,600	2,600	(5)
West	[6] 16,930	40,944	44,830	50,377	51,597	62,901
Greece [7]	775	1,200	5,800	3,800	6,000	5,700
Hungary	60	(5)	300	(5)	(5)	(5)
Ireland	----	152	375	1,207	1,118	(5)
Italy	14,900	35,800	40,100	40,200	40,100	40,500
Norway	113	301	234	414	413	500
Poland [8]	12,677	17,850	18,000	18,000	20,000	21,300
Portugal	384	746	1,311	1,621	1,921	1,700
Rumania [3] [8]	2,673	4,000	4,000	4,000	5,000	6,000
Spain	31,366	29,685	39,266	40,442	42,384	54,204
Sweden	20,395	23,900	22,673	19,693	20,593	23,714
U. S. S. R. [3] [8]	54,200	90,000	111,600	128,400	154,200	183,200
United Kingdom	3,017	2,505	3,336	4,925	5,774	4,357
Yugoslavia	42,434	72,144	86,039	78,750	78,968	85,152
Asia:						
Burma [3]	10	300	1,000	2,000	3,000	8,000
China [3]	300	1,000	1,200	1,500	2,000	(5)
Hong Kong	----	----	----	179	300	300
Iran	----	----	2,000	1,100	17,500	16,300
Japan	8,165	9,132	10,896	12,876	17,484	18,516
Korea:						
North [3]	} [3] 5,882	} 5,000	3,000	(5)	(5)	(5)
Republic		87	40	----	142	149
Philippines	17	550	879	571	2,300	2,434
Thailand (Siam)	----	183	691	1,321	1,048	3,600
Turkey	815	200	260	600	[3] 1,000	[3] 1,400
Africa:						
Algeria	935	1,121	1,393	2,838	4,220	7,950
Belgian Congo	658	180	----	----	----	----
Egypt	12	12	1	144	15	99
French Equatorial Africa	2,788	731	1,814	2,504	3,551	4,424
French Morocco	16,819	37,155	48,759	68,134	83,608	78,860
Nigeria	73	29	12	4	27	35
Northern Rhodesia [8]	8,057	14,169	13,905	14,194	12,802	11,694
Southern Rhodesia	60	83	----	----	----	62
South-West Africa	9,340	38,400	33,680	39,230	[4] 52,842	[4] 59,227
Spanish Morocco	150	159	178	370	732	[3] 600
Tanganyika	2	----	652	1,561	2,833	[3] 3,500
Tunisia	9.353	17,767	18,860	21,250	23,270	23,700
Uganda (exports)	4	39	44	9	8	16
Union of South Africa	151	166	600	900	575	500
Australia	193,383	216,918	222,694	228,407	236,780	249,099
Total (estimate)	1,286,000	1,550,000	1,670,000	1,690,000	1,840,000	1,900,000

[1] This table incorporates a number of revisions of data published in previous Lead chapters.
[2] Imports into United States.
[3] Estimate.
[4] Tonnage recoverable from ore.
[5] Data not available; estimate by senior author of chapter included in total.
[6] Average for 1945–48.
[7] Includes lead content of zinc-lead concentrates.
[8] Smelter production.

TABLE 22.—World smelter production of lead, by countries where smelted, 1944–48 (average) and 1949–53 in metric tons [1] [2]

[Compiled by Pauline Roberts and Berenice B. Mitchell]

Country	1944-48 (average)	1949	1950	1951	1952	1953
North America:						
Canada	144,004	132,608	154,551	147,609	166,367	150,915
Guatemala	121	68	271	60	316	658
Mexico	184,397	212,004	230,831	219,107	237,443	214,972
United States (refined) [3]	378,734	431,692	458,171	376,142	428,597	424,309
South America:						
Argentina	21,005	18,037	18,960	24,000	20,000	13,000
Brazil	296	1,172	4,200	[4] 3,000	1,946	2,450
Peru	36,496	36,017	31,693	44,247	48,622	59,160
Europe:						
Austria [5]	5,758	9,841	10,910	11,147	10,316	11,836
Belgium [5]	28,869	79,304	62,094	72,821	79,506	76,351
Czechoslovakia	[6] 3,419	(7)	(7)	(7)	(7)	(7)
France	20,841	54,450	61,236	47,974	51,538	54,917
Germany:						
East	[4] 58,660 (East and West)	[4] 10,000	[4] 12,000	16,800	[4] 18,000	[4] 18,000
West		54,551	66,619	76,063	92,682	106,775
Greece	908	2,389	2,125	3,890	2,460	[4] 2,500
Hungary	[8] 674	(7)	300	(7)	(7)	(7)
Italy	12,752	26,346	37,469	36,480	34,931	37,994
Poland	12,677	17,850	18,000	18,000	20,000	21,300
Portugal	263	304	591	724	1,065	(7)
Rumania [4]	2,673	4,000	4,000	4,000	5,000	6,000
Spain	30,988	33,021	40,568	44,711	46,543	51,249
Sweden	9,947	10,757	16,681	9,307	11,390	16,410
U. S. S. R.[4]	54,200	90,000	111,600	128,400	154,200	183,200
United Kingdom [5]	2,800	2,134	3,048	4,158	3,986	4,357
Yugoslavia	28,500	56,760	57,204	60,068	67,180	70,796
Asia:						
Burma	1,514	230	11	4,966	2,675	8,746
China	524	[5] 2,062	[4] [5] 4,000	[4] [5] 5,000	[4] [5] 6,000	[4] [5] 9,000
India	182	603	636	873	1,150	1,728
Indochina	10					
Japan	12,826	7,716	9,984	10,740	15,156	17,724
Korea:						
Korea, Republic of	[9] 183	100	(7)	(7)	126	50
North Korea	[9] 4,333	[4] 5,000	[4] 3,000			[4] 2,000
Africa:						
French Morocco	564	7,073	12,097	22,322	30,088	27,433
Northern Rhodesia	8,057	14,169	13,905	14,194	12,802	11,694
South-West Africa	29					
Tunisia	9,541	19,429	23,536	22,906	25,506	27,280
Australia [10]	155,234	152,464	163,102	168,418	159,153	175,236
Total (estimate)	1,235,000	1,495,000	1,640,000	1,600,000	1,790,000	1,810,000

[1] Data derived in part from Monthly Bulletin of the United Nations, Statistical Summary of the Mineral Industry (Colonial Geology 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] Figures cover lead refined from domestic and foreign ores; refined lead produced from foreign base bullion not included.
[4] Estimate.
[5] Includes scrap.
[6] Average for 1945–48.
[7] Data not available; estimate by senior author of chapter included in total.
[8] Data represented Trianon Hungary after October 1944.
[9] Average for 1946–48.
[10] Excluding lead content of bullion exported, figures for which are as follows: 1944–48 average, 14,609 metric tons; 1949, 33,145; 1950, 37,615; 1951, 32,384; 1952, 38,314; 1953, 34,840.

TABLE 23.—Foreign lead smelting and refining capacity, 1953 [1]

[Yearbook of American Bureau of Metal Statistics, 1953, and Minerais et Métaux Société Anonyme, 1953]

Location	Company	Type [1]	Estimated annual capacity for refined lead short tons
Argentina:			
Mercedes	Elaboracion General del Plomo, S. A.	S. & R.	7,900
Puerto Vilelas (Chaco)	National Lead Co., S. A.	do	19,800
Australia:			
Port Pirie, South Australia	Broken Hill Assoc. Smelters Pty., Ltd.	do	246,400
Mount Isa, Queensland	Mount Isa Mines, Ltd.	S.	55,100
Austria: Gailitz, Carinthia	Bleiberger Bergwerks-Union	S. & R.	11,000
Belgium:			
Beersee	Cie Mét. de la Campine	S.	6,600
Hoboken	Soc. Gen. Mét. de Hoboken	S. & R.	66,100
Overpelt	Cie des Métaux d'Overpelt-Lommel et de Corphalie.	do	19,800
Baelen-Wezel	Soc. Anon. des Mines et Fonderies de Zinc de la Vieille Montagne.	do	48,200
Brazil:			
Apiai, São Paulo	Instituto de Pesquisas Tecnologicas	do	3,900
Panelas, Parana	Plumbum, S. A.	do	11,000
Burma: Namtu	Burma Corp. (1951), Ltd.	do	74,000
Canada: Trail, B. C.	Consolidated Mining & Smelting Co. of Canada.	do	220,000
Czechoslovakia:			
Banska Stiavnica	State-owned	do	1,600
Pribram	do	do	4,400
France:			
Mortagne	Cie Royale Asturienne des Mines	do	4,100
Couëron	Soc. Anon. des Mines et Fonderies de Pontgibaud.	do	27,500
L'Estaque	Soc. Min. et Met. de Peñarroya	R.	19,800
Noyelles Godault	do	S. & R.	79,400
Saint-Denis (Seine)	Ste. Francais des Metaux et Alliages Blanco.	do	22,000
Germany, West:			
Mechernich	Gewerkschaft Merchernicher Werke	do	14,300
Hamburg	Norddeutsche Affinerie	do	33,100
Clausthal & Lautenthal	Preussag-Harzer Berg- und Hüttenwerke	do	26,400
Braubach	Blei- und Silberhütte Braubach	do	44,100
Binsfeldhammer	Stolberger Zink A. G. f. Bergbau u. Zinkhüttenbetrieb.	do	55,100
Oker (Harz)	Unterharzer Berg- und Hüttenwerke G. m. b. H.	do	26,400
Friedrich-August-Hütte, Post Nordenham.	Metallwerke Unterweser A. G.	do	26,400
Germany, East:			
Hettstedt	Mansfeldscher Kupferschieferbergbau A. G.	do	3,300
Freiberg (Saxony)	Vereiningung Volkseigener Betriebe-Buntmetall.	do	11,000
Greece: Laurium	Cie Française des Mines du Laurium	do	6,600
Guatemala: Villa Linda-Huehuetenango.	Compania Minera de Huehuetenango, S. A.	S.	
India: Tundoo, Katrasgarh	Metal Corp. of India, Ltd.	S & R.	6,600
Italy:			
Monteponi, Sardinia	Soc. di Monteponi	do	13,200
La Spezzia	Soc. Min. & Met. di Pertusola	do	26,400
S. Gavino Monreale, Sardinia	Montevecchio Soc. Italiana del Piombo e dello Zinco.	do	39,700
Japan:			
Kamioka	Mitsui Mining & Smelting Co., Ltd.	do	7,900
Takehara	do	do	7,100
Hosokura	Mitsubishi Metal Mining Co., Ltd.	do	11,900
Saganoseki	Nihon Mining Co., Ltd.	do	12,700
Aizu	Nihon Soda, K. K.	R.	2,000
Chirigishima & Annaka	Toho Aen K. K.	S & R.	2,900
Mexico:			
Monterrey, N. L.	American Metal Co., Ltd.	R.	108,000
Do	American Smelting & Refining Co.	do	216,000
Torreon, Coah.	American Metal Co., Ltd.	S.	
Chihuahua	American Smelting & Refining Co.	do	
San Luis Potosi	do	do	
Concepcion del Oro, Zacs.	Mazapil Copper Co., Ltd.	do	
Mazatlan	Met. Occidental, S. A. (Mosa)	do	
Morocco: Oued-el-Heimer	Fonderies Peñarroya-Zellidja	S & R.	38,600
Netherlands: Arnhem	N. V. Hollandsche Metallurgische Bedrijven.	do	6,600

[1] S denotes smelter, R refinery.

TABLE 23.—Foreign lead smelting and refining capacity, 1953 [1]—Continued

[Yearbook of American Bureau of Metal Statistics, 1953, and Minerais et Métaux Société Anonyme, 1953]

Location	Company	Type [1]	Estimated annual capacity for refined lead short tons
Peru: Oroya	Cerro de Pasco Corp	S. & R.	77,200
Poland:			
Trzebinia	Giesche Sp. Akcyjna	do	11,000
Mala Dabrowka	Giesche Sp. Akcyjna (Huta Walther Croneck).	do	16,500
Strzybnica	Polska Huta (Tarnowitz)	do	33,100
Brzozowice-Kamien	Zaklady Hohenlohego	R	3,100
Federation of Rhodesia and Nyasaland: Broken Hill, Northern Rhodesia.	Rhodesia Broken Hill Dev. Co	S	19,800
Rumania:			
Firija de Jos, Satu Mare	State Mines, Baia-Mare Soc. "Minaur"	S. & R.	5,500
Baia-Mare, Lucaci	Phönix, Fabrica de Acid Sulfuric si Prod. Chim.	do	3,600
Spain:			
Linares (Jaén)	Cia. "La Cruz"	do	40,200
Do	Cia. Sopwith	do	27,500
Malaga	Cia. Min. Met. Los Guindos	do	22,000
Peñarroya	Soc. Min. et Met. de Peñarroya	do	66,100
Santa Lucia, Cartagena (Murcia).	do	do	33,100
Bellmunt de Ciurana (Tarragona).	Minas del Priorato	do	6,600
Renteria	Cie. Royale Asturienne des Mines	do	8,800
Alsúa (Vizcaya)	Industrias Reunidas Minero-Metalurgicas.	do	13,200
Sweden:			
Rönnskär	Bolidens Gruv A. B.	do	22,000
Fliseryd	Svenska Ackumulator AB Jungner		5,000
Tunisia:			
Souk-el-Khémis	Soc. Anon. Francaise de Djebel Hallouf	S. & R.	2,600
Mégrine	Soc. Min. et Met. de Peñarroya	do	27,600
Bizerte	Mines & Fonderies Tunisiennes	do	3,900
United Kingdom:			
Northfleet	Britannia Lead Co., Ltd	R	82,700
Rotherhithe and Darley Dale	H. J. Enthoven & Sons, Ltd	do	44,100
London, Chester and Newcastle-on-Tyne.	Associated Lead Manufacturers, Ltd	S. & R.	82,700
U. S. S. R.:			
Chimkent (Kazakhstan)	State-owned	do	110,000
Leninogorsk (Kazakhstan)	do	do	110,000
Tetiukhe (Siberia)	do	do	5,500
Dzhaudzhukau (Caucasus)	do	do	16,500
Yugoslavia:			
Mezica	Rudnici i Topionice Olova i Cinka (Trepca).	do	16,500
Zvecan	do	do	66,100

[1] S denotes smelter, R refinery.

NORTH AMERICA

Canada.[11]—Mine output of lead in Canada in 1953 totaled 197,200 short tons, an increase of 17 percent over the 1952 total. The increased production came largely from British Columbia and Yukon. Output, by Provinces, was as follows: British Columbia, 153,600 tons; Newfoundland, 17,800 tons; Yukon, 14,400 tons; Quebec, 9,200 tons; Nova Scotia, 1,900 tons; and Ontario, 300 tons. Production of refined lead by The Consolidated Mining & Smelting Co. of Canada, Ltd., which operates Canada's only lead smelter at Trail, British Columbia, was 165,800 tons compared with 182,900 tons in 1952.

British Columbia was again the leading lead-producing Province in 1953 by a wide margin. The Sullivan zinc-lead-silver mine at Kim-

[11] Neelands, R. E., Lead in Canada, 1953 (Preliminary): Canada Dept. of Mines and Tech. Surveys, 1953.

berley, owned by Consolidated Mining & Smelting Co., is Canada's principal source of lead. About 11,000 tons of ore was mined daily in 1953, and approximately 430 tons of lead concentrate averaging 63 percent lead and 650 tons of zinc concentrate averaging 48 percent zinc was produced per calendar day for shipment to Trail. About 3,000 tons a day of coarse waste rock was eliminated from the mill feed in a sink-float plant and returned to the mine for use as fill. Production at Consolidated's Bluebell lead-zinc mine on the east side of Kootenay Lake was increased. Construction of a 1,000-ton mill at the company H. B. zinc-lead mine near Salmo was completed, but commencement of production awaits an improvement in metal prices. Sil-Van Consolidated Mining & Milling Co., Ltd., began to produce lead and zinc concentrates in a 150-ton mill in June at its property near Smithers. Giant Mascot Mines, Ltd., deepened its underground workings and increased production to about 500 tons of ore a day at its lead property near Spillamacheen. Canadian Exploration, Ltd., completed a large-scale development program, including installation of about 7,000 feet of conveyor-belt ore-transport systems, at its Jersey zinc-lead mine near Salmo. Trackless mining methods are to be used. Due to the decline in metal prices the daily tonnage milled was reduced in December from 1,800 tons to 1,000. Other producers of lead concentrate included: Tulsequah Mines, Ltd., a subsidiary of Consolidated Mining & Smelting Co., Taku River area; Violamac Mines, Ltd., and Carnegie Mines, Ltd., near Sandon; Sunshine Lardeau Mines, Ltd., near Camborne; Silver Standard Mines, Ltd., Hazelton; and Yale Lead & Zinc Mines, Ltd., at Ainsworth. Because of low prices during the year production was suspended at a number of lead-zinc mines, the most important being Reeves MacDonald Mines, Ltd., which discontinued operation of its 1,200-ton concentrator in April. Operations were discontinued also at the Zincton and Paradise mines of Sheep Creek Gold Mines, Ltd.; the Cork Province, Monarch, and Kicking Horse mines of Base Metals Mining Corp., Ltd.; and the Premier and Indian Mines of Silbak Premier Mines, Ltd. Britannia Mining & Smelting Co., Ltd., discontinued the production of lead concentrates early in 1953.

In Newfoundland, Buchans Mining Co., Ltd., operated its 1,350-ton mill at an average of 950 tons a day, producing zinc, lead, and copper concentrates containing a total of about 17,800 tons of recoverable lead.

United Keno Hill Mines, Ltd., the principal operator in the Yukon, increased production of lead and zinc concentrates from its property in the Mayo district, particularly from newly developed levels at the Hector mines. A new deeper level was established at the adjoining Calumet mine. The 150-ton mill constructed jointly by Mackeno Mines, Ltd., Yukeno Mines, Ltd., and Bibis Yukon Mines, Ltd., also in the Mayo District, began to produce lead concentrates in April. Most of the ore treated came from the Mackeno mine and from the workings of Bellekeno mines.

In the Province of Quebec, lead concentrates were produced by New Calumet Mines, Ltd., Pontiac County; Anacon Lead Mines, Ltd., and United Montauban Mines, Ltd., Portneuf County; Golden Manitou Mines, Ltd., Abitibi County; and Consolidated Candgo Mines, Ltd., North Gaspé County. Ascot Metals Corp., Ltd., produced a bulk copper-lead concentrate from its Suffield and Moulton Hill mines near Sherbrooke. The Moulton Hill mine was closed in October. United Montauban Mines, Ltd., commenced production of zinc and lead concentrates in a new 500-ton mill about mid-1953.

Mindamar Metals Corp., Ltd., continued to operate the Stirling mine, Cape Breton Island (Nova Scotia), at which production had been resumed in 1952. It produced zinc concentrate and copper-lead concentrate containing about 1,900 tons of lead.

In Ontario a small tonnage of lead concentrate was produced by Matachewan Consolidated Mines, Ltd., from the Matarrow lead mine in the Matachewan area. The operation was uneconomic, and the mine was closed in January 1953.

Intense exploration activity for base metals again was in evidence in New Brunswick. Brunswick Mining & Smelting Corp., Ltd., continued diamond-drill exploration of its large zinc-lead deposit 25 miles southwest of Bathurst, discovered in 1952. Overburden was stripped from a section of the ore zone to permit mining a small tonnage of ore for metallurgical tests, which will be carried out in 1954. In September the company acquired the Anacon-Leadridge property about 5 miles north of the Brunswick deposit, where a similar type of ore body was delineated. The 2 deposits are estimated to contain over 50 million tons of reserves to a depth of 1,000 feet, averaging 5.3 percent zinc and 1.7 percent lead, with appreciable quantities of silver, copper, tin, and pyrite. Keymet Mines, Ltd., completed constructing a 200-ton mill at its property 15 miles north of Bathurst, where production of zinc and lead concentrates was expected to begin early in 1954.

In Northwest Territories, Pine Point Mines, Ltd., a subsidiary of Consolidated Mining & Smelting Co. and Ventures, Ltd., discontinued in September an exploratory diamond-drilling program that had been active several years at its zinc-lead deposit at Pine Point, Great Slave Lake. Several million tons of ore, averaging 10 percent combined metals, has been blocked out on the Pine Point property; a large part of the reserves may be mined by open-pit methods. Ore-dressing tests have shown that high-grade concentrates can be produced.

Greenland.—The Mestersvig lead-zinc deposit in East Greenland continued under active development by the Nordic Mining Co., Ltd., throughout 1953. According to the Danish press, the management planned to continue exploration throughout the winter of 1953–54 with a labor force of about 50 men. Work during the summer was primarily surface drilling, which was to be continued until more knowledge of the extent and value of the mineralization was revealed. The company notified the Danish Government, which owns 27.5 percent of the capital stock, that only 2.5 million ($368,000) of the original 15 million kroner ($2,210,000) capital would remain by the end of 1953 and that the company must be prepared to discontinue its exploration if additional capital is not subscribed. A considerable tonnage of lead-zinc ore has been proved. Mestersvig is 7 miles from docking facilities on a fiord that is normally ice free only 4 to 5 weeks a year and has in some years been icelocked throughout the year.

Mexico.—Mine and smelter production of lead declined approximately 10 percent in 1953 compared to 1952. This relatively moderate decrease, in view of the substantially lower average price during the year, was attributed to two factors. The first and more important factor is the inflexibility of operating levels of large Mexican mines. To reduce costs by closing down or by laying off part of the working force involves complex legal and administrative problems and is attended by heavy indemnity payments to workers released. In consequence, production tends to be maintained, if company resources permit, with little consideration of short-term market conditions. The second factor was the production and export tax subsidy provided by a decree of July 28, 1953. Provisions of the decree provide for a sliding-scale subsidy to mines whose net monthly contributions of production and export taxes to the Government are less than 200,000 pesos. This prevented a number of marginal mines from closing.

The American Smelting & Refining Co. operated its lead smelter at San Luis Potosi throughout the year, except for a strike of about 4 weeks' duration in April and May. Operating mines in Mexico owned or leased by the American Smelting & Refining Co.[12] that produced lead ores included the Charcas unit, San Luis Potosi; the Parral, Santa Barbara, Santa Eulalia, Montezuma Lead, and Plomosas units, Chihuahua; the Taxco unit, Guerrero; the Angangueo unit, Michoacan; and the Aurora-Xichu unit, Guanajuato. During 1953 the American Smelting & Refining Co. virtually completed construction of the mine plant, mill, powerplant, and townsite at the Nuestra Senora lead-zinc-silver property, Cosala, Sinaloa, which will produce and mill 12,000 tons of ore monthly. Exploration and development of the Rosario lead-zinc property at Rosario, Sinaloa, were continued, and design work for mine and mill plant was in progress. Limited ore reserves at the Angangueo unit, in combination with a disastrous fire at the Dolores mine, caused the company to make application to the Government to abandon the Angangueo operations; and the Michoacan Railway & Mining Co., Ltd., owner of the property, was notified that the lease would not be renewed after December 31, 1954.

The American Metal Co., Ltd.,[13] through its Mexican subsidiary, Cia Minera de Peñoles, S. A., produced lead concentrates at its Avalos unit, Avalos, Zacatecas; Icampo unit, Boquillas, Coahuila; Calabaza unit, Etzatlan, Jalisco; Topia unit, Topia, Durango; and Guadalupe unit, Villaldama, Nuevo Leon. The Topia unit completed its first full year of operation with satisfactory technical results. Lead concentrates were smelted at the company Torreon, Coahuila, smelter and refined at the Monterrey, Nuevo Leon, refinery.

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.).

SOUTH AMERICA

Argentina.—Compania Minera Aguilar, S. A., a subsidiary of St. Joseph Lead Co., produced 19,800 metric tons of lead concentrates and 31,800 of zinc concentrates in 1953 compared with 23,100 and 30,400 tons, respectively, in 1952. The lead concentrates were smelted at the National Lead Co., S. A., smelter at Barranqueras (Puerto Villelas), Chaco Territory. The St. Joseph Lead Co. re-

[12] American Smelting & Refining Co., 55th Annual Report for the Year Ending December 31, 1953.
[13] American Metal Co., Ltd., Annual Report for the 66th Year, 1953.

ported that the potential ore-reserve position of the Aquilar mine had improved markedly during 1953.[14]

Peru.—Mine output of lead increased from 98,100 metric tons in 1952 to a record 122,900 tons in 1953. Smelter production increased 22 percent to 59,200 tons—also a new high—as the Cerro de Pasco Corp. operated its smelter at above 80 percent of rated capacity.

Chavin Mines Corp. (controlled by Ventures, Ltd., through Frobisher, Ltd., and associated companies) continued underground development at its property in the Andes about 100 miles southeast of Lima. At the end of 1953 underground work had indicated about 430,000 metric tons of ore averaging 9.1 percent lead, 15.4 percent zinc, and 1.3 percent copper and 4.5 ounces of silver per ton. The company plans to construct a mill in the near future based on successful tests.[15]

EUROPE

France.—Mine production of lead in 1953 was virtually the same as in 1952—11,500 metric tons. Imports of lead ores, predominantly from French Morocco, and pig lead, largely from Tunisia and Morocco, totaled 68,200 (gross weight) and 40,000 tons, respectively. Domestic production of refined lead was 54,900 tons. Consumption of primary lead totaled about 90,000 tons.

Germany, West.—Mine production of lead increased 22 percent to 62,900 metric tons in 1953 despite closings and curtailments at marginal mines. Increased output was the outgrowth of recent heavy investments in developing and exploiting lead and zinc ores. The major lead-zinc producing areas of West Germany are in the Harz Mountains and the Rhineland. The more important mines include Mechernich (Gewerkschaft Mechernicher Werke), Rammelsberg (Unterharzer Berg-und Hüttenwerke G. m. b. H.), Ramsbeck and Holzappel (Stolberger Zinc A. G. für Bergbau und Hüttenbertrieb), Bad Grund (Preussische Bergwerks und Hütten A. G.), Auguste Victoria (Gewerkschaft Auguste Victoria), and Leuderich (A. G. des Altenbergs für Bergbau und Zinchüttenbetrieb). The Mechernich is one of the largest lead deposits in the world, containing nearly 2 million tons of metal. The ore, however, is very low grade, assaying on an average only 1 to 2 percent lead.[16]

In 1953 West Germany imported 60,000 tons of lead in ores and concentrates and 20,700 tons of pig lead and scrap, while exports of pig lead and scrap totaled 37,400 tons. Lead (primary and secondary) consumption increased from 127,200 tons in 1952 to 154,000 in 1953.

Ireland.—The Irish Republic has three nonferrous ore-mining enterprises.[17] Abbeytown Mining Co., Ltd., works a deposit of galena and sphalerite at Ballysodare, on the northwest coast, near Sligo Bay. About 300 tons of ore is extracted daily by open-pit methods; shipments are in the form of concentrates. Wicklow Mining Co., Ltd., operates at Glendalough, County Wicklow; the deposit contains galena and sphalerite. Silvermines Lead & Zinc Co. works a galena deposit in the Silvermine Mountains northeast of Limerick.

[14] St. Joseph Lead Co., 90th Annual Report to the Stockholders, 1953.
[15] Ventures, Ltd., Annual Report, 1953.
[16] Metal Bulletin (London), No. 3844, November 17, 1953, pp. 14-15.
[17] Metal Bulletin (London), July 27, 1954, p. 11.

Italy.—Mine production of lead in Italy in 1953 was virtually the same as in 1952—about 40,000 metric tons—while smelter production increased slightly to 40,000 tons. The bulk of the output came from mines in Sardinia, Italy's most important lead- and zinc-mining Province. A second sink-float plant was under construction at the end of the year at Montevecchio, the largest lead-zinc mine in Sardinia, and a new lead-zinc flotation plant had been built by Societa per Azroni Piombo e Zinco (SAPEZ) at the Aguxau Mount mine. Exploration of lead-zinc properties outside of the established mining areas in Sardinia was undertaken by a new company (RI. MI. SA.), formed as a joint venture of four mining companies in the region.

U. S. S. R.—The lead resources of the U. S. S. R. were described and evaluated in a textbook.[18] Production, consumption, and imports of lead are given, as well as the location of lead deposits and estimated reserves, and the location and capacity of smelters and recovery factors.

United Kingdom.—Output of recoverable lead increased slightly to 4,400 metric tons in 1953. A large lead deposit was discovered at Riber Hillside, Matlock, Derbyshire, by Matlock Lead Mines in 1953.[19] The company proposes to erect a plant capable of treating enough ore to produce 10,000 tons of lead a year. A lead-zinc mine at Llanwrst, North Wales, was reopened during the year by Llanwrst Lead Mines, Ltd.[20]

Consumption of lead in the United Kingdom in 1953 totaled 308,600 metric tons, of which 158,000 tons was imported virgin lead, 66,700 tons English refined, and 83,900 tons scrap, including remelted lead. The principal uses of lead were cable coverings (92,500 tons); batteries, including oxides and compounds (52,700 tons); and sheet and pipe (71,700 tons).[21]

Yugoslavia.—Mine production of lead in 1953 was slightly below the alltime high recorded in 1950, but output of refined lead established a new peak—70,800 tons. Of the many lead-zinc mines in Yugoslavia the Stari Trg mine in the Trepca group is by far the largest, with about 10.5 million tons of ore reserves containing an estimated lead content of 660,000 tons. Nine flotation mills, including 2 (Lece and Suplja Stena) completed in 1953, treat the ore from these mines; combined daily milling capacity is approximately 5,000 metric tons. Smelter-refinery units are at Zvecan (70,000 metric tons annual capacity) and Mezica (15,000 tons). Known lead-zinc ore reserves in Yugoslavia total about 18 million metric tons, of which approximately 13 million tons, with an estimated 780,000 tons of lead-metal content, is the share of the Trepca mines.

ASIA

Burma.—The Burma Corp., Ltd., operator of the Bawdwin silver-lead-zinc mine in the Shan States of northern Burma, continued to expand mine output and rehabilitate the mine and mill, as well as the lead smelter at Namtu. Since the mine was reopened in the

[18] Shimkin, Demitri B., Minerals—A Key to Soviet Power: Harvard University Press, Cambridge, Mass., 1953, ch. 4, pp. 120–129.
[19] Mining World, vol. 15, No. 13, December 1953, p. 67.
[20] Mining World, vol. 15, No. 11, October 1953, p. 92, and Metal Bulletin (London), No. 3849, Dec. 4, 1953, p. 20.
[21] Metal Bulletin (London), No. 3868, February 12, 1954, p. 17.

summer of 1952 mine production has increased steadily and in 1953 totaled 58,500 tons. Ore was concentrated in the rebuilt Bawdwin mill, and in all about 3,900 metric tons of zinc and 8,000 tons of lead were produced in concentrate form. About 8,700 metric tons of lead and 580,000 troy ounces of silver were refined at Namtu during the year. The company plans to increase further its rate of ore production to about 300,000 tons a year, which is well below the 480,000 tons production in effect 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 and 20 percent lead and 15.5 ounces of silver per ton.

India.—The Geological Survey of India reported an output of 2,800 metric tons of lead concentrates with an average content of 73.08 percent lead and 6.5 percent zinc and 24.78 ounces of silver per ton in 1953. Production was from the Zawar lead-zinc mines of the Metal Corporation of India. These deposits are estimated to contain 1 million tons of high-grade, 2 million tons of medium-grade, and 6 to 8 million tons of low-grade ore. Average content of the ore mined in 1952 was about 5 percent lead and 7 percent zinc. The company smelter at Tundoo, Katrasgarh, Bihar, treated 2,700 tons of concentrates to recover 1,700 tons of lead.

Thailand.—Production of lead ore by the Consolidated Mining Co. increased from 2,000 metric tons in 1952 to 7,100 tons (recoverable metal content about 3,600 tons) in 1953. Exports of ore, all to Canada, totaled 6,000 tons. Lead-zinc ore reserves at the company Nong Plai mine in Kanburi are estimated at 900,000 metric tons; ore mined in 1952 was reported to average 55 to 70 percent combined lead and zinc, with the lead content slightly higher than that of zinc.

AFRICA

Algeria.—Mine output of lead concentrates increased from 6,700 metric tons in 1952 to 11,500 in 1953; lead-metal content was approximately 4,200 and 8,000 tons, respectively. The largest producers were Compagnie des Mines d'Ouasta (3,400 tons), Société Minière & Metallurgigne de Peñarroya (2,700 tons), and Société Algerienne du Zinc (2,300 tons).

Federation of Rhodesia and Nyasaland.—Rhodesia Broken Hill Development Co., Ltd., in northern Rhodesia, the only producer of lead and zinc in the Federation, produced 11,700 metric tons of lead in 1953 compared with 12,800 tons in 1952. The new company lead smelter began operations during the year but owing to technical difficulties operated intermittently and produced only 1,200 tons of lead. The remainder of the output was produced at the old plant, chiefly in Newnam hearth furnaces. Proved and indicated oxide and sulfide ore reserves at the end of 1953 totaled about 2.5 million short tons averaging 17.2 percent lead and 26.7 percent zinc.

French Morocco.—Output of lead concentrates (72 percent lead) decreased from 115,300 metric tons in 1952 to 110,400 in 1953. The sharp drop in world lead and zinc prices early in 1953 caused many small Moroccan lead mines to curtail or suspend operations. Sixteen mines were reported to have shut down by the end of the year, leaving 22 in operation. Three companies—Société des Mines de Zellidja, Compagnie Royale Asturienne des Mines, and Société des Mines d'Aouli—supplied 86 percent of the entire output. The Zellidja-Peñarroya lead smelter at Oued-El-Heimer processed 42,000 tons of lead concentrate during the year and recovered 27,400 tons of lead. Société des Mines d'Aouli obtained authorization from the Protectorate Government to build and operate a hydroelectric power station in the Upper Moulouya Basin. This authorization was reportedly sought with a view to building a lead smelter near Midelt, which would be well placed to process the concentrates from the mines of the Midelt-Taouz-Haut Guir region, most of which are under the control of the Peñarroya group.

South-West Africa.—Lead content of ores and concentrates produced in South-West Africa in 1953 totaled 59,200 metric tons compared with 52,800 tons in 1952. Virtually the entire output was exported—31,400 tons to the United States and 27,400 to Belgium. The Tsumeb mine of Tsumeb Corp., Ltd., was by far the largest producer, with more than 90 percent of the total output. The South-West Africa Co., operating a mine at Abenab, is the only other producer in the territory. Tsumeb Corp. continued sinking its seven-compartment DeWet shaft, which is to become the main operating shaft of the mine, and installed a mechanical loading plant at Walvis Bay that can handle 300 tons of concentrates an hour.

Tanganyika.—Exports of lead concentrates by Uruwira Minerals, Ltd., from the pilot plant at the Mpanda mine increased from 4,800 tons in 1952 to 6,100 in 1953.[22] Construction of the new 1,200-ton-per-day lead-copper heavy-medium separation and flotation plant at Mukwamba continued satisfactorily.[23] In 1952 the Mutual Security Agency, as agent for the Defense Materials Procurement Agency, agreed to advance $1,640,000 to Uruwira for plant construction. The dollars will be repaid with 5-percent interest by deliveries of copper and lead to United States stockpiles until December 31, 1956. The United States also has a purchase option on up to 50 percent of production for 10 years after the advance and interest have been repaid.

Tunisia.—The output of lead concentrates in 1953 was 37,900 metric tons, a slight gain over 1952. The most important mines were Djebel Semene (7,000 tons), El Grefo (6,200 tons), Sidi Bou Aouane (5,400 tons), and Djebel Hallouf (3,500 tons). Pig-lead output was 27,300 tons; the Megrine smelter furnished 22,800 tons, Djebel Hallouf 1,700 tons, and Bizerte 2,800 tons.

AUSTRALIA

Mine and smelter production of lead increased moderately in 1953 to 249,100 and 175,200 metric tons, respectively. Increased output at the larger mines in New South Wales and Queensland more than offset the small losses incurred by closing of some of the marginal cost producers in Western Australia. Price controls of both zinc and lead, established at A£95 September 4, 1952, were discontinued by Queensland September 13, 1952, but remained in effect in the other

[22] Mining Magazine (London), vol. 90, No. 4, April 1954, p. 207.
[23] Mining World, New Uruwira Mill Discards 50-Percent Feed by HMS to Triple Lead-Copper Flotation Head: Vol. 16, No. 1, January 1954, pp. 49–52, 77.

five States until April 17, 1953. Thereafter both zinc and lead prices declined, reflecting the changes on the London Metal Exchange and elsewhere. The Dominion embargo on export of zinc and lead was removed at the end of March 1953.

In New South Wales the Consolidated Zinc Corp., Ltd., which operates the New Broken Hill Consolidated, Ltd., and the Zinc Corporation, Ltd., mines, milled 542,600 long tons (449,300 tons in 1952) to produce 108,400 tons (87,400) of zinc concentrate and 105,600 tons (77,200) of lead concentrates. Mill heads in 1953 averaged 15.4 percent lead (13.5 percent in 1952) and 11.7 percent zinc (11.2) and 3.4 ounces of silver (3.1). The annual report of the Zinc Corp. lists reserves of 8,300,000 long tons of high-grade ore, with yet larger quantities indicated. Other producers in the Broken Hill district were North Broken Hill, Ltd., and Broken Hill South, Ltd.

Lake George Mining Corp., Ltd., mined complex basemetal ore at Captain's Flat. In the fiscal year ended June 30, 1953, 178,000 long tons was milled compared with 180,000 tons in the preceding fiscal year. Metals contained in marketable products were 14,300 tons of zinc, 8,200 tons of lead, 900 tons of copper, 183,400 ounces of silver, and 4,000 ounces of gold. Ore reserves of 1,600,000 tons average 6.4 percent lead, 11.5 percent zinc, and 0.62 percent copper and 1.39 ounces of silver and 0.07 ounces of gold. The corporation's annual report states that overall costs per ton of ore milled were A£10.7 as compared with A£4.3 in 1947.

Mount Isa Mines, Ltd., milled 623,800 long tons of 6.4-percent zinc and 7.4-percent lead ore in the fiscal year ended June 30, 1953, to recover 41,800 tons of 51.2-percent zinc concentrate and 115,700 tons of 33.8-percent lead concentrate. The lead concentrate was smelted at Mount Isa and the zinc concentrate exported. Estimated reserves of lead-zinc-silver ores at the end of the year totaled 9,880,000 tons containing 8.5 percent lead and 6.9 percent zinc and approximately 6 ounces of silver per ton. Drilling below the limits of open-cut mining showed increased values in lead, zinc, and silver. A new ventilation shaft and air-conditioning plant was being installed. Exploratory diamond drilling in the Northern Prospect area indicated excellent potentialities.

The Electrolytic Zinc Co. of Australasia, Ltd., operated its Rosebery and Hercules mines and during the fiscal year milled 168,800 tons (162,600 tons in 1952) of ore averaging 18.0 percent zinc, 5.2 percent lead, and 0.44 percent copper and 6.45 ounces of silver and 0.09 ounce of gold per ton to recover 48,000 tons of 55.3-percent zinc concentrate, 9,300 tons of 58.6-percent lead, and 4,400 tons of 18.25-percent copper concentrate.

Lead and Zinc Pigments and Zinc Salts

By Robert L. Mentch[1] and Esther B. Miller[2]

NOTEWORTHY features of the lead-and-zinc-pigments industry in 1953 were the increased volume of business in litharge, zinc oxide, and leaded zinc oxide and the continued decrease in shipments of lithopone and white lead. Shipments of litharge increased 10 percent over the 1952 rate and shipments of zinc oxide and leaded zinc oxide each increased 5 percent, while shipments of lithopone and white lead declined 15 and 2 percent, respectively.

Shipments of red lead, zinc chloride, and zinc sulfate advanced 1, 11, and 13 percent, respectively.

The increased shipments of pigments and salts are attributed largely to increases in the volume of business in industries that are important consumers of these products. In 1953 the production of passenger automobiles was 42 percent above the 1952 total; the output of trucks and buses decreased 1 percent, however. Consumption of natural and synthetic rubber increased 6 percent compared with 1952. The value of public and private construction was 7 percent greater than in 1952, and the value of sales of paint, varnish, and lacquer materials was 7 percent higher than in 1952.

Decreased shipments of white lead—one of the oldest and formerly the largest tonnage paint pigment—and lithopone are attributed to the growing use of other pigments, notably titanium dioxide and inert pigments.

Supplies of lead and zinc, the chief raw materials of the pigments industry, were abundant throughout the year. Lead and zinc selling prices declined further during the year; reductions (in addition to those in 1952) brought ending prices to the lowest point since the spring and summer of 1950. Common lead, New York, opened at 14.75 cents a pound, reached a low of 12 cents in April, and recovered to 13.5 cents in September, where it remained for the balance of the year. The quotation for Prime Western grade slab zinc, East St. Louis, fell from a high of 13 cents a pound in January to 10 cents in September, where it remained for the rest of 1953.

Lead- and zinc-pigment price quotations followed pig-lead and slab-zinc prices closely throughout the year. Quotations for the pigments fell as lead-and zinc-metal prices declined. Ending quotations ranged from 1 to 11 percent lower than beginning prices.

Shipments of white lead (dry) in 1953 increased 6 percent, but shipments of the "in oil" variety decreased 13 percent. Total shipments of both varieties were the smallest by far since long before the beginning of the present century, reflecting, to a great extent, the marked increase in utilization of other competitive white pigments.

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Litharge shipments increased 14,000 tons or 10 percent in 1953, the largest percentage and tonnage gain among the pigments covered by this report. Shipments of red lead increased 1 percent during the year but were well below the yearly average for the preceding 10 years. Figure 1 shows trends in shipments of lead pigments for 1910-53.

Zinc oxide (lead-free) shipments increased 5 percent in 1953 and were the highest since 1950. Leaded zinc oxide shipments also increased 5 percent above the 1952 rate of deliveries to consumers. The use of lithopone has declined substantially in the post World War II period; in 1953 shipments were 15 percent lower than in 1952 and considerably below those for all years from 1917–52.

Shipments of zinc salts increased moderately in 1953; zinc chloride gained 11 percent and zinc sulfate 13 percent.

TABLE 1.—Salient statistics of the lead [1] and zinc pigments industry of the United States, 1944–48 (average) and 1949–53

	1944–48 (average)	1949	1950	1951	1952	1953
Production (shipments)[2] of principal pigments:						
White lead (dry and in oil)..short tons..	62,644	27,355	45,176	35,415	26,663	26,217
Red lead......do....	40,146	24,866	35,072	35,352	30,926	31,333
Litharge.......do....	146,525	121,052	177,658	154,753	140,798	154,518
Zinc oxide.....do....	147,642	110,132	160,829	147,716	142,210	148,627
Leaded zinc oxide short tons..	68,773	36,722	63,973	44,341	37,892	39,712
Lithopone.....do....	146,225	78,335	105,650	102,837	61,832	52,439
Value of products:						
All lead pigments....	$61,916,000	$58,564,000	$79,858,000	$89,273,000	$72,230,000	$64,303,000
All zinc pigments....	49,913,000	43,152,000	71,322,000	74,599,000	63,950,000	56,475,000
Total..............	111,829,000	101,716,000	151,180,000	163,872,000	136,180,000	120,778,000
Value per ton received by producers:						
White lead (dry).....	$229	$351	$335	$426	$403	$378
Red lead............	236	333	314	397	376	312
Litharge............	241	324	292	383	348	285
Zinc oxide..........	166	230	258	311	307	264
Leaded zinc oxide....	174	242	262	320	313	259
Lithopone...........	92	115	124	141	137	132
Foreign trade:						
Lead pigments:						
Value of exports..	$1,135,000	$1,157,000	$950,000	$984,000	$933,000	$799,000
Value of imports.	162,000	143,000	344,000	1,797,000	451,000	16,000
Zinc pigments:						
Value of exports..	3,798,000	3,426,000	2,124,000	6,855,000	4,352,000	1,468,000
Value of imports.	9,800	52,000	1,275,000	930,000	90,000	287,000
Export balance.	4,761,200	4,388,000	1,455,000	5,112,000	4,744,000	1,964,000

[1] Excludes basic lead sulfate, data for which are withheld to avoid disclosure of individual company operations.
[2] Reported as sales before 1945.

The distribution pattern for shipments of pigments to consumers in 1953 remained virtually the same as in previous years. The paint industry continued to be the largest user by far of white lead, leaded zinc oxide, and lithopone, receiving approximately 90, 99, and 71 percent, respectively, of shipments. The paint industry also became the largest user of red lead in 1953, taking 47 percent of the total shipments and displacing storage-battery makers as the chief user,

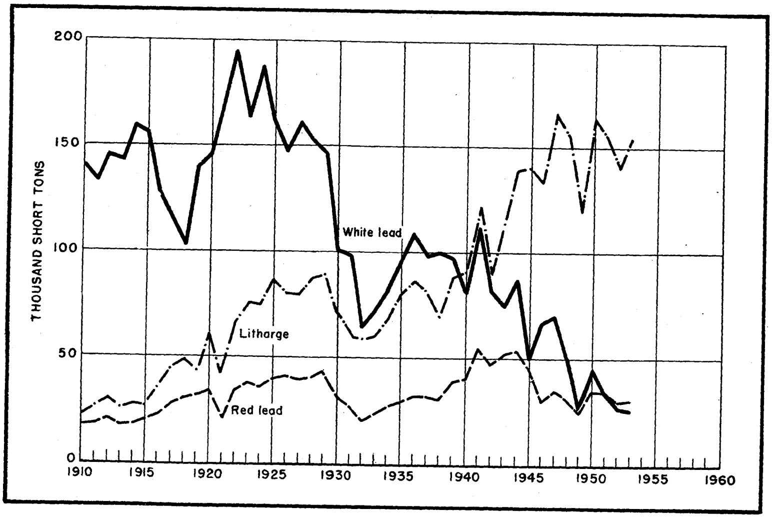

FIGURE 1.—Trends in shipments of lead pigments, 1910–53.

In addition, 21 percent of zinc oxide (lead-free) shipments and 3 percent of litharge shipments went into paint manufacture. Storage-battery manufacturers were the chief users of litharge and the second largest users of red lead, receiving 67 and 45 percent, respectively, of producers' deliveries. The rubber industry continued to be the largest consumer of zinc oxide, receiving 53 percent of total shipments. Relatively small quantities of litharge, lithopone, and leaded zinc oxide were also used in manufacturing rubber products. The ceramics industry ranks fourth in consumption of lead and zinc pigments and was surpassed only by the paint, storage-battery, and rubber in-

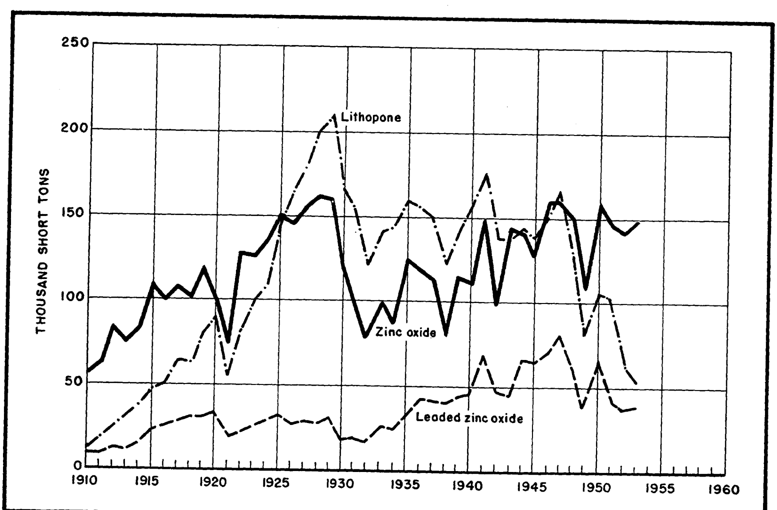

FIGURE 2.—Trends in shipments of zinc pigments, 1910–53.

dustries. In 1953, 14 percent of litharge shipments, 6 percent of lead-free zinc oxide shipments, 4 percent of red lead shipments, and 3 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 increased 5 and 13 percent, respectively, in 1953 and were slightly higher than the former records established in 1951. In 1953 production and shipments of titanium pigments were 93 and 99 percent higher than in 1945, an indication of the inroads that titanium pigments have made in the pigment field since the end of World War II. 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 Volume I, 1953.

PRODUCERS AND PLANTS

A list of companies producing lead and zinc pigments and zinc salts, plants, and the products manufactured in 1953 follows:

White lead:	
The Eagle-Picher Co	East Chicago, Ind.
Euston Lead Co	Scranton, Pa.
W. P. Fuller & Co	South San Francisco, Calif.
John R. MacGregor Lead Co	Chicago, Ill.
National Lead Co	Do.
Do	Oakland, Calif.
Do	Perth Amboy, N. J.
Do	Philadelphia, Pa.
Do	St. Louis, Mo.
Red lead and litharge:	
Associated Lead & Zinc Co	Seattle, Wash.
The Eagle-Picher Co	East Chicago, Ind. [1]
Do	Galena, Kans.
Do	Joplin, Mo.
Do	Newark, N. J.
W. P. Fuller & Co	South San Francisco, Calif.
Hammond Lead Products, Inc	Hammond, Ind.
Linklater Co	Montebello, Calif.
John R. MacGregor Lead Co. [1]	Chicago, Ill.
National Lead Co	Atlanta, Ga.
Do	Charleston, W. Va.
Do	Chicago, Ill.
Do	Dallas, Tex.
Do	Philadelphia, Pa.
National Lead Co. (Morris P. Kirk & Son, Inc.)	Los Angeles, Calif.
National Lead Co	Oakland, Calif.
Do	St. Louis, Mo.
Western Lead Products Co	Los Angeles, Calif.
Zinc chloride:	
American Cyanamid Corp. (Calco Chemical Division).	Bound Brook, N. J.
American Smelting & Refining Co	Alton, Ill.
Do	Omaha, Nebr.
Do	Perth Amboy, N. J.
Do	Selby, Calif.
Chemicals, Inc	Chicago, Ill.
Jordan Co	Do.

[1] Litharge only.

E. I. du Pont de Nemours & Co	Cleveland, Ohio
Do	East Chicago, Ind.
Mallinckrodt Chemical Works	St. Louis, Mo.
Marathon Battery Co	Wausau, Wis.
National Lead Co. (Morris P. Kirk & Son, Inc.)	Los Angeles, Calif.
Rohm & Haas Co	Bridesburg, Pa.
The Ruby Chemical Co	Columbus, Ohio
Zinc sulfate:	
The Chemical & Pigment Co. (Division of The Glidden Co.).	Oakland, Calif.
E. I. du Pont de Nemours & Co	Cleveland, Ohio
Do	Newport, Del.
Mallinckrodt Chemical Works	St. Louis, Mo.
The Sherwin-Williams Co. (Ozark Smelting & Mining Division).	Coffeyville, Kans.
Sullivan Mining Co	Kellogg, Idaho.
Tennessee Corp	East Point, Ga.
Virginia Smelting Co	West Norfolk, Va.
Zinc oxide and leaded zinc oxide:	
American Chemet Corp.[2]	East Helena, Mont.
American Zinc Co. of Illinois	Hillsboro, Ill.
American Zinc Oxide Co.[3]	Columbus, Ohio.
The Eagle-Picher Co	Galena, Kans.
Do	Hillsboro, Ill.
Harshaw Chemical Co.[3]	Cleveland, Ohio.
Monsanto Chemical Co.[3]	St. Louis, Mo.
The New Jersey Zinc Co. of Pa	Palmerton, Pa.
Rohm & Haas Co.[3]	Bristol, Pa.
Royce Chemical Co.[3]	Carlton Hill, N. J.
St. Joseph Lead Co.[3]	Josephtown, Pa.
The Sherwin-Williams Co. (Ozark Smelting & Mining Division).[2]	Coffeyville, Kans.
Superior Zinc Corp.[3]	Bristol, Pa.
United Industrial & Chemical Corp.[3]	Bayonne, N. J.
Lithopone:	
The Chemical & Pigment Co. (Division of The Glidden Co.).	Collinsville, Ill.
Do	Oakland, Calif.
E. I. du Pont de Nemours & Co	Newport, Del.
The New Jersey Zinc Co. (Mineral Point Zinc Division).	Depue, Ill.
The Sherwin-Williams Co. (Ozark Smelting & Mining Division).	Coffeyville, Kans.

[2] Leaded zinc oxide only.
[3] Zinc oxide only.

In addition, the Auto-Lite Battery Corp., the Electric Storage Battery Co., Willard Storage Battery Co., and General Motors Corp. produced a substitute product (black oxide of lead) for litharge for use in the manufacture of storage batteries.

E. I. du Pont de Nemours & Co. shut down its Newport, Del., lithopone plant permanently in December 1953 and reported expansion of titanium-pigment facilities at the same plant.

PRODUCTION

The value of shipments of lead and zinc pigments in 1953 (exclusive of those for basic lead sulfate and zinc sulfide, which cannot be shown) was $120,778,000, an 11-percent decrease from the 1952 value. Lead pigments comprised 53 percent of the total value, and zinc pigments 47 percent, the same proportions as in 1952.

For many years figures on "sales" were used in this series of reports as a better guide to activity in the pigments industry than production. Beginning with 1945 the base was changed to "shipments" to conform with data compiled on Bureau of Mines lead and zinc schedules. Available information for 1945 (the year of change) indicates little difference between sales and shipments in that year. In reporting tonnages of pigments, an attempt is made to avoid all duplication, one of the chief problems being that finished pigments frequently are blended to make another product. Basic lead sulfate and zinc oxide, for example, are blended to make leaded zinc oxide, and in this instance the pigment weights appear in the total for the last-named class only. Pigments consumed by producing companies to make products beyond those covered by this report—that is, paints, storage batteries, and other articles—are considered shipments.

LEAD PIGMENTS

Combined shipments of lead pigments increased 7 percent in quantity in 1953 but decreased 11 percent in value. Substantial reductions in average prices received by producers explained the marked decrease in value.

Average values of lead pigments reported by producers dropped for the second successive year and were well below the record selling prices of 1951. The average price received for white lead (dry) in 1953 was $378 per ton—6 percent less than that in 1952; red lead sold at an average of $312 per ton—a decrease of 17 percent; and litharge brought $285 per ton—18 percent less than the 1952 average.

White Lead.—The downward trend in the use of white lead, first evident in the late 1920's, continued as competitive pigments supplanted both the dry and "in oil" varieties in many paint formulations. Total shipments in 1953 declined slightly from 1952 and were the lowest by far since long before the beginning of the 20th century. Statistics show the extent of the decline forcefully; in 1953 shipments were equivalent to only 18 percent of average yearly shipments for 1910–14 and to 32 percent of average yearly shipments for 1941–45.

Basic Lead Sulfate.—The Bureau of Mines is not at liberty to publish figures on basic lead sulfate for 1946–53.

Red Lead.—Shipments of red lead increased 1 percent in 1953 but were 42 percent below shipments in 1944, the peak year.

Orange Mineral.—No shipments of orange mineral were reported in 1947–53.

Litharge.—Shipments of litharge increased 10 percent above the 1952 total and were exceeded only in 4 earlier years—1947, 1948, 1950 and 1951.

Battery manufacturers produced 82,000 tons of black or gray suboxide of lead in 1953 for their own use in place of litharge. This quantity compares with 76,000 tons in 1952 and 77,000 tons in 1951. This suboxide production required 78,000 tons of pig lead in 1953, 72,000 tons in 1952, and 73,000 tons in 1951.

TABLE 2.—Production and shipments of lead pigments[1] in the United States, 1952–53

Pigment	1952				1953			
	Production (short tons)	Shipments			Production (short tons)	Shipments		
		Short tons	Value[2]			Short tons	Value[2]	
			Total	Average			Total	Average
White lead:								
Dry	16,405	15,779	$6,353,285	$403	16,544	16,784	$6,337,051	$378
In oil[3]	11,454	10,884	5,177,314	476	9,249	9,433	4,210,823	446
Red lead	32,620	30,926	11,634,969	376	32,009	31,333	9,776,657	312
Litharge	144,564	140,798	49,064,874	348	156,871	154,518	43,978,371	285

[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, 1944–48 (average) and 1949–53, in short tons

Year	White lead			Red lead	Orange mineral	Litharge
	Dry	In oil	Total			
1944–48 (average)	35,267	27,377	62,644	40,146	127	146,525
1949	15,719	11,636	27,355	24,866		121,052
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

[1] Excludes basic lead sulfate, data for which are withheld to avoid disclosure of individual company operations.

ZINC PIGMENTS AND SALTS

Total shipments of zinc pigments in 1953 were essentially unchanged from 1952, but the value of shipments decreased 12 percent owing to substantial price reductions. Shipments of lead-free zinc oxide—the most important of the zinc pigments in tonnage and value—increased 5 percent. Shipments of leaded zinc oxide also increased 5 percent, but lithopone shipments declined 15 percent—the largest decrease among the products covered by this report.

Average values of zinc pigments reported by producers fell for the second year in succession and were considerably below the record selling prices of 1951. The average price received for zinc oxide (lead-free) in 1953 declined 14 percent to $264 per ton; leaded zinc oxide dropped to $259 per ton, or 17 percent less than the 1952 average; and lithopone sold at $132 per ton, a decrease of 4 percent.

Shipments of the zinc salts, zinc chloride and zinc sulfate, increased 11 and 13 percent, respectively, above the 1952 totals. The average value of zinc chloride (50° B. solution) was the same as in 1952—$93 per ton—whereas the average value received for zinc sulfate declined from $163 per ton in 1952 to $143 per ton.

TABLE 4.—Production and shipments of zinc pigments and salts in the United States, 1952–53

Pigment or salt	1952				1953			
	Production (short tons)	Shipments			Production (short tons)	Shipments		
		Short tons	Value [1]			Short tons	Value [1]	
			Total	Average			Total	Average
Zinc oxide [2]	137,957	142,210	$43,614,186	$307	155,645	148,627	$39,266,282	$264
Leaded zinc oxide [2]	37,869	37,892	11,860,158	313	39,819	39,712	10,284,801	259
Lithopone	60,220	61,832	8,475,200	137	54,593	52,439	6,923,487	132
Zinc chloride, 50° B	50,599	51,966	4,822,995	93	60,234	57,537	5,323,919	93
Zinc sulfate	19,349	19,587	3,189,611	163	22,449	22,220	3,181,411	143

[1] Value at plant, exclusive of container.
[2] Zinc oxide containing 5 percent or more lead is classed as leaded zinc oxide. In this table data for leaded zinc oxide include a small quantity containing less than 5 percent lead.

TABLE 5.—Zinc pigments and salts shipped [1] by manufacturers in the United States, 1944–48 (average) and 1949–53, in short tons

Year	Zinc oxide	Leaded zinc oxide	Lithopone	Zinc chloride (50° B.)	Zinc sulfate
1944–48 (average)	147,642	68,773	146,225	61,063	21,200
1949	110,132	36,722	78,335	55,208	20,065
1950	160,829	63,973	105,650	64,564	23,912
1951	147,716	44,341	102,837	60,730	23,524
1952	142,210	37,892	61,832	51,966	19,587
1953	148,627	39,712	52,439	57,537	22,220

[1] Reported as sales before 1945.

Zinc Oxide.—Lead-free zinc oxide shipments increased 5 percent above 1952 and were the highest since 1950.

TABLE 6.—Production of zinc oxide (lead-free) by processes, 1944–48 (average) and 1949–53, as percent of total

Process	1944–48 (average)	1949	1950	1951	1952	1953
American process (ore and primary residues)	75	71	72	75	74	74
French process (metal and scrap)	16	17	18	18	20	20
Other	9	12	10	7	6	6
Total	100	100	100	100	100	100

Leaded Zinc Oxide.—Shipments of leaded zinc oxide increased 5 percent in 1953 but were considerably below average yearly shipments in the preceding 10 years.

Four grades of leaded zinc oxide, classified according to lead content, are produced in the United States. The bulk of the output, however, is the 5- to 35-percent grade; only relatively small quantities of the other grades—less than 5 percent lead, over 35 to 50 percent lead, and over 50 percent lead—are produced. For publication purposes, the 2 top and 2 lower grades are combined. Production in 1953 (comparison with 1952 in parentheses) was as follows: 35,517 (32,401) tons of 35 percent lead and under and 4,302 (5,468) tons of over 35 percent lead.

Lithopone.—Lithopone shipments fell 15 percent below 1952 deliveries and were the lowest since 1916.

The lithopone statistics in this report are given on the basis of ordinary lithopone sold as such plus the ordinary lithopone content of the high-strength product.

Consumption of ordinary lithopone in the manufacture of titanated lithopone has diminished to very small proportions. The trend has been downward almost continuously since 1937, when 19,400 tons was used in making the titanated variety. The tonnage consumed for this purpose in 1953 was 60 percent below that used in 1952 and the smallest on record. The lithopone figures in table 7 are included in the totals for ordinary lithopone in other tables.

Zinc Sulfide.—In 1953 only one company produced zinc sulfide; the Bureau of Mines is not at liberty to publish figures for this pigment.

Zinc Chloride.—Shipments of zinc chloride (50° B. solution) increased 11 percent in 1953.

Zinc Sulfate.—Zinc sulfate shipments (gross weight) in 1953 were 13 percent higher than in 1952.

TABLE 7.—Titanated lithopone produced in the United States and ordinary lithopone used in its manufacture, 1944–48 (average) and 1949–53, in short tons

Year	Titanated lithopone produced	Ordinary lithopone used	Year	Titanated lithopone produced	Ordinary lithopone used
1944–48 (average)	6,240	5,270	1951	1,550	1,300
1949	2,000	1,700	1952	900	750
1950	3,400	2,900	1953	360	300

RAW MATERIALS USED

Figures covering the raw materials used in making pigments and salts in 1953 and 1952 are shown in the accompanying tables.

Lead pigments and zinc pigments and salts are manufactured from a variety of materials, including ore, refined metal, and such secondary materials as scrap, residues, ashes, drosses, and skimmings. In 1953 approximately 95 percent of the lead in pigments was derived from pig lead and the remainder from ore; in 1952 and 1951 the percentage of contained lead from metal was 95 and 94, respectively. Of the lead in ore used to make leaded zinc oxide, about 23 percent (13 in 1952) was from foreign sources. The proportion of zinc in zinc pigments was as follows: 74 percent (76 in 1952) from ore and concentrates, 14 (11) percent from slab zinc, and 12 (13) percent from secondary materials; about 33 (26) percent of the ore used was of foreign origin.

Tables 8 and 9 give the source of the metal used in manufacturing each pigment and salt. Pig lead is employed exclusively, either directly or indirectly, in manufacturing white lead, litharge, red lead, and orange mineral and is used also in manufacturing basic lead sulfate. The lead content of leaded zinc oxide made from basic lead sulfate, which in turn is made from pig lead, is credited to pig lead in the table. Zinc oxide is the only pigment in which considerable slab zinc is used. Ore is employed in manufacturing zinc oxide, leaded zinc oxide, lithopone, zinc sulfide, zinc sulfate, and basic lead sulfate. Nearly half of the zinc contained in lithopone (43 percent in 1953 and 45 in 1952) and virtually all of that in zinc chloride (100 percent in 1953 and 1952) produced in the United States are derived from secondary material. The proportion of zinc oxide production derived from metal and scrap increased to 29 percent in 1953 compared with 26 percent in 1952. For a number of years before the United States entered World War II there had been a large increase in the quantity of secondary zinc used in manufacturing zinc oxide. The scarcity of supplies of both metal and scrap caused the proportion of the total

TABLE 8.—Lead content of lead and zinc pigments[1] produced by domestic manufacturers, by sources, 1952–53, in short tons

Pigment	1952				1953			
	Lead in pigments produced from—			Total lead in pigments	Lead in pigments produced from—			Total lead in pigments
	Ore		Pig lead		Ore		Pig lead	
	Domestic	Foreign			Domestic	Foreign		
White lead			22,287	22,287			20,634	20,634
Red lead			29,570	29,570			29,016	29,016
Litharge			134,445	134,445			145,890	145,890
Leaded zinc oxide	8,358	1,275		9,633	7,367	2,186		9,553
Total	8,358	1,275	186,302	195,935	7,367	2,186	195,540	205,093

[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, 1952–53, in short tons

Pigment or salt	1952					1953				
	Zinc in pigments and salts produced from—				Total zinc in pigments and salts	Zinc in pigments and salts produced from—				Total zinc in pigments and salts
	Ore		Slab zinc	Secondary material[2]		Ore		Slab zinc	Secondary material[2]	
	Domestic	Foreign				Domestic	Foreign			
Zinc oxide	57,839	23,811	16,240	12,872	110,762	57,315	31,391	21,022	14,548	124,276
Leaded zinc oxide	15,357	3,211			18,568	15,107	5,121			20,228
Lithopone	5,544	796	2	5,261	11,603	4,378	1,635	9	4,489	10,511
Total pigments	78,740	27,818	16,242	18,133	140,933	76,800	38,147	21,031	19,037	155,015
Zinc chloride				11,399	11,399				13,644	13,644
Zinc sulfate	2,422	297		3,622	6,341	2,350	947		4,214	7,511

[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.

oxide made by the French process—which uses only metal and scrap—to drop sharply in 1942 and to continue comparatively low in 1943–46, despite the fact that the total percentage from metal and scrap rose in 1943 and continued upward almost without interruption in 1944–51. The production of zinc oxide from metal and scrap furnished the following percentages of the total: 41 percent in 1939, 16 percent in 1942, 19 percent in 1943, 22 percent in 1944, 25 percent in 1945, 26 percent in 1946, 28 percent in 1947, 26 percent in 1948, 29 percent in 1949 and 1950, and 24 percent in 1951.

CONSUMPTION AND USES

LEAD PIGMENTS

White Lead.—The bulk of the white lead used in the United States goes into the making of paint; the paint industry usually consumes 90 percent or more of the total. In 1953, however, the customary percentage was not indicated by available statistics. This situation probably was due to 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 a substantial part of the entire "Other" classification doubtless belongs properly under paint. Shipments to ceramic makers and manufacturers of plasticizers and stabilizers composed 3 and 4 percent, respectively, of the total distribution in 1953.

TABLE 10.—Distribution of white lead (dry and in oil) shipments,[1] [2] by industries 1944–48 (average) and 1949–53, in short tons

Industry	1944-48 (average)	1949	1950	1951	1952	1953
Paints	57,087	24,284	38,920	28,718	21,223	21,030
Ceramics	1,237	894	1,815	1,548	1,079	785
Other	4,320	2,177	[3] 4,441	[3] 5,149	[3] 4,361	[3] 4,402
Total	62,644	27,355	45,176	35,415	26,663	26,217

[1] Reported as sales before 1945.
[2] Excludes basic lead sulfate, data for which are withheld to avoid disclosure of individual company operations.
[3] Includes the following tonnages for plasticizers and stabilizers: 1950—1,257; 1951—1,003; 1952—986; 1953—1,089.

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 became the largest consumer of red lead in 1953 for the first time since distribution of pigments by industries was reported in 1929. Storage-battery makers (formerly the chief users) received 45 percent of total shipments compared with nearly 47 percent for paint manufacturers. In 1952 shipments for storage batteries and paints were 45 and 43 percent, respectively, of the total. Relatively small quantities were used in making ceramics.

TABLE 11.—Distribution of red-lead shipments,[1] by industries, 1944–48 (average) and 1949–53, in short tons

Industry	1944–48 (average)	1949	1950	1951	1952	1953
Paints	13, 211	9, 634	14, 103	14, 740	13, 149	14, 570
Storage batteries	22, 358	12, 163	17, 478	16, 722	13, 796	13, 975
Ceramics	997	603	981	834	388	1, 188
Other	3, 580	2, 466	2, 510	3, 056	3, 593	1, 600
Total	40, 146	24, 866	35, 072	35, 352	30, 926	31, 333

[1] Reported as sales before 1945.

Orange Mineral.—No shipments of orange mineral have been reported since 1946, when 123 tons went to various industries.

Litharge.—The use of litharge for storage batteries regularly is roughly two-thirds of total shipments; in 1953 the proportion was 67 percent compared with 69 percent in 1952. The ceramics industry is the second largest consumer of litharge; shipments for this purpose increased 32 percent above 1952 and comprised 14 percent of the total in 1953. Shipments for chrome pigments, oil refining, and rubber increased 5, 6, and 6 percent, respectively, while shipments for varnish, insecticides, and floor coverings declined 30, 15, and 24 percent, respectively.

TABLE 12.—Distribution of litharge shipments,[1] by industries, 1944–48 (average) and 1949–53, in short tons

Industry	1944–48 (average)	1949	1950	1951	1952	1953
Storage batteries	88, 129	77, 163	105, 558	94, 064	97, 656	103, 849
Ceramics	15, 079	13, 299	27, 771	22, 815	15, 906	20, 924
Chrome pigments	9, 437	8, 557	10, 017	11, 117	8, 376	8, 821
Oil refining	6, 729	5, 720	6, 488	6, 068	4, 080	4, 342
Varnish	3, 545	4, 286	4, 347	5, 584	5, 572	3, 915
Insecticides	14, 320	5, 353	10, 651	5, 691	2, 724	2, 305
Rubber	2, 412	1, 398	3, 047	2, 641	2, 109	2, 230
Floor coverings	126	62	220	1, 772	791	603
Other	6, 748	5, 214	9, 559	5, 001	3, 584	7, 529
Total	146, 525	121, 052	177, 658	154, 753	140, 798	154, 518

[1] Reported as sales before 1945.

ZINC PIGMENTS AND SALTS

Zinc Oxide.—Shipments of lead-free zinc oxide to consuming industries followed the same distribution pattern in 1953 as in previous years. The rubber industry and paint manufacturers remained by far the leading consumers, accounting for 53 (51 in 1952) and 21 percent (22), respectively, of total shipments. Shipments for ceramics and coated fabrics and textiles each comprised 6 percent of the total (5 and 4 in 1952). Shipments to all consuming industries except floor coverings increased in 1953.

TABLE 13.—Distribution of zinc oxide shipments,[1] by industries, 1944–48 (average) and 1949–53, in short tons

Industry	1944–48 (average)	1949	1950	1951	1952	1953
Rubber	74, 377	58, 496	82, 944	71, 507	72, 774	78, 439
Paints	29, 489	26, 205	39, 699	32, 934	31, 424	31, 920
Ceramics	8, 294	6, 982	12, 679	10, 324	7, 760	8, 862
Coated fabrics and textiles [2]	12, 571 (Coated fabrics and textiles and Floor coverings)	5, 200	6, 303	7, 265	6, 262	8, 718
Floor coverings		2, 665	3, 670	3, 114	2, 413	2, 234
Chemical warfare	5, 948					
Other	16, 963	10, 584	15, 534	22, 572	21, 577	18, 454
Total	147, 642	110, 132	160, 829	147, 716	142, 210	148, 627

[1] Reported as sales before 1945.
[2] Includes the following tonnages for rayon: 1949—4,470; 1950—4,850; 1951—5,275; 1952—5,852; 1953—7,388.

Leaded Zinc Oxide.—Leaded zinc oxide (all grades) is used almost exclusively as a pigment in paint manufacturing; in 1953, 99 percent of total shipments was for this purpose. Small quantities (less than 1 percent of shipments) are used by the rubber industry.

TABLE 14.—Distribution of leaded zinc oxide shipments,[1] by industries, 1944–48 (average) and 1949–53, in short tons

Industry	1944–48 (average)	1949	1950	1951	1952	1953
Paints	65, 759	35, 938	63, 002	43, 678	37, 607	39, 276
Rubber	167	124	240	82	9	41
Other	2, 847	660	731	581	276	395
Total	68, 773	36, 722	63, 973	44, 341	37, 892	39, 712

[1] Reported as sales before 1945.

Lithopone.—The chief use of lithopone is in the manufacture of paints, varnish, and lacquers; approximately three-fourths of the total shipments goes to these industries. In 1953 shipments for paints, etc., declined 17 percent and comprised 71 percent (73 in 1952) of the total. Shipments for use in coated fabrics and textiles, rubber, and printing ink increased 2, 13, and 9 percent, respectively, while shipments for paper and floor coverings decreased 32 and 14 percent, respectively.

TABLE 15.—Distribution of lithopone shipments,[1] by industries, 1944–48 (average) and 1949–53, in short tons

Industry	1944–48 (average)	1949	1950	1951	1952	1953
Paint, varnish, and lacquers [2]	116, 150	56, 146	78, 177	76, 614	45, 267	37, 452
Coated fabrics and textiles	6, 960	6, 602	7, 945	4, 814	5, 698	5, 806
Paper	4, 294	2, 375	3, 821	6, 462	3, 089	2, 096
Floor coverings	9, 852	6, 380	5, 297	4, 620	3, 009	2, 575
Rubber	2, 117	3, 245	4, 092	3, 295	1, 523	1, 723
Printing ink	(3)	(3)	838	868	657	716
Other	6, 852	3, 587	5, 480	6, 164	2, 589	2, 071
Total	146, 225	78, 335	105, 650	102, 837	61, 832	52, 439

[1] Reported as sales before 1945.
[2] Includes a small quantity, not separable, used for printing ink, except in 1950, 1951, and 1952.
[3] Included in "Other" before 1950, except for those quantities reported under "Paint, varnish, and lacquers."

Zinc Chloride.—Statistics on the end-use distribution of zinc chloride shipments are not available. The principal uses of the salt are in wood preserving, battery manufacturing, vulcanized fiber, oil refining, and as a soldering flux.

Zinc Sulfate.—The textile (rayon) industry has ranked first in consumption of zinc sulfate since 1946, when the agricultural use (fertilizers and fungicides) led; in 1953 shipments for rayon increased 10 percent from 1952 and comprised 41 percent of the total. Agriculture continued to be the second largest use; shipments for this purpose increased 33 percent and composed 30 percent of total shipments. Among the smaller uses, shipments for chemicals and glue increased, whereas shipments for flotation reagents, electrogalvanizing, textile dyeing and printing, and paint and varnish processing decreased.

TABLE 16.—Distribution of zinc sulfate shipments,[1] by industries, 1944–48 (average) and 1949–53, in short tons

Industry	1944–48 (average), gross weight	1949		1950		1951		1952		1953	
		Gross weight	Dry basis	Gross weight	Dry basis	Gross weight	Dry basis	Gross weight	Dry basis	Gross weight	Dry basis
Rayon	7, 685	10, 591	7, 957	11, 217	8, 322	10, 073	7, 925	8, 181	6, 812	9, 008	7, 612
Agriculture	7, 094	4, 429	3, 595	5, 841	4, 880	5, 588	4, 847	5, 111	4, 446	6, 773	5, 894
Chemicals	2, 037	1, 197	851	1, 879	1, 377	2, 871	2, 243	1, 675	1, 489	2, 539	2, 105
Flotation reagents	1, 238	921	757	952	727	858	736	1, 070	950	736	648
Glue	450	453	370	579	464	396	337	391	329	601	501
Textile dyeing and printing	250	30	21	145	129	1, 400	1, 163	350	301	155	138
Electrogalvanizing	315	217	154	324	203	190	129	342	243	337	225
Paint and varnish processing	455	663	585	189	119	32	20	172	130	106	70
Other	1, 676	1, 564	979	2, 786	1, 820	2, 116	1, 274	2, 295	1, 422	1, 965	1, 219
Total	21, 200	20, 065	15, 269	23, 912	18, 041	23, 524	18, 674	19, 587	16, 122	22, 220	18, 412

[1] Reported as sales before 1945.

PRICES

Total and average values received by producers for lead and zinc pigments and zinc salts are given in the tables in the first part of this report. Average values of litharge, red lead, and white lead declined $63, $64, and $25 per ton in 1953 and were the lowest for white lead since 1950 and for red lead and litharge since 1946. The price of pig lead fluctuated from a high of 14.75 cents a pound to a low of 12 cents a pound in 1953 in contrast with the wide variation in 1952 (13.5–19 cents), hence the range in pigment quotations was not as pronounced in 1953 as in 1952.

Average values received for the zinc pigments, zinc oxide, leaded zinc oxide, and lithopone in 1953 were $43, $54, and $5 less than values in 1952 but remained at a relatively high level compared with other years. Quotations for Prime Western grade slab zinc, East St. Louis, in 1953 ranged from a high of 13 cents a pound to a low of 10 cents a pound compared with a fluctuation of 7 cents (19.5–12.5) in 1952.

The average value of zinc chloride in 1953 remained unchanged from the record established in 1952 while zinc sulfate declined $20 a ton or 12 percent from 1952.

TABLE 17.—Range of quotations on lead pigments, and zinc pigments and salts at New York (or delivered in the East), 1950–53, in cents per pound

[Oil, Paint and Drug Reporter]

Product	1950	1951	1952	1953
White lead (basic lead carbonate), dry, carlots, barrels	14.00–18.50	18.50–20.10	16.25–20.10	16.25–17.25
Basic lead sulfate (sublimed lead), less than carlots, barrels	13.25–18.75	18.75–20.19	15.75–20.19	15.00–15.75
Red lead, dry, 95 percent or less, less than carlots, barrels	14.25–20.75	20.75–22.57	17.25–22.57	15.75–18.50
Orange mineral, American, less than carlots, barrels	16.60–23.10	23.10–24.92	19.60–24.92	18.10–20.85
Litharge, commercial, powdered, less than carlots, barrels	13.25–19.75	19.75–21.65	16.25–21.65	14.75–17.50
Zinc oxide:				
American process, lead free, bags, carlots	11.00–16.00	16.00–17.60	14.25–17.60	13.50–14.25
American process, 5 to 35 percent lead, barrels, carlots	11.25–16.88	16.88–18.35	14.40–18.35	14.00–14.40
French process, red seal, bags, carlots	12.25–17.25	17.25–18.85	15.25–18.85	14.75–15.50
French process, green seal, bags, carlots	12.75–17.75	17.75–19.35	16.00–19.35	15.25–16.00
French process, white seal, barrels, carlots	13.50–18.50	18.25–19.85	16.50–19.85	15.75–16.50
Lithopone, ordinary, less than carlots, bags	6.50– 8.50	8.50– 8.90	8.25– 8.90	8.25– 8.50
Zinc sulfide, less than carlots, bags, barrels	13.50–25.00	25.00–26.30	26.30	25.30–26.30
Zinc chloride, works:				
Solution, tanks	3.25– 4.10	4.10– 5.35	4.10– 5.35	4.10– 4.85
Fused, drums	7.00– 9.85	9.85	9.60– 9.85	9.85–10.85
Zinc sulfate, crystals,[1] less than carlots, barrels	4.95–10.15	10.15–11.20	18.10–11.20	8.10–10.30

[1] Includes granulated.

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 1953 these products were exported and imported at a greatly reduced scale from 1952; the value of major classes of exports was $2,267,000 compared with $5,285,000 in 1952. The value of imports declined from $541,000 to $303,000.

Imports of lead pigments were negligible in 1953 and consisted chiefly of litharge, which totaled less than 100 tons. Imports of zinc oxide—the only item of significance among the zinc pigments and salts—increased nearly sevenfold in 1953.

The United States exported small tonnages of litharge, white lead, red lead, and lead arsenate in 1953, but the quantities constituted only a small portion of shipments by domestic producers.

Zinc oxide and lithopone are the pigments (of the classes covered by this report) exported in greatest tonnages from the United States. Exports of these pigments each declined 61 percent from the quantities exported in 1952 and comprised 2 and 7 percent, respectively, of total domestic shipments.

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

TABLE 18.—Value of foreign trade of the United States in lead and zinc pigments and salts, 1951–53

[U. S. Department of Commerce]

	Imports for consumption			Exports		
	1951	1952	1953	1951	1952	1953
Lead pigments:						
White lead	$886,973	$139,829	$44	$272,695	$222,092	$219,514
Red lead	89,351	623	47	266,098	183,649	153,830
Litharge	788,064	273,719	15,281	445,201	527,450	425,848
Other lead pigments	32,373	36,386	678	(1)	(1)	(1)
Total	1,796,761	450,557	16,050	(1)	(1)	(1)
Zinc pigments:						
Zinc oxide	779,299	88,056	275,122	3,238,685	2,720,203	883,821
Zinc sulfide	----------	----------	6,460	(1)	(1)	(1)
Lithopone	151,165	2,308	5,658	3,615,915	1,632,106	584,279
Total	930,464	90,364	287,240	6,854,600	4,352,309	1,468,100
Lead and zinc salts:						
Lead arsenate	2,664	36,879	----------	165,215	62,498	83,139
Other lead compounds	68,609	12,550	6,457	(1)	(1)	(1)
Zinc arsenate	----------	22	27	(1)	(1)	(1)
Zinc chloride	194,595	79,645	25,379	(1)	(1)	(1)
Zinc sulfate	15,565	10,767	3,958	(1)	(1)	(1)
Total	281,433	139,863	35,821	(1)	(1)	(1)
Grand total	3,008,658	680,784	339,111	(1)	(1)	(1)

[1] Data not available.

TABLE 19.—Lead pigments and salts imported for consumption in the United States, 1944–48 (average) and 1949–53

[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	
1944–48 (average)	41	65	301	19	6	12	(1)	$166,327
1949	161	23	96	23	6	----------	(1)	142,607
1950	944	70	12	57	27	----------	2	344,555
1951	2,575	215	1,855	53	----------	7	180	1,868,034
1952	390	2	621	53	(1)	81	32	499,986
1953	(1)	(1)	60	1	4	----------	18	22,507

[1] Less than 1 ton.

TABLE 20.—Zinc pigments and salts imported for consumption in the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Year	Short tons							Total value
	Zinc oxide		Lithopone	Zinc sulfide	Zinc chloride	Zinc arsenate	Zinc sulfate	
	Dry	In oil						
1944–48 (average)	37	1	(1)	(1)	(1)		371	$27,758
1949	239	(1)	12		17		120	60,984
1950	5,093	2	1,201	33	210		159	1,317,141
1951	1,772	10	794		714		201	1,140,624
1952	173	(1)	11		275	(1)	66	180,798
1953	1,157	29	30	23	179	(1)	46	316,604

[1] Less than 1 ton.

TABLE 21.—Lead pigments and salts exported from the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Year	Short tons				Total value
	White lead	Red lead	Litharge	Lead arsenate	
1944–48 (average)	1,940	1,430	1,788	1,854	$1,654,338
1949	699	1,042	1,357	430	1,343,513
1950	815	549	1,612	520	1,166,259
1951	767	585	1,038	313	1,149,209
1952	675	435	1,233	128	995,689
1953	818	417	1,238	152	882,331

TABLE 22.—Zinc pigments and salts exported from the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Year	Short tons		Total value	Year	Short tons		Total value
	Zinc oxide	Lithopone			Zinc oxide	Lithopone	
1944–48 (average)	10,258	13,510	$3,798,061	1951	8,895	20,473	$6,854,600
1949	5,040	14,460	3,426,118	1952	7,615	9,985	4,352,309
1950	3,094	9,357	2,124,367	1953	2,971	3,927	1,468,100

Lime

By Oliver Bowles,[1] Annie L. Marks,[2] and James M. Foley[2]

LIME production in 1953 reached a new high, exceeding the previous record of 1951. Lime sold or used in 1953 totaled 9,674,000 short tons. This figure, however, is not strictly comparable with that of 1952 and preceding years. In the past, part of the captive tonnage (lime used by companies in their own plants) was included with open-market lime to obtain more complete data on uses. In 1953 steps were taken to include all captive-tonnage lime to present a complete picture of the lime industry. In 1952 the figure for total lime produced—8,073,000 short tons—included 486,000 tons of captive tonnage; therefore the open-market lime sold in 1952 was 7,587,000 tons. Of the total sold or used in 1953—9,674,000 short tons—1,560,000 tons was captive tonnage, and open-market sales amounted to 8,114,000 tons, a gain of 7 percent over 1952. In some tables that follow a breakdown has been made between open-market and captive tonnage.

Substantial gains were recorded in 1953 for chemical, industrial, and refractory uses, but sales of both building and agricultural lime declined. Of the total sold or used, 79 percent was in the form of quicklime and dead-burned dolomite and 21 percent in hydrated form.

TABLE 1.—Salient statistics of lime sold or used in the United States, 1944–48 (average) and 1949–53

	1944–48 (average)	1949	1950	1951	1952	1953
Active plants	188	180	168	155	160	156
Sold or used by producers:						
By types:						
Quicklime .... short tons	3,605,366	3,305,648	3,833,872	4,369,269	4,262,229	5,337,268
Hydrated lime .... do	1,581,380	1,693,946	1,885,101	1,919,783	1,882,824	2,042,100
Dead-burned dolomite ... do	1,299,213	1,318,708	1,759,443	1,966,460	1,928,025	2,294,815
Total lime:						
Short tons	6,485,959	6,318,302	7,478,416	8,255,512	8,073,078	9,674,183
Value [1]	$56,927,683	$69,319,374	$83,247,990	$96,934,611	$95,231,221	$112,158,060
Per ton	$8.78	$10.97	$11.13	$11.74	$11.80	$11.59
Total open-market lime short tons	6,109,126	5,962,935	7,022,225	7,720,333	7,587,443	8,114,396
Total captive tonnage lime short tons	[2] 376,833	[2] 355,367	[2] 456,191	[2] 535,179	[2] 485,635	1,559,787
By uses:						
Agricultural .... do	377,624	328,528	332,687	343,619	392,383	329,455
Building .... do	812,776	1,052,097	1,248,989	1,234,136	1,191,263	1,166,240
Chemical and industrial .. do	3,996,346	3,618,969	4,137,297	4,711,297	4,561,407	5,883,673
Refractory (dead-burned dolomite) .... short tons	1,299,213	1,318,708	1,759,443	1,966,460	1,928,025	2,294,815
Imports for consumption .... do	25,383	34,332	34,284	34,025	24,008	37,202
Exports .... do	38,875	59,927	50,491	63,295	64,952	79,934

[1] Selling value, f. o. b. plant, excluding cost of containers.
[2] Incomplete figures; before 1953 there was only a partial coverage of captive plants.

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Figure 1 shows the relation of building-lime production to the volume of new building construction. A fair parallelism is indicated until 1948, but thereafter the building-lime output lagged behind new construction. The downward trend of building-lime output is particularly marked since 1950.

As lime is used extensively in many industrial plants, the output of refractory and chemical lime tends to follow the trend of industrial production. This relationship is shown in figure 1. The high point reached by refractory and chemical lime in 1953 is due partly to the more complete coverage of captive tonnage discussed in a previous paragraph.

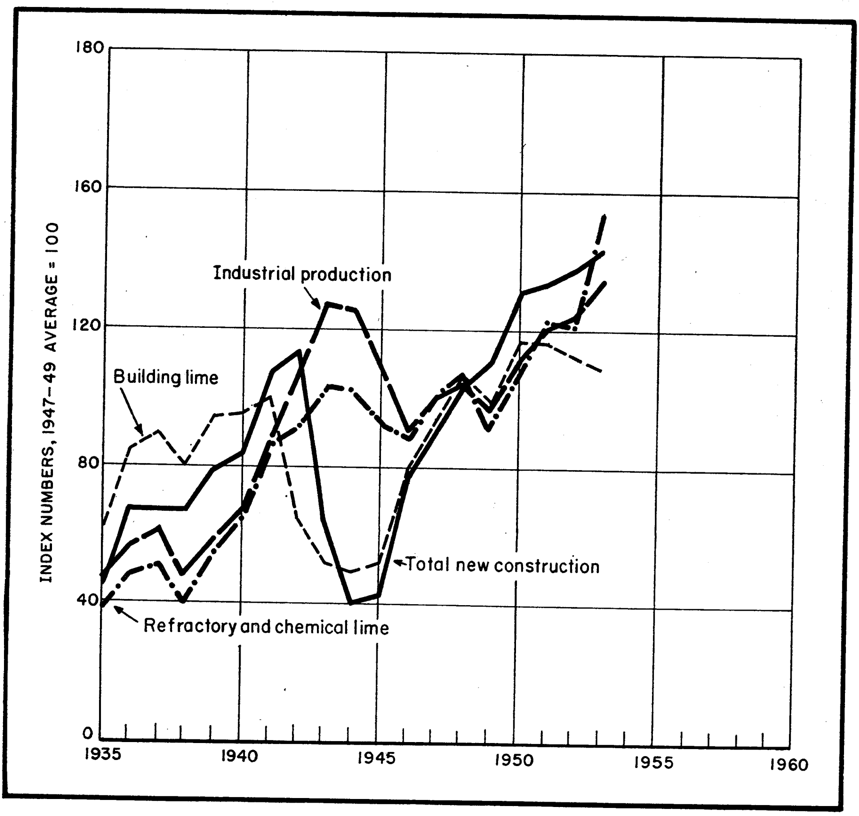

FIGURE 1.—Production of building lime compared with physical volume of total new construction, and output of refractory and chemical lime compared with industrial production, 1935–53. Units are reduced to percentages of the 1947–49 average. Statistics on new construction from Construction and Building Materials, U. S. Department of Commerce, and on industrial production from Federal Reserve Board.

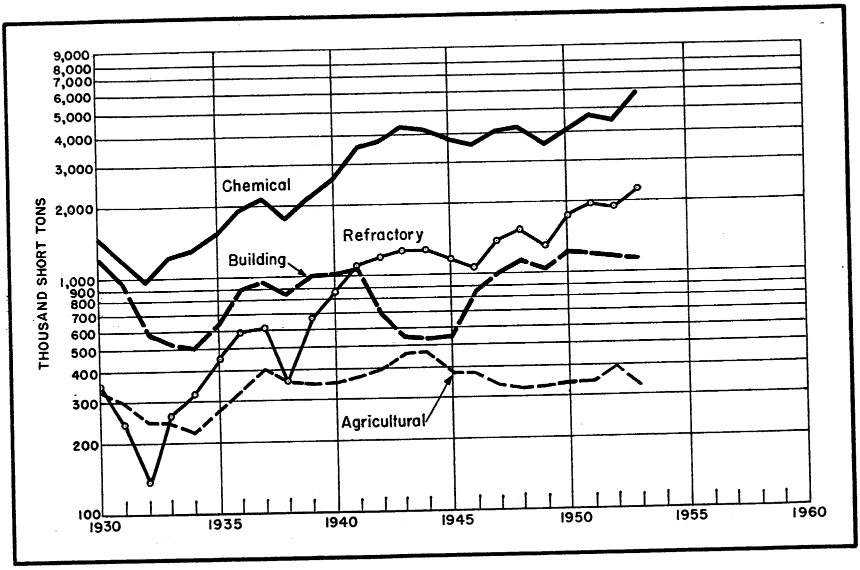

FIGURE 2.—Trends in major uses of lime, 1930–53

Figure 2 shows the trends in production of lime by principal uses over a period of years.

DOMESTIC PRODUCTION

The total output of open-market lime was 7 percent higher in 1953 than in 1952. The gains were in dead-burned dolomite (20 percent) and in chemical and industrial sales (6 percent). Sales for building and agriculture each declined 2 percent. Chemical, industrial, and refractory lime combined composed 82 percent of total open-market sales in 1953. Building lime was 14 percent and agricultural 4 percent of the total.

On the basis of total output (open-market plus captive) the chemical, industrial, and refractory lime reached 85 percent of gross production, building lime 12 percent, and agricultural 3. Lime was produced in 34 States and 2 Territories.

As in previous years, Ohio, Pennsylvania, and Missouri were the leading producers. Their combined output was 57 percent of the total in 1953. Illinois, Virginia, Texas, Alabama, and California were next in order. They supplied 23 percent of the total. It appears, therefore, that about four-fifths of the United States output originates in these eight States.

TABLE 2.—Lime (quick, hydrated, and dead-burned dolomite) sold or used by producers in the United States, 1952–53, by States

State or Territory	1952			1953		
	Active plants	Short tons	Value	Active plants	Short tons	Value
Alabama	7	424,028	$4,458,604	8	470,541	$5,018,156
Arizona	4	53,019	757,390	5	96,408	1,238,204
Arkansas	1	(1)	(1)	2	(1)	(1)
California	6	238,957	3,752,738	6	301,422	4,653,303
Connecticut	1	(1)	(1)	1	(1)	(1)
Florida	2	(1)	(1)	2	(1)	(1)
Georgia	1	7,854	87,587	1	9,345	95,484
Hawaii	1	8,894	240,786	1	7,431	223,575
Illinois	6	460,775	5,917,038	6	519,992	6,986,560
Indiana	1	(1)	(1)	1	(1)	(1)
Iowa	1	(1)	(1)	2	(1)	(1)
Louisiana				1	(1)	(1)
Maine	1	(1)	(1)	1	(1)	(1)
Maryland	7	72,885	746,893	6	71,705	707,736
Massachusetts	3	132,135	1,999,545	3	135,383	2,156,205
Michigan	3	(1)	(1)	3	(1)	(1)
Minnesota	1	(1)	(1)	1	(1)	(1)
Missouri	7	1,130,970	11,326,941	7	1,212,107	12,084,130
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	2,205,432	28,393,260	18	2,945,800	35,310,353
Oklahoma	1	(1)	(1)	1	(1)	(1)
Oregon	2	(1)	(1)			
Pennsylvania	28	1,202,981	13,842,213	24	1,335,300	16,010,114
Puerto Rico	3	8,575	195,000	2	7,338	157,467
South Dakota	1	(1)	(1)	1	(1)	(1)
Tennessee	3	100,189	1,005,235	3	114,474	1,177,461
Texas	9	281,604	2,622,975	10	475,569	4,380,831
Utah	3	(1)	(1)	2	(1)	(1)
Vermont	3	(1)	(1)	2	(1)	(1)
Virginia	12	442,845	4,448,924	12	477,384	4,947,418
Washington	2	(1)	(1)	2	(1)	(1)
West Virginia	5	(1)	(1)	5	(1)	(1)
Wisconsin	7	107,813	1,368,556	7	123,997	1,566,085
Undistributed		1,194,122	14,067,536		1,369,987	15,444,978
Total	160	8,073,078	95,231,221	156	9,674,183	112,158,060

1 Figures that may not be shown separately are combined as "Undistributed" to avoid disclosure of individual company operations.

Size of Plants.—No significant change in distribution of production by size of plant was noted in 1953. The importance of the larger plants is indicated in table 4, where it is shown that 66 percent of the total lime produced in the United States in 1953 was obtained from plants producing 100,000 tons and more per year—6 percent greater than in 1952.

Hydrated Lime.—When water is added to quicklime, which has the chemical composition CaO or CaO·MgO, it combines with it to form hydrated lime, $Ca(OH)_2$ or $Ca{\cdot}Mg{\cdot}(OH)_2$. The hydrated form is preferred for some applications; also it has some advantages in handling and transportation. Substantial quantities of lime are hydrated before shipment. Production by States is indicated in table 5.

TABLE 3.—Lime sold or used by producers in the United States,[1] 1952–53, by types and major uses

	1952				1953				Change from 1952, percent
	Sold	Used [2]	Total	Percent of total	Sold	Used	Total	Percent of total	
By type:									
Quicklime	(3)	(3)	6,190,254	77	6,242,759	1,389,324	7,632,083	79	+23
Hydrated lime	(3)	(3)	1,882,824	23	1,871,637	170,463	2,042,100	21	+8
Total lime	7,587,443	485,635	8,073,078	100	8,114,396	1,559,787	9,674,183	100	+20
By use:									
Agricultural:									
Quicklime	163,138		163,138	2	123,087		123,087	1	−25
Hydrated lime	229,245		229,245	3	206,368		206,368	2	−10
Total	392,383		392,383	5	329,455		329,455	3	−16
Building:									
Quicklime	(3)	(3)	216,351	3	150,315	52,399	202,714	2	−6
Hydrated lime	(3)	(3)	974,912	12	948,453	15,073	963,526	10	−1
Total	(3)	(3)	1,191,263	15	1,098,768	67,472	1,166,240	12	−2
Chemical and other industrial:									
Quicklime	(3)	(3)	3,882,740	48	3,706,606	1,304,861	5,011,467	52	+29
Hydrated lime	(3)	(3)	678,667	8	716,816	155,390	872,206	9	+29
Total	(3)	(3)	4,561,407	56	4,423,422	1,460,251	5,883,673	61	+29
Refractory (dead-burned dolomite)	(3)	(3)	1,928,025	24	2,262,751	32,064	2,294,815	24	+19

[1] Includes Hawaii and Puerto Rico.
[2] 1952–53 captive tonnage figures are not comparable because the coverage for 1952 was incomplete.
[3] Figures that may not be shown separately are combined in "total" column.

TABLE 4.—Distribution of lime (including refractory) plants, 1951–53, according to size of production

Size group (short tons)	1951 [1]			1952 [1]			1953 [2]		
	Plants	Production		Plants	Production		Plants	Production	
		Short tons	Percent of total		Short tons	Percent of total		Short tons	Percent of total
Less than 1,000	11	4,483	(3)	12	4,982	(3)	11	6,507	(3)
1,000 to less than 5,000	23	62,869	1	26	76,517	1	17	52,010	1
5,000 to less than 10,000	13	96,617	1	17	116,896	1	21	144,837	1
10,000 to less than 25,000	30	497,545	6	26	443,834	6	23	375,001	4
25,000 to less than 50,000	28	1,054,314	13	35	1,302,652	16	33	1,190,762	12
50,000 to less than 100,000	24	1,563,026	19	19	1,248,714	16	23	1,551,233	16
100,000 and over	26	4,976,658	60	25	4,879,483	60	28	6,353,833	66
Total	155	8,255,512	100	160	8,073,078	100	156	9,674,183	100

[1] Includes captive tonnage in part.
[2] Includes captive tonnage.
[3] Less than 1 percent.

TABLE 5.—Hydrated lime sold or used by producers in the United States, 1952–53, by States, in short tons

State or Territory	1952 [1]				1953			
	Active plants	Open-market	Captive	Total	Active plants	Open-market	Captive	Total
Alabama	5	62,480		62,480	5	57,538		57,538
California	5	(2)	(2)	33,289	5	33,738		33,738
Georgia	1	(2)	(2)	6,718	1	6,940	2,405	9,345
Hawaii	1	8,858		8,858	1	7,388		7,388
Illinois	4	54,226		54,226	4	59,995		59,995
Maryland	4	18,818		18,818	3	18,376		18,376
Massachusetts	3	(2)	(2)	53,375	3	(2)	(2)	56,617
Missouri	5	181,398		181,398	6	205,714		205,714
Ohio	14	(2)	(2)	670,702	14	(2)	(2)	655,398
Pennsylvania	14	(2)	(2)	332,009	14	324,306		324,306
Tennessee	3	19,726		19,726	3	22,900		22,900
Texas	6	(2)	(2)	71,700	7	69,481	150,088	219,569
Virginia	10	73,119		73,119	10	56,458		56,458
Other States [3]	32	(2)	(2)	296,406	32	307,471	7,287	314,758
Undistributed		1,439,165	25,034			701,332	10,683	
Total	107	1,857,790	25,034	1,882,824	108	1,871,637	170,463	2,042,100

[1] Includes captive tonnage in part.
[2] Figures that may not be shown separately are combined as "Undistributed" to avoid disclosure of individual company operations.
[3] Includes the following States and number of plants in 1953 (1952 same as 1953 unless shown differently in parentheses): Arizona 3, Arkansas 1, Connecticut 1, Florida 1, Indiana 1, 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 (2), Vermont 1, Washington 1, West Virginia 4 (3), and Wisconsin 5.

CONSUMPTION AND USES

Geographic data on sales of lime by uses presented in table 6 are given, as in 1952, on a district rather than on a State basis in order that more complete information may be made available than was possible during earlier years.

Table 7 shows the quantity of lime applied to the major uses, as well as considerable detail on the chemical and industrial applications during 1952–53. For the first time a clear-cut division has been made between open-market and captive tonnage. The 2 years are comparable with respect to the open-market product, but the captive-tonnage items are not comparable because of incomplete coverage of the captive-tonnage plants in 1952.

Open-market sales in 1953 were 7 percent greater than in 1952. Of the open-market items that are comparable, substantial gains were registered in 1953 for sales to calcium carbide plants, for coke and gas purification, and explosive and insecticide uses. Smaller gains were made in sales to glassmakers, tanneries, as a flux in metallurgical plants, and for making precipitated calcium carbonate. Declines in sales were recorded for food products, ore concentration, petroleum and salt refining, and rubber manufacture.

Sales of lime for agricultural use declined 16 percent while lime used in the building trades declined 2 percent. Both tonnage and value of lime sold or used in 1952–53 according to major uses are indicated in table 8.

TABLE 6.—Lime (quick and hydrated and dead-burned dolomite) sold or used by producers in the United States in 1953, 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, Vermont	13,147	$161,733	54,298	$816,477	130,818	$2,058,867	330	$4,257	198,593	$3,041,334
Districts 2 and 3: Maryland, New Jersey, New York, Pennsylvania, and West Virginia	210,888	2,261,613	144,837	1,930,994	1,070,897	12,209,492	376,591	5,135,099	1,803,213	21,537,198
District 4: Virginia	19,215	243,030	10,819	117,477	447,350	4,586,911			477,384	4,947,418
District 5: Ohio	52,376	618,108	556,537	8,328,900	922,655	7,350,473	1,414,232	19,012,872	2,945,800	35,310,353
District 7: Illinois, Indiana, and that portion of Missouri east of the 93d meridian			(2)	(2)	1,175,530	11,937,235	(2)	(2)	1,627,434	18,005,078
Districts 6, 8, and 9: Iowa, Michigan, Minnesota, South Dakota, and Wisconsin	(2)	(2)	(2)	(2)	295,183	3,241,741			345,755	3,709,108
Districts 10-11: Alabama, Florida, Georgia, and Tennessee	(2)	(2)	95,669	1,033,156	516,518	5,476,102	(2)	(2)	628,435	6,719,605
District 12: Arkansas, Oklahoma, Louisiana, and that portion of Missouri west of the 93d meridian	(2)	(2)	(2)	(2)	450,382	3,961,181			532,375	4,802,191
District 13: Texas	350	3,512	38,086	437,864	437,133	3,939,455			475,569	4,380,831
Districts 14 and 15: Arizona, California, Montana, Nevada, Oregon, Washington, and Utah	(2)	(2)	109,634	2,061,190	427,996	5,746,774	(2)	(2)	624,856	9,323,902
Noncontiguous Territories:										
Hawaii			(2)	(2)	(2)	(2)			7,431	223,575
Puerto Rico	(2)	(2)	(2)	(2)	(2)	(2)			7,338	157,467
Undistributed [2]	33,479	138,372	156,360	1,786,662	9,211	255,357	503,662	7,303,156		
Total	329,455	3,426,368	1,166,240	16,512,720	5,883,673	60,763,588	2,294,815	31,455,384	9,674,183	112,158,060

[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 1952–53, by uses, in short tons

Use	1952			1953		
	Open-market	Captive [1]	Total	Open-market	Captive [1]	Total
Agriculture	392, 383	----------	392, 383	329, 455	----------	329, 455
Building:						
Finishing lime	597, 065	----------	597, 065	522, 027	5, 506	527, 533
Mason's lime	469, 507	----------	469, 507	466, 704	4, 366	471, 070
Other (including masonry mortars)	54, 490	70, 201	124, 691	110, 037	57, 600	167, 637
Total	1, 121, 062	70, 201	1, 191, 263	1, 098, 768	67, 472	1, 166, 240
Chemical and other industrial:						
Alkalies (ammonium, potassium and sodium compounds)	(2)	----------	(2)	4, 738	906, 516	911, 254
Asphalts and other bitumens	(2)	----------	(2)	(2)	----------	(2)
Bleach, liquid and powder [3]	4, 440	----------	4, 440	4, 803	----------	4, 803
Brick, sand-lime and slag	(2)	(2)	20, 575	(2)	(2)	17, 038
Brick, silica (refractory)	17, 616	----------	17, 616	19, 704	----------	19, 704
Calcium carbide and cyanamide	558, 370	----------	558, 370	607, 196	----------	607, 196
Calcium carbonate (precipitated)	20, 222	----------	20, 222	21, 005	----------	21, 005
Coke and gas (gas purification and plant byproducts)	29, 060	----------	29, 060	35, 900	----------	35, 900
Explosives	9, 569	----------	9, 569	20, 880	----------	20, 880
Food and food byproducts	29, 734	----------	29, 734	26, 288	----------	26, 288
Glassworks	237, 172	----------	237, 172	245, 274	----------	245, 274
Glue	7, 844	----------	7, 844	14, 696	----------	14, 696
Grease, lubricating	5, 187	----------	5, 187	6, 943	----------	6, 943
Insecticides, fungicides, and disinfectants	70, 347	----------	70, 347	88, 965	----------	88, 965
Medicines and drugs	(2)	----------	(2)	(2)	----------	(2)
Metallurgy:						
Nonferrous smelter flux	1, 378	----------	1, 378	(2)	(2)	51, 860
Steel (open-hearth and electric furnace flux)	1, 076, 495	146, 048	1, 222, 543	1, 132, 230	150, 564	1, 282, 794
Ore concentration [4]	191, 586	113, 723	305, 309	150, 270	152, 211	302, 481
Wire drawing	24, 598	----------	24, 598	32, 975	----------	32, 975
Other [5]	10, 399	----------	10, 399	(2)	(2)	13, 185
Oil drilling	(2)	----------	(2)	14, 260	----------	14, 260
Paints	(2)	(2)	25, 926	(2)	(2)	29, 118
Paper mills	683, 628	----------	683, 628	(2)	(2)	768, 961
Petrochemicals (glycol)	(2)	----------	(2)	(2)	----------	(2)
Petroleum refining	40, 621	----------	40, 621	39, 995	----------	39, 995
Rubber manufacture	2, 028	----------	2, 028	1, 631	----------	1, 631
Salt refining	9, 677	----------	9, 677	9, 200	----------	9, 200
Sewage and trade-wastes treatment	(2)	(2)	89, 338	93, 677	787	94, 464
Soap and fat	815	----------	815	(2)	----------	(2)
Sugar refining	(2)	(2)	35, 492	(2)	(2)	26, 930
Tanneries	64, 991	----------	64, 991	71, 052	----------	71, 052
Varnish	(2)	----------	(2)	(2)	----------	(2)
Water purification	(2)	(2)	601, 592	618, 636	19, 021	637, 657
Wood distillation	14, 206	----------	14, 206	2, 170	----------	2, 170
Undistributed [6]	802, 598	114, 324	143, 999	952, 688	231, 152	276, 748
Unspecified	274, 731	----------	274, 731	208, 246	----------	208, 246
Total	4, 187, 312	374, 095	4, 561, 407	4, 423, 422	1, 460, 251	5, 883, 673
Refractory lime (dead-burned dolomite)	1, 886, 686	41, 339	1, 928, 025	2, 262, 751	32. 064	2, 294, 815
Grand total lime	7, 587, 443	485, 635	8, 073, 078	8, 114, 396	1, 559, 787	9, 674, 183
Hydrated lime included in above distribution	1, 857, 790	25, 034	1, 882, 824	1, 871, 637	170, 463	2, 042, 100

[1] The 1952–53 captive tonnage figures are not comparable because the coverage for 1952 was incomplete.
[2] Included with "Undistributed" and "Total" columns to avoid disclosure of individual company operations.
[3] Bleach used in paper mills excluded from "Bleach" and included with "Paper mills."
[4] Includes flotation, cyanidation, bauxite purification, and magnesium manufacture.
[5] Includes barium and vanadium processing, cupola, gold recovery, and unspecified metallurgical uses.
[6] Includes alcohol, alkalies, asphalt, brick (sand-lime and slag), medicine and drugs, magnesium products, oil drilling, paints, paper mills, petrochemicals (glycol), polishing compounds, retarder, soap and fat, sugar, sulfur, tobacco, varnish, and miscellaneous industrial uses.

TABLE 8.—Lime (quick, hydrated, and dead-burned dolomite) sold or used by producers in the United States,[1] 1952–53, by major uses

Use	1952			1953		
	Short tons	Value [2]		Short tons	Value [2]	
		Total	Average		Total	Average
Agricultural	392,383	$3,816,603	$9.73	329,455	$3,426,368	$10.40
Building:						
Finishing lime	597,065	8,643,902	14.48	527,533	8,067,677	15.29
Mason's lime	469,507	6,236,377	13.28	471,070	6,349,110	13.48
Other (including masonry mortars)	124,691	1,351,882	10.84	167,637	2,095,933	12.50
Total building	1,191,263	16,232,161	13.63	1,166,240	16,512,720	14.16
Chemical and industrial uses	4,561,407	49,084,002	10.76	5,883,673	60,763,588	10.33
Refractory (dead-burned dolomite)	1,928,025	26,098,455	13.54	2,294,815	31,455,384	13.71
Grand total lime	8,073,078	95,231,221	11.80	9,674,183	112,158,060	11.59

[1] Includes Hawaii and Puerto Rico.
[2] Selling value, f. o. b. plant, excluding cost of container.

The sales distribution of hydrated lime by uses is indicated in table 9.

TABLE 9.—Hydrated lime sold or used by producers, in the United States, 1952–53, by uses, in short tons

Use	1952			1953		
	Open market	Captive[1]	Total	Open market	Captive[1]	Total
Agricultural	229,245	----------	229,245	206,368	----------	206,368
Building	955,068	19,844	974,912	948,453	15,073	963,526
Chemical and Industrial:						
Bleach, liquid and powder	2,428	----------	2,428	2,358	----------	2,358
Brick, sand-lime and slag	(2)	(2)	7,628	(2)	(2)	7,122
Brick, silica	14,477	----------	14,477	16,713	----------	16,713
Coke and gas	691	----------	691	1,149	----------	1,149
Food products	15,721	----------	15,721	14,766	----------	14,766
Insecticides, fungicides, and disinfectants	60,017	----------	60,017	74,774	----------	74,774
Metallurgy	(2)	(2)	25,452	29,453	----------	29,453
Paints	(2)	(2)	16,494	(2)	(2)	14,790
Paper mills	38,988	----------	38,988	43,013	----------	43,013
Petroleum	26,332	----------	26,332	23,372	----------	23,372
Sewage and trade-waste treatment	(2)	(2)	49,632	46,348	----------	46,348
Sugar refining	26,132	----------	26,132	21,528	----------	21,528
Tanneries	34,192	----------	34,192	39,858	----------	39,858
Water purification	(2)	(2)	237,438	233,448	----------	233,448
Undistributed [3]	375,284	5,190	43,830	85,710	155,390	219,188
Unspecified	79,215	----------	79,215	84,326	----------	84,326
Total	673,477	5,190	678,667	716,816	155,390	872,206
Grand total, hydrated lime	1,857,790	25,034	1,882,824	1,871,637	170,463	2,042,100

[1] The 1952–53 captive tonnage figures are not comparable because the coverage for 1952 was incomplete.
[2] Included with "Undistributed" and "Total" columns to avoid disclosure of individual company operations.
[3] Includes cement products, glass, glue, grease (lubricating), medicines and drugs, oil-well drilling, rubber, wood distillation, and miscellaneous industrial uses.

To furnish a more comprehensive picture of the various materials used in liming land, table 10 shows, in addition to agricultural lime, the quantities of oystershells, limestone, and calcareous marl that are applied to soil improvement.

TABLE 10.—Agricultural lime and other liming materials sold or used by producers in the United States, 1952–53, by kinds

Kind	1952				1953			
	Short tons		Value		Short tons		Value	
	Gross weight	Effective lime content [1]	Total	Average	Gross weight	Effective lime content [1]	Total	Average
Lime:								
Quicklime	163, 138	138, 660	$1, 333, 784	$8. 18	123, 087	104, 620	$3,426,368 (Quicklime and hydrated lime)	$10. 40 (Quicklime and hydrated lime)
Hydrated lime	229. 245	160, 470	2, 482. 819	10. 83	206. 368	144, 460		
Oystershells (crushed) [2]	72, 917	34, 270	419, 306	5. 75	85, 371	40, 120	358. 330	4. 20
Limestone	[3] 21, 152, 208	[3] 9, 941, 540	[3] 34, 463, 963	1. 63	18, 452, 513	8, 672, 680	30, 133. 864	1. 63
Calcareous marl	260, 213	109, 280	187, 148	. 72	277, 354	116, 490	173, 347	. 63
Total	----------	[3] 10, 384, 220	[3] 38, 887, 020	------	----------	9, 078, 370	34, 091, 909	------

[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 lime is produced in a relatively small number of large plants, interstate shipments are important. Furthermore, limes vary so much from plant to plant in physical and chemical properties that the specialized needs of consuming industries commonly demand shipments from distant points. Accordingly, as table 11 indicates, large quantities enter interstate trade. The principal States that exported lime beyond their borders in 1953 were Ohio, Missouri, Pennsylvania, and Virginia.

Data on origin and destination of lime shipments, by States and groups of States, in 1953 are given in table 12.

TABLE 11.—Apparent consumption of lime sold or used in continental United States in 1953, by States, in short tons

State	Sales by producers	Shipments from States [1]	Shipments into States	Apparent consumption		Total
				Quicklime	Hydrated lime	
Alabama	470, 541	188, 512	14, 392	283, 626	12, 795	296, 421
Arizona	96, 408	7, 104	8, 050	90, 161	7, 193	97, 354
Arkansas	(2)	(2)	(2)	53, 980	17, 089	71, 069
California	301, 422	43, 466	91, 856	265, 939	83, 873	349, 812
Colorado			26, 808	20, 332	6, 476	26, 808
Connecticut	(2)	(2)	(2)	28, 770	25, 836	54, 606
Delaware			68, 681	50, 722	17, 959	68, 681
District of Columbia			11, 987	230	11, 757	11, 987
Florida	(2)		(2)	83, 939	55, 781	139, 720
Georgia	9, 345	3, 142	78, 434	58, 258	26, 379	84, 637
Idaho			4, 347	1, 869	2, 478	4, 347
Illinois	519, 992	260, 576	384, 060	489, 002	154, 474	643, 476
Indiana	(2)	(2)	(2)	386, 069	44, 303	430, 372
Iowa	(2)	(2)	(2)	114, 200	18, 202	132, 402
Kansas			53, 085	36, 211	16, 874	53, 085
Kentucky			375, 942	350, 208	25, 734	375, 942
Louisiana	237, 553		129, 068	314, 709	51, 912	366, 621
Maine	(2)		(2)	57, 646	4, 380	62, 026
Maryland	71, 705	15, 405	133, 938	143, 838	46, 400	190, 238
Massachusetts	135, 383	86, 342	50, 652	42, 365	57, 328	99, 693
Michigan	(2)	(2)	(2)	272, 917	66, 492	339, 409
Minnesota	(2)	(2)	(2)	83, 828	18, 957	102, 785
Mississippi			44, 991	38, 932	6, 059	44, 991
Missouri	1, 212, 107	1, 059, 620	20, 245	118, 584	54, 148	172, 732
Montana	(2)	(2)	(2)	32, 226	4, 522	36, 748
Nebraska			12, 869	2, 504	10, 365	12, 869
Nevada	(2)	(2)	(2)	33, 092	3, 193	36, 285
New Hampshire			10, 023	3, 501	6, 522	10, 023
New Jersey	(2)	(2)	(2)	65, 023	115, 107	180, 130
New Mexico			5, 761	962	4, 799	5, 761
New York	(2)	(2)	(2)	349, 120	149, 138	498, 258
North Carolina			85, 677	54, 209	31, 468	85, 677
North Dakota			7, 282	3, 688	3, 594	7, 282
Ohio	2, 945, 800	1, 697, 141	290, 955	1, 372, 826	166, 788	1, 539, 614
Oklahoma	(2)	(2)	(2)	24, 878	10, 803	35, 681
Oregon			(2)	43, 997	8, 919	52, 916
Pennsylvania	1, 335, 300	527, 657	705, 644	1, 265, 495	247, 792	1, 513, 287
Rhode Island			16, 454	8, 327	8, 127	16, 454
South Carolina			21, 538	11, 031	10, 507	21, 538
South Dakota	(2)		(2)	4, 257	1, 844	6, 101
Tennessee	114, 474	89, 418	32, 890	24, 507	33, 439	57, 946
Texas	475, 569	52, 193	43, 065	258, 342	208, 099	466, 441
Utah	(2)	(2)	(2)	77, 004	7, 289	84, 293
Vermont	(2)	(2)	(2)	243	2, 010	2, 253
Virginia	477, 384	379, 861	56, 661	112, 141	42, 043	154, 184
Washington	(2)	(2)	(2)	39, 761	13, 236	52, 997
West Virginia	(2)	(2)	(2)	246, 147	31, 477	277, 624
Wisconsin	123, 997	68, 637	94, 642	109, 256	40, 746	150, 002
Wyoming			2, 752	482	2, 270	2, 752
Undistributed	1, 132, 434	596, 624	2, 059, 865			
Total	9, 659, 414	5, 075, 698	4, 942, 614	7, 529, 354	1, 996, 976	9, 526, 330

[1] Includes 147,853 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 1953, 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	2,024,311	344,823	2,369,134	106,183	7,730	113,913	210		210	50,465	5,455	55,920	3,677	2,705	6,382
Delaware, District of Columbia, Maryland, New Jersey, New York, Pennsylvania, West Virginia	613,728	177,357	791,085	1,188,474	386,561	1,575,035	33,364	20,524	53,888	226,568	19,510	246,078	6,575	1,000	7,575
Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont	2,645	33,759	36,404	61,459	6,483	67,942	74,278	63,473	137,751	1,433	200	1,633	882		882
Florida, Georgia, North Carolina, South Carolina, Virginia	10,589	77,007	87,596	12,640	8,465	21,105	32,355	9,880	42,235	123,030	35,533	158,563	136,962	33,642	170,604
Alabama, Kentucky, Louisiana, Mississippi, Tennessee	67,355	36,566	103,921	2,291	30	2,321				9,495	4,158	13,653	593,892	34,415	628,307
Arkansas, Kansas, Nebraska, Oklahoma, Texas	18,091	9,412	27,503	30	90	120					222	222	141		141
Iowa, Minnesota, Missouri, Wisconsin	65,361	46,518	111,879							20		20			
Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Utah, Washington, Wyoming	22,554	3,819	26,373							9,872	25	9,897		175	175

Destination	Origin											
	Arkansas, Oklahoma, Texas, Kansas, Nebraska			Iowa, Minnesota, Missouri, Wisconsin			Arizona, California, Colorado, Montana, Nevada, Oregon, South Dakota, Utah, Washington			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	886	5	891	335,082	71,339	406,421				2,520,814	432,057	2,952,871
Delaware, District of Columbia, Maryland, New Jersey, New York, Pennsylvania, West Virginia		2	2	51,866	14,676	66,542				2,120,575	619,630	2,740,205
Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont				155	288	443				140,852	104,203	245,055
Florida, Georgia, North Carolina, South Carolina, Virginia	1,544	800	2,344	2,458	851	3,309				319,578	166,178	485,756
Alabama, Kentucky, Louisiana, Mississippi, Tennessee	54,124	35,490	89,614	284,825	19,280	304,105				1,011,982	129,939	1,141,921
Arkansas, Kansas, Nebraska, Oklahoma, Texas	298,464	217,879	516,343	59,126	35,627	94,753	63		63	375,915	263,230	639,145
Iowa, Minnesota, Missouri, Wisconsin	2,300	90	2,390	358,187	85,445	443,632				425,868	132,053	557,921
Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Utah, Washington, Wyoming	6,749	8,335	15,084	64,044	24,498	88,542	510,551	112,834	623,385	613,770	149,686	763,456

PRICES

The average selling price of lime f. o. b. plant in 1953 was $11.59 compared with $11.80 in 1952. The trend in prices over a period of years is indicated in figure 3.

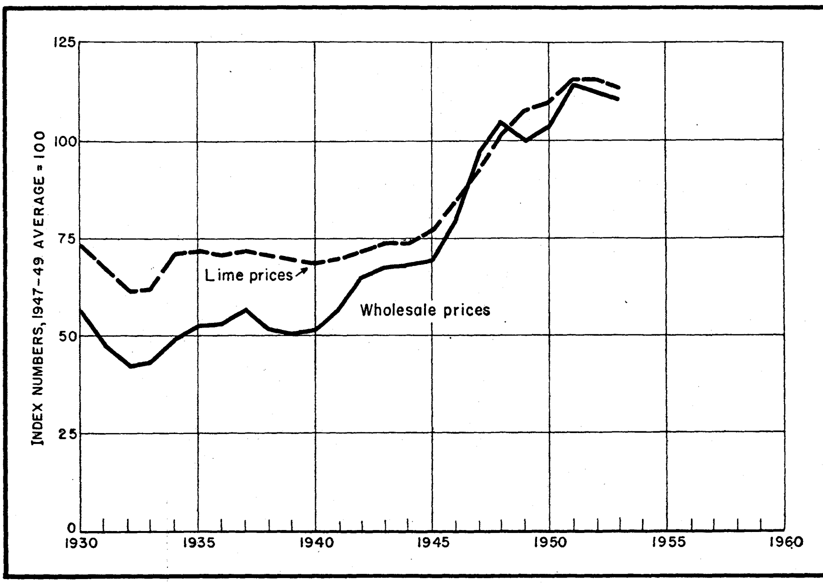

FIGURE 3.—Average price of lime per ton compared with wholesale prices of all commodities, 1930–53. Units are reduced to percentages of the 1947–49 average. Wholesale prices from U. S. Department of Labor.

FOREIGN TRADE [3]

Imports.—Imports of lime into the United States are relatively small, although, as indicated in tables 13 and 14, they were somewhat

TABLE 13.—Lime imported for consumption in the United States, 1944–48 (average) and 1949–53

[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
1944–48 (average)	1,286	$18,221	23,593	$248,224	504	$18,901	25,383	$285,346
1949	1,674	35,129	30,807	545,792	1,851	72,680	34,332	653,601
1950	1,253	23,910	30,904	524,132	2,127	86,425	34,284	634,467
1951	1,131	22,704	29,849	554,362	3,045	128,207	34,025	705,273
1952	109	2,940	21,557	377,926	2,342	123,596	24,008	504,462
1953	2,177	30,944	31,149	506,704	3,876	259,427	37,202	797,075

[1] "Dead-burned basic refractory material consisting chiefly of magnesia and lime."
[2] Includes weight of immediate container.

[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.

larger in 1953 than during other recent years. They originate chiefly in Canada to supply local needs in border areas, particularly in Washington State and the Niagara district.

TABLE 14.—Lime imported for consumption in the United States, 1951–53, by country and customs district [1]

[U. S. Depart ent of Commerce]

Country of origin	Customs district of entry	1951		1952		1953	
		Short tons [2]	Value	Short tons [2]	Value	Short tons [2]	Value
Canada	Buffalo	8,946	$89,530	5,857	$61,046	11,875	$185,195
	Dakota			(3)	5		
	Maine and New Hampshire	1	32			101	1,040
	Michigan	2	35				
	St. Lawrence			1	20		
	Vermont					2,853	37,130
	Washington	22,031	487,469	15,762	318,481	18,496	364,253
Mexico	Arizona			44	600		
United Kingdom	Massachusetts					1	30
	New Orleans			2	713		
	New York			(3)	1		
Total		30,980	577,066	21,666	380,866	33,326	537,648

[1] Exclusive of dead-burned basic refractory material.
[2] Includes weight of immediate container.
[3] Less than 1 ton.

Exports.—Exports are relatively small (tables 15 and 16). About half of the exports are consigned to Canada, and most of the remainder to Central and South America, chiefly Costa Rica, Honduras, and Panama.

TABLE 15.—Lime exported from the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Year	Short tons	Value	Year	Short tons	Value
1944–48 (average)	38,875	$497,665	1951	63,295	$1,157,652
1949	59,927	937,444	1952	64,952	1,156,991
1950	50,491	825,927	1953	79,934	1,422,238

TECHNOLOGY

Calcination.—A succession of carefully controlled calcination tests on limestone has developed more precise data on lime burning than has been available heretofore. The results of the tests and their interpretation have appeared in a series of articles published during 1953.[4] The first series of tests was to determine the temperature of calcination in relation to time, using samples of equal size and surface area. For these tests 1¼-inch cubes of limestone were used. It is pointed out that a high rate of calcination may be attained using temperatures as high as 2,300° or 2,400° F., but a poor lime results;

[4] Azbe, Victor J., Theory and Practice of Lime Calcination; Part I: Rock Products, vol. 56, No. 2, February 1953, pp. 100–103; Part II, No. 3, March, pp. 102–104; Part III, No. 4, April, pp. 138–139, 170; Part IV; No. 5, May, pp. 84–87; Part V, No. 7, July, pp. 80–86, 90; Part VI, No. 9, September, pp. 100–104, 134–135; Part VII, No. 12, December, pp. 111–114, 146–148.

TABLE 16.—Lime exported from the United States, 1951–53, by country of destination

[U. S. Department of Commerce]

Destination	1951 Short tons	1951 Value	1952 Short tons	1952 Value	1953 Short tons	1953 Value
Bahamas	10	$370	49	$1,505	92	$3,145
Canada	16,757	248,072	23,771	322,562	37,976	546,226
Canal Zone	138	4,105	174	3,864	12	2,326
Chile	8	546	5	405		
Colombia	4,022	85,902	5,430	107,876	4,410	97,778
Costa Rica	15,494	289,472	13,363	268,270	12,242	236,269
Cuba	72	2,241	8	170	15	541
Dominican Republic	649	12,539	124	2,389		
El Salvador	100	4,456	106	4,051	100	2,909
Haiti	600	12,961	(1)	220	47	1,700
Honduras	14,317	251,822	9,738	176,338	14,212	244,839
Japan	25	1,307	57	3,720	25	1,250
Leeward and Windward Islands			50	2,083		
Liberia	15	450	3	290	52	1,843
Mexico	2,474	62,368	2,540	64,524	3,110	84,218
Netherlands Antilles	85	1,621	55	1,286	33	631
Nicaragua	281	5,715	350	7,374	555	12,793
Panama	6,545	125,776	6,792	138,715	6,155	152,319
Philippines	170	3,983	60	1,510	90	5,101
Saudi Arabia	119	1,782	1,352	25,767	114	4,422
Venezuela	1,310	35,619	843	18,581	594	21,057
Other countries	104	6,545	82	5,491	100	2,871
Total	63,295	1,157,652	64,952	1,156,991	79,934	1,422,238

[1] Less than 1 ton.

better lime is obtained by using lower temperatures over a longer time. However, the time can be shortened by increasing surface exposure and improving heat transmittance. The series deals with such subjects as effect of stone sizes on preheating, calcining, and overheating; rates of heat absorption, using limestone particles of various shapes and sizes; factors governing time of calcination; the use of separate kilns for large and small stone; and problems of heat transfer and temperature control. The series of articles was to be continued in 1954.

Recent German research on limestone calcination has been reviewed. Such research, conducted with great precision on raw material of high purity, has brought out more clearly than heretofore the relation of time and temperature of calcination to the specific weight of the lime obtained. Calcination at a low temperature (800° C.) gives a loosely packed reactive lime of low specific weight. With calcination at successively higher temperatures there is evidence of increasing particle size, closer packing, higher specific weight, and lower reactivity. The method of test and the results are described in detail.[5]

The National Lime Association has for many years sponsored fundamental research on lime at Massachusetts Institute of Technology. One project was designed primarily to determine why different limestones yield different results when calcined under the same conditions. Many tests have been made, but no conclusive results have yet been attained. Much information has, however, been assembled on the quality of lime in relation to physical and chemical

[5] Azbe, Victor J., Calcination and Hydration Research: Rock Products, vol. 57, No. 2, February 1954, pp. 118–120.

properties of the stone, and calcining conditions. Progress on this problem during the past year has been described.[6]

Passage of Solids and Gases Through Kilns.—A small-model cylinder made of heavy wire screen is a useful tool for studying the passage of solid particles through a rotary kiln. Such a tool has been used by one lime company in elaborating a formula worked out by the Bureau of Mines in 1927 for determining the rate of flow of solid particles through a kiln. The Bureau of Mines found that the rate of travel of the charge through the kiln varied directly with the slope and the diameter and also with the square root of the angle of repose of the material being processed. The model kiln was used to obtain data which simplified the formula. The formula was used to determine the rate of advance of the charge per revolution of the kiln. Such information is of practical use in calculating the depth of charge in the kiln.

Further tests with the model kiln brought out the interesting facts that, under normal conditions, the travel of the charge per revolution is not affected by the size of feed, depth of the bed, or the speed of rotation or length of the kiln. Even a narrow dam or ring which is lower than the load surface has no retarding effect on the flow. The effect of constrictions of various heights and in different zones is discussed in a description of these tests.[7]

Research has also been conducted on gas-flow problems of both shaft and rotary kilns. In gas-fired shaft kilns the main objectives are to obtain maximum gas penetration and distribution into the kiln charge, and so to regulate the air stream that effective ignition will be attained. Producer gas, having a relatively low B. t. u. content is supplied in large volume and low pressure,whereas natural gas with high B. t. u. content is supplied in lower volume and at higher pressure. The air supply also varies—less air and lower velocity are needed for producer-gas than for natural-gas kilns. In rotary kilns gas flows are larger and velocities lower than in shaft kilns. Rotary kilns operate under varied fuel-input conditions, therefore the pattern of air flow to the burner nozzle and flame varies considerably. The position of the burner, the shape of the hood, the air velocity, and the "tension" or "compression" of the air (induced- or forced-draft conditions) are factors that affect flame steadiness, flame length, and temperature distribution. It has been found that the hot gases in the rotary kiln tend to flow along the top section away from the bed of material to be calcined. Equipment has been designed to create a spinning or spiral gas flow that will bring the hot gases into closer contact with the kiln charge. The desirability of substituting spiral, long-path, high-velocity gas movement for sluggish, stratified, short-path flow is stressed. Further detail is presented in recent articles.[8]

Hydration.—A lime company has devised a process for hydrating dolomitic lime that operates without the use of pressure. The hy-

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6 Rock Products, Quality Control—Theme of Lime-Operating Committee: Vol. 56, No. 11, November 1953, pp. 84–91, 126.

7 Warner, Irving, Rotary Kiln Loading: Rock Products, vol. 56, No. 5, May 1953, pp. 72-73; No. 8, August, pp. 128–129, 216; No. 11, November, pp. 79–80, 122.

8 Bauer, Wolf G., Control of Gas-Flow Patterns in Vertical and Rotary Kilns, Part I, Air Flow in Relation to Fuel Stream Flow: Pit and Quarry, vol. 45, No. 12, June 1953, pp. 104–105, 116; Part II, Gas-Flow Modifications in Rotary Equipment, vol. 46, No. 4, October, pp. 115–116.

drator is equipped with heat exchangers which accomplish hydration in about 1 hour. The overburned or otherwise slow-hydrating oxides are automatically retained for a longer period in the hydrator. The product is reported to satisfy the American Society for Testing Materials specification which calls for a maximum of 8 percent unhydrated oxide.[9]

Testing.—A photographic device known as a "Leukometer" has been developed for measuring the whiteness of lime. Reflected light is measured by a selenium cell and appropriate galvanometer and the result recorded as relative whiteness compared with a standard barytes white. The whiteness of ground lime is impaired by the presence of overburned material; and it is claimed that, by means of a Leukometer, aided by a calibration curve for the particular lime involved, the proportion of overburned material may be determined within 1 percent of its actual content.[10]

Uses.—Lime, because of its low price and wide availability, is the most widely used neutralizing agent. Research at Mellon Institute has revealed the importance of proper calcination and slaking on reactivity. Overburning and the presence of impurities both tend to reduce reactivity and impair neutralizing action. Dolomitic limes are usually more effective than high-calcium limes. More detail on results attained has been published.[11]

The National Lime Association maintains several research fellowships in addition to the one at MIT mentioned previously. One at Rutgers University relates primarily to studies of the use of lime in acid neutralization. A fellowship at Purdue University is directed toward the use of lime in chemical separation of emulsified oils from waste products at petroleum and other plants. A fellowship established at the University of Texas pertains to the application of lime in stabilizing soils for road-base and subbase construction.

Road stabilization has become an important use for lime. Recent tests indicate that substitution of quicklime for hydrated lime has advantages in lower cost and in obtaining larger quantities of CaO per ton of material purchased.[12]

Recovery and reuse of lime at paper mills are attaining greater importance. The West Virginia Pulp & Paper Co. is now operating a 350-foot rotary kiln of the most modern design to calcine lime carbonate sludge from its pulp-cooking process. The stored slurry, containing 30 percent solids, is dewatered in centrifugal filters to 38 percent moisture before it enters the kiln. Calcination is accomplished with natural gas. Only 1 to 2 percent of the lime is lost during the recovery cycle, and this is made up by adding limestone in ¼- to ⅜-inch sizes to the sludge.[13]

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[9] Rock Products, Complete Hydration of Lime without the Use of Autoclaves: Vol. 56, No. 12, December 1953, pp. 118–120.

[10] Building Science Abstracts (London), vol. 26 (N. S.), No. 11, November 1953, p. 323.

[11] Hoak, Richard D., Lime—Ubiquitous Neutralizing Agent: Rock Products, vol. 56, No. 10, October 1953, pp. 93, 126.

[12] Engineering News Record, Texas Stabilizes Roads With Quicklime: Vol. 150, No. 6, Feb. 5, 1953, pp. 38–41.

[13] Trauffer, Walter E., Virginia Paper Mill Operates Highly Instrumented New Kiln to Supply Process Lime: Pit and Quarry, vol. 45, No. 12, June 1953, pp. 101–102, 112.

WORLD PRODUCTION

Foreign statistical data on lime are too scattered and incomplete to permit compilation of a table of world production; however, statistics and other information available for some countries may be of interest.

Belgian Congo.—There were 65 limekilns operating in Belgian Congo in 1952 compared with 57 in 1951. Production reached 49,000 metric tons in 1950, 66,500 in 1951, and 83,000 in 1952. Much of it is used as building lime, but substantial quantities are employed as neutralizer in electrolytic copper and cobalt plants.[14]

Canada.—Canada is an important lime producer. Forty-two plants are scattered from the Atlantic to the Pacific coast. They have a total of approximately 150 kilns ranging from small pot types to continuous rotary kilns of large size. Production in 1953 was 1,185,000 tons valued at $13,458,000 compared with 1,176,000 tons valued at $13,613,000 in 1952.

Union of South Africa.—The first rotary lime-burning plant in the Union had reached the planning stage early in 1953. As a result of extensive geological exploration, Northern Lime Co., Ltd., has discovered a large deposit of high-grade limestone at Silverstreams about 100 miles west of Kimberley. The company plans to construct a rotary-kiln plant capable of producing over 100,000 tons of lime a year. The first stage of the project will cost about £1,200,000. Calcining equipment now in use in South Africa consist almost entirely of vertical mixed-feed kilns.[15]

Lime production in the Union totaled 419,000 short tons valued at £1,002,000 in 1951 and 464,000 short tons valued at £1,358,000 in 1952.

Other Countries.—El Salvador produced 20,000 metric tons of lime valued at US$400,000 in 1953. Production of lime in the Dominican Republic during the first half of 1953 totaled 10,500 metric tons.

According to the Philippine Bureau of Mines, production of lime in the Philippines during 1950 totaled 632,300 metric tons, 455,900 tons of which was derived from limestone and the balance from shells.

Production of lime in Costa Rica during 1953, according to a consular report, reached 3,200 metric tons.

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[14] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 5, November 1953, p. 64.
[15] Cement Lime and Gravel (London), First Rotary Lime-Burning Kiln in South Africa: Vol. 27, No. 10, April 1953, p. 431.

Lithium

By Joseph C. Arundale[1] and Annie L. Marks[2]

THE MANY important industrial applications and rapidly growing demand for lithium in its various forms have created widespread and intense interest in this element. Facilities for producing lithium minerals and compounds were again greatly expanded in 1953; domestic output doubled; and further expansions were being planned. Projects in Canada and Southern Africa were being discussed.

DOMESTIC PRODUCTION

The shortage of lithium minerals and compounds persisted through 1953, but several projects were being pushed to relieve the situation. The goal of 10 million pounds of lithium carbonate equivalent production capacity announced in 1952 by the Defense Production Administration seemed assured of achievement.

With expansion of mining and milling facilities in the Kings Mountain district of North Carolina and completion of its lithium-chemical plant at Sunbright, Va., Foote Mineral Co. more than doubled the Nation's capacity to produce lithium minerals and compounds.

TABLE 1.—Shipments of lithium ores and compounds from mines in the United States, 1935–39 (average), 1944–48 (average), and 1949–53

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	1951	12,897	[1] $896,000	956
1944–48 (average)	5,030	300,859	387	1952	15,611	[1] 1,052,000	1,088
1949	4,838	345,970	475	1953	27,240	[1] 2,134,000	1,767
1950	9,306	579,922	747				

[1] Partly estimated.

Most of the lithium expansion in 1953 was taking place in the Kings Mountain district of North Carolina. The history of lithium activities in this area was reviewed in an article.[3] There was interest in this district as a source of lithium as early as the latter part of the 1930's. In addition to early investigations of cassiterite possibilities in the area, considerable exploration was done in the 19 years before 1953. In 1942 to 1944 the Solvay Process Co. did some trenching and churn drilling and about 10,000 feet of diamond drilling. The area also was surveyed by the Federal Geological Survey.

[1] Assistant chief, Construction and Chemical Materials Branch.
[2] Statistical clerk.
[3] Goter, E. R., Hudspeth, W. R., and Rainey, D. L., Mining and Milling of Lithium Pegmatites at King Mountain, N. C.: Min. Eng., vol. 5, No. 9, September 1953, pp. 890–893.

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In 1942 a concentrating plant was constructed by Solvay Process Co. This plant started operation in 1943 and discontinued operations in February 1946 when the demand for lithium dropped. In the fall of 1954 Foote Mineral Co. purchased the Solvay properties and acquired additional properties. Renovation of the mill and preparation of the quarry for mining were begun early in 1952 and a new crushing plant was built. The company opened several new pits, did several thousand feet of trenching and detailed geologic mapping, conducted a program of diamond drilling, revised the flowsheet, and expanded the facility.

In the fall of 1953 Foote Mineral Co. began sustained production from its new lithium-chemical plant at Sunbright, Va. The spodumene, the raw material used in this plant, comes from the company mine at Kings Mountain.

Lithium Corp. of America announced liquidation of its wholly owned subsidiary, Metalloy Corp., as of July 1. All property and assets of Metalloy were distributed to Lithium Corp. of America, and all obligations of the unit have been assumed by the parent corporation.[4]

A fire destroyed the concentrating plant of the Tinton Mining Co. at Tinton, S. Dak., on November 28.[5]

CONSUMPTION AND USES

Requirements for lithium have grown rapidly in recent years as its markets have been developed. Many new and vital uses are expected to increase requirements greatly in the near future. Some lithium uses, such as in all-purpose greases, aluminum-brazing compounds, and storage batteries, have direct application in defense activities. Other applications, as in organic reductions, ceramics, air conditioning and metallurgy, are extremely important to industry. This rapid expansion, the diversity of uses, and the fact that lithium is employed in the form of several of its minerals, lithium compounds, and the metal, makes it difficult to determine the nature and extent of even short-term requirements.

It was reported that the use of lithium for atmosphere control in normalizing automobile-engine crankshafts has permitted a substantial reduction in cleaning time and costs without changing the existing furnace design. Two standard lithium vaporizers were attached to each side of a direct-fired furnace; these were small, refractory-lined gas-fired chambers. Through the middle of the chamber is a rectangular refractory tube holding a boat of lithium compound. When the chamber is heated the compound is vaporized, and the lithium vapor is picked up by the products of combustion, which enter the tube and are carried into the furnace, providing a high degree of atmosphere control. Lithium was said not only to inhibit formation of additional oxide on the castings but tended to change the character of the scale on the metal when it was put in the furnace, making it relatively soft, thin, and flaky. A 50-percent reduction in cleaning time was claimed as a result of this method.[6]

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[4] Oil, Paint and Drug Reporter, vol. 164, No. 2, July 13, 1953, p. 45.
[5] Pit and Quarry, vol. 36, No. 7, January 1954, p. 76.
[6] Iron Age, vol. 171, No. 11, Mar. 12, 1953, pp. 185, 187.

PRICES

Prices of lithium minerals were not quoted in the trade journals. Sales of spodumene concentrates were reported during the year at about $12.50 per short-ton unit (20 pounds) of contained lithia (Li_2O).

According to E&MJ Metal and Mineral Markets, lithium metal, 98 percent pure, was quoted at $11 to $14 a pound, depending on quantity.

The Oil, Paint and Drug Reporter quoted the following prices for lithium compounds in 1953 (first price quoted is at the beginning of the year; second price is at the end of the year): Lithium benzoate, drums, per pound, $1.67–$1.65; lithium bromide, N. F., barrels, works, freight equalized, per pound, $2.10, no change; lithium carbonate, technical, drums, per pound, $0.80–$0.90; lithium chloride, crystals, drums, per pound, $0.95, no change; lithium citrate, N. F., barrels, drums, kegs, per pound, $1.05–$1.60; lithium fluoride, barrels, per pound, $1.80–$2.20; lithium hydride, powder, drums, works, per pound, $12, no change; lithium hydroxide, monohydrate, drums, per pound, $0.91–$1.10; lithium salicylate, drums, per pound, $1.60, no change.

FOREIGN TRADE

Exports of lithium minerals from South-West Africa in 1952, by countries of destination, were as follows:[7]

	Short tons	*Value*
Amblygonite:		
Germany, West	368	$8,355
United Kingdom	124	2,872
United States	22	475
Lepidolite:		
United States	7,391	46,139
France	701	4,381
Petalite: United States	1,406	10,497
Total	10,012	72,719

The Office of International Trade announced that, effective June 4, lithium salts and compounds were added to the positive list of commodities requiring validated licenses for exportation from the United States.

The most significant foreign trade in lithium minerals involving the United States is imports of lepidolite and petalite from Southern Africa—the world's principal source of these minerals. Lithium minerals and compounds are not separately classified in import and export schedules, and therefore no official figures are available.

American Potash & Chemical Corp. announced its intention of offering lepidolite and petalite imported from Southern Rhodesia.[8] This will supplement the supply of lithium compounds produced by this firm from the brine of Searles Lake in California.

[7] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 3, September 1953, pp. 59–60.
[8] Glass Industry, vol. 34, No. 12, December 1953, p. 674.

TECHNOLOGY

A patent was issued on a process for preparing lithium chloride from spodumene. The process includes roasting spodumene with calcium chloride, which yields lithium chloride, recovering this lithium chloride in solution, filtering and cooling the solution to remove impurities.[9]

Lithium metal in excess of 99.5 percent purity was made in tests conducted at the Oak Ridge National Laboratory for the Atomic Energy Commission by Carbide & Carbon Chemicals Co., a division of Union Carbide & Carbon. In connection with the stable isotope program of this laboratory, measurements of physical properties of pure or nearly pure isotopes and their compounds were carried out to determine possible significant differences. For dependable values it was necessary to have high chemical purity. The apparatus in which the pure lithium metal was prepared consisted of a "pot" made of 1⅞-inch-O. D. stainless-steel tubing with 5/32-inch wall thickness, a removable cover, and a delivery tube to a "condenser" of 1½-inch stainless tube of 1/16-inch wall thickness. Heating was done with a nichrome resistance ribbon. The temperature of distillation was about 500° C. The constituents with higher vapor pressures than lithium were deposited in the condenser beyond the lithium, and those with lower vapor pressures than lithium were either deposited before it or remained with the undistilled charge.[10]

The operation of American Potash & Chemical Corp. at Trona, Calif., was described in an article.[11]

In the main plant cycle brine from Searles Lake is evaporated in triple-effect evaporators. Concentration of the brine results in precipitation of insoluble dilithium sodium phosphate as very finely divided particles. This material is withdrawn from the evaporators along with burkeite, a double salt of sodium sulfate and sodium carbonate. Burkeite with entrained dilithium-sodium phosphate is washed free of sodium carbonate and then dissolved to yield a burkeite solution containing dilithium-sodium phosphate in suspension. The dilithium-sodium phosphate is floated with light mineral oil and a fatty acid derivative. The lithium is recovered as a slurry, dewatered on filter presses, and dried. This material is treated with sulfuric acid, producing mixed sulfates of lithium and sodium plus phosphoric acid. Lithium carbonate is precipitated with sodium carbonate from a solution of these mixed sulfates. The lithium carbonate is recovered by centrifuging and dried in a steam-heated rotary drier. This process also was reviewed in detail in another article.[12]

Production methods used by Foote Mineral Co. at Kings Mountain were reviewed.[13] Equipment in this open-pit operation in 1953 included air compressors with a combined capacity of about 900 c. f. m., two 4-inch wagon drills for drilling benches, one 3-inch wagon drill used in stripping, and two jackhammers. A Northwest 25 shovel

[9] Cunningham, George L., Cincinnati, Ohio (assignor to Scientific Design Co., Inc., New York, N. Y.), Preparation of Lithium Chloride from Spodumene: U. S. Patent 2,627,452, Feb. 3, 1953.

[10] Baker, P. S., Duncan, F. R., and Greene, H. B., Preparation of High-Purity Lithium Metal by Vacuum Distillation: Science, vol. 118, No. 3078, Dec. 25, 1953, pp. 778–780.

[11] California Dept. of Natural Resources, Lithium Compounds: Mineral Information Service, Div. of Mines, vol. 6, No. 9, Sept. 1, 1953, 6 pp.

[12] Chemical Engineering, vol. 60, No. 9, September 1953, pp. 144, 146, 148, 150.

[13] Goter, E. R., Hudspeth, W. R., and Rainey, D. L., Mining and Milling of Lithium Pegmatites at Kings Mountain, N. C.: Min. Eng., vol. 5, No. 9, September 1953, pp. 890–893.

and a Bucyrus-Erie 38–B shovel are used for both stripping and loading ore, and a P & H 255A crane with a 40-foot boom and 4,000-pound ball is used for secondary breaking. Two 10-ton Euclid trucks are used for hauling, supplemented by two 2-ton GMC trucks hauling on a contract basis. A TD 18 with hydraulic dozer blade is used for clearing, cleaning, and roadwork.

In the concentrating mill ore crushed to minus-¾-inch is ground in pebble mills, deslimed in a hydrocyclone, and fed to Humphreys spirals. About 5 percent by weight of the spiral feed is removed from the ports as a rougher heavy-mineral concentrate and delivered to a table to recover a heavy mineral concentrate consisting of cassiterite, columbite, and tantalite with small quantities of pyrrhotite, pyrite, and monazite. The spirals rejects are laundered to a spiral classifier which discharges the sands into a conditioner. Conditioners in series are operated at about 55 percent solids. The following reagents are added: Amine, a silicate-gangue mineral collector; caustic, a pH regulator; dextrene, a selective depressant for spodumene in an alkaline circuit; and pine oil, as a frother. The conditioner discharge is diluted to about 25 percent solids as a feed for flotation cells. In this separation the float product contains the gangue minerals; quartz, mica, feldspar, and hornblende are floated, and the spodumene is depressed. This spodumene concentrate is dewatered and delivered to storage.

The Bureau of Mines investigated the recovery of beryl from ore produced by Foote Mineral Co.[14] Construction was begun in 1953 on an expansion program to increase the capacity of this operation.

WORLD REVIEW

Canada.—Quebec Lithium Corp., a subsidiary of Sullivan Consolidated, Ltd., conducted diamond drilling in a pegmatite area near Val d'Or, Quebec, in LaCorne Township, and is reported to have disclosed about 2 million tons of spodumene ore having an average content of 1.2 to 1.3 percent lithium oxide. The drilling was done over a length of 2,500 feet and explored the structures to a vertical depth of 400 feet. The spodumene occurs in a series of pegmatite dikes whose widths range from 10 to 50 feet. Dips are nearly vertical. Sullivan Consolidated staked 4,000 acres in this area in 1940. Exploration originally was done in a search for molybdenum and resulted in the spodumene findings. Since that time 10,000 acres has been added to the claims. The property covers a length of approximately 15 miles east-west along a strike of the pegmatite dikes.

Another company interested in the area is Ventures, Ltd., which, through its subsidiary, Lakefield Research, Ltd., holds controlling interest in LaCorne Lithium Mines with property in both LaCorne and LaMotte Townships. Preliminary drilling was done in 1946, and an estimated 300,000 tons averaging better than 20 percent spodumene was said to be indicated in a series of pegmatites.[15]

Quebec Tantalum & Lithium Mining Co., Inc., was reported to hold 1,600 acres in Figuery Township, Quebec, and also about 2,400 acres of property in Villemontel Township about 6 miles to the west of the strike of its Figuery Township acreage. Both groups cover

[14] Clemmons, B. H., and Browning, J. S., Strategic Beryllium From Domestic Pegmatites: Min. Eng., vol. 5, No. 8, August 1953, pp. 786–788.
[15] Northern Miner (Toronto), vol. 39, No. 10, May 28, 1953, pp. 1, 4.

portions of a belt of pegmatite dikes that may contain spodumene. Exploration of the Villemontel claims was underway and the company expected to begin exploration of the Figuery Township property.[16]

France.—Salts of lithium have been manufactured in France since before World War I, but at that time the chief uses were in pharmaceuticals.[17] After the war the use of lithium in batteries was begun, and in 1941 France began using lithium for welding. During World War II lithium was employed in special greases for the aviation industry.

The sole producer of lithium in France in 1953 was Société des Usines Chimiques Rhône-Poulenc, Paris. The company produced lithium carbonate, lithium hydroxide, lithium fluoride, and lithium chloride. Total production was about 10 metric tons per month; this was the firm's production capacity. No breakdown of the quantity of each salt produced is available.

Lepidolite and spodumene imported from South Africa were the raw materials used in producing lithium salts in France.

Rhône-Poulenc developed its own manufacturing processes, which it considers confidential. The only information made available by the company was that the process used was not the same as that employed in the United States. Consumption of lithium compounds in France, in percent, was estimated as follows: Production of batteries, 35; production of greases, 25; pharmaceuticals, 20; and aluminum and magnesium welding, 20.

According to Rhône-Poulenc, French requirements of lithium compounds totaled approximately 10 metric tons per month. The only serious problem that faced the industry was obtaining regular supplies of raw materials from Africa.

According to spokesmen for the industry, the outlook in France was satisfactory. The company expects that larger quantities of lithium compounds will be used in French consuming industries.

Mozambique.—It was reported that Empreza Mineira de Alto Ligonha Lda. had started large-scale production of lepidolite ore from quarries at Mahipa and a few other large pegmatite dikes in the company 5,000-square-kilometer concession. Difficulties were encountered in keeping the product up to grade. Beryl and columbite are recovered as byproducts.[18]

South-West Africa.—The following firms and individuals produced lithium minerals in South-West Africa in 1952:

Amblygonite:
- M. H. C. Brockman, P. O. Box 4, Karibib.
- J. C. Horn, Poste Restante, Usakos.
- P. A. Marais, Libertas, P. O. Usakos.
- W. Stiepelmann, Sandamap, P. O. Usakos.
- S. W. A. Beryllium Mines (Pty.), Ltd., P. O. Box 37, Usakos.
- 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. Gems (Pty.), Ltd., P. O. Box 42, Swakopmund.
- S. W. A. Lithium Mines, P. O. Box 1517, Windhoek.

Petalite: S. W. A. Lithium Mines, P. O. Box 1517, Windhoek.

[16] Northern Miner (Toronto), vol. 39, No. 32, Oct. 29, 1953, p. 24.
[17] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 3, September 1953, pp. 58–59.
[18] Mining World, vol. 16, No. 2, February 1954, p. 62.

Magnesium

By H. B. Comstock[1]

STOCKS of magnesium in the United States for strategic purposes warranted closing 5 of the 6 Government-owned producing plants by June 30, 1953. This left production of magnesium in the United States in the hands of Dow Chemical Co. at its Freeport, Tex., plant and the Government-owned Velasco, Tex., plant, which Dow continued to operate under its lease agreement.

Consumption of magnesium in 1953 for producing items for the civilian market reached an alltime high of above 26,000 tons, or over half of the magnesium used. Expansion of facilities for extrusion and sheet rolling resulted in the use of magnesium for many products that had been previously fabricated from heavier or scarcer metals.

TABLE 1.—Salient statistics of the magnesium-metal industry in the United States, 1944–48 (average) and 1949–53

	1944-48 (average)	1949	1950	1951	1952	1953
Production:						
Primary magnesium [1] short tons	43,511	11,598	15,726	40,881	105,821	93,075
Secondary magnesium [1] do	9,121	5,962	9,476	11,526	11,477	11,930
Average quoted price per pound—primary [2] cents	20.5	20.5	22.0	24.5	24.5	26.6
Domestic consumption short tons	40,625	11,947	18,051	35,710	43,847	50,240
Exports [3] do	4,497	708	908	761	1,163	2,949
World production do	81,000	[4] 37,000	45,000	89.000	[4] 169,000	170,000

[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, 1954.)
[3] Primary magnesium and alloys.
[4] Revised figure.

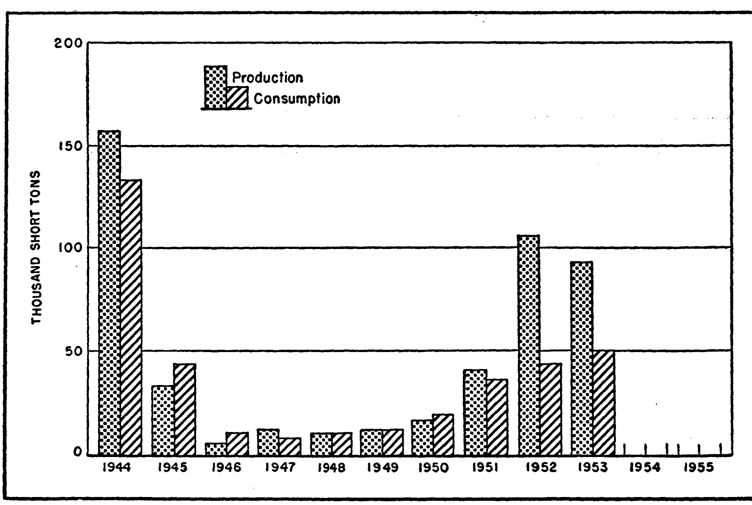

FIGURE 1.—Domestic production and consumption of primary magnesium. 1944–53.

[1] Commodity-industry analyst.

TABLE 2.—Production of primary magnesium in the United States, 1944–48 (average) and 1949–53, by months, in short tons

Month	1944–48 (average)	1949	1950	1951	1952	1953
January	5, 250	988	1, 002	1, 876	7, 425	9, 908
February	4, 919	884	913	1, 709	7, 794	9, 078
March	5, 047	988	948	1, 885	8, 893	10, 352
April	4, 623	958	957	2, 043	8, 800	9, 751
May	4, 222	987	972	2, 194	9, 093	9, 116
June	3, 802	950	1, 175	2, 512	8, 670	7, 286
July	4, 222	985	1, 332	2, 998	9, 529	6, 207
August	3, 722	970	1, 400	3, 418	9, 771	6, 266
September	2, 610	974	1, 635	4, 166	8, 422	6, 076
October	2, 234	941	1, 690	5, 147	8, 990	6, 341
November	1, 652	969	1, 760	6, 010	9, 122	6, 227
December	1, 208	1, 004	1, 942	6, 923	9, 312	6, 467
Total	43, 511	11, 598	15, 726	40, 881	105, 821	93, 075

DOMESTIC PRODUCTION

Primary.—The production of primary magnesium in 1953 fell to 93,075 tons, a decrease of 12 percent from that reported in 1952. Output from the Dow Chemical Co. plant at Freeport, Tex., was 32 percent of 1953 production. The remaining 68 percent was produced in 6 of the 7 Government-owned magnesium plants. These figures do not include the small quantity of high-purity magnesium produced at the Government-owned plant at Canaan, Conn., during the latter half of 1953 for the Atomic Energy Commission. The 6 Government-owned plants that were rehabilitated in 1951 and produced 76 percent of the output of primary magnesium in 1952 produced at 95 percent of their total rated capacity during the first quarter of 1953 and at the rate of 80 percent during the second quarter.

TABLE 3.—Production of magnesium in reactivated Government-owned plants, 1951–53

	Date production started	Date production ceased	Rated annual capacity (tons)	Production (tons)
Electrolytic process:				
Velasco, Tex.[1]	Apr. 16, 1951		36, 000	91, 695
Painesville, Ohio	July 27, 1951	June 3, 1953	18, 000	29, 106
Silicothermic process:				
Canaan, Conn.	Mar. 27, 1951	June 30, 1953	5, 000	7. 650
Manteca, Calif.	June 8, 1951	July 10, 1953	10, 000	16. 953
Spokane, Wash.[2]	Aug. 15, 1951	June 30, 1953	[2] 24, 000	14, 383
Wingdale, N. Y.	Nov. 15, 1951	May 29, 1953	5, 000	4, 390
Total			98, 000	164, 177

[1] Production continued throughout 1953.
[2] Shut down to one-fourth capacity on Aug. 31, 1952, owing to electric power shortage in the Northwest. Annual rated capacity reduced to 20,000 tons on Aug. 1, 1952.

Stocks of magnesium were adequate by March 1953 to warrant plans for closing the high-cost Government-owned plants. A directive by the Munitions Board, dated April 7, 1953, scheduled the following plans for ceasing magnesium production for defense in the Government-owned plants: The Canaan, Conn., and Spokane, Wash., plants to cease production by June 30, 1953, or sooner if possible;

the Painesville, Ohio, Wingdale, N. Y., and Manteca, Calif., plants to be shut down by June 30, 1953, or sooner if possible, and placed in such standby condition that they could be reactivated to produce at 50 percent of rated capacity during the first year of reactivation; and the Velasco, Tex., plant to continue in operation by extension of the contract with Dow Chemical Co., to produce magnesium through June 30, 1954.

Table 3 shows the date on which each of the reactivated plants began production, the date production ceased, and the total production obtained from each plant during this period of operation.

Effective July 1, 1953, the Munitions Board granted the Atomic Energy Commission a permit to take over custody and accountability of the entire Canaan, Conn., plant from General Services Administration. On July 16, 1953, Nelco Metals, Inc., which had operated the plant for GSA until June 30, 1953, began to produce magnesium under its contract with the Atomic Energy Commission.

On July 17, 1953, GSA announced the leasing of a major portion of the Spokane magnesium plant to Pacific Northwest Alloys, Inc., to produce ferroalloys (particularly low-carbon ferrochrome). The 10-year lease contained an option to renew for two 5-year periods, and it also contained the national security clause, which provided that the entire facility could be reconverted to magnesium production on short notice. The Government-owned dolomite quarry was not included in the lease. The Government retained the quarry for possible use in future production of magnesium.

TABLE 4.—Magnesium recovered from scrap processed in the United States, 1952–53, in short tons

Recoverable magnesium-alloy content of scrap processed			Magnesium recovered from scrap processed		
Kind of scrap	1952	1953	Form of recovery	1952	1953
New scrap:			Magnesium-alloy ingot [1] (gross weight)	6,411	6,713
Magnesium-base	2,529	3,945	Magnesium-alloy castings (gross weight)	716	436
Aluminum-base	1,711	1,947			
Total	4,240	5,892			
			Magnesium-alloy shapes	1	
			In aluminum alloys	3,022	3,113
Old scrap:			In zinc and other alloys	40	4
Magnesium-base	6,519	5,393	Chemical and other dissipative uses	14	86
Aluminum-base	718	645	Cathodic protection	1,273	1,578
Total	7,237	6,038			
Grand total	[2] 11,477	11,930	Grand total	[2] 11,477	11,930

[1] Figures include secondary magnesium incorporated in primary magnesium ingot.
[2] Includes 929 tons of alloying ingredients.

Secondary.—Because of the high reclamation value of magnesium scrap the use of secondary magnesium has been common practice with consumers since the early years of commercial fabrication of the metal and its alloys. Magnesium scrap was classified under three major headings: New scrap, old scrap, and nonreclaimable fines. New scrap and nonreclaimable fines were the types of scrap generated in the foundries and fabricating plants. The new scrap, in the form of solid pieces of primary magnesium ingots, casting scrap, and solid wrought scrap, was readily remelted and taken back into the forming and fabrication processes. Nonreclaimable fines included grinding dust, sawings, and filings. The safest, most economical manner of handling these fines was to dispose of them by burning, as they accumulated in the plants. Old scrap, which was obtained from disassembly of used equipment, was handled with care to insure its freedom from rivets, bushings, studs, and copper and aluminum-base metals that might contaminate the melt.

The total recovery of secondary magnesium, including its recovery as an alloy ingredient and as secondary magnesium incorporated in primary magnesium ingot, was 11,930 short tons in 1953 compared with 11,477 short tons in 1952. Of this quantity, 9,338 tons was recovered from 11,555 tons of magnesium-base scrap. The remaining 2,592 tons was recovered from aluminum scrap. Old scrap constituted about 55 percent of the scrap consumed. Of the 1953 recovery, 56 percent was unalloyed ingot, 26 percent aluminum-base alloys, and 13 percent anode and strip for cathodic protection.

CONSUMPTION AND USES

Consumption of primary magnesium in 1953 totaled 50,240 tons, an increase of 6,393 tons above 1952 consumption and 42,835 tons below 1953 production. Over half of the magnesium consumed in 1953 was for civilian requirements. Increases were noted, particularly in the transportation industries. A trend toward wider use of magnesium-alloy parts in automobiles was evident. By the end of 1953 the cast-magnesium wheel had become a standard item for racing cars.[2]

TABLE 5.—Domestic consumption of primary magnesium (ingot equivalent and magnesium content of magnesium-base alloys) by uses, 1944–48 (average) and 1949–53, in short tons

Product	1944–48 (average)	1949	1950	1951	1952	1953
For structural products:						
Castings:						
Sand	13,384	3,088	3,090	10,179	14,513	14,306
Die	541	127	242	994	2,777	2,401
Permanent mold	13,509	44	573	646	1,115	1,106
Wrought products:						
Sheet and plate	1,473	2,155	3,357	5,761	5,569	7,103
Extrusions (structural shapes, tubing)	2,815	3,364	3,400	5,241	3,756	6,481
Forgings	161	200	104	735	12	24
Total for structural products	31,883	8,978	10,766	23,556	27,742	31,421
For distributive or sacrificial purposes:						
Powder	2,810	--------	56	482	1,553	1,219
Aluminum alloys	3,791	1,759	3,722	5,994	8,598	10,347
Other alloys	32	39	255	401	960	418
Scavenger and deoxidizer	296	404	473	1,332	1,229	423
Chemical	232	224	373	447	566	363
Cathodic protection	1,581	235	1,937	2,364	2,100	2,539
Other [1]	--------	308	469	1,134	1,099	3,510
Total for distributive or sacrificial purposes	8,742	2,969	7,285	12,154	16,105	18,819
Grand total	40,625	11,947	18,051	35,710	43,847	50,240

[1] Includes primary metal consumed for experimental purposes, for reduction of titanium and zirconium and in making secondary magnesium alloy.

[2] Modern Metals, Magnesium Dockboards and Car Wheels: Vol. 10, No. 1, February 1954, p. 38.

The greatest increase in magnesium consumption in 1953 was noted in wrought products, which was 46 percent above 1952 for these items. Part of this increase was caused by the start of the heavy-press program for the Department of Defense and the increased capacity for rolling sheet in 1953. The first of the heavy presses, the 14,000-ton extrusion press at Lafayette, Ind., began operation in August 1953, when both aluminum and magnesium extrusions were produced. The first high-speed, high-production rolling mill for magnesium started operation in November 1953 at Madison, Ill. Hot-rolled magnesium plate 6 feet wide and in lengths up to 60 feet was produced from 2,000-pound rolling ingots on this 84-inch reversing breakdown coil mill. All previous production of magnesium sheet and plate had been on hand mills utilizing rolling ingots weighing not more than 350 pounds.[3]

A decrease in 1953 of 3 percent below 1952 in consumption of magnesium for castings was accounted for by the extension, over a longer period of time, for attaining defense-equipment goals.

Distributive or sacrificial uses of magnesium rose to an alltime high of 18,819 tons in 1953. The expanded production of titanium and zirconium caused part of this increased use of magnesium in 1953. Consumption of magnesium for cathodic protection in 1953 rose 21 percent above that of 1952, and its use in aluminum alloys in 1953 was 20 percent above that in 1952.

The first international magnesium exposition was held at the National Guard Armory, Washington, D. C., March 31 to April 2, 1953, under the auspices of the Magnesium Association (headquarters address: 122 East 42d Street, New York, N. Y.). Although half the space at the exposition was devoted to military applications, many items for civilian use were exhibited. These included extension ladders, business machines, cameras, bakery cabinets, textile-machinery parts, handtrucks, dockboards, automotive truck bodies, and a new all-magnesium automobile body.

Government agency exhibitors at the exposition were the Federal Bureau of Mines, Army, Navy, Marine Corps, Air Force, and National Advisory Committee for Aeronautics. The displays of the Bureau of Mines illustrated its research in magnesium-production processes and in developing magnesium alloys of improved structural properties; and the methods, developed by the Bureau, for producing titanium and zirconium by using magnesium as a reducing agent. The Armed Forces exhibited the Navy skyrocket jet fighter plane and the S–55 helicopter, both of which contain large quantities of magnesium; and the first all-magnesium plane, the Air Force XP–65 Flying Wing. Increased uses of magnesium by the Army were noted in the exhibit of the all-magnesium M–33 Ordnance fire-control-system trailer and the magnesium arctic shelter.

Exhibitors from Canada, England, and Germany also participated.

STOCKS

At the close of 1953 consumers' stocks of primary magnesium were 8,396 tons (slightly above 8 weeks' supply at the rate of consumption during the year), and producers' stocks were 8,166 tons. Government

[3] American Metal Market, Dow Chemical Operating High-Speed Rolling Mill for Magnesium: Vol. 9, No. 213, Nov. 3, 1953, p. 1.

agencies continued to hold quantities of magnesium as provided in the Critical Materials Stockpiling Act (Pub. 520, 79th Cong., 2d sess., as amended).

Stocks of magnesium scrap were 1,753 tons at the end of 1953, or 308 tons more than at the beginning of the year.

PRICES

The base price of domestic magnesium, which had remained at 24.5 cents per pound since September 30, 1950, rose on March 9, 1953, to 27 cents.[4] The price of primary magnesium ingot remained at 27 cents to the close of the year.

During 1953 there was no change in the price of 31 cents per pound for remelt (secondary) magnesium.

FOREIGN TRADE[5]

Imports.—During 1953 imports of magnesium increased to 2,451 tons compared with 300 tons in 1952. About 10 percent of the imports of magnesium in 1953 was in the form of scrap metal; the remainder came from Norway in the form of primary ingot under its agreement with the United States.[6] Duty on magnesium metallic scrap was suspended on October 1, 1950, and Public Law 221 of the 83d Congress extended the suspension to June 30, 1954. Tariff rates during 1953 on other classifications of magnesium remained as follows: Metallic, 20 cents per pound; alloys, powder, sheets, tubing, wire, manufacturers, etc., 20 cents per pound on magnesium content plus 10 percent ad valorem. The imports were received from 10 countries in 1953 compared with 7 countries in 1952. Of the 2,451 tons of magnesium metal and scrap imported, 2,236 tons was from Norway, 110 from the Philippines, 53 from Canada, 22 from Taiwan, 11 from Algeria, 10 from French Morocco, 5 from Australia, 3 from the United Kingdom, and less than 1 ton each from Switzerland and the Netherlands.

Exports.—Exports of magnesium in 1953 totaled 2,970 tons—over twice the quantity exported in 1952. In September 1953 the Office of International Trade announced removal of magnesium metal from the timetable (quarterly-quota period) licensing for export. Of the primary metal, alloys, and scrap exported during 1953, 1,745 tons was delivered to West Germany, 385 to Mexico, 193 to Canada, 169 to Sweden, 133 to Japan, 79 to Venezuela, 58 to Yugoslavia, 44 to Saudi Arabia, 24 to Argentina, 20 to Austria, 15 to Lebanon, 12 each to Spain and Belgium-Luxembourg, 10 to Colombia, 7 each to Australia and France, 6 to the Netherlands Antilles, 5 each to Iran and Nicaragua, 4 to Indonesia, 3 to Union of South Africa, and 13 to other countries.

Norway received 7 tons of the magnesium powder exported; Belgium-Luxembourg and Israel each received 3 tons; Brazil and the Netherlands, 2 tons each; Canada and Greece, 1 ton each; and other countries, 2 tons.

[4] E&MJ Metal and Mineral Markets, vol. 24, No. 11, Mar. 12, 1953, p. 1.
[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.
[6] Mining World, Norway: Vol. 14, No. 4, April 1952, p. 57.

TABLE 6.—Magnesium imported for consumption and exported from the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Year	Imports						Exports					
	Metallic and scrap		Alloys (magnesium content)		Sheets, tubing, ribbons, wire, and other forms (magnesium content)		Metal and alloys in crude form, and scrap		Primary forms, n. e. c.		Powder	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1944–48 (average)	240	$80,733	(1)	$31	7	$12,911	4.463	$2,072,919	401	$310,724	466	$577,426
1949	2,560	537,113	(1)	80	(1)	28	432	184,707	276	214,732	(2)	(2)
1950	843	218,129	3	5,056	22	38.280	586	245,539	322	213.641	(2)	(2)
1951	3,871	998,214	18	29,525	90	190.050	575	308,865	186	228,427	(2)	(2)
1952	252	81,635	1	1,940	47	88,001	[3] 1,066	[3] 618,005	[3] 97	[3] 245,211	43	59,843
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

[1] Less than 1 ton.
[2] Data not separately classified.
[3] Due to changes in items included in each classification, data are not strictly comparable with earlier years.

TECHNOLOGY

Interest in new and improved magnesium alloys was noted early in 1953, when the alloy containing beryllium was placed on the market in May. The new magnesium alloy, designated as AZ91B, showed lower melt loss and increased efficiency over former magnesium alloys and proved to be competitive with aluminum as a die-casting material.[7]

The Bureau of Mines continued research to develop fundamental data concerning improved mechanical properties and aging characteristics of magnesium-lithium-aluminum alloys, which were considered the lightest and most ductile of the magnesium-base alloys.

A paper was read at the ninth annual meeting of the Magnesium Association in November 1953 describing the outstanding mechanical properties of magnesium alloys containing 2 to 3 percent thorium and the new uses for them that had been developed in 1953.[8]

The primary producer of magnesium reported research on recovery of magnesium from solidified sludge from electrolytic cells, which might lead to adding over 1,000 tons to the annual productive capacity of the Freeport, Tex., plant.[9]

Improvements in rolling magnesium and finishing techniques were described.[10] It was reported that, by applying an electric current to the magnesium sheet before the sheet is passed through the heated rolls, sheet could be rolled as thin as 0.001 inch.

Machining techniques described indicated that it had become common practice by 1953 to finish magnesium parts for aircraft to tolerances of 0.00007 inch.[11]

[7] Modern Metals, New Magnesium Die-Casting Alloy: Vol. 9, No. 4, May 1953, p. 86.
[8] Steel, Thorium Improves Magnesium Alloys: Vol. 133, No. 14, Dec. 14, 1953, pp. 126–128.
[9] Chemical and Engineering News, vol. 32, No. 13, Mar. 29, 1954, p. 1189.
[10] Materials and Methods, Magnesium Developments: Vol. 38, No. 6, December 1953, p. 3.
[11] Modern Metals, Machining Magnesium: Vol. 9. No. 11. December 1953, pp. 54–55.

New surface treatments were described;[12] this included information concerning the anodic coating designated as the HAE treatment, formerly withheld from publication for security reasons. The HAE coating was developed by Harry A. Evangelides, a chemical engineer with Army Ordnance. This coating has a combination of properties, including relative freedom from porosity, resistance to temperatures to above 2,500° F., and chemical inertness.

Further research was noted in use of magnesium as fuel in aircraft, automobiles, and other motor-powered equipment. The special design of an aircraft engine using magnesium powder as fuel was reported to have been developed and tested, and a feature of the engine was reported to be the comparatively small number of working parts.[13]

A new method for making magnesium printing plates faster and more economically, which led to increased volume of use in 1953, was discussed.[14]

Improvements in magnesium-casting techniques in 1953 were reported to have made it possible to pour one of the largest magnesium castings on record. Weighing approximately 1,530 pounds, the casting, which was a base for military electronic equipment, 114 inches long by 93 inches wide by 33 inches high, required 197 cores, which were contained in a flask measuring 128 inches long by 112 inches wide by 48 inches high.[15]

Advances in the electroplating of die castings were reported as the chief factor in their increased use by the automotive industry during 1953.[16]

WORLD REVIEW

World production of primary magnesium in 1953 was estimated at 154,000 metric tons (170,000 short tons), compared with 153,000 metric tons (169,000 short tons) in 1952. The United States continued to lead in production and consumption of magnesium. Expanded use of this lightest of the structural metals was noted in reports of exports from the United States of more than twice the quantity of magnesium exported in 1952. Plans were announced during 1953 for production of magnesium in Argentina and resumption of production of magnesium in Japan.[17]

Canada.—Production of primary magnesium in Canada in 1953 was reported to have increased about 20 percent above 1952. All defense requirements for magnesium in Canada were met during 1953 without curtailment of commercial orders, and several new civilian uses were developed.[18] The addition to facilities in 1952 at the Arvida, Quebec, electrolytic plant brought annual magnesium-production capacity of Canada to between 9,000 and 10,000 short tons. Before World War II Canada's annual consumption of magnesium did not exceed 15 tons; in 1953 it was estimated at 1,500 tons.[19] Fabricating facilities in Canada in 1953 were reported to be 7 foundries, a 2,400-ton extrusion press, and a 500-ton vertical forming press.

[12] Chemical and Engineering News, Magnesium to the Fore: Vol. 31, No. 46, Nov. 16, 1953, pp. 4778–4779.
[13] Iron Age, Magnesium: Vol. 172, No. 20, Nov. 12, 1953, p. 123.
[14] Modern Metals, Printing-Plate Progress: Vol. 10, No. 1, February 1954, p. 92.
[15] Iron Age, Foundry: Vol. 173, No. 6, Feb. 11, 1954, p. 150.
[16] Hanawalt, J. D., Magnesium: Eng. and Min. Jour., vol. 155, No. 2, February 1954, p. 90.
[17] Light Metals, The Industry in the World Today: Vol. 16, No. 187, October 1953, p. 332.
[18] American Metal Market, vol. 61, No. 48, Mar. 12, 1954, p. 12.
[19] Northern Miner (Toronto), vol. 38, No. 41, Jan. 1, 1953, pp. 1, 7.

TABLE 7.—World production of magnesium metal, by countries, 1944–48 (average) and 1949–53, in metric tons [1]

[Compiled by Helen L. Hunt]

Country	1944–48 (average)	1949	1950	1951	1952	1953
Canada	1,684	(2)	1,600	4,000	[3] 5,000	[3] 6,000
China, Manchuria	130	(2)	(2)	(2)	(2)	(2)
France	655	494	407	875	1,090	998
Germany:						
East [3]	6,000	1,000	1,000	1,000	1,000	1,000
West	[3] 1,120	----------	----------	----------	----------	----------
Italy	546	----------	122	677	976	1,447
Japan	802	----------	----------	----------	----------	----------
Korea	528	----------	----------	----------	----------	----------
Norway	[3] 400	----------	----------	120	[3] 1,300	[3] 4,500
Switzerland	[3] 340	----------	250	250	300	[3] 250
Taiwan (Formosa)	91	----------	----------	----------	----------	----------
U. S. S. R. [3]	15,800	19,000	20,000	30,000	40,000	50,000
United Kingdom [4]	5,259	2,600	3,000	5,000	4,600	5,400
United States	39,472	10,521	14,266	37,086	95,999	84,436
Total (estimate)	73,100	34,000	41,000	81,000	153,000	154,000

1 This table incorporates a number of revisions of data published in previous Magnesium chapters.
2 Data not available; estimate by author of chapter included in total.
3 Estimate.
4 Primary metal and remelt alloys.

France.—The magnesium industry in France was controlled in 1953 by the 2 aluminum producers—Pechiney at St. Auban (Hautes Alpes) and Ugine at Jarrie (Isére), but a combined sales organization, Société Générale du Magnesium, represented the 2 companies. The St. Auban plant remained closed during 1953. The Jarrie works, equipped to produce special steels, ferroalloys, alumina, aluminum, magnesium, and industrial chemicals, was reported to have produced 998 tons of magnesium in 1953. A new company, Société le Magnesium Thermique, was promoted to undertake both production and fabrication of magnesium.[20] A patent issued in France in 1951 was published describing a thermic process for reducing magnesium-bearing ores to magnesium metal (French Patent 977,711).[21]

Italy.—The silicothermic plant at Bolzano was the sole producer of magnesium in Italy in 1953. Consumption of the metal in Italy during 1953 was limited to a large extent to the aircraft industry.[22]

Japan.—Production of magnesium in Japan ceased at the close of World War II. During 1953 the Riken Kinzoku Co. magnesium plant at Ube was reported ready to resume production.[23] The Riken Kinzoku Co., an amalgamation of Nichiman Magnesium Kabushiki Kaisha (Japan-Manchukuo Magnesium Co., Ltd.), Riken Magnesium K. K., and the South Manchurian Railway, was the sole commercial producer of magnesium during 1933–36 and remained the principal supplier of the metal until 1942. This company's electrolytic plant at Ube originally utilized brines or byproduct bitterns as the source of magnesium. In 1941 two experiments with production from sea water were started. By 1944 about 25 percent of the metal produced in the Riken Kinzoku plant was derived from sea water.

Norway.—All production of primary magnesium in Norway in 1953 came from the electrolytic plant at Herøya. Rebuilding of this plant,

20 Work cited in footnote 17.
21 Light Metals Bulletin, Magnesium: Vol. 15, No. 15, Aug. 7, 1953, p. 574.
22 Work cited in footnote 17.
23 Work cited in footnote 17.

which was bombed beyond repair during World War II, was begun in 1951 when the factories of Herøya Elektrokjemiske Fabrikker A/S were purchased by Norsk Hydro, known at that time as Norway's largest chemical concern.[24] The rebuilt Herøya plant, which was designed for an annual capacity of 12,000 metric tons, produced 1,300 tons of magnesium in 1952. Almost all of Norway's magnesium output in 1952 was exported, about half to the United States and half to the United Kingdom. In September 1953 it was reported that Norsk Hydro had executed a contract with a firm in West Germany to sell magnesium in that area.[25] Under an agreement with the United States Government, Norsk Hydro will deliver a minimum of 3,000 tons of magnesium to the United States by July 1955.[26]

Switzerland.—Production of magnesium in Switzerland was first reported in 1926 by the S. A. Pour la Fabrication du Magnesium at its Martigny/Bourg plant. Production at this plant ceased in 1947 and was not resumed until 1950. In 1952 production of magnesium at the Martigny/Bourg plant was reported at 300 metric tons, and consumption was estimated at 400 tons. Production in 1953 was estimated at 250 tons, or about 50 percent of the annual capacity of the Martigny/Bourg plant. The principal use of magnesium in Switzerland in 1953 was as an alloying agent with aluminum.

U. S. S. R.—Although satisfactory information was not available on production of magnesium in the Union of Soviet Socialist Republics in 1953, reports received during that year indicated that production had risen to 40,000 metric tons in 1952. A further increase to 50,000 tons in 1953 was estimated.

United Kingdom.—The 4,000-ton electrolytic plant at Clifton Junction, Manchester, was the only plant producing primary magnesium in the United Kingdom in 1953. No expansion of the facilities at this plant was contemplated owing to limited supplies of electric power. However, investigations were reopened during 1953 into the possibilities of erecting a plant in Scotland to utilize the large deposits of magnesium-rich dolomite in Ross-shire for production of the metal; and research work was continued at Clifton Junction on processes of producing magnesium that would be largely independent of electricity supplies.[27]

In December 1953 the British Minister of Supply issued an order, effective January 1, 1954, removing all control from the acquisition, disposal, treatment, use, and consumption of magnesium.[28]

[24] Light Metals, Magnesium Production in Norway: Vol. 15, No. 166, January 1952, p. 4.
[25] E&MJ Metal and Mineral Markets, Norwegian Magnesium Sales: Vol. 24, No. 37, Sept. 10, 1953, p. 6.
[26] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 2, August 1953, p. 26.
[27] Light Metals, The Industry in the World Today: Vol. 16, No. 187, October 1953, p. 332.
[28] Metal Bulletin (London), No. 3855, Dec. 24, 1953, p. 24.

Magnesium Compounds

By Donald R. Irving [1] and Frances P. Uswald [2]

DOMESTIC production of crude magnesite, caustic-calcined and refractory magnesia, and dead-burned dolomite increased during 1953. Production and sales of high-grade magnesias increased; those of precipitated magnesium carbonate and magnesium hydroxide decreased. Magnesium sulfate and magnesium chloride production were about the same as in 1952.

TABLE 1.—Salient statistics of magnesite, magnesia, and dead-burned dolomite in the United States, 1944–48 (average) and 1949–53

	1944–48 (average)	1949	1950	1951	1952	1953
Crude magnesite produced: [1]						
Short tons	393, 214	287, 315	429, 392	670, 167	510, 750	553, 147
Value	$2, 819, 180	[2] $1,950,153	[2] $3,091,135	[2] $4,506,712	$2, 871, 548	[2] $3, 223, 759
Average per ton	$7.17	$6.79	$7.20	$6.72	$5.62	$5.83
Caustic-calcined magnesia sold or used by producers:						
Short tons	57, 546	32, 505	41, 447	49, 981	38, 055	43, 020
Value [3]	$3, 545, 839	$3, 109, 381	$4, 136, 898	$4, 810, 379	$3, 769, 466	$3, 991, 309
Average per ton [4]	$61.62	$95.66	$99.81	$96.24	$99.05	$92.78
Refractory magnesia sold or used by producers:						
Short tons	284, 660	250, 389	335, 440	432, 197	386, 873	399, 132
Value	$9, 328, 862	$10, 477, 856	$14, 915, 854	$18, 400, 131	$17, 255, 837	$19, 060, 796
Average per ton [4]	$32.77	$41.85	$44.47	$42.57	$44.60	$47.76
Dead-burned dolomite sold or used by producers:						
Short tons	1, 299, 213	1, 318, 708	1, 759, 443	1, 966, 460	1, 928, 025	2, 294, 815
Value	$12, 859, 914	$15, 930, 226	$21, 725, 560	$26, 375, 313	[5] $26,098,455	$31, 455, 384
Average per ton	$9.90	$12.08	$12.35	$13.41	[5] $13.54	$13.71

[1] Consists of crude ore, heavy-medium concentrate, and flotation concentrate.
[2] Partly estimated; most of crude is processed by mining companies, and very little enters open market.
[3] Includes specialty magnesias of high unit value.
[4] Average receipts f. o. b. mine shipping point.
[5] Revised figure.

DOMESTIC PRODUCTION AND CONSUMPTION

Magnesite.—Production of crude magnesite (consisting of crude ore, heavy-medium concentrates, and flotation concentrates) in the United States in 1953 increased 8 percent in quantity and 12 percent in value compared with 1952, according to reports by producers. However, the 1953 figures were 17 percent less in quantity and 28 percent less in value than the corresponding 1951 data. The output in 1952 was low because of a strike that closed most domestic iron and steel plants 2 months or longer.

Magnesia.—Refractory magnesia sold or used by producers increased 3 percent in quantity and 10 percent in value in 1953 compared with 1952. Most of the refractory magnesia output is used in refractories for basic open-hearth steel furnaces. The expansion of iron and steel capacity during 1950–53 required larger than normal quantities

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

of refractory magnesia for new furnace installations, with a consequent increase in the quantity of refractory magnesia consumed per short ton of basic open-hearth steel. The consumption factor decreased during 1953 to 8.0 pounds per ton, the lowest since 1950, when the factor was 7.8 pounds per ton. In 1951 and 1952, 9.4 pounds of refractory magnesia was sold or used per short ton of basic open-hearth steel. During 1953 the iron and steel industry consumed 122,124,661 long tons of iron ore, an increase of 21 percent over 1952 and of 6 percent over the previous high in 1951. The rated annual iron- and steel-production capacity on December 31, 1953, was 124.3 million short tons of steel compared with 117.5 million short tons on December 31, 1952.

Caustic-calcined magnesia sold or used by producers increased 13 percent in quantity and 6 percent in value in 1953 compared with 1952. The average value per ton of caustic-calcined magnesia is derived from reports by producers of all grades of caustic-calcined magnesia to avoid disclosure of individual company operations. Most of the material is sold for a considerably lower price per ton than the average value shown in table 1.

The proportion of magnesia derived from processes utilizing raw sea water, sea-water bitterns, and well brines as a raw-material source (usually with dead-burned dolomite as a causticizer) compared with the proportion derived from magnesite, brucite, and dolomite has been increasing for the past several years. In 1953, 49 percent of the magnesia sold or used by producers was derived from sea water and well brines compared with 44 percent in 1952 and 42 percent in 1948. The proportion of refractory magnesia derived from sea water and well brines was 44 percent in 1953, 40 percent in 1952, and 35 percent

TABLE 2.—Magnesia sold or used by producers in the United States, 1952–53, by kind and source

Magnesia	From magnesite, brucite, and dolomite		From well brines, raw sea water, and sea-water bitterns [1]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1952						
Caustic-calcined [2]	4,528	$761,268	33,527	$3,008,198	38,055	$3,769,466
Refractory	232,766	8,057,848	154,107	9,197,989	386,873	17,255,837
Total	237,294	8,819,116	187,634	12,206,187	424,928	21,025,303
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

[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.

in 1948; the proportion of caustic-calcined magnesia from these sources was 87 percent in 1953, 88 percent in 1952, and 65 percent in 1948. Magnesia sold or used by producers in the United States, 1952–53, by kind and source, is given in table 2.

Dolomite.—Dead-burned dolomite sold by producers increased 19 percent in quantity and 21 percent in value in 1953 compared with 1952 (table 3). The increase indicated a trend toward increased consumption of dead-burned dolomite (replacing refractory magnesia) in the repair of basic open-hearth furnace linings. The quantity of dead-burned dolomite consumed in Government-owned plants producing magnesium metal in 1953 was less than half that consumed in 1952. All Government-owned magnesium plants were closed by the end of June 1953.

TABLE 3.—Dead-burned dolomite sold in and imported into the United States, 1944–48 (average) and 1949–53

Year	Sales of domestic		Imports [1]		Year	Sales of domestic		Imports [1]	
	Short tons	Value	Short tons [2]	Value		Short tons	Value	Short tons [2]	Value
1944–48 [3]	1,299,213	$12,859,914	504	$18,901	1951	1,966,460	$26,375,313	2,719	$128,207
1949	1,318,708	15,930,226	1,851	72,680	1952	1,928,025	[4] 26,098,455	2,342	123,596
1950	1,759,443	21,725,560	2,127	86,425	1953	2,294,815	31,455,384	3,876	259,427

[1] "Dead-burned" basic refractory material consisting chiefly of magnesia and lime.
[2] Includes weight of immediate container.
[3] Average.
[4] Revised figure.

Brucite.—Basic Refractories, Inc., 845 Hanna Bldg., Cleveland 15, Ohio, continued to produce brucite from its mine at Gabbs, Nev. The 1953 output was somewhat greater than that of 1952. A small quantity of brucite was produced by United States Brucite Corp. from the White Horse Group claims, Mohave County, Ariz.

Olivine.—The quantity of olivine sold or used by producers in the United States in 1953 increased over the 1952 output, but data must be withheld to avoid disclosure of individual company operations. Harbison-Walker Refractories Co., 1800 Farmers Bank Bldg., Pittsburgh, Pa., the largest producer, continued to mine from its Addie quarry near Addie, N. C. The Wray mine near Green Mountain, N. C., was operated by C. R. Wiseman, Spruce Pine, N. C. The H. P. Scheel Co. operated its mine and mill near Sedro-Wooley, Wash.

Other Magnesium Compounds.—Production of extra-light and light magnesias, U. S. P. and technical grades, increased 18 percent in 1953, compared with 1952 and sales increased 14 percent (table 4). Production and sales of precipitated magnesium carbonate and magnesium hydroxide decreased; magnesium sulfate and magnesium chloride production were about the same in 1953 as in 1952.

The mines and plants producing magnesite, brucite, and other magnesium compounds in 1953 in the United States are listed in table 5.

TABLE 4.—Specified magnesium compounds produced, sold, and used by producers in the United States, 1952–53 [1] [2]

Products [1]	Plants	Produced	Sold		Used
		Short tons	Short tons	Value	Short tons
1952					
Specified magnesias (basis 100 percent MgO), U. S. P. and technical:					
Extra-light and light	5	1,986	2,012	$1,100,078	(2)
Heavy	2	(2)	(2)	(2)	
Total	[3] 5	(2)	(2)	(2)	(2)
Precipitated magnesium carbonate	7	43,267	5,380	870,003	37,882
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)

[1] In addition, magnesium chloride, nitrate, phosphate, acetate and trisilicate were produced.
[2] Figures withheld to avoid disclosure of individual company operations.
[3] A plant producing more than 1 grade is counted but once in arriving at total.
[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, 1953

Company	Location of mine or plant	Products	Raw materials
ARIZONA			
United States Brucite Corp.	Mohave County	Brucite	
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.

TABLE 5.—Mines and plants producing magnesite, brucite, and other magnesium compounds in the United States, 1953—Continued

Company	Location of mine or plant	Products	Raw materials
		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.
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.
		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 1953 compared with January 1952 quotations are given in table 6.

TABLE 6.—Prices quoted on selected magnesium compounds, carlots, 1952–53

Commodity	Unit	Container	F. o. b.	Source	January 1952	January 1953	December 1953
Magnesite:							
Caustic-calcined oxychloride-cement grade, powdered	Short ton	Bulk	Chewelah, Wash	(1)	$36.30	$36.30	$38.00
Dead-burned, grain	do	Bags	do	(1)	41.80	41.80	43.75
Do	do	do	Newark, Calif	(2)	75.00	75.00	[3] 80.00
Periclase: Kiln-run 90 percent	do	Bulk	do	(2)	55.00	57.00	[4] 62.00
Epsom salt: Tech. grade	100 lb	Bags		(5)	2.15	2.15	2.15
Magnesia, calcined:							
Tech. grade	Pound	Cartons	Works	(5)	.32–.3475	.32–.3475	.32–.3475
Synthetic, rubber grade	do	do	do	(5)	.31	.31	.31
U. S. P.:							
Light	do	do		(5)	.34–.36	.34–.36	.34–.36
Heavy	do	Barrels		(5)	.36–.38	.36–.38	.36–.38
Magnesium carbonate:							
Tech. grade	do	Bags	(6)	(5)	.095	.095	.095
U. S. P. grade	do	do	(6)	(5)	.1125	.1125	.1125
Magnesium chloride: Powdered	Short ton	Barrels	Works	(5)	50.00	50.00	50.00
Magnesium hydroxide: Medicinal grade	Pound			(5)	.29–.30	.265–.30	.265–.30

[1] E&MJ Metal and Mineral Markets.
[2] Westvaco Chemical Division, Food Machinery & Chemical Corp.
[3] Effective June 1.
[4] Effective April 1.
[5] Oil, Paint and Drug Reporter.
[6] Magnesium carbonate is quoted freight allowed to New Jersey (except to Atlantic, Burlington, Cape May, Cumberland, Gloucester, Ocean, and Salem Counties) and to Philadelphia County, Pa. Freight is equalized with New York City on all other destinations.

FOREIGN TRADE [3]

Imports for consumption of "dead-burned and grain magnesite and periclase" in 1953 increased 61 percent in quantity and 112 percent in value compared with 1952. Austria supplied 84 percent of the total compared with 74 percent in 1952 and 39 percent in 1951; Canada supplied 7 percent compared with 8 percent in 1952 and 14 percent in 1951. Imports from Yugoslavia (9 percent of the total) were reported for the first time. No imports were reported from Italy, Norway, or the United Kingdom in 1953. The quantity of "lump caustic-calcined magnesite" increased; the quantity of "ground caustic-calcined magnesite" decreased (table 7). Imports of other magnesium compounds in 1953 are shown in table 8.

TABLE 7.—Magnesite imported for consumption in the United States, 1951–53, by countries

[U. S. Department of Commerce]

Country	1951		1952		1953	
	Short tons	Value	Short tons	Value	Short tons	Value
CRUDE MAGNESITE						
Canada			4	$184		
India			11	290		
Total			15	474		
LUMP CAUSTIC-CALCINED MAGNESITE						
Canada	8	$467				
India	1,963	71,792	839	$32,050	1,141	$50,608
Netherlands	1,277	58,732				
Yugoslavia			828	28,391	1,413	48,284
Total	3,248	130,991	1,667	60,441	2,554	98,892
GROUND CAUSTIC-CALCINED MAGNESITE						
Austria	496	$19,949	303	$10,003	56	$1,778
Canada			8	516		
Germany	32	1,267				
Greece	209	7,800				
India			22	1,297	22	1,300
Netherlands	204	10,405	16	941	16	891
United Kingdom	3	382	4	528	4	551
Yugoslavia					61	2,352
Total	944	39,803	353	13,285	159	6,872
DEAD-BURNED AND GRAIN MAGNESITE AND PERICLASE						
Austria	11,314	$516,886	18,011	$785,657	33,026	$1,634,786
Brazil	56	1,995				
Canada	3,995	365,263	2,074	204,518	2,888	648,422
Germany	1,000	47,628	1	21		
India			2,379	92,029		
Italy	3,808	195,377	1,504	64,112		
Norway	1,000	41,833	500	15,400		
United Kingdom	7,612	227,422				
Yugoslavia					3,383	185,191
Total	28,785	1,396,404	24,469	1,161,737	39,297	2,468,399

[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.

Exports in 1953 of magnesite, magnesia, and manufactures except refractories were valued at $3,785,362 compared with $2,845,786 in 1952.

TABLE 8.—Magnesium compounds imported for consumption in the United States, 1944–48 (average) and 1949–53

[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
1944–48 (average)	16	$5,142	156	$36,614	10	$575	4	$364	14	$10,574	(2)	$10
1949	(3)	2	192	61,385	6	852	358	9,928	9	7,601		
1950	-------	-------	234	51,043	8	835	1,962	45,233	158	24,851	-------	-------
1951	-------	-------	194	59,847	3	292	2,547	59,373	562	90,826	3	1,479
1952	7	496	182	53,841	2	172	4,606	113,518	614	139,977	96	31,914
1953	-------	-------	253	72,498	319	9,878	6,782	167,478	182	66,479	1	437

[1] Includes magnesium silicofluoride or fluosilicate and calcined magnesium sulfate.
[2] 40 pounds.
[3] 50 pounds.

TECHNOLOGY

Many articles on basic refractories were published during 1953, most of them describing the results of investigations of physical and chemical properties, performance, and special applications of magnesia and chromite-magnesia refractories.[4] Improvements in manufacture, raw materials requirements, and the economics of basic refractories were reviewed.[5] Data were presented on the chemistry, preparation, and mode of application of magnesium-compound cements.[6] The effects of silica content and sintering additions on

[4] Arisztid, Cser, [Mineralogical Calculation of Basic Refractory Materials]: Kohaszati Lapok (Budapest), vol. 8, No. 7, July 1953, pp. 162–164.
Austin, L. W., The Testing and Development of Basic Refractories for the Open-Hearth: Blast Furnace and Steel Plant, vol. 41, No. 6, June 1953, pp. 639–645.
Bosch, F. M., The Lining of a High-Frequency Furnace: Proc. 11th Internat. Cong. Pure Appl. Chem., vol. 5, 1947, pp. 417–423.
Brisbane, S. M., and Segnit, E. R., Action of Potash on Magnesite-Chrome Refractories: Australian Jour. Appl. Sci. (Victoria, Australia), vol. 4, No. 2, June 1953, pp. 335–343.
Hyslop, J. F., Chemical Notes on Chrome-Magnesite: Trans. British Ceram. Soc. (Stoke-on-Trent, England), vol. 52, No. 10, October 1953, pp. 554–564.
Hutter, L., [Durability of Basic Refractories for Open-Hearth Construction Judged From Different Kinds of Service]: Radex-Rundschau (Radenthein, Austria), No. 2, February 1953, pp. 66–85.
Lanser, P., and Skalla, N., [Hydration-Resistant Magnesite Refractories]: Radex-Rundschau (Radenthein, Austria), No. 6, July 1953, pp. 40–43.
Massengale, G. B., Mong, L. E., and Heindl, R. A., Permeability and Other Properties of a Variety of Refractory Materials: Jour. Am. Ceram. Soc., vol. 36, No. 7, July 1953, pp. 222–229.
Mayer, Karl, and Knuppel, Helmut, [Lining an 800-ton Pig-Iron Mixer With Chemically Bound Magnesite Bricks]: Stahl u. Eisen (Düsseldorf, Germany), vol. 73, No. 23, Nov. 5, 1953, pp. 1463–1468.
McKendrick, A., Refractories for the Basic Open-Hearth Furnace: Refractories Jour. (London), vol. 29, No. 11, November 1953, pp. 455–464.
Nagai, Shoichiro, Ota, Zenzo, Tanemura, Fumikaza, and Ogino, Hirotoshi, Chromite Magnesia Refractories Which Use Sea-Water Magnesia: Jour. Ceram. Assoc. Japan (Tokyo), vol. 61, No. 682, April 1953, pp. 152–154.
Parnham, H., The Development of Chrome-Magnesite Bricks: Ceram. Symposium, British Ceram. Soc. (Stoke-on-Trent, England), 1953, pp. 513–535.
[5] Bashforth, G. R., Refractory Policy and Control: British Steelmaker (London), vol. 19, No. 10, October 1953, pp. 586–594.
Dodd, A. E., Raw Materials for the Manufacture of Basic Refractories: Paper from Ceramics, A Symposium, British Ceram. Soc. (Stoke-on-Trent, England), 1953, pp. 474–487. Refractories, 1950–53; Progress Review No. 28: Jour. Inst. Fuels (London), vol. 26, No. 155, December 1953, pp. 312–317.
Iron Age, Metals and Materials Review and Forecast: Vol. 171, No. 1, Jan. 1, 1953, p. 281.
[6] Walter-Levy, Leone, de Wolff, P. M., and Sollilhavoup, Irene, [The Setting of the Salt $MgCl_2.2MgCO_3.Mg(OH)_2.6H_2O$]: Compt. rend. (Paris), vol. 236, 1953, pp. 2069–2071.
Nagai, Shoichiro, and Jukumori, Yasushi, Magnesia Cement Which Uses Sea-Water Magnesia: Jour. Ceram. Assoc. Japan (Tokyo), vol. 61, No. 684, June 1953, pp. 266–269.
Paranjpe, N. V., Magnesium Oxychloride Cements: Bombay Technol. (Bombay), vol. 3, No. 1, 1952–53, pp. 1-11.

refractoriness under load and the resistance of the calcined product to corrosion by converter slag were investigated for the white variety of Polish magnesite.[7] Heavy-medium separation plants recovering magnesite, dolomite, and brucite were described.[8] Primary drilling practices at the Northwest Magnesite Co. quarries were traced from the original use of compressed-air actuated jackhammers and hand-sharpened drill steel to the adoption of an electric-powered, crawler-mounted, self-propelled rotary drill.[9] The process and operation of the plant at Hartlepool, England, for recovery of magnesia from sea water and calcined dolomite were described briefly.[10] The physical and mechanical properties of olivine and its preparation for foundry sand mixtures, based on experiments at the University of Washington's foundry laboratory, were described in a report.[11] Thermal, optical, and X-ray analyses were made to determine changes in structure during hydration and decomposition of some Transvaal serpentines. It was shown that pure forsterite was formed by fusing appropriate quantities of sintered serpentine and magnesia.[12] Laboratory and pilot-plant tests on the manufacture of magnesium pyrophosphate from apatite and serpentine were described.[13] Forsterite refractories made from peridotite and sea-water magnesia were said to be the most stable to corrosion by fused phosphates.[14] A report was issued on serpentine in California.[15] A number of articles of a theoretical nature were published during 1953.[16]

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[7] Nadachowski, F., Processing of the White Variety of Polish Magnesite: Prace Inst. Ministerstwa Hutnic, vol. 5, 1953, pp. 245–258 (English summary).
Chemical Abstracts, vol. 48, No. 14, July 25, 1954, p. 8499h.

[8] American Cyanamid Co., H-M Separation Processes for Mineral Concentration TN 500 A350: Mineral Dressing Notes, No. 19, January 1953, 32 pp.

[9] Fisk, R. L., Changes in Primary Drilling at Northwest Magnesite: Min. Cong. Jour., vol. 29, No. 11, November 1953, pp. 34–36.

[10] Gilpin, W. C., Refractory Magnesia From Sea Water: Refractories Jour.; vol. 29, No. 2, February 1953, pp. 48–54.

[11] Snyder, W., Advantages and Limitations of Olivine Molding and Core Sand: Am. Foundryman, vol. 23, No. 1, January 1953, pp. 65–68.

[12] Vermaas, F. H. S., The Thermal Characteristics of Some Transvaal Serpentines and the Production of Forsterite: Jour. of Chem., Metal., and Min. Soc. of South Africa (Johannesburg); vol. 53, No. 7, January 1953, pp. 191–200.

[13] Akerman, K., Dankiewicz, J., Dankiewicz, M., Gryglik, E., Pletti, Z., and Przylocka, K., [Manufacturing Magnesium Pyrophosphate From Apatite and Serpentine] (Polish): Przemysl Chemiczny (Warsaw), vol. 32, No. 10, October 1953, pp. 495–497.

[14] Nagai, Shoichiro, and Ando, Jumpei, Refractories for Fused Phosphates: Jour. Ceram. Assoc. Japan (Tokyo), vol. 61, No. 680, February 1953, pp. 64–68.

[15] California Dept. of Natural Resources, Division of Mines, Serpentine in California: Mineral Inf. Service, vol. 6, No. 4, Apr. 1, 1953, pp. 1–11.

[16] Bacon, G. E., and Roberts, F. F., Neutron Diffraction Studies of Magnesium Ferrite Aluminate Powders: Acta Crystallographica (London), vol. 6, No. 1, January 1953, pp. 57–62.
Carlson, E. T., Peppler, R. B., and Wells, L. S., Studies in the System Magnesia-Silica-Water at Elevated Temperatures: Nat. Bureau of Standards, Jour. Research, Research Paper 2448, vol. 51, No. 4, October 1953, pp. 179–184.
Coughanour, L. W. and DeProsse, V. A., Phase Equilibria in the System $MgO-TiO_2$: Nat. Bureau of Standards, Jour. Research, Research Paper 2435, vol. 51, No. 2, August 1953, pp. 85–88.
Cremer, E., and Allgeuer, K., [Equilibrium Pressures of Magnesite]: Radex-Rundschau (Radenthein, Austria), No. 2, February 1953, pp. 54–57.
Hensler, J. R., and Henry, E. C., Electrical Resistance of Some Refractory Oxides and Their Mixtures in the Temperature Range 600° to 1,500° C.: Jour. Am. Ceram. Soc., vol. 36, No. 3, March 1953, pp. 76–83.
Karkhanovala, M. D., and Hummel, F. A., The Polymorphism of Cordierite: Jour. Am. Ceram. Soc., vol. 36, No. 12, December 1953, pp. 389–392. Reactions in the System $Li_2O.MgO-Al_2O_3.SiO_2$: 1. The Cordierite-Spodumene Join: Jour. Am. Ceram. Soc., vol. 36, No. 12, December 1953, pp. 393–397.
Kiyoura, Raisaku, and Ito, Yoshitaka, Thermal Transformation of Synthetic and Natural Serpentines, Especially Exothermic Reactions: Jour. Ceram. Assoc. Japan (Tokyo), vol. 61, No. 689, November 1953, pp. 525–528.
Lempicki, A., Electrical Conductivity of MgO Single Crystals at High Temperatures: Proc. Phys. Soc. (London), vol. 66, No. 400B, April 1953, pp. 281–283.
On, R. L., High-Temperature Heat Contents of Magnesium Orthosilicate and Ferrous Orthosilicate: Jour. Am. Chem. Soc., vol. 75, No. 3, Feb. 5, 1953, pp. 528–529.
Osborn, E. F., Subsolidus Reactions in Oxide Systems in the Presence of Water at High Pressures: Jour. Am. Ceram. Soc., vol. 36, No. 5, May 1953, pp. 147–151.
Roy, Della M., Roy, Rustum, and Osborn, E. F., The System $MgO-Al_2O_3-H_2O$ and Influence of Carbonate and Nitrate Ions of the Phase Equilibria: Am. Jour. Sci., vol. 251, No. 5, May 1953, pp. 337–361.
Shiraki, Yoichi, Cordierite Bodies With Chlorite: Jour. Ceram. Assoc. Japan (Tokyo), vol. 61, No. 689, November 1953, pp. 532–536.

Kaiser Aluminum & Chemical Sales, Inc., released a color motion picture, entitled "Bricks From the Sea," showing the manufacture of basic refractories. The picture shows operations from the extraction of magnesia to the use of the refractories in the production of steel, cement, copper, and basic products.[17]

WORLD REVIEW

Estimated world production of crude magnesite increased about 5 percent in 1953, compared with 1952. Production data, by countries are given in table 9.

Austria.—Magnesite deposits and their exploitation were described in articles published during 1953.[18] Exports of caustic-calcined and refractory magnesia, and magnesia brick, 1949–53, by countries of destination, are given in tables 10, 11, and 12. These exports are one of Austria's most important sources of foreign exchange.

TABLE 9.—World production of magnesite, by countries,[1] 1944–48 (average) and 1949–53, in metric tons [2]

[Compiled by Helen L. Hunt]

Country [1]	1944–48 (average)	1949	1950	1951	1952	1953
North America: United States	356,033	260,646	389,536	607,962	463,342	501,804
South America: Venezuela	2,786	1,800	1,400	1,600	(3)	(3)
Europe:						
Austria	259,580	520,500	543,817	664,296	742,259	804,716
Czechoslovakia	[4] 64,660	(3)	[4] 173,000	(3)	(3)	(3)
Germany, West	[4] 10,000	11,264	1,311	(3)	(3)	(3)
Greece	8,212	17,090	26,256	63,859	81,591	73,540
Italy	1,058	735	274	246	(3)	76
Norway	1,584	1,108	1,850	1,453	1,479	[4] 1,000
Spain	7,789	6,691	7,632	13,733	12,625	15,107
Yugoslavia	[4] 29,400	87,934	59,269	89,915	37,782	122,517
Asia:						
Cyprus (exports)	93	20	20	20	20	20
India	43,652	92,018	53,707	118,650	90,470	[4] 100,000
Korea:						
North	[4] 54,065 (North and Republic of)	(3) (North and Republic of)	(3)	(3)	(3)	(3)
Republic of			(3)	(3)	328	
Turkey	1,230	6,370	450	505	750	[4] 400
Africa:						
Egypt	20					
Kenya	32	10	181			
Southern Rhodesia	4,854	7,640	8,615	14,814	10,952	9,819
Tanganyika (exports)			83	2,716		102
Union of South Africa	7,718	10,487	11,782	18,773	24,409	22,887
Oceania:						
Australia	29,683	34,129	35,960	39,762	42,813	47,142
New Zealand	303	568	346	589	588	525
Total (estimate)	1,760,000	2,700,000	3,000,000	3,800,000	3,800,000	4,000,000

[1] Unless otherwise stated, quantities in this table represent crude magnesite mined. In addition to countries listed, magnesite is also produced in Brazil, 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] Data not available; estimate by senior author of chapter included in total.
[4] Estimate.

[17] Chemical and Engineering News, vol. 31, No. 3, Jan. 19, 1953, p. 303.
[18] Angel, F. and Weiss, P., [The Tux Magnesite Deposits]: Radex Rundschau (Radenthein, Austria), No. 7/8, August-September 1953, pp. 335–352.
Awerzger, A., [The Underground Workings of the Magnesite Deposits of the Millstatter Alps]: Radex Rundschau (Radenthein, Austria), No. 7/8, August-September 1953, pp. 354–362.
L'Echo des mines et de la métallurgie, [Exploitation of Magnesia in Austria]: Paris, July 1953, No. 3458, pp. 477–479.

TABLE 10.—Exports of caustic-calcined magnesia from Austria, by countries of destination, 1949–53, in metric tons [1] [2]

Country	1949	1950	1951	1952	1953
Argentina	-----------	65	42	30	5
Australia	15	-----------	-----------	-----------	8
Belgium-Luxembourg	75	119	193	240	164
Bulgaria	-----------	-----------	-----------	59	133
Czechoslovakia	1,926	2,549	3,426	3,177	2,782
Denmark	223	221	268	70	16
Finland	-----------	15	-----------	-----------	-----------
France	3,239	2,492	2,866	2,673	2,803
Germany:					
East	-----------	2,601	5,415	4,807	3,104
West	23,650	34,993	44,145	44,094	58,459
Hungary	750	2,183	879	1,379	57
Italy	1,408	2,092	2,562	1,886	2,214
Netherlands	326	307	668	139	45
Norway	317	34	-----------	45	40
Rumania	-----------	22	7	-----------	99
Sweden	138	-----------	15	15	50
Switzerland	1,055	1,289	1,271	1,215	1,217
Trieste	-----------	-----------	-----------	15	-----------
United Kingdom	351	280	177	236	704
United States	-----------	6	505	272	75
Others	-----------	-----------	-----------	-----------	35
Total	33,473	49,268	62,439	60,352	72,010

[1] Compiled by John E. McDaniel, Division of Foreign Activities, Bureau of Mines, from Customs Returns of Austria.
[2] This table incorporates a number of revisions of data published in the previous Magnesium Compounds chapter.

TABLE 11.—Exports of refractory magnesia from Austria, by countries of destination, 1949–53, in metric tons [1] [2]

Country	1949	1950	1951	1952	1953
Argentina	17	828	688	660	895
Belgium-Luxembourg	1,055	995	1,617	2,841	1,477
Brazil	148	30	-----------	-----------	178
Bulgaria	-----------	-----------	-----------	-----------	2,994
Chile	130	12	600	1,439	17
Czechoslovakia	664	497	26	51	389
Denmark	289	257	406	436	300
Finland	106	230	3,015	765	431
France	9,868	7,178	11,295	13,422	11,220
Germany:					
East	-----------	239	87	4,866	3,209
West	16,084	23,624	15,898	21,547	19,826
Greece	25	64	170	96	34
Hungary	3,410	1,218	63	115	29
India	24	108	100	-----------	673
Italy	6,041	6,694	6,884	11,880	9,973
Netherlands	355	222	3,422	287	222
Norway	85	124	110	47	174
Peru	801	790	1,198	-----------	41
Poland	5,034	6,477	3,726	2,761	4,568
Rumania	1,181	887	565	1,039	5,368
Spain	-----------	-----------	-----------	-----------	13
Sweden	1,011	1,085	881	1,526	710
Switzerland	1,236	1,740	21,455	3,171	507
Trieste	652	-----------	100	-----------	-----------
Turkey	-----------	93	7	70	37
United Kingdom	1,481	377	1	494	1,164
United States	22,571	7,887	4,150	8,169	6,654
Yugoslavia	7,671	8,434	7,094	5,323	643
Others	17	263	183	600	733
Total	79,956	70,353	83,741	81,605	72,479

[1] Compiled by John E. McDaniel, Division of Foreign Activities, Bureau of Mines, from Customs Returns of Austria.
[2] This table incorporates a number of revisions of data published in the previous Magnesium Compounds chapter.

TABLE 12.—Exports of magnesia brick from Austria, by countries of destination, 1949–53, in metric tons [1] [2]

Country	1949	1950	1951	1952	1953
Argentina	22	1, 418	1, 255	627	727
Belgian Congo	68	----------	50	19	120
Belgium-Luxembourg	6, 371	6, 250	7, 433	9, 023	10, 307
Bulgaria	181	32	----------	140	261
Chile	23	138	99	68	208
Czechoslovakia	5, 363	2, 662	877	1, 373	463
Denmark	1, 587	1, 593	2, 836	2, 224	3, 944
Finland	643	1, 590	1, 620	1, 850	3, 768
France	22, 993	16, 791	22, 169	27, 541	34, 425
Germany:					
East	----------	1, 033	1, 504	2, 414	2, 460
West	13, 601	17, 407	24, 784	28, 314	28, 209
Greece	118	704	548	628	648
Hungary	3, 673	4, 076	4, 039	4, 826	3, 996
Italy	4, 822	8, 198	11, 081	17, 358	16, 539
Netherlands	1, 218	1, 433	2, 601	3, 083	3, 436
Norway	527	621	597	583	994
Poland	6, 158	6, 753	4, 450	7, 063	14, 112
Rumania	4, 345	4, 982	1, 000	3, 996	4, 512
South Africa	139	60	1, 003	1, 360	2, 282
Spain	88	----------	----------	----------	511
Sweden	9, 816	10, 162	9, 306	9, 833	11, 598
Switzerland	992	1, 219	1, 598	1, 884	1, 447
Trieste	30	----------	----------	----------	----------
Turkey	416	1, 937	643	1, 658	2, 136
United Kingdom	----------	----------	26	1, 492	1, 084
Yugoslavia	5, 294	5, 386	2, 747	7, 551	7, 841
Others	1, 083	968	2, 546	2, 250	2, 260
Total	89, 571	95, 413	104, 812	137, 158	158, 288

[1] Compiled by John E. McDaniel, Division of Foreign Activities, Bureau of Mines, from Customs Returns of Austria.
[2] This table incorporates a number of revisions of data published in the previous Magnesium Compounds chapter.

Brazil.—Harbison-Walker Minerios, S. A., holds under lease from Magnesium do Brasil seven major magnesite deposits in Ceara. The deposits lie in a belt about 75 miles long and 20 miles wide. A diamond-drilling and surface-mapping program was completed during 1953.[19]

Canada.—Canadian Refractories, Ltd., Montreal, built a $4 million plant at Marelan, Quebec, to manufacture basic brick from Canadian brucite and magnesitic dolomite. The plant had enough capacity to supply all of Canada's requirements and a surplus of brick for export.[20] The Steetley Co. of Canada announced plans to construct a $2 million plant at West Flamboro to produce about 50,000 tons of dead-burned dolomite per year.[21]

Czechoslovakia.—A new magnesite mine in the Slovak area near Lubenick will supply about 60 percent of the refractories requirements of the nationalized iron and steel industry.[22]

Greece.—Exports of magnesite and calcined magnesia, 1950–53, are shown in tables 13 and 14.

[19] Harbison-Walker Refractories Co., Burns and Mixes: Pittsburgh, Pa., December 1953, pp. 2–3, 16.
[20] Canadian Mining and Metallurgical Bulletin, vol. 46, No. 494, June 1953, p. 391.
[21] Pit and Quarry, vol. 45, No. 7, January 1953, p. 76.
[22] Mining World, vol. 15, No. 9, August 1953, p. 69.

TABLE 13.—Exports of magnesite from Greece, by countries of destination, 1950–53, in metric tons [1] [2]

Country	1950	1951	1952	1953
France			2,143	
Germany, West		600	12,040	8,893
Italy			2,100	
United Kingdom	1,778	3,461	525	640
Others	231	14,602	75	1,200
Total	2,009	18,663	16,883	10,733

[1] Compiled by John E. McDaniel, Division of Foreign Activities, Bureau of Mines, from Customs Returns of Greece.
[2] This table incorporates a number of revisions of data published in the previous Magnesium Compounds chapter.

TABLE 14.—Exports of calcined magnesia from Greece, by countries of destination, 1950–53, in metric tons [1] [2]

Country	1950	1951	1952	1953
Germany	3,258	9,390	8,122	6,036
Netherlands		10,401	10,877	730
United States		90	3,700	
Others	1,256	2,856	257	9
Total	4,514	22,737	22,956	6,775

[1] Compiled by John E. McDaniel, Division of Foreign Activities, Bureau of Mines, from Customs Returns of Greece.
[2] This table incorporates a number of revisions of data published in the previous Magnesium Compounds chapter.

India.—Magnesite deposits occur in the States of Kashmir, Madras, Mysore, Rajasthan, and Uttar Pradesh. The reserves in Uttar Pradesh were being investigated by the Geological Survey of India and appeared to be large. The largest and highest grade deposits are in the Salem district, Madras, where reserves are estimated to exceed 80 million long tons. The probable reserves in India are of the order of 100 million long tons.

Magnesite Syndicate, Ltd., British-managed, has been producing in the Salem district since 1900, and at the end of 1953 output was about 1,000 long tons of crude magnesite per month. In 1953 the company was operating 3 of its 7 calcining kilns.

Salem Magnesite, Ltd., Indian-owned and Indian-managed, has been producing since 1950. In November 1953, 2 calcining kilns with a daily capacity of 15 long tons of crude ore each and 1 kiln with a capacity of 5 long tons of crude ore were in operation. The larger kilns, about 40 feet high, were fed manually, but conveyors were being installed. Concrete foundations also were completed in August 1953 for 6 additional kilns, with a combined capacity of 100 tons of crude ore per day.[23] The expansion was made possible through an agreement with a Japanese firm, Tokyo Refractories Industry, to provide

[23] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 2, February 1954, pp. 61–63.

machinery and technical assistance in exchange for 1,000 long tons of magnesia clinker per month for export to steel companies in Yawata and Fuji, Japan.[24]

Netherlands.—Imports of refractory magnesia, 1950–53, are given in table 15; exports are given in table 16.

TABLE 15.—Imports of refractory magnesia into the Netherlands, by countries of origin, 1950–53, in metric tons [1] [2]

Country	1950	1951	1952	1953
Austria	558	322	296	274
Belgium-Luxembourg	----	----	10	----
Greece	2,451	9,019	14,415	4,623
India	4,735	1,870	1,546	2,541
Germany, West	----	----	209	45
Yugoslavia	13,844	7,622	2,845	8,475
United Kingdom	----	----	28	----
Others	162	65	1	61
Total	21,750	18,898	19,350	16,019

[1] Compiled by John E. McDaniel, Division of Foreign Activities, Bureau of Mines, from Customs Returns of the Netherlands.
[2] This table incorporates a number of revisions of data published in the previous Magnesium Compounds chapter.

TABLE 16.—Exports of refractory magnesia from the Netherlands, by countries of destination, 1950–53, in metric tons [1] [2]

Country	1950	1951	1952	1953
Belgium-Luxembourg	372	391	460	403
Czechoslovakia	149	69	58	----
Denmark	1,009	1,167	1,173	903
Egypt	----	105	59	52
Finland	1,231	1,033	660	647
France	99	427	87	64
Germany, West	11,678	7,436	9,572	8,325
Netherland Antilles	----	----	123	----
New Zealand	----	----	56	----
Norway	632	561	453	385
Portugal	41	52	98	59
Sweden	1,169	1,377	1,052	898
Union of South Africa	124	131	197	123
United Kingdom	1,939	2,383	2,025	2,913
Others	758	2,219	99	114
Total	19,201	17,351	16,172	14,886

[1] Compiled by John E. McDaniel, Division of Foreign Activities, Bureau of Mines, from Customs returns of the Netherlands.
[2] This table incorporates a number of revisions of data published in the previous Magnesium Compounds chapter.

Norway.—A/S Olivin, a State-owned enterprise, was producing about 11,000 metric tons per year of olivine sand from a deposit near Aalesund. Reserves were estimated to be 2 billion tons. The capacity of the mine was about double the output, and foreign markets were being sought. Increasing quantities were being used to replace quartz sand in Norwegian foundries to reduce the likelihood of workers contracting silicosis.[25]

Southern Rhodesia.—Exports of magnesite, 1950–53, are given in table 17.

[24] Chemical Age, vol. 68, No. 1770, June 13, 1953, p. 906.
[25] Smith, M. F. (vice consul), State Department Dispatch 918, United States Embassy, Oslo, Norway, Apr. 15, 1953, p. 24.

TABLE 17.—Exports of magnesite from Southern Rhodesia, by countries of destination, 1950–53, in metric tons [1] [2]

Country	1950	1951	1952	1953
Belgian Congo		53		18
Northern Rhodesia			104	
Union of South Africa	3,012	11,802	13,195	8,355
Total	3,012	11,855	13,299	8,373

[1] Compiled by John E. McDaniel, Division of Foreign Activities, Bureau of Mines, from Customs returns of Southern Rhodesia.
[2] This table incorporates a number of revisions of data published in the previous Magnesium Compounds chapter.

Spain.—A magnesite deposit was being developed near El Escorial.[26]

Yugoslavia.—A plant in Ranko-Vicevo near Kraljevo was manufacturing magnesia and chromite-magnesia refractories. The magnesite was obtained from deposits between Goles and Drenica.[27]

[26] Mining Journal (London), vol. 241, No. 6173, Dec. 11, 1953, p. 686.
[27] Mining World, vol. 15, No. 12, November 1953, p. 80.

Manganese

By Gilbert L. DeHuff[1]

IMPORTS of manganese ore in 1953 were 3.5 million short tons, almost 1 million tons more than in the previous record year 1952. Purchases by the Government for stockpiling purposes were a factor that contributed to this large tonnage, but increased industry stocks at the end of the year showed that industrial acquisitions also had considerable importance. At the same time, the domestic manganese-ore-mining industry was stimulated by premium prices of the Government purchase programs, increasing manganese-ore production considerably above that in 1952. With the steel industry operating at a high rate throughout the greater part of the year, manganese-ore consumption reached a record high, as did also production of alloys.

TABLE 1.—Salient statistics of manganese in the United States, 1944–48 (average) and 1949–53, gross weight in short tons

	1944–48 (average)	1949	1950	1951	1952	1953
Manganese ore (35 percent or more Mn):						
Mine shipments:						
Metallurgical ore	159,020	110,928	122,944	95,255	100,999	139,960
Battery ore	7,919	14,983	11,507	9,752	14,380	17,576
Miscellaneous ore	324	224				
Total mine shipments	167,263	126,135	134,451	105,007	115,379	157,536
General imports	1,433,503	1,544,584	1,834,925	1,767,580	[1] 2,668,780	3,500,986
Consumption	1,434,635	1,360,042	1,650,429	1,892,609	1,809,189	2,195,742
Ferromanganese:						
Domestic production	615,322	577,345	719,680	791,260	758,721	907,533
Imports for consumption	50,275	65,014	109,948	119,764	64,095	126,518
Exports	8,850	6,627	580	633	1,453	1,112
Consumption	641,272	617,645	774,852	883,841	796,826	931,401
Spiegeleisen:						
Domestic production	132,641	78,167	42,375	77,017	58,666	97,729
Imports for consumption	1,453	1,737	8,595		44	785
Exports	2,093		363	85	34	
Consumption	128,739	75,841	76,280	80,556	69,029	73,512

[1] Revised figure.

DOMESTIC PRODUCTION

Promising exploration projects for manganese ore continued to be eligible for Defense Minerals Exploration Administration assistance in the form of advances to the extent of 75 percent of the approved cost of the project. Considerable interest was shown in this source of funds.

The Wenden, Ariz., depot of General Services Administration opened in January for the purchase of low-grade manganese ores of domestic origin, under much the same regulations as those for the station at Deming, N. Mex. Low-grade manganese ores and some

[1] Commodity-industry analyst.

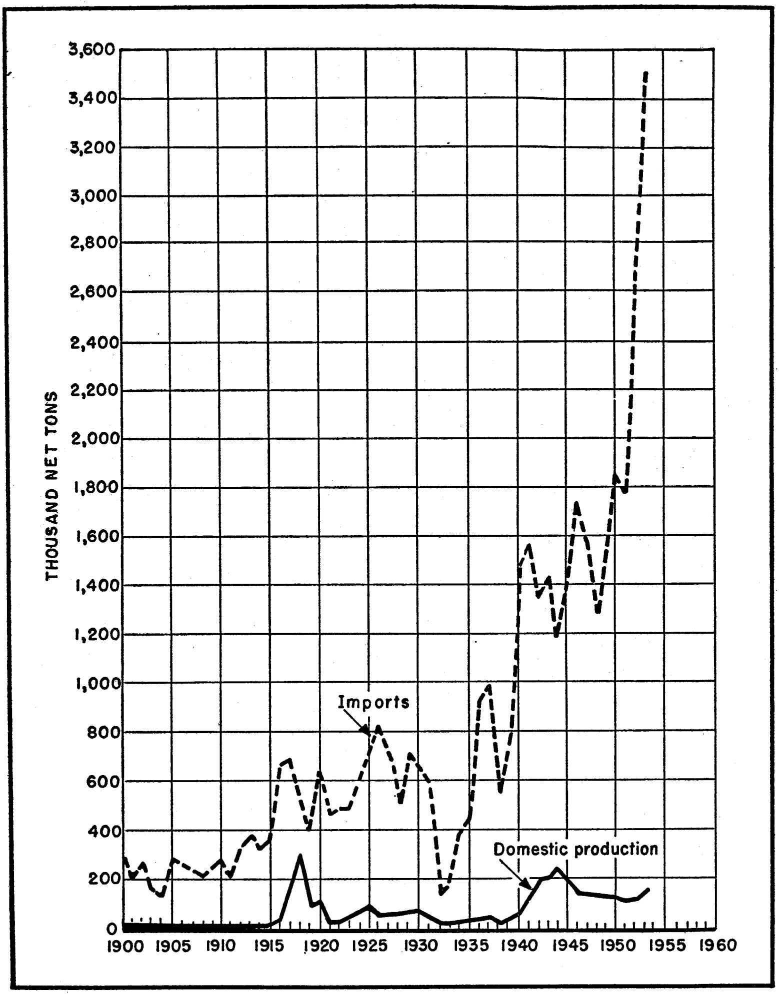

FIGURE 1.—General imports and domestic production (mine shipments) of manganese ore, 1900–53.

good-grade ores soon were received at a rate to tax the receiving capacity of the new depot. By the end of the year over one-third of its quota of 6 million long-ton units of manganese had been received. Low-grade manganese ores and some higher grade ores were received throughout the year at the previously established depots at Deming, N. Mex., Butte, Mont., and Philipsburg, Mont. The minimum acceptable manganese content at Wenden, Deming, and Philipsburg continued to be 15 percent and at Butte 12 percent. In January GSA amended the Butte regulation to provide for purchasing oxide ores containing not less than 18 percent manganese, and in February the regulation was amended further to accept oxide ores f. o. b. railway cars at Philipsburg. At all depots purchases continued to be limited to ores amenable to beneficiation to National Stockpile specifications. The GSA "carlot" program for purchasing domestic manganese ores containing a minimum manganese content of 40 percent and otherwise meeting specifications and regulations was revised in February to accept slags meeting the same chemical specifications as ore; the program gained momentum during the year. Most of the ore purchased came from Arkansas, Tennessee, and Virginia. In August President Eisenhower signed a bill extending the life of the various domestic manganese-purchase programs an additional 2 years to the close of business June 30, 1958.

TABLE 2.—Manganiferous raw materials shipped by producers in the United States, 1944–48 (average) and 1949–53, 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
1944–48 (average)	159,020	155,970	1,182,636	239,290	7,919	324	707
1949	110,928	24,885	1,052,231	158,902	14,983	224	1,279
1950	122,944	115,269	972,328	183,842	11,507		
1951	95,255	106,203	[1] 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		

[1] Revised figure.

Shipments of various grades of manganese-bearing ores given in tables 3 to 5 do not include shipments of manganese ore or low-grade manganese ore to low-grade GSA depots. Such shipments were made from Arizona, California, Colorado, Montana, Nevada, New Mexico, Utah, and Washington. In addition, battery concentrates containing 35 percent or more manganese were produced in California and Montana, and synthetic battery ore was made in Nevada from low-grade Nevada and Utah ores. Manganiferous zinc residuum was produced from New Jersey zinc ores.

TABLE 3.—Metallurgical manganese ore shipped from mines in the United States, 1944–48 (average) and 1949–53, by States, in short tons

State	1944–48 (average)	1949	1950	1951	1952	1953
Alabama	16		138			
Arizona	1,997	223	222	173	203	(1)
Arkansas	3,185	2,851	1,224	3,718	2,246	6,123
California	4,642	280	37		3,589	720
Georgia	438					
Missouri						(2)
Montana	133,922	107,399	119,694	91,080	90,772	102,878
Nevada	4,778			58	105	18,368
New Mexico	1,126		1,320	226	2,360	
Oregon						46
South Carolina	304					
Tennessee	99	175	133		126	2,625
Texas					56	
Utah	6		120		95	
Virginia	5,784		56		1,011	8,454
Washington	2,723				436	(1)
Undistributed						746
Total	159,020	110,928	122,944	95,255	100,999	139,960

[1] Included with "Undistributed."
[2] Small tonnage included with "Undistributed."

TABLE 4.—Ferruginous manganese ore shipped from mines in the United States 1944–48 (average) and 1949–53, by States, in short tons

State	1944–48 (average)	1949	1950	1951	1952	1953
Arizona	88			224		
Arkansas	6,957	5,555	6,359	1,429	896	
California	922	386	640		56	534
Colorado	17				76	
Georgia	446					
Michigan	390					
Minnesota	24,553	3,482	16,206	14,728	31,502	201,090
Montana	3,492	5,517	6,810	7,598	9,357	5,598
Nevada	8,799	4,964	8,942	1,250	7,947	25,064
New Mexico	95,722		74,348	79,605	52,934	(1)
North Carolina						(2)
Oregon						271
South Carolina	34					
Tennessee	1,556					
Utah	10,987	4,981	1,964	1,369	3,397	5,155
Virginia	2,714	1,279				
Washington					142	
Wyoming						(1)
Undistributed						35,026
Total	156,677	26,164	115,269	106,203	106,307	272,738

[1] Included with "Undistributed."
[2] Small tonnage included with "Undistributed."

TABLE 5.—Manganiferous iron ore shipped from mines in the United States, 1944–48 (average) and 1949–53, by States, in short tons

State	1944–48 (average)	1949	1950	1951	1952	1953
Michigan	9,474		117,619	[1] 69,626	22,095	76,251
Minnesota	1,173,162	986,720	853,632	[1] 995,923	880,616	890,401
New Mexico		65,511		239		
Utah			1,077			
Total	1,182,636	1,052,231	972,328	[1] 1,065,788	902,711	966,652

[1] Revised figure.

As of the end of the year, total deliveries at the various low-grade GSA depots since inception of the programs, expressed in terms of long-ton units of contained manganese, were as follows: Butte and Philipsburg, 429,000; Deming, 790,000; and Wenden, 2,089,000. Quota for the combined Montana depots is 6 million long-ton units, and the same ultimate quantity is authorized for each of the other 2. The grade of the ore accepted averaged approximately 20 percent manganese at Butte and Wenden, 27 percent at Deming, and 30 percent at Philipsburg. Deliveries on the carlot program since its inception totaled 557,000 long-ton units out of an authorized 19 million. The average manganese content of ore received on this program was not far above the 40-percent minimum called for in the specifications.

Montana, with 72 percent of the domestic production, was the principal manganese-ore-producing State, but Nevada became important with the advent of manganese-nodule shipments by Manganese, Inc. Montana's production of metallurgical ore consisted of Anaconda nodules, averaging 57 percent manganese, made from carbonate ore obtained from the mines at Butte. Manganese, Inc., at Henderson, Nev., processed Three Kids oxide ore to produce nodules of 47-percent manganese content. Arizona, Arkansas, California, Missouri, Oregon, Tennessee, Virginia, and Washington also reported shipments of metallurgical manganese ore.

Battery-grade concentrates were produced in Montana by Trout Mining Division of American Machine & Metals, Inc., and at the Ladd mine in California by Teekay Mines, Inc., subsidiary of Taylor Knapp Co. Western Electrochemical Co., at Henderson, Nev., produced 2,332 short tons of synthetic battery ore; the raw material was entirely of domestic origin.

Ferruginous manganese ores were shipped from California, Minnestoa, Montana, Nevada, New Mexico, North Carolina, Oregon, Utah, and Wyoming, with Minnesota providing 74 percent of the total. Manganiferous iron ore was shipped from Minnesota and Michigan.

CONSUMPTION AND STOCKS

Consumption of manganese ore in 1953 exceeded that in the previous year by 21 percent, creating a new record. Domestic sources supplied 4 percent and foreign sources 96 percent compared with 5 and 95 percent, respectively, in 1952, 7 and 93 percent in each of the years 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 increased 35 percent to 1.7 million short tons.

Allocation of manganese ores was suspended May 19, 1953, but the Government retained authority to issue special directives covering deliveries.

The consumption in 1953 of manganese as ferroalloys and directly charged ore per short ton of open-hearth, bessemer, and electric steel produced was 13.5 pounds compared to 13.6 pounds in 1952. Of the 13.5 pounds, 12.1 pounds was in the form of ferromanganese, 1.15 pounds of silicomanganese, 0.2 pound of spiegeleisen, and 0.05 pound of ore and manganese metal. These data apply to the consumption of manganese in the production of steel ingots and that part of steel castings produced by companies that also manufacture steel ingots. The companies reporting in this part of the survey approximate those reporting production to the American Iron and Steel Institute. If the manganese consumed by companies that produce only castings is also taken into account, the total pounds of manganese consumed per short ton of steel in 1953 becomes 14.1, of which 12.5 represents ferromanganese, 1.3 silicomanganese, 0.2 spiegeleisen, and 0.1 ore, metal, and briquets.

TABLE 6.—Manganese and manganiferous ores shipped from mines in the United States in 1953, by States

	Metallurgical			Battery			Total			
	Shippers	Short tons		Shippers	Short tons		Shippers	Short tons		Value
		Gross weight	Manganese content		Gross weight	Manganese content		Gross weight	Manganese content	
Manganese ore: [1]										
Arizona	1	(2)	(2)				1	(2)	(2)	(3)
Arkansas	9	6,123	2,812				9	6,123	2,812	$526,647
California	4	720	287	1	4,693	1,751	5	5,413	2,038	(3)
Missouri	1	(4)	(4)				1	(4)	(4)	(3)
Montana	1	102,878	58,641	1	10,551	4,664	2	113,429	63,305	(3)
Nevada	4	18,368	8,561	4	[5] 1,782	[5] 1,006	7	20,150	9,567	1,684,555
Oregon	1	46	18				1	46	18	(3)
Tennessee	3	2,625	1,044				3	2,625	1,044	201,898
Utah				1	[6] 550	[6] 311	1	550	311	(3)
Virginia	8	8,454	3,321				8	8,454	3,321	635,926
Washington	1	(2)	(2)				1	(2)	(2)	(3)
Undistributed		746	319					746	319	(3)
Total	33	139,960	75,003	7	17,576	7,732	39	157,536	82,735	[7] 12,479,759
Ferruginous manganese ore: [8]										
California	4	534	142				4	534	142	[7] 10,355
Minnesota	2	201,090	24,030				2	201,090	24,030	(3)
Montana	1	5,598	1,299				1	5,598	1,299	(3)
Nevada	10	25,064	5,200				10	25,064	5,200	[7] 431,559
New Mexico	1	(2)	(2)				1	(2)	(2)	(3)
North Carolina	1	(4)	(4)				1	(4)	(4)	(3)
Oregon	1	271	68				1	271	68	(3)
Utah	8	5,155	1,301				8	5,155	1,301	[7] 82,316
Wyoming	2	(2)	(2)				2	(2)	(2)	(3)
Undistributed		35,026	3,963					35,026	3,963	(3)
Total	30	272,738	36,003				30	272,738	36,003	[7] 1,899,642
Manganiferous iron ore: [9]										
Michigan	1	76,251	5,246				1	76,251	5,246	(3)
Minnesota	3	890,401	50,672				3	890,401	50,672	(3)
Total	4	966,652	55,918				4	966,652	55,918	5,047,220

[1] Containing 35 percent or more manganese (natural).
[2] Included with "Undistributed."
[3] Included in total.
[4] Small tonnage included with "Undistributed."
[5] Prorated portion of synthetic battery ore produced in Nevada from low-grade Nevada ore.
[6] Prorated portion of synthetic battery ore produced in Nevada from low-grade Utah ore.
[7] Estimate.
[8] Containing 10 to 35 percent manganese (natural).
[9] Containing 5 to 10 percent manganese (natural).

TABLE 7.—Manganiferous raw materials available for consumption in the United States in 1953

	Ore containing 35 percent or more Mn		Ore and residuum containing 10 to 35 percent Mn		Ore containing 5 to 10 percent Mn	
	Short tons	Mn content (percent)	Short tons	Mn content (percent)	Short tons	Mn content (percent)
Domestic shipments	157,536	52.52	556,496	14.39	966,652	5.78
Imports for consumption	3,115,023	44.72	185,233	22.66		
Total available for consumption	3,272,559	45.09	741,729	16.45	966,652	5.78

TABLE 8.—Consumption of manganese ore and manganese alloys in the United States, 1952–53, and stocks Dec. 31, 1953, gross weight in short tons

Category of use and form in which consumed	Quantity consumed 1952	Quantity consumed 1953	Stocks, Dec. 31, 1953 [1] (including bonded warehouses)
Manganese alloys and manganese metal:			
Manganese ore:			
Domestic	84,097	74,089	6,310
Foreign	1,629,895	1,983,766	1,618,554
Total manganese ore	1,713,992	2,057,855	1,624,864
Ferromanganese, silicomanganese, and manganese metal			71,113
Spiegeleisen			19,776
Steel ingots and steel castings: [2]			
Manganese ore:			
Domestic	10	3,729	910
Foreign	1,288	341	17
Total manganese ore	1,298	4,070	927
Ferromanganese:			
High-carbon	684,745	810,649	115,646
Medium-carbon / Low-carbon	52,429	65,547	10,106
Total ferromanganese	737,174	876,196	125,752
Spiegeleisen	52,876	60,113	34,290
Silicomanganese	76,602	95,552	10,573
Manganese metal	1,246	896	195
Steel castings: [3]			
Manganese ore:			
Domestic	5	13	209
Foreign	647	234	250
Total manganese ore	652	247	459
Ferromanganese:			
High-carbon	33,630	29,370	6,296
Medium-carbon / Low-carbon	3,576	3,301	842
Total ferromanganese	37,206	32,671	7,138
Spiegeleisen	5,539	4,256	1,359
Silicomanganese	13,442	11,858	2,055
Manganese briquets	2,073	2,027	381
Manganese metal	266	301	55
Pig iron:			
Manganese ore:			
Domestic	5,143	6,707	9,400
Foreign	26,798	58,541	22,736
Total manganese ore	31,941	65,248	32,136
Dry cells:			
Manganese ore:			
Domestic	4,720	4,995	1,459
Foreign	35,177	36,552	21,428
Total manganese ore	39,897	41,547	22,887

See footnotes at end of table.

TABLE 8.—Consumption of manganese ore and manganese alloys in the United States, 1952–53, and stocks Dec. 31, 1953, gross weight in short tons—Con.

Category of use and form in which consumed	Quantity consumed		Stocks, Dec. 31, 1953 [1] (including bonded warehouses)
	1952	1953	
Chemicals:			
Manganese ore:			
Domestic	5,251	478	150
Foreign	16,158	26,297	10,095
Total manganese ore	21,409	26,775	10,245
Miscellaneous products:			
Ferromanganese:			
High-carbon	17,203	16,919	2,936
Medium-carbon Low-carbon	5,243	5,615	1,530
Total ferromanganese	22,446	22,534	4,466
Spiegeleisen	10,614	9,143	2,663
Silicomanganese	2,615	6,090	1,266
Manganese briquets	14,554	15,297	3,536
Grand total:			
Manganese ore:			
Domestic	99,226	90,011	18,438
Foreign	1,709,963	2,105,731	1,673,080
Total manganese ore	[4] 1,809,189	[4] 2,195,742	[5] 1,691,518
Ferromanganese:			
High-carbon	735,578	856,938	
Medium-carbon Low-carbon	61,248	74,463	137,356
Total ferromanganese	796,826	931,401	[6] 137,356
Spiegeleisen	69,029	73,512	58,088
Silicomanganese	92,659	113,500	[6] 13,894
Manganese briquets	16,627	17,324	[6] 3,917
Manganese metal [7]	1,512	1,197	[6] 250
Producers' stocks of ferromanganese, silicomanganese, and manganese metal	------------	------------	71,113

[1] Excluding Government stocks.
[2] Includes only that part of castings made by companies that also produce steel ingots.
[3] Excludes companies that produce both steel castings and steel ingots.
[4] The greater part of the consumption of ore was used in the manufacture of ferromanganese and silicomanganese. Combining consumption of ore with that of ferromanganese and silicomanganese would result in duplication.
[5] Excludes small tonnages of dealers' stocks.
[6] Excludes producers' stocks.
[7] Manufacturers of steel ingots and manufacturers of steel castings only.

Electrolytic Manganese and Manganese Metal.—Electro Manganese Corp., Knoxville, Tenn., completed its new plant in Knoxville, thereby doubling the company capacity for producing electrolytic manganese. Defense Materials Procurement Agency advanced funds for this expansion of facilities and agreed to purchase up to 36 million pounds of metal produced by the new equipment. The life of the contract is 5 years from the start of operations. The new plant was placed in operation in November, and rated capacity was attained before the end of the year. Electro Metallurgical Co. produced manganese metal in electric furnaces.

Ferromanganese.—Production of ferromanganese in the United States was 908,000 short tons in 1953, a 20-percent increase above the 759,000 tons of 1952. The following plants were active producers during the year: Anaconda Copper Mining Co., Anaconda and Black Eagle, Mont.; Bethlehem Steel Co., Johnstown, Pa.; Electro Metallurgical Co., Division of Union Carbide & Carbon Corp., Alloy, W.

Va., Ashtabula, Ohio, Marietta, Ohio, Niagara Falls, N. Y., and Sheffield, Ala.; E. J. Lavino & Co., Reusens, Va., and Sheridan, Pa.; New Jersey Zinc Co., Palmerton, Pa.; Ohio Ferro-alloys Corp., Philo, Ohio; Tennessee Products & Chemical Corp., Chattanooga, Tenn.; Tenn Tex Alloy & Chemical Corp., Houston, Tex.; United States Steel Corp., Ensley, Ala., Clairton, Duquesne, and Etna, Pa. The quantity of ferromanganese made in blast furnaces was almost three times that made in electric furnaces. Manganese ore consumed in the manufacture of ferromanganese totaled 1,905,000 short tons in 1953, including 4 percent of domestic origin and 96 percent foreign. The domestic portion in 1952 was 6 percent and in 1951 7 percent. The recovery of manganese from the ore was 82.0 percent in 1953 compared with 88.6 percent in 1952, 86.2 percent in 1951, and 83.6 percent in 1950. Shipments of ferromanganese from producing furnaces increased 22 percent in quantity and 38 percent in value from 1952.

TABLE 9.—Ferromanganese and spiegeleisen imported into and made from domestic and imported ores in the United States, 1952–53

	1952		1953	
	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]	55,356	42,591	49,338	39,472
From imported ore[2]	703,365	541,140	858,195	656,964
Total domestic production	758,721	583,731	907,533	696,436
Imported	64,095	51,029	126,518	98,207
Total ferromanganese	822,816	634,760	1,034,051	794,643
Spiegeleisen:[3]				
Domestic production[4]	58,666	11,663	97,729	19,041
Imported	44	[2] 8	785	[2] 141
Total spiegeleisen	58,710	11,671	98,514	19,182
Total available supply of metallic manganese in ferromanganese and spiegeleisen		646,431		813,825
Open-hearth, bessemer, and electric[5] furnace steel produced	93,168,039		111,609,719	
	Percent			
Available supply of metallic manganese in:				
Ferromanganese and spiegeleisen imported	7.90		12.08	
Ferromanganese made from imported ore	83.71		80.73	
Ferromanganese made from domestic ore	6.59		4.85	
Spiegeleisen made from domestic ore	1.80		2.32	
Ferromanganese and spiegeleisen made from domestic ore	8.39		7.17	
Spiegeleisen made and imported	1.81		2.36	
Mn in ferromanganese of domestic origin compared to total Mn in ferromanganese made and imported	6.7		5.0	
Mn in spiegeleisen of domestic origin compared to total Mn in spiegeleisen made and imported	99.9		98.4	

[1] Number of domestic plants making ferromanganese: 1952, 15; 1953, 18.
[2] Estimated.
[3] Number of domestic plants making spiegeleisen: 1952, 3; 1953, 4.
[4] Less than 1,000 short tons produced from foreign ore.
[5] Includes crucible.

TABLE 10.—Ferromanganese produced in the United States and metalliferous materials consumed in its manufacture, 1944–48 (average) and 1949–53

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		
1944–48 (average)	615,322	78.68	484,099	1,100,726	104,074	3,890	1.958
1949	577,345	78.33	452,249	1,054,445	114,924	2,540	2.025
1950	719,680	76.96	553,834	1,311,421	105,382	----------	1.969
1951	791,260	76.05	601,758	1,416,813	110,607	11,667	1.930
1952	758,721	76.94	583,731	1,364,618	83,614	18,227	1.909
1953	907,533	76.74	696,436	1,829,382	75,594	31,562	2.099

TABLE 11.—Manganese ore used in manufacture of ferromanganese in the United States, 1949–53, by source of ore

Source of ore	1949		1950		1951		1952		1953	
	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	114,924	59.13	105,382	58.02	110,607	58.34	83,614	56.95	75,594	57.48
Foreign:										
Africa	367,339	46.24	606,248	46.00	641,013	44.36	510,452	45.59	637,934	45.85
Brazil	138,917	40.76	128,940	40.82	146,108	40.83	118,842	40.03	192,280	40.20
Chile	3,838	47.78	7,279	47.68	8,484	47.15	12,586	47.21	36,456	43.95
Cuba	36,344	38.83	42,893	39.20	103,263	39.50	136,436	39.82	172,700	39.89
India	258,372	46.96	447,749	48.15	449,780	48.03	477,428	46.03	716,568	44.51
Indonesia	--------	-------	--------	-------	801	46.94	8,291	43.77	6,763	44.48
Mexico	27,952	40.81	25,851	41.48	40,402	40.81	51,571	40.84	42,675	41.99
New Caledonia	--------	-------	--------	-------	--------	-------	12,092	46.35	40	47.50
Philippines	10,922	45.12	5,036	46.84	5,232	44.76	7,064	41.19	8,586	41.52
Turkey	--------	-------	2,928	45.97	9,505	42.64	16,053	39.90	8,382	45.76
U. S. S. R.	210,761	44.91	44,497	43.59	10,097	46.01	--------	-------	508	45.87
Other	--------	-------	--------	-------	2,128	39.66	13,803	37.36	6,490	47.63
Grand total	1,169,369	46.41	1,416,803	46.77	1,527,420	45.71	1,448,232	45.07	1,904,976	44.56

TABLE 12.—Ferromanganese shipped from furnaces in the United States, 1944–48 (average) and 1949–53

Year	Short tons	Value	Year	Short tons	Value
1944–48 (average)	618,616	$80,353,705	1951	795,745	$122,346,198
1949	560,180	86,463,708	1952	738,088	133,996,006
1950	731,421	116,043,055	1953	900,110	185,192,588

Silicomanganese.—Increased use of silicomanganese was again evident in 1953, when the quantity consumed was 12.2 percent of ferromanganese consumption compared to 11.6 percent in 1952 and 10.5 percent in 1951. It is used by the steel industry as a furnace-control agent, as a deoxidizer, and as a means of adding manganese to the steel. It is particularly suited for use in producing either low-carbon or high-manganese steels.

Spiegeleisen.—Production of spiegeleisen in the United States increased 67 percent in 1953 to 98,000 short tons from 59,000 tons in 1952. Shipments from furnaces were virtually the same in 1953 as in 1952 but increased 9 percent in value. Four companies produced spiegeleisen in four plants in 1953: Inland Steel Co., East Chicago, Ind.; New Jersey Zinc Co., Palmerton, Pa.; Tenn Tex Alloy & Chemical Corp., Houston, Tex.; and United States Steel Corp., Clairton, Pa.

TABLE 13.—Spiegeleisen produced and shipped in the United States, 1944–48 (average) and 1949–53

Year	Produced (short tons)	Shipped from furnaces		Year	Produced (short tons)	Shipped from furnaces	
		Short tons	Value			Short tons	Value
1944–48 (average)	132,641	132,312	$4,798,997	1951	77,017	79,168	$5,368,989
1949	78,167	53,888	2,972,653	1952	58,666	67,129	4,730,631
1950	42,375	65,163	3,875,823	1953	97,729	67,247	5,144,470

Manganiferous Pig Iron.—Pig-iron furnaces used 1,248,000 short tons of manganese-bearing ores containing (natural) over 5 percent manganese in 1953. Of this total, 1,061,000 tons was of domestic origin and 187,000 tons foreign. Of the domestic ores used, 994,000 tons contained (natural) 5 to 10 percent manganese, 61,000 tons contained 10 to 35 percent manganese, and 7,000 tons contained over 35 percent manganese. Of the foreign ores used, none contained less than 10 percent manganese, 128,000 tons contained (natural) 10 to 35 percent manganese, and 59,000 tons contained 35 percent or more manganese.

TABLE 14.—Foreign ferruginous manganese ore and manganiferous iron ore consumed in the United States, 1950–53, in short tons

Source of ore	Ferruginous manganese ore				Manganiferous iron ore			
	1950	1951	1952	1953	1950	1951	1952	1953
Africa	2,034	2	1,048	626	43,725			
Brazil			361					
Egypt	92,905	87,455	152,483	129,490				
Total	94,939	87,457	153,892	130,116	43,725			

Battery and Miscellaneous Industries.—Manufacturers of dry-cell batteries consumed 42,000 short tons of manganese ore in 1953 or 4 percent more than in 1952. Of the total, 5,000 short tons was of domestic origin, a slightly higher proportion than in the previous year. Chemical plants used 27,000 short tons, of which only 500 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 were 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 manganese 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 $1.20 to $1.22 per long-ton unit of manganese, c. i. f. United States ports, duty extra, and immediately dropped to $1.18 to $1.21, which continued to be quoted until the early part of August. Prices then gradually dropped, to close the year at $1.08 to $1.10 nominal, with little demand for offerings of average grade. Long-term contracts for ore from various sources were quoted at the beginning of the year as nominal at 90 to 93 cents and at the end of the year nominal at 90 cents, c. i. f. United States ports, duty extra. Quotations for chemical ores by E&MJ Metal and Mineral Markets remained unchanged throughout the year at $65 to $75 per ton for foreign ore of 80-percent manganese dioxide content and $45 to $50 for domestic ore containing 70 to 72 percent manganese dioxide. 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 subject to an impost of 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 1953 was $205.74 per short ton compared with $181.54 in 1952. Shortly before the middle of the year the principal eastern producers using blast furnaces changed their method of pricing ferromanganese from a gross-ton basis for alloy of 78- to 82-percent manganese content, to a short-ton basis for alloy of 74- to 76-percent manganese content. The new carlot price was set at $200 per short ton or 10 cents per pound of alloy and remained unchanged to the end of the year. The old price, which prevailed at the beginning of the year, was the equivalent of 10.10 cents per pound. According to Iron Age, the selling price of ferromanganese in carlots at eastern centers averaged 10.04 cents per pound for the year. The average value for spiegeleisen shipped, f. o. b. domestic furnaces, was $76.50 per short ton in 1953 compared with $70.47 in 1952. The quoted price on a gross-ton basis, as given by Iron Age for spiegeleisen of 19- to 21-percent manganese content, was $85 for the first 5 months of the year and $86 for the remainder, giving an average of $85.58. Price controls on ferroalloys were removed by Office of Price Stabilization on March 17.

FOREIGN TRADE[2]

Imports of manganese ore for 1953 were the highest on record, surpassing the previous year's alltime high by almost 1 million short tons. The average grade—44.9 percent manganese compared with 45.2 and 46.1 percent for 1952 and 1951, respectively—decreased only slightly, considering the large increase in tonnage. As in the previous 2 years, no ore was received from the Soviet Union; however, Russian ore reentered world markets in the course of the year.

United States imports from India established a new record for any supplying country for the second consecutive year by climbing to 1¼ million short tons. India provided 37 percent of the total ore received. Four countries—India, Gold Coast, Union of South Africa, and Cuba—in that order of importance, with the last three rather closely grouped, again supplied three-fourths of the total United States imports, as they did in 1952.

Import data shown in table 16 include receipts of ore classified as battery and chemical grade, totaling 93,218 short tons in 1953, and averaging 54.5 percent manganese or 86.2 percent manganese dioxide. Of this quantity, 76,270 tons came from Gold Coast, 1,565 from India, 7,997 from French Morocco, 6,210 from Cuba, and 1,176 from Chile. Imports for consumption of battery and chemical grade totaled 87,070 short tons valued at $4,301,841 or $49.41 per short ton f. o. b. foreign ports. Of the total, Gold Coast supplied 70,122 tons valued at $3,491,882; India, 1,565 tons at $35,960; French Morocco, 7,997 at $447,451; Cuba, 6,210 at $278,480; and Chile, 1,176 at $48,068.

Imports for consumption of ferromanganese in 1953 increased 97 percent over 1952 to 126,518 short tons, and the value increased 84 percent. Exports of ferromanganese decreased 23 percent to 1,112 short tons. Exports of manganese ore and concentrates (10 percent or more manganese) totaled 6,894 short tons valued at $552,359.

[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 16.—Manganese ore (35 percent or more Mn) imported into the United States, 1952–53, by countries [1]

[U. S. Department of Commerce]

Country	General imports [2] (short tons)				Imports for consumption [3]					
					Short tons				Value	
	Gross weight		Mn content		Gross weight		Mn content			
	1952	1953	1952	1953	1952	1953	1952	1953	1952	1953
Angola	[4] 64,463	63,863	31,501	31,141	[4] 68,297	64,395	33,655	31,343	$3,030,600	$2,768,024
Australia	-----	10,320	-----	4,541	-----	10,320	-----	4,541	-----	347,500
Belgian Congo	54,144	140,478	27,000	70,198	56,321	140,478	28,032	70,198	2,496,334	5,784,670
Brazil	169,372	169,768	75,052	75,821	174,241	155,373	77,448	68,844	4,300,963	4,863,567
British Western Pacific Islands	-----	1,176	-----	588	-----	-----	-----	-----	-----	-----
Burma	-----	554	-----	324	-----	-----	-----	-----	-----	-----
Chile	[4] 28,590	61,799	[4] 12,733	28,306	21,733	32,416	9,646	13,969	757,713	1,126,079
Costa Rica	91	364	38	167	-----	455	-----	206	-----	12,111
Cuba	259,230	397,257	113,051	172,355	259,230	397,257	113,051	172,355	8,801,648	13,990,786
French Morocco	85,316	73,587	[4] 42,872	36,761	74,191	66,730	37,159	33,616	[4] 3,343,136	3,313,568
French Pacific Islands	22,459	7,963	10,303	3,699	9,628	14,360	4,529	6,459	353,533	424,019
Gold Coast	[4] 368,069	511,259	[4] 177,377	253,355	[4] 282,053	333,622	135,350	164,526	8,204,873	14,309,989
Greece	8,372	6,569	3,175	2,982	1,350	4,046	547	1,660	29,446	104,265
India	1,028,289	1,296,905	461,763	572,640	772,456	1,218,174	352,018	539,871	[4] 22,318,538	38,449,667
Indonesia	13,126	6,984	5,959	3,092	13,878	7,390	6,340	3,472	567,414	292,235
Mexico	135,718	171,462	57,214	70,936	92,251	129,862	39,258	55,227	2,675,885	3,886,241
New Zealand	545	-----	265	-----	545	-----	265	-----	24,887	-----
Peru	3,687	4,704	1,736	2,005	3,755	1,153	1,766	570	140,046	39,326
Philippines	10,587	12,955	4,677	5,859	10,587	12,955	4,677	5,859	321,594	459,187
Portugal	-----	6,593	-----	3,106	-----	-----	-----	-----	-----	-----
Portuguese Asia	55,815	88,565	23,902	36,961	45,777	79,210	[4] 19,417	33,070	1,686,791	3,027,397
Turkey	41,149	39,513	18,545	18,140	18,908	40,803	8,319	18,793	666,577	1,764,381
Union of South Africa	319,719	428,348	140,552	177,943	298,305	406,024	129,567	168,421	6,110,503	8,548,845
United Kingdom	[4] 39	-----	[4] 24	-----	[4] 39	-----	[4] 24	-----	[4] 4,410	-----
Total	[4] 2,668,780	3,500,986	[4] 1,207,739	1,570,920	[4] 2,203,545	3,115,023	[4] 1,001,068	1,393,000	[4] 65,834,891	103,511,857

[1] Changes for 1951 in Minerals Yearbook, 1952, p. 698, are as follows: Brazil, $1,786,310; total, $44,964,130.
[2] Ore received in the United States during year; part went into consumption, and remainder entered bonded warehouses.
[3] Receipts during year for consumption and ore withdrawn from bonded warehouses during year; excludes imports for manufacture in bond and export.
[4] Revised figure.

TABLE 17.—Ferromanganese imported for consumption in the United States 1951–53, by countries

[U. S. Department of Commerce]

Country	1951			1952			1953		
	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
Canada	67,374	52,878	$10,918,197	29,020	22,735	$5,473,927	341	286	$94,221
France	13,356	10,444	1,714,963	3,834	2,995	579,759	21,052	16,827	4,464,421
Germany	67	32	5,198	[1] 63	[1] 25	[1] 5,198	[1] 51,856	[1] 38,894	[1] 19,358,900
Japan	165	133	22,773	------	------	----------	23,236	17,445	4,007,749
Mexico	------	------	------	------	------	----------	89	70	16,075
Norway	38,637	31,344	7,358,514	30,296	24,674	8,550,625	29,832	24,604	9,223,263
Yugoslavia	165	115	26,494	882	600	149,435	112	81	16,380
Total	119,764	94,946	20,046,139	64,095	51,029	14,758,944	126,518	98,207	27,181,009

[1] West Germany.

TABLE 18.—Spiegeleisen[1] imported for consumption in the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Year	Gross weight (short tons)	Value	Year	Gross weight (short tons)	Value
1944–48 (average)	1,453	$62,685	1951	----------	----------
1949	1,737	86,217	1952	44	$3,658
1950	8,595	474,259	1953	785	63,149

[1] Exclusive of spiegeleisen containing not more than 1 percent carbon, manganese metal, and manganese boron.

TABLE 19.—Ferromanganese exported from the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Year	Gross weight (short tons)	Value	Year	Gross weight (short tons)	Value
1944–48 (average)	8,850	$1,292,099	1951	633	$206,614
1949	6,627	1,360,279	1952	1,453	474,686
1950	580	139,876	1953	1,112	389,064

TECHNOLOGY

The Rolla, Mo., station of the Bureau of Mines developed methods for melting, fabricating, and treating manganese-copper alloys having high damping capacity and satisfactory mechanical properties.

In the hydrometallurgical pilot plant of the Bureau of Mines at Boulder City, Nev., a caustic leach of silica from western low-grade manganese ores or concentrates of high silica content showed promise for upgrading such materials to meet specifications of metallurgical-grade ore. The spent leach liquors were regenerated by treatment with fresh-burned lime to precipitate the silica as calcium silicate.[3] Work on the dithionate leach process was continued in the pilot plant, improving process and product and obtaining data necessary for estimating costs for commercial application. In the dithionate process, manganese is extracted with sulfur dioxide and recovered as high-grade manganese hydroxide by precipitation with lime.

Bureau of Mines laboratory tests on the electrolysis of sodium sulfate solutions developed a cyclic method for processing manganese ores. Sodium sulfate is electrolyzed in a diaphragm cell to give an anolyte containing sulfuric acid and a catholyte containing caustic soda, part of which is carbonated in a cyclic manner to form soda ash. Reduced ore is leached with the anolyte to dissolve the manganese, and the impurities are precipitated by addition of catholyte. Manganese in the pregnant solution is precipitated as synthetic rhodochrosite with a carbonated catholyte, and sodium sulfate is regenerated. Calcining the manganese carbonate gives a high-grade product, and the carbon dioxide is returned to the carbonation step. The cells used were equipped with synthetic fiber diaphragms and permselective membranes which permit transfer of anions or cations during electrolysis.

Sulfatization of Cuyuna manganiferous carbonate slate was accomplished in the Bureau of Mines Minneapolis pilot plant, using a differential, high-temperature, sulfur dioxide-air roast in a 20-inch-diameter shaft furnace, 80-percent manganese extraction being obtained with good manganese-iron ratios. The raw material was first calcined at relatively low temperature to obtain better permeability for action of the sulfatizing gas. The temperature range for conversion of the manganese content to water-soluble sulfate is between 600° and 850° C. In this range iron sulfate is not produced, and phosphorus does not convert to a water-soluble form. In these tests sulfur dioxide gas was diluted with 9 parts of air to simulate the gas which might be expected to be produced by the roasting of pyrite and pyrrhotite concentrates.

Continued experimental work by the Bureau of Mines at College Park, Md., on shaft-furnace chloridization of ore from the Maple Mountain-Hovey Mountain area of Aroostook County, Maine, using hydrogen chloride gas, resulted in extracting approximately 90 percent of the manganese and 45 percent of the iron content of the feed in the form of a sublimate consisting mainly of the dichlorides of manganese and iron, with comparatively minor quantities of potassium, sodium, magnesium, and aluminum chlorides. These chlorides were then hydrolyzed at 600° to 700° C. in an atmosphere consisting of 10 parts of steam to 1 part of hydrogen chloride. Oxides of manganese and iron were recovered in the residue and hydrogen chloride in the condensate. A recovery system involving a recirculating solution of 75-percent sulfuric acid recovered the hydrogen chloride as a dry gas for reuse in the chloridizing furnace. The material from Maple Mountain-Hovey Mountain has its manganese content largely in the form of silicates, while that from the Dudley Farm area of the northern district, Maine, has much of its manganese as carbonate.

[3] Lundquist, R. V., Upgrading Domestic Manganese Ores by Leaching With Caustic Soda: Min. Eng., vol. 5, No. 4, April 1953, pp. 413–417.

Leaching of the Dudley Farm material with dilute (7 percent) sulfuric acid obtained extractions of more than 90 percent of its manganese content, with an acid consumption of 3.8 pounds per pound of manganese extracted.

Work also continued at College Park, in cooperation with the American Iron and Steel Institute, on the pilot-plant investigation of the lime-clinkering carbonate-leach process for recovering manganese from various open-hearth slags. In the process, manganese is released from its combination with silica or other acid constituents by clinkering with limestone. The manganese oxides in the clinker are then reduced by hydrogen or carbon monoxide to MnO, which is dissolved selectively in an ammoniacal solution of ammonium carbonate. The manganese is then precipitated as the carbonate by distilling off a portion of the ammonia.

Silicomanganese produced from rhodonite material at the Bureau of Mines, Albany, Oreg., station responded satisfactorily to use tests in a steel-plant open hearth. Additional electric smelting tests at Albany produced high-silicon ferromanganese and high-manganese spiegeleisen as ultimate products from rhodonite and other highly siliceous manganese-bearing raw materials.

In June, Defense Materials Procurement Agency announced the signing of a contract with E. S. Nossen Laboratories, Inc., Paterson, N. J., for installing a half-million dollar pilot plant to test the Nossen nitric acid process for recovering manganese from low-grade materials. Essentially the process consists of grinding the feed to minus 60-mesh, reduction in a reducing atmosphere to manganous oxide, leaching out the manganese with nitric acid, addition of sulfuric acid to remove impurities, concentration of the manganese nitrate solution, and its subsequent decomposition in the presence of air at 200° C. to obtain manganese dioxide and nitric acid. The manganese dioxide, free of phosphorus and iron, is then purified by washing.[4]

The United States Steel Corp. pioneered at its Duquesne works by placing in operation in July a plant containing 5 electrostatic precipitators to clean gas from 2 ferromanganese furnaces. Because of fineness of the dust contained in the gases, standard gas-cleaning equipment could not be used. Since the start of operations the specially designed equipment has effectively cleaned the gas and produced briquets from the precipitated dust. These will provide a source of manganese when means to remove their alkali content are developed.[5]

Pioche Manganese Co., an affiliate of Combined Metals Reduction Co., began producing ferromanganese in electric furnaces at Henderson, Nev., from the complex manganese-lead-zinc ore of Pioche, Nev. The ore is floated to produce a manganese concentrate, and the lead and zinc are recovered as separate concentrates. The manganese concentrates are then fed to a rotary kiln to produce manganese nodules, which serve as feed for the ferromanganese furnaces.[6]

A new steel-alloy wire was developed for the Signal Corps by Battelle Memorial Institute. Manganese in the range of 14.5 to 18.5 percent replaced nickel and part of the chromium contained in the

[4] Nossen, E. S., Manganese Concentration From Low-Grade Domestic Ore—Nossen Nitric Acid Cycle: Ind. Eng. Chem., vol. 43, No. 7, July 1951, pp. 1695–1700.
[5] Good, C. H., Ferromanganese Furnace Fumes Cleaned Successfully: Iron Age, vol. 174, No. 2, July 8, 1954, pp. 95–97.
[6] Mining and Contracting Review, vol. 55, No. 8, August 1953, pp. 6–8, 12.

stainless steel wire formerly used. The new high-strength wire is flexible, is not easily magnetized, and has relatively low electrical conductivity, good workability, and moderate corrosion resistance.[7]

A new use for manganese is indicated as an alloying element in titanium alloys. One such alloy having small percentages of manganese and iron is claimed to increase the tensile strength of titanium by at least 25 percent.

The substitution of titanium for manganese in the sulfur control of steel continued to receive considerable study.

WORLD REVIEW

The data in table 20 are from official statistics of the various countries, supplemented by information from semiofficial and other sources.

Angola.—During the first 5 months of 1953 production of manganese ore by Companhia do Manganese de Angola was at the rate of 7,000 metric tons per month, with most of the production coming from the Quitota mines, located 31 kilometers southwest of Quizenga Station on the Luanda railway. A fleet of 15-ton trucks was used to haul the ore to the station. An appreciable tonnage of manganese ore has been more or less confirmed in the area, although some of this is of high iron and silica content.[8] Angola's total production for the year was 66,000 metric tons averaging approximately 48 percent manganese.

Australia.—Exports of manganese ore were resumed in 1953, having been largely prohibited throughout the previous year.

Belgian Congo.—Construction of a washing plant was begun at the Kisenge mine of Beceka Manganese, the Congo's principal producer of manganese ore, and experimental sintering of fines was carried out at the Lubumbashi smelter. The latter work indicated that the grade of the fines could be raised from 42 to 50 percent manganese. Should these results be confirmed by later tests, consideration will be given to installing a sintering plant.[9] The Kisenge mine produced 203,000 metric tons of ore in 1953 compared with 116,000 tons in 1952, accounting for most of the Congo's 1953 production. The remaining 13,000 tons came from the Kasakalesa mine of SUDKAT, which is now close to exhaustion. Besides increased production at Kisenge, improved transportation facilities, particularly on the Benguela railway, and improved ore-handling facilities at Lobito contributed to increased exports. All of the 1953 exports passed through the port of Lobito, Angola; approximately 80 percent of the shipments went to the United States.[10]

Brazil.—It is reported that the Brazilian firm, Mineracão Bomfim Limitada, is actively working manganese deposits discovered 2 or more years ago along the Aripuana River in the inland State of Amazonas and that some of this ore has been exported from the port of

[7] Iron Age, Steel Alloys Will Save Nickel: Vol. 172, No. 21, Nov. 19, 1953, p. 100.
[8] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 2, August 1953, pp. 27–28.
[9] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 6, December 1953, pp. 28–29.
[10] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 1, July 1954, p. 13.

TABLE 20.—World production of manganese ore, by countries [1], 1944–48 (average) and 1949–53, in metric tons [2]

[Compiled by Berenice B. Mitchell and Pearl J. Thompson]

Country [1]	Percent Mn	1944–48 (average)	1949	1950	1951	1952	1953
North America:							
Canada (shipments)		41					
Cuba	36–50+	133,269	62,503	79,209	154,091	251,677	[3] 353,218
Mexico	40+	48,566	53,900	32,400	79,190	141,696	244,816
United States (shipments)	35+	151,737	114,427	121,971	95,260	104,670	142,914
South America:							
Argentina	35–38	[3] 3,585	(4)	1,200	2,500	(4)	(4)
Brazil (exports)	38–50	164,825	149,896	148,339	119,900	172,510	166,101
Chile	40–50	22,958	28,870	33,530	36,578	[3] 48,600	[3] 60,000
Peru	40+	25		762	946	2,215	[3] 3,200
Europe:							
Greece	35+	183	150	320	10,592	22,924	12,533
Hungary (concentrates) [3]	35–48	25,980	40,000	40,000	40,000	40,000	40,000
Italy	30	17,473	24,302	19,434	28,557	40,570	39,156
Portugal	35+	5,196	508	798	7,615	11,065	12,546
Rumania	30–36	[3] 23,161	66,816	(4)	(4)	(4)	(4)
Spain	40+	25,171	18,651	19,002	20,790	28,493	28,968
Sweden	30+	(4)		58	(4)	(4)	(4)
Switzerland		1,707					
U. S. S. R. (estimate)	[5] 41+	1,602,400	1,500,000	2,000,000	2,500,000	2,500,000	[5] 3,500,000
United Kingdom		5,874					
Yugoslavia	30+	6,707	13,837	13,338	12,868	12,687	10,017
Asia:							
Burma	35+	[3] 308			[3] 2,000	6,604	8,718
China	41	[3] 15,576	(4)	(4)	(4)	(4)	(4)
India	40+	368,092	656,190	897,100	1,304,536	1,485,733	[3] 1,752,700
Indonesia		2,845				7,833	16,986
Iran [6]	36–46		[3] 4,200	[3] 9,360	7,179	6,700	11,680
Japan	32–40	120,793	100,000	134,066	198,000	207,376	183,899
Korea, Republic of	30–48	(4)	(4)	100	2,247	7,416	3,058
Malaya	30	1,016		[7] 72	[7] 195		
Philippines	35–51	[3] 9,788	26,288	29,867	22,343	20,627	21,508
Portugese India	32–50+	1,199	16,220	38,220	86,793	111,066	150,000
Turkey	30–50	4,698	22,576	32,178	50,517	106,395	74,884
Africa:							
Angola	48	1,000	18,600	9,308	46,192	55,094	65,864
Belgian Congo	50	9,768	12,247	16,990	70,945	127,978	216,664
French Morocco	35–50	91,740	233,825	287,265	372,233	426,316	429,517
Gold Coast (exports) [8]	48	641,767	752,963	722,784	819,018	806,934	757,963
Rhodesia:							
Northern	30+				1,280	3,989	7,243
Southern		[9] 10	166			1,433	
South-West Africa				993	6,560	26,507	36,881
Spanish Morocco	50	[9] 13	653	36	1,122	3,635	3,419
Tunisia	35–40	68					
Union of South Africa	40+	204,786	655,175	790,937	758,870	874,637	827,656
Oceania:							
Australia		1,984	13,303	15,108	8,096	7,182	19,083
Fiji		[9] 71	102	203	641	2,042	(4)
New Caledonia	45+		2,100	5,392	20,135	16,850	4,715
New Zealand		255	310	358	408	324	294
Papua		127	[10] 163	22	41	(4)	43
Total (estimate)		3,800,000	4,600,000	5,600,000	7,000,000	7,800,000	9,300,000

[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: 1944–48 (average), 12,010; 1949, 138,568; 1950, 152,169; 1951, 155,364; 1952, 209,164; and 1953, 278,806; occasionally a small tonnage contains more than 35 percent manganese.

[2] This table incorporates a number of revisions of data published in previous Manganese chapters.

[3] Estimate.

[4] Data not available; estimate by author of chapter included in total.

[5] The 1953 production estimated for ore of 35 percent or more manganese content.

[6] Year ending March 20 of year following that stated.

[7] Exports.

[8] Dry weight.

[9] Average for 1 year only, as 1948 was first year of production.

[10] Year ending June 30 of year stated.

Itacoatiara.[11] Reports in the Manaus newspaper, Jornal do Comercio, indicate that important surface deposits of high-grade manganese ore have been recently discovered in the border region between the States of Amazonas and Para.[12] To insure manganese ore for Brazil's heavy industries, the Government considered prohibiting its export from the mines of Conselheiro Lafaiete, Saude, Bournier, and Itabira in the State of Minas Gerais.[13] It was announced that the Brazilian National Accounts Court had approved and registered a contract with Bethlehem Steel Corp. running until 1968, for the annual export of 1 million tons of manganese ore from the Amapa deposits.[14]

Authorization of an Export-Import Bank loan of up to $67 million was announced early in January, together with signing of a Defense Materials Procurement Agency purchase contract, to further the development and eventual production of 5.5 million tons of good-grade manganese ore from the Amapa deposits in the federal territory of that name, north of the Amazon River delta. At least 70 percent of the above tonnage is to be offered to the United States, the United States Government to receive a total of 400,000 tons of ore during the first 2 years, with option to receive 30 percent of the total output. The DMPA contract runs until June 30, 1962, or until repayment of the loan, should that be accomplished sooner. A floor price of 65 cents per long-ton unit, based on 45- to 47-percent manganese content (c. i. f. eastern seaboard ports), is guaranteed for any part of the production offered to the United States Government up to 5.5 million tons. With the funds now made available, development necessary to large-scale production can be accomplished. This includes construction of 134 miles of railroad to the port of Santana on the north bank of the Amazon River near its mouth, towns at mine and river, dock and loading facilities, and mine plant. Bethlehem Steel Corp. has a stock interest in Industria e Comercio de Minerios, S. A. (Icomi), the Brazilian corporation undertaking the project. A contract between the United States Steel Corp, and the State of Mato Grosso was reported as awaiting final approval by the Brazilian Government to clear the way for development and mining of the large Urucum deposits near the Bolivian border.

British Guiana.—Extensive exploration of the manganese concessions of Barima Gold Mining Co. (Canada), Ltd., was continued by African Manganese Co., Ltd.[15] Similarity between the geology of the northwestern district of British Guiana and that of Gold Coast was noted in the Report of the British Guiana Geological Survey Department for 1951.[16]

Canada.—The very large proved reserves of iron ore at the properties of Iron Ore Co. of Canada include 40,045,000 long tons of manganiferous iron ore averaging 50.25 percent iron and 7.70 percent manganese in the Quebec deposits and 13,321,000 long tons averaging 49.93 percent iron and 7.45 percent manganese in the Labrador deposits. Several companies were interested in prospecting and exploring manganiferous deposits in the Bathurst and Woodstock areas of New Brunswick.

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[11] United States Consulate, State Department Dispatch 93: Belem, Para, Brazil, June 8, 1953, 2 pp.
[12] United States Consulate, State Department Dispatch 94: Belem, Para, Brazil, June 11, 1953, 2 pp.
[13] Mining World, vol. 15, No. 13, December 1953, p. 77.
[14] Daily Metal Reporter, vol. 53, No. 142, July 23, 1953, p. 1.
[15] Northern Miner, vol. 39, No. 27, Sept. 24, 1953, p. 18.
[16] Mining Magazine, vol. 88, No. 4, April 1953, pp. 249–250.

Chile.—A résumé of the manganese industry in Chile up to 1953 was published.[17]

Cuba.—The Charco Redonda mine in Oriente Province continued to supply the major portion of Cuba's production of manganese ore; all of its output was direct shipping ore. Numerous small mines contributed the remaining portion of the island's production, which included some chemical ore. Several companies were extensively exploring large, low-grade deposits.

French Equatorial Africa.—Agreements were completed between Government authorities concerned and Cie. Miniére de l'Ogooue (Comilog), with the result that the firm can proceed to develop and mine its manganese deposits in Gabon. United States Steel Corp. has a 49-percent interest in Comilog, and the balance is divided between three French firms. The deposits lie northwest of Franceville, roughly 250 miles inland from Pointe Noire. The ore is believed to occur as a tabular body approximately 15 feet thick and to occupy an area of 36 square miles, with only a thin cover of soil. The deposit has been known since 1938, and it is said that initial work has confirmed an estimate of 50 million to 75 million tons of ore averaging 48 to 50 percent manganese after sorting. Transportation remains a problem to be solved, but plans call for first shipment of ore in 1960, with 300,000 tons a year going to United States Steel Corp.[18] [19]

French Morocco.—An aerial tramway for transporting ore over the High Atlas Mountains was completed late in the year. It is 29 kilometers long and will mean savings in transportation costs for the important Imini and Ti Ouine mines in South Morocco. Capacity is 50 tons an hour.[20] Proved reserves at Imini in 1952 totaled 7 million metric tons of ore, averaging 47 percent manganese. Production was then at the rate of 200,000 tons a year; 140,000 tons of which was sintered at Sidi Marouf, 20,000 tons exported directly to France, and 40,000 tons exported as chemical ore. The ore occurs as well-crystallized pyrolusite in three virtually horizontal sedimentary beds at relatively shallow depths. An average analysis, as found in prospecting, gave 49.86 percent manganese, 77.35 percent manganese dioxide, 3.0 percent iron, 8.77 percent silica, and 1.06 percent lead. Mining has been both open-pit and underground, with timbering an appreciable cost item. The desert location of the mine dictates use of a dry method of concentration, with the result that pneumatic tables are used. The product of the sinter plant for 1951 had an average manganese content of 56.05 percent; the concentrate feed averaged 49.86 percent manganese.[21]

Goa (Portuguese India).—Exports of manganese ore from Goa totaled 207,000 long tons in 1953, a 43-percent increase over the 145,000 tons exported in 1952. The United States received 86 percent of Goa's 1953 exports.[22]

Gold Coast.—For the third consecutive year, African Manganese Co., Ltd., produced approximately 800,000 tons of manganese ore.

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17 Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 2, February 1953, pp. 17–21.
18 Mining World, vol. 15, No. 7, June 1953, p. 67.
19 Mining World, vol. 16, No. 5, April 15, 1954, p. 93.
20 Mining World, vol. 16, No. 2, February 1954, p. 58.
21 Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 3, March 1954, pp. 15–19.
22 Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 2, February 1954, pp. 25–26.

With the exception of approximately 1,000 tons a month from the mine at Hotopa, the entire output came from the Nsuta mine. Additional rolling stock and earth-moving equipment were delivered, and 2,490,000 tons of earth and rock was handled.[23]

India.—Shivrajpur Syndicate, largest producer in Bombay State, and Central Provinces Manganese Ore Co., Ltd., of Nagpur, are believed to be the only two companies in India engaged in underground mining for manganese ore. Both operations are mechanized to some extent. The Shivrajpur and Bamankua mines of Shivrajpur Syndicate mine ore of the following percentage analysis:

Grade	Mn	Fe	SiO_2	P
First	50.00	4.75	6.00	0.245
Second	46.30	5.55	9.30	.252
Third	44.00	5.70	12.50	.245

The ore at the Shivrajpur mines lies in two steeply dipping reefs, intensely folded along the strike. One averages 48 percent or more manganese content and is approximately 1 mile long; the other averages 42 percent manganese and is roughly 800 feet shorter. The ore in both is said to extend 500 feet in depth, becoming progressively higher in grade and hardness. The Shivrajpur mines are about 300 feet above sea level. At the Bamankua mine, 4 miles from the Shivrajpur rail station, the reef runs 2,500 feet along strike and is 100 feet wide. The ore is harder than that at Shivrajpur. Other manganese-mining operations of Bombay States are described.[24] The large mine owners sell their production on long-term contracts direct to foreign buyers; the small mine owners usually sell theirs at either the railhead or the port to mineral exporters or to other dealers. Foreign buyers frequently pay 70 to 80 percent of the value of the ore upon shipment, paying the balance after receipt of analyses made in the purchaser's laboratories. Most of the manganese ore from Bombay State is exported through the port of Bombay, but an appreciable tonnage goes through Mormugao, Goa.

Iran.—The only manganese mine being worked at the beginning of 1953 in Iran was reported to be the Robat Karim mine, 24 kilometers southeast of Tehran, with a production rate of 300 metric tons of ore a month, averaging 46 percent manganese.[25]

Mexico.—Reported output of manganese ore in 1953 was 245,000 tons averaging 31.0 percent Mn compared with 1952 output of 142,000 tons averaging 31.8 percent Mn. Domestic consumption of 1,000 tons monthly is not included. The reported output for both years was exported to the United States.[26] As part of a 3-year program to develop sources of manganese on this continent, Defense Materials Procurement Agency signed contracts for purchasing 550,000 tons of low-grade Mexican manganese ore for delivery to an El Paso, Tex., depot for later processing to meet steel-industry requirements. The price to be paid is $19.30 per long ton for ore containing 25 percent manganese (equivalent to 77.2 cents per long-ton unit), f. o. b. freight cars at the depot, with a premium of 70 cents per ton for each 1 percent

[23] Mining World, vol. 16, No. 5, Apr. 15, 1954, p. 93.
[24] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 5, November 1953, pp. 14–28.
[25] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 2, February 1953, p. 23.
[26] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 4, April 1954, p. 24.

of manganese content above 25 percent Mn and a penalty of $1.00 per ton for each 1 percent below 25 percent, down to and including 20 percent; ore containing less than 20 percent manganese or more than 20 percent silica not acceptable. The ore is to come from approximately 100 mines in the States of Chihuahua, Durango, Zacatecas, San Luis Potosi, and Jalisco.

Norway.—A Netherlands firm was reported to be engaged in experimental mining of manganese-ore layers at Bremsnuten, Telemark, southern Norway.[27]

Philippines.—Manganese deposits are widespread in the Republic but seldom of large size. High labor costs, drastic import controls on equipment and supplies, lack of transportation facilities, high cost of lighterage, and unsettled conditions in many parts of the islands have been given as factors discouraging venture capital, in spite of good prices.[28] Manganese-ore reserves in 1949 were estimated at more than 500,000 metric tons, of which General Base Metals was credited with 201,000 tons averaging 45 percent Mn. At the end of 1951 reserves for the company were estimated at 200,000 tons of positive ore, plus 500,000 tons each of probable and possible ore, with only a small portion of the claims explored. In 1953 the company was constructing a sintering plant; much of the company production was being exported to Japan.[29]

Solomon Islands.—Surveys have suggested that manganese deposits may soon be worked.[30]

South-West Africa.—The report of South African Minerals Corp., Ltd., for the period from November 1, 1952, to January 31, 1953, stated that 2 diamond drills had been purchased and prospecting of the 350-square-mile concession continued. Exports for the period were 9,128 long tons of ore.[31] Due to increased mechanization, output for the 5 months ended October 30, 1953, was reported to have increased considerably, but operations were affected by a shortage of native labor.[32]

Surinam.—African Manganese Co. was expected to begin exploration of a tract under option along the Surinam Railway between kilometers 90 and 100.[33]

Union of South Africa.—Most of the present production of manganese ore comes from the Postmasburg district, where it occurs as tabular deposits or irregular bodies in sedimentary rocks. Mining is by "open-cast methods or modifications applicable to shallow depths." Manganese ore is also mined to a limited extent in the Krugersdorp district.[34] The chairman of South African Manganese, Ltd., reported to shareholders that higher export prices and improved railway-car supply were responsible for the greatly increased profits for the fiscal year ended June 30, 1953; large quantities of ore were supplied to local consumers; promising deposits of manganese ore were discovered as a result of intensive geophysical and geological work over an extensive area under option in the Kuruman district; and prospecting operations were being continued.[35]

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27 Mining World, vol. 15, No. 13, December 1953, p. 69.
28 Engineering and Mining Journal, vol. 154, No. 3, March 1953, pp. 97–99.
29 Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 2, August 1953, pp. 29–31.
30 Chemical Engineering and Mining Review (Melbourne), vol. 46, No. 2, Nov. 10, 1953, p. 73.
31 Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 3, September 1953, p. 30.
32 Mining World, vol. 16, No. 1, January 1954, p. 70.
33 Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 6, December 1953, p. 30.
34 South African Mining and Engineering Journal, vol. 64, pt. 1, No. 3152, July 11, 1953, p. 799.
35 South African Mining and Engineering Journal, vol. 64, pt. 2, No. 3176, Dec. 26, 1953, p. 651.

U. S. S. R.—According to Russian sources, mechanization of the Chiatura mines of West Georgia is well advanced.[36]

Venezuela.—Concessions in the State of Bolivar, east of Upata, were being explored, and indications were that the work would lead toward eventual production of manganese ore from the district.

Yugoslavia.—Rhodochrosite is found in the lead-zinc mines of Trepca and Zletovo. A separating plant with an annual capacity of 24,000 tons of manganese concentrates was scheduled for the Zletovo mine for completion in 1954. At Trepca (Zvecan) the extraction of manganese from flotation tailings was under exploration and development.[37] [38]

[36] Mining Journal (London), vol. 240, No. 6132, Feb. 27, 1953, p. 244.
[37] Metal Bulletin (London), No. 3759, Jan. 13, 1953, p. 22.
[38] Mining World, vol. 15, No. 12, November 1953, pp. 78, 80.

Mercury

By Helena M. Meyer[1] and Gertrude N. Greenspoon[2]

ALMOST unprecedented imports featured the mercury industry in 1953, for the second successive year. The year was featured also by moderately higher domestic production, a substantial rise in industrial consumption, and a falling price.

Only in 1949 were receipts of the metal from abroad larger than in 1953. In the latter year Government barter contracts, using surplus commodities, contributed substantially to the large movement of mercury to the United States, whereas in 1949, purchases of surplus supplies from Italy with Economic Cooperation Administration counterpart funds and largely for the National Stockpile, accounted for the alltime record. Forty-four percent of imports in 1953 were from Italy and 33 percent from Spain; Mexico supplied 16 percent, or almost double receipts in 1952 and the largest since the war year 1944. On the other hand, entries from Yugoslavia dropped markedly in 1953. Total imports (general) were 85,800 flasks in 1953, 68,700 in 1952, and 96,900 in 1949.

Exports (550 flasks) and reexports (920) together amounted to only 2 percent of imports.

Mercury producers did not expand output notably, despite the highest 3-year price level of all time. Production rose 14 percent above 1952 to 14,300 flasks compared with 12,500 flasks, but was only about one-third of the average annual rate in 1941–45. California supplied 65 percent of the total in 1953, Nevada 23 percent, Idaho 7 percent, and Oregon 5 percent.

Ten mines (7 in California and 1 each in Nevada, Idaho, and Oregon) supplied 96 percent of the total.

TABLE 1.—Salient statistics of the mercury industry in the United States, 1944–48 (average) and 1949–53

[Flasks of 76 pounds]

	1944–48 (average)	1949	1950	1951	1952	1953
Production	26,286	9,930	4,535	7,293	12,547	14,337
Number of producing mines	56	23	16	47	39	48
Average price per flask: New York	$102.34	$79.46	$81.26	$210.13	$199.10	$193.03
Imports for consumption	29,405	103,141	56,080	47,860	71,855	83,393
Exports	821	577	447	241	400	546
Consumption	43,743	39,857	49,215	56,848	42,556	52,259

Industrial consumption of mercury rose 23 percent in 1953 largely because three new chlorine and caustic soda plants using mercury cells were opened, and capacity at another plant was expanded. The additional quantities needed for these plants were offset partly by abandonment of the process at another such plant. The new plants were at Anniston, Ala., Calvert City, Ky., and Moundsville, W. Va.,

[1] Assistant chief, Base Metals Branch.
[2] Statistical assistant.

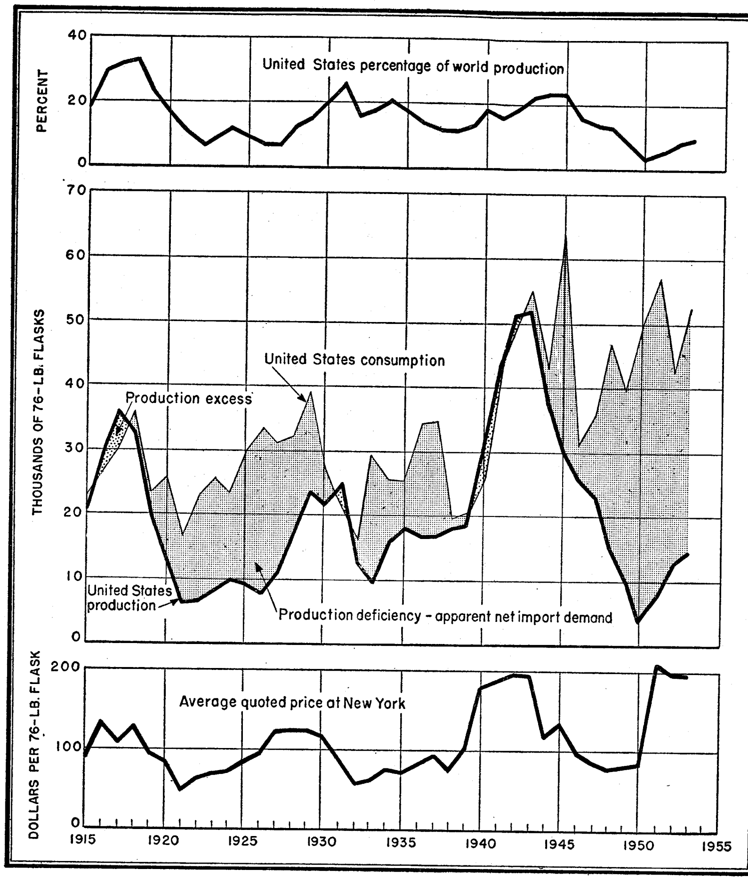

FIGURE 1.—Trends in production, consumption, and price of mercury, 1915–53.

and the expansion was at Syracuse, N. Y. The closed plant was at Jersey City, N. J. Another large plant, completed but not put into operation in 1952, continued idle in 1953. Use of mercury for agricultural purposes and wood insecticides, fungicides, and bactericides, increased in 1953, and for other purposes increases and decreases were fairly equally divided.

With more than enough mercury available for all normal requirements, mercury prices trended downward, with only one minor interruption, from the first week in the year until October. In the final quarter of 1953, as in 1952, imports of metal were higher than in other quarters; but, nonetheless, in the final quarters of both years spot metal supplies became scarce, and the downtrends in prices were reversed.

World production of mercury rose 7 percent, according to preliminary data. Spain and Italy, by far the largest mercury-producing countries, had respectively an increase of 15 percent and a decrease of 8 percent that were virtually counterbalancing on a quantity basis. Japan, Mexico, and the United States had increases of 104, 33, and 14

TABLE 2.—Salient statistics of the mercury industry, 1910–53

Year	Production			Imports for consumption (flasks of 76 lb.)	Exports (flasks of 76 lb.)	Apparent consumption (flasks of 76 lb.)	Price	
	World (flasks of 76 lb.)	United States (flasks of 76 lb.)	United States (percent of world total)				Average per flask of 76 lb. at New York	Adjusted by wholesale index [1]
1910	107,053	20,330	19	9	1,898	18,441	[2] $47.69	$104
1911	120,423	20,976	17	6,209	287	26,898	[2] 47.16	112
1912	120,650	24,734	21	1,088	306	25,516	[2] 43.03	96
1913	117,465	19,947	17	2,259	1,125	21,081	[2] 40.07	88
1914	108,601	16,330	15	8,090	1,427	22,993	[2] 48.95	110
1915	112,871	20,756	18	5,551	3,328	22,979	[2] 88.17	195
1916	101,544	29,538	29	5,585	8,763	26,360	[2] 127.16	229
1917	115,087	35,683	31	5,138	10,636	30,185	[2] 107.72	141
1918	99,256	32,450	33	6,631	3,057	36,024	[2] 125.12	147
1919	89,940	21,133	23	10,495	8,987	22,641	[2] 93.38	104
1920	84,470	13,216	16	13,982	1,533	25,665	[2] 82.20	82
1921	61,916	6,256	10	10,462	388	16,330	[2] 46.07	73
1922	91,819	6,291	7	16,697	287	22,701	[2] 59.74	95
1923	93,040	7,833	8	17,836	314	25,355	[2] 67.39	103
1924	89,138	9,952	11	12,996	205	22,743	[2] 70.69	111
1925	103,344	9,053	9	20,580	201	29,432	[2] 84.24	125
1926	115,969	7,541	7	25,634	114	33,061	[2] 93.13	143
1927	149,905	11,128	7	19,941	(3)	[4] 30,900	118.16	191
1928	149,083	17,870	12	14,562	(3)	[4] 32,300	123.51	196
1929	162,699	23,682	15	14,917	(3)	[4] 38,500	122.15	197
1930	108,985	21,553	20	3,725	(3)	[4] 25,200	115.01	205
1931	99,069	24,947	25	549	[5] 4,984	20,512	87.35	184
1932	82,644	12,622	15	3,886	[5] 214	16,294	57.93	138
1933	59,828	9,669	16	20,315	(3)	[4] 29,700	59.23	138
1934	76,939	15,445	20	10,192	(3)	[4] 25,400	73.87	152
1935	100,261	17,518	17	7,815	(3)	[4] 25,200	71.99	138
1936	123,878	16,569	13	18,088	263	34,400	79.92	152
1937	133,136	16,508	12	18,917	454	35,000	90.18	161
1938	150,000	17,991	12	2,362	713	19,600	75.47	148
1939	145,000	18,633	13	3,499	1,208	20,900	103.94	207
1940	215,000	37,777	18	171	9,617	[6] 26,800	176.87	346
1941	275,000	44,921	16	7,740	2,590	[6] 44,800	185.02	326
1942	265,000	50,846	19	[7] 38,941	[7] 345	[6] 49,700	196.35	306
1943	236,000	51,929	22	[7] 47,805	[7] 385	[6] 54,500	195.21	291
1944	163,000	37,688	23	19,553	750	[6] 42,900	118.36	175
1945	131,000	30,763	23	68,617	1,038	[6] 62,429	134.89	196
1946	154,000	25,348	16	13,894	907	[6] 31,552	98.24	125
1947	168,000	23,244	14	13,008	884	[6] 35,581	83.74	87
1948	107,000	14,388	13	31,951	786	[6] 46,253	76.49	73
1949	121,000	9,930	8	103,141	577	[6] 39,857	79.46	80
1950	143,000	4,535	3	56,080	447	[6] 49,215	81.26	79
1951	147,000	7,293	5	47,860	241	[6] 56,848	210.13	183
1952	151,000	12,547	8	71,855	400	[6] 42,556	199.10	178
1953	161,000	14,337	9	83,393	546	[6] 52,259	193.03	175

1 Quoted price divided by Bureau of Labor Statistics wholesale price index (1947–49=100).
2 Quoted price for 75-pound flask calculated to equivalents for 76-pound flasks.
3 Not separately classified for 1927–30 and 1933–35.
4 Estimated by Bureau of Mines.
5 From a special compilation, Bureau of Foreign and Domestic Commerce.
6 Actual consumption.
7 Large quantities reexported in 1942 and 1943 are included in imports but not exports.

percent, respectively, in 1953. Yugoslavia's output continued at the high rate for 1950-52.

The new modern large plant for treating mercury ores being installed at the Almaden mine, Spain, was completed in 1953. The probable eventual level of production was not indicated.

Cartel.—A recent report [3] credited to Minas de Almaden y

3 American Metal Market, Mercury: vol. 60, No. 215, Nov. 6, 1953, p. 8.

Arrayanes, Spanish member of Mercurio Europeo before the Spanish-Italian mercury cartel dissolved at the beginning of 1950, denied the allegation that the cartel had been reestablished. A company spokesman stated that the break was final and that it was completely untrue that a production agreement existed between Spain and Italy.

Defense Minerals Exploration Administration.—The chapter on Mercury in 1952 listed exploration loans granted by DMEA to the end of 1952. The assistance advanced amounts to 75 percent of costs for approved mercury-exploration contracts. The following applicants were awarded contracts in 1953:

State and contractor:	*Project location*	*Value* *Total*	*Value* *Government participation*
Alaska:			
DeCoursey Mountain Mining Co.	Otter Mining District	$81,000	$60,750
Do	Georgetown Mining district.	88,349	66,262
California:			
Walabu Mining Co	Kern County	26,000	19,500
Ronnie Smith	Contra Costa County	73,571	55,178
Oregon:			
Morris L. & Chas. J. Page DBA Strickland Butte Mines.	Crook County	5,600	4,200
Bonanza Oil & Mine Corp	Douglas County	50,056	37,542
Roba & Westfall	Grant County	20,140	15,105

On May 15 mercury was removed [4] from the list of minerals eligible for exploration benefits under provisions of the Defense Production Act, as amended.

DOMESTIC PRODUCTION

Mercury production in the United States trended upward without interruption from 1950 through 1953, more than trebling during that period, but output in 1950 was the smallest in 100 years, and that in 1953 was only 42 percent of the annual average for the 10-year period 1938–47. As has been stated before in the Minerals Yearbook chapters on mercury, mine owners and lessers were not encouraged to return to large scale production by the relatively high prices of recent years. The World War II experience of unstable prices, with attendant adverse effects on producers, had been recent enough to be well remembered.

California continued to rank first in production in 1953, supplying 65 percent of the total for the United States, and Nevada was in its customary second place, with 23 percent; Idaho ranked third and Oregon fourth.

The number of producing properties increased from 39 in 1952 to 48 in 1953. This was the largest number of producers, by a scant margin over 1951, since 1946. Among the additions to producers in 1953 were the Red Devil, Alaska; Cloverdale, Calif.; and Fresno, Tex. The Cloverdale mine produced for the first time since 1943.

Of the 48 producing mines in 1953, 10, each producing 100 flasks or more, supplied 96 percent of total production. The largest producers are listed here.

[4] Reinstated in March 1954.

TABLE 3.—Mercury produced in the United States, 1950–53, by States

Year and State	Producing mines	Flasks of 76 pounds	Value [1]
1950:			
California	14	3,850	$312,851
Nevada	1	680	55,257
Oregon	1	5	406
Total	16	4,535	368,514
1951:			
Arizona and Texas	3	77	16,180
California	27	4,282	899,777
Idaho	1	357	75,016
Nevada	12	1,400	294,182
Oregon	4	1,177	247,323
Total	47	7,293	1,532,478
1952:			
Alaska	1	28	$5,575
California	24	7,241	1,441,683
Idaho	1	887	176,602
Nevada	9	3,523	701,429
Oregon	4	868	172,819
Total	39	12,547	2,498,108
1953:			
Alaska	2	40	7,721
California	28	9,290	1,793,249
Idaho and Texas	2	1,105	213,298
Nevada	11	3,254	628,120
Oregon	5	648	125,083
Total	48	14,337	2,767,471

[1] Value calculated at average price at New York.

TABLE 4.—Mercury produced in the United States, 1910–53, 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

[1] Includes States shown as "(2)".
[2] Included with "Other." Bureau of Mines not at liberty to publish separately.

California.—Lake County, Abbott; San Benito County, New Idria (including San Carlos); San Luis Obispo County, La Libertad; Santa Clara County, Guadalupe; Sonoma County, Cloverdale, Culver-Baer, and Mount Jackson (including Great Eastern).

Idaho.—Valley County, Hermes.

Nevada.—Humboldt County, Cordero.

Oregon.—Douglas County, Bonanza.

TABLE 5.—Mercury produced in the United States, 1944–48 (average) and 1949–53, by quarters, in flasks of 76 pounds

Quarter	1944–48 (average)	1949	1950	1951	1952	1953
First	7,430	1,440	1,700	880	3,050	3,530
Second	7,140	1,460	1,010	1,400	3,000	3,790
Third	6,430	} 6,980	{ 1,100	1,600	3,320	3,040
Fourth	5,080		630	3,270	3,130	3,970
Total: Preliminary	26,080	9,880	4,440	7,150	12,500	14,330
Final	26,286	9,930	4,535	7,293	12,547	14,337

For many years the grade of mercury ore treated in the United States trended downward, as shown by table 6; but the downtrend was interrupted in 1944–47, and in 1947 the average tenor of ore more than doubled that in 1941–42. The grade then dropped again to little more than half the 1947 average in 1951 but recovered again in 1952 and 1953, increasing 1.3 pounds in that period.

TABLE 6.—Mercury ore treated and mercury produced therefrom in the United States, 1927–53 [1]

[That material from old dumps which is not separable is included with ore]

Year	Ore treated (short tons)	Mercury produced: Flasks of 76 pounds	Mercury produced: Pounds per ton of ore	Year	Ore treated (short tons)	Mercury produced: Flasks of 76 pounds	Mercury produced: Pounds per ton of ore
1927	99,969	10,711	8.1	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				

[1] Excludes mercury produced from placer operations and from clean-up activity at furnaces and other plants.

In addition to the mercury produced at the mines in 1953, at least 2,800 flasks was reported produced from scrap, compared with 2,500 flasks in 1952 and 2,000 flasks in both 1951 and 1950. Additional unreported quantities were known to have been recovered.

A report on the quicksilver deposits of Steens Mountain and Pueblo Mountains, Harney County, Oreg., was published recently.

An abstract of the report follows: [5]

The object of this survey was to examine the quicksilver deposits with the hope of locating large tonnages of low-grade ore.

The deposits occur in the south-central part of Harney County and are more than 100 miles from either Burns, Oreg., or Winnemucca, Nev., the nearest towns. The region is sparsely settled by stockmen; Fields, Denio, and Andrews are the only settlements.

The range consisting of Steens Mountain and Pueblo Mountains is a dissected fault block, 90 miles long in a north-south direction and as much as 25 miles wide, tilted gently to the west. Pre-Tertiary metamorphic and plutonic rocks occur at the southern end, but most of the block consists of Pliocene volcanic rocks. The major boundary faults on the east side of the range are concealed by alluvium. Minor northwestward-trending faults branch from them, their throws diminishing toward the crest of the range; other minor fractures occur near, and parallel to, the mountain front. The quicksilver lodes were formed in and along these subsidiary fractures.

The lodes occur in a more or less continuous belt just west of the eastern front of the range. They are steeply dipping and arranged in subparallel clusters, commonly standing out as resistant siliceous ribs against the softer kaolinized rocks that flank them. The lodes were formed in two hydrothermal stages, the first producing the reef-like masses of chalcedony and quartz with their halos of limonitic and calcitic clays and the second introducing silica and barite along with sulfides of iron, copper, and mercury. The second stage, the ore producer, was possible only where the siliceous lodes were fractured by movements later than the first period of alteration. The ore minerals occur in veins of chalcedony, clear quartz, and barite, or in open crush-breccias of reef rock. The veins seldom exceed 6 inches in thickness, and the breccia bodies measure only tens of feet. The primary ore minerals are chiefly mercurian tetrahedrite (schwatzite), chalcopyrite, and cinnabar, the latter being the only producer of mercury. In a host of secondary minerals an earthy mixutre of cinnabar and "limonite" is of particular interest because it forms by weathering of schwatzite.

The primary ore minerals show a marked lateral variation. In the southern part of the district hematite, pyrite, and chalcopyrite, accompanied by a little schwatzite, are dominant. A few miles to the north schwatzite increases greatly in amount, chalcopyrite is abundant, and a little primary cinnabar is present. From the central part of the district northward, primary cinnabar increases in relation to the other sulfides until, at the northern end of the district, it is the only ore mineral.

The total production of quicksilver, which has come chiefly from the Mogul and Alexander mines and the Steens Mountain prospect, has been only about 55 flasks. Judged from ore in sight, future production is not likely to be greater. There are no low-grade ore bodies of large tonnage, and high-grade ore is irregularly distributed. The region must remain one for the operator equipped with a small retort for the treatment of hand-picked ore.

Deposition of mercury ores in the Terlingua district, Texas, was described in a report [6] recently released.

The report is abstracted as follows:

The geologic relations of the Terlingua quicksilver deposits, considered together with more general chemical and physical limitations, serve to indicate the probable mode of transportation and causes of deposition of the ore. In the zone of deposition, the ore-bearing fluid was a liquid or a mixed liquid and vapor, as shown by replacement of limestone. Deposition at a representative depth of 900 feet took place under the following probable conditions: a fluid pressure of about 30 atmospheres (certainly less than 66 atmospheres); a temperature near 200° C (certainly less than 286° C). The ore-bearing fluid contained sulfur, chlorine, iron, ammonia, and at least 10^{-5} percent of mercury (0.1 part per million). It had a pH greater than 6. Concentration of a large part of the ore beneath relatively impermeable rocks was caused by hydrodynamic conditions that involved floating of the ore-bearing fluid on cooler and heavier meteoric water, thus

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[5] Williams, Howel, and Compton, Robert R., Quicksilver Deposits of Steens Mountain and Pueblo Mountains, Southeast Oregon: Geol. Survey Bull. 995-B, 1953, pp. 19–77.

[6] Thompson, Geo. A., Transportation and Deposition of Quicksilver Ores in the Terlingua District, Texas: Econ. Geol., vol. 49, No. 2, March-April 1954, pp. 175–197.

largely restricting the ore-bearing fluid to the upper part of the permeable zone. Precipitation of cinnabar may have been caused by changes in temperature and pressure in the presence of a gas phase, by dilution, and to a small extent by chemical reaction with clay. Supersaturated or colloidal solutions are postulated to explain the sporadic distribution of ore on a small scale, and a catalytic effect of the clay on supersaturated solutions is suggested.

CONSUMPTION AND USES

Mercury consumption rose 23 percent above 1952; it was 8 percent less than the alltime peacetime peak in 1951, but otherwise was the largest since the war year 1945. As in 1951, the high rate of consumption was caused chiefly by the expansion of chlorine and caustic soda capacity. In 1953 three new installations were using mercury cells, and another such plant was expanded. This overall expansion was offset only in small part by abandonment of the process at another plant. Still another plant, completed in 1952 but not put into operation, continued idle in 1953. The new plants were at Anniston, Ala., Calvert City, Ky., and Moundsville, W. Va.; the expansion was at Syracuse, N. Y.; and the closed plant was at Jersey City, N. J.

The use of mercury for pharmaceuticals increased 33 percent over the small quantity for 1952. Agricultural use, which includes in-

TABLE 7.—Mercury consumed in the United States, 1944–48 (average) and 1949–53, in flasks of 76 pounds

Use	1944–48 (average)	1949	1950	1951	1952	1953
Pharmaceuticals	6,010	3,443	5,996	2,761	1,395	1,858
Dental preparations	778	[1] 963	[1] 1,458	[1] 803	[1] 1,027	[1] 1,117
Fulminate for munitions and blasting caps	930	149	289	494	337	39
Agriculture (includes insecticides, fungicides, and bactericides for industrial purposes)	4,518	4,667	4,504	7,737	5,886	6,936
Antifouling paint	1,370	1,683	3,133	2,500	1,178	655
Electrolytic preparation of chlorine and caustic soda	661	755	1,309	1,543	2,507	2,380
Catalysts	4,013	2,520	2,743	2,635	1,048	826
Electrical apparatus	9,737	[1] 7,323	[1] 12,049	[1] 10,250	[1] 8,018	[1] 9,630
Industrial and control instruments	4,536	[1] 5,016	[1] 5,385	[1] 6,158	[1] 6,412	[1] 5,546
Amalgamation	123	165	192	154	151	200
General laboratory	329	345	646	524	629	1,241
Redistilled	6,617	[1] 6,642	[1] 7,600	[1] 8,776	[1] 7,547	[1] 7,784
Other	3,934	6,186	3,911	12,513	6,421	14,047
Total	[2] 43,743	39,857	49,215	56,848	42,556	52,259

[1] 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 1944–52, compared with 47 percent for instruments, 7 percent for dental preparations, and 36 percent for electrical apparatus in 1953.

[2] The items, which were on a partial coverage basis in 1944, do not add to the total.

TABLE 8.—Mercury consumed in the United States, 1944–48 (average) and 1949–53, by quarters, in flasks of 76 pounds

Quarter	1944–48 (average)	1949	1950	1951	1952	1953
First	10,580	10,400	10,600	16,000	10,100	12,700
Second	13,380	7,600	11,300	11,600	9,500	13,200
Third	10,060	8,000	12,400	7,400	13,200	11,000
Fourth	9,680	13,900	15,300	21,600	10,200	15,500
Total: Preliminary	43,700	39,900	49,600	56,600	43,000	52,400
Final	43,743	39,857	49,215	56,848	42,556	52,259

secticides, fungicides, and bactericides for industrial purposes, rose 18 percent, and electrical use took 20 percent more than in 1952. Among the applications that required less metal than in 1952 were antifouling paint, which continued the decline from 1950 (falling 44 percent), and industrial and control instruments, which dropped 14 percent.

STOCKS

Consumers' and dealers' inventories of mercury declined 23 percent in 1953, a drop that was anticipated, because of the starting up during the year of chlorine capacity at new and expanded plants. Metal had been accumulated over a period for the new installations. A large part of the metal in industry's hands continued to be held at another large chlorine plant completed more than a year before but not put into operation by the end of 1953. Except for such metal, inventories were well below those normally held by industry. Of the total metal held on December 31, 80 percent was in the hands of 10 companies; 5 companies held 73 percent.

TABLE 9.—Stocks of mercury in hands of producers and of consumers and dealers, 1949–53, in flasks of 76 pounds

End of year	Producers	Consumers and dealers	Total
1949	5,354	15,600	20,954
1950	2,719	32,900	35,619
1951	1,072	29,100	30,172
1952	685	33,700	34,385
1953	1,121	25,900	27,021

Stocks held by domestic producers usually comprise only a small fraction of the total for the industry as a whole. These stocks rose 64 percent in 1953 but continued small in relation to most earlier recent years.

In addition to the metal shown in table 9, noteworthy quantities of mercury are held in the National Stockpile, but data on such quantities may not be disclosed.

The Office of Defense Mobilization assumed responsibility for the direction and administration of the National Stockpile program (PL 520, as amended) on June 12, 1953, in accordance with the provisions of Reorganization Plan No. 3.

In the current list of strategic and critical materials mercury was included in Group 1, described as follows:

Materials in Group 1 will be acquired through purchases pursuant to Section 3 (a) and by transfer of Government-owned surpluses pursuant to Section 6 (a) of Public Law 520, 79th Congress.

PRICES

The average annual mercury quotation in 1953 was 3 percent less than in 1952 and 8 percent below the alltime peak in 1951; other than for those years, however, the annual price was higher than in all earlier years except 1942 and 1943. Conditions of ample world supply in relation to requirements until the final quarter of the year resulted in a downtrending price. Large contracts for mercury in the latter

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part of the year seriously reduced the availability of spot metal at least, and the price trend reversed. At the beginning of the year, prices ranged from $217 to $219 a flask; they fell continuously, with one minor exception, to $183 to $185 in October and rose to $187 to $189 at the year end. The monthly quotation for October—$183.42—was the lowest since December 1950. Weekly price changes in 1953 are shown in table 11.

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, 1951–53

Month	1951			1952			1953		
	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	$195.00	$167.37	$27.63	$206.35	$205.14	$1.21	$212.96	$199.01	$13.95
February	215.27	204.59	10.68	202.00	205.11	[3] 3.11	205.09	199.44	5.65
March	217.33	204.62	12.71	207.00	206.26	.74	198.12	199.20	[3] 1.08
April	215.60	204.66	10.94	203.77	206.03	[3] 2.26	195.89	199.27	[3] 3.38
May	212.92	204.65	8.27	199.62	204.59	[3] 4.97	195.00	198.87	[3] 3.87
June	210.00	204.66	5.34	195.24	203.28	[3] 8.04	191.92	198.07	[3] 6.15
July	206.80	204.62	2.18	189.81	181.79	8.02	190.46	198.20	[3] 7.74
August	195.85	204.52	[3] 8.67	187.00	180.90	6.10	188.31	198.18	[3] 9.87
September	206.25	204.52	1.73	190.68	179.48	11.20	185.20	193.15	[3] 7.95
October	216.96	204.57	12.39	191.00	180.15	10.85	183.42	178.31	5.11
November	216.30	204.65	11.65	201.82	189.36	12.46	184.09	173.57	10.52
December	213.20	204.24	8.96	214.89	198.52	16.37	185.92	173.54	12.38
Average	210.13	203.37	6.76	199.10	194.89	4.21	193.03	192.49	.54

[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 1953 [1]

Week ended—	Price range	Week ended—	Price range
Jan. 7	$217–$219	July 1	$191–$193
14	215–217	8	191–193
21	212–214	15	191–193
28	210–212	22	190–192
Feb. 4	208–210	29	190–192
11	207–209	Aug. 5	190–192
18	205–207	12	188–191
25	203–205	19	188–191
Mar. 4	202–204	26	188–191
11	200–203	Sept. 2	188–191
18	195–197	9	186–189
25	200–203	16	186–188
Apr. 1	200–203	23	184–186
8	198–201	30	184–186
15	195–197	Oct. 7	184–186
22	195–197	14	184–186
29	195–197	21	183–185
May 6	195–197	28	183–185
13	195–197	Nov. 4	183–185
20	195–197	11	183–185
27	195–197	18	184–186
June 3	195–197	25	185–187
10	193–195	Dec. 2	185–187
17	191–193	9	185–187
24	191–193	16	186–188
		23	186–188
		30	187–189

[1] E&MJ Metal and Mineral Markets.

Mercury was quoted in London at a range of £70 10s. to £71 (equivalent to $197.40 to $198.80) from the first week in January through the third week in May and at £70 5s. to £70 10s. (equivalent to $196.70 to $197.40) from the following week through September 3. The range was £70 to £70 10s. for the next 2 weeks, and then the price dropped to £64 15s. (equivalent to $181.30) for the period through the middle of October, declined to £61 15s. (equivalent to $172.90) the following week and continued at that level throughout the remainder of the year. Thus the London price did not strengthen as it did in the United States at the end of the year.

FOREIGN TRADE [7]

Receipts of mercury for consumption in the United States in 1953 were 83,400 flasks, or 16 percent more than 1952, only 19 percent less than the alltime record of 103,100 flasks in 1949, and second only to that record. Government barter contracts, involving surplus commodities, contributed substantially to the large receipts of mercury in 1953.

Demand and prices for mercury trended downward from the first of the year until the last months, when the trend was reversed. Forty-eight percent of the imports were received in the final quarter of the year, and press reports were to the effect that a large part of the anticipated foreign production in the first part of 1954 was under contract at the year end. The foregoing trends followed closely movements in 1952.

Tariff.—A duty of 25 cents a pound ($19 a flask) on imports of mercury has been in effect since 1922.

Exports of mercury rose 37 percent in 1953. This relatively small quantity class continued to be negligible in relation to total imports.

Reexports, relatively insignificant, were larger than exports but were equivalent to only 1 percent of imports for consumption.

Imports.—Of the 83,400 flasks imported for consumption in 1953 (71,900 in 1952), 36,100 (26,300) came from Italy, 28,100 (27,100) from Spain, 13,300 (7,900) from Mexico, 5,600 (10,400) from Yugoslavia; 300 (200) came from countries that normally are not mercury producers and must have reshipped the metal.

General imports (imports for immediate consumption plus entries into bonded warehouses) afford a better measure than imports for consumption (imports for immediate consumption plus withdrawals from bonded warehouses for consumption) of material actually entering the country during a calendar period.

Imports of mercury compounds are relatively insignificant—those of mercuric chloride were 8,000 pounds from Canada, 2,000 from United Kingdom, and 500 from Yugoslavia; of mercurous chloride, 12,700 from Canada; of oxide (red precipitate), 2,700 from United Kingdom, 2,200 from Spain, and 1,300 from India; and of mercury preparations not specifically provided for, 400 pounds from United Kingdom.

[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 12.—Mercury imported for consumption in the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Country	1944–48 (average)		1949		1950	
	Flasks of 76 pounds	Value	Flasks of 76 pounds	Value	Flasks of 76 pounds	Value
Canada	667	$115,429	7	$319	107	$9,407
Chile	420	50,757				
Czechoslovakia	40	1,984				
Denmark					300	20,103
Honduras	5	724				
Italy	2,377	142,269	84,894	5,830,409	14,974	738,217
Japan	1,356	85,472	2,709	142,772	793	35,222
Mexico	7,688	796,158	3,091	179,206	3,480	180,418
Netherlands					575	32,289
Peru	41	5,793				
Spain	16,280	1,744,184	9,264	448,592	28,462	1,265,719
Sweden					1,061	64,441
United Kingdom					800	49,600
Yugoslavia	531	27,335	3,176	160,635	5,528	298,856
Total	29,405	2,970,105	103,141	6,761,933	56,080	2,694,272

Country	1951		1952		1953	
	Flasks of 76 pounds	Value	Flasks of 76 pounds	Value	Flasks of 76 pounds	Value
Bolivia	19	$1,744				
Canada	660	125,906	20	$7,398	171	$33,217
French Morocco			50	8,250		
Germany	250	39,904				
Honduras	10	2,140				
India					25	3,666
Italy	21,868	2,875,681	26,276	5,033,235	36,120	5,938,004
Japan	250	14,980			25	4,600
Mexico	5,109	843,523	7,941	1,302,837	13,298	2,079,096
Netherlands	350	21,700	100	18,979	50	8,959
Peru					6	875
Spain	11,954	1,573,982	27,102	4,404,675	28,049	4,549,115
Sweden	680	107,370				
Switzerland	204	23,450				
United Kingdom	47	3,285	1	261	(1)	36
Yugoslavia	6,459	952,924	10,365	1,771,052	5,649	951,008
Total	47,860	6,586,589	71,855	12,546,687	83,393	13,568,576

1 Less than 1 flask.

TABLE 13.—Mercury imported (general imports) into the United States, in 1953, by months

[U. S. Department of Commerce]

Month	Flasks of 76 pounds	Month	Flasks of 76 pounds
January	13,696	August	7,213
February	5,058	September	4,416
March	5,511	October	12,583
April	2,660	November	20,759
May	2,385	December	7,246
June	1,386		
July	2,871	Total	85,784

Exports.—Of the exports of 546 flasks (400 in 1952), 210 (28) went to Canada, 147 (77) to Brazil, 41 (none) to Japan, 35 (35) to Colombia, 21 (64) to Venezuela, and the remainder in lots of less than 20 flasks to 19 other countries.

Reexports were 916 flasks in 1953 (259 in 1952). Of the total, 307 (none) went to Japan, 285 (190) to Canada, 127 (none) to the Netherlands, 70 (none) to West Germany, 50 (25) to Colombia, 29 (21) to Brazil, 26 (none) to Korea, 18 (13) to Cuba, and 4 (1) to Venezuela.

TABLE 14.—Mercury imported (general imports) into the United States, 1944–48 (average) and 1949–53, in flasks of 76 pounds

[U. S. Department of Commerce]

Country	1944–48 (average)	1949	1950	1951	1952	1953
Bolivia				19		
Canada	657	29	107	660	20	171
Chile	480					
Denmark			300			
French Morocco					50	
Germany				250		
Honduras	5			10		
Italy	3,359	84,628	18,073	17,633	[1] 26,025	37,827
Japan	1,371	2,777	793	250		25
Mexico	8,572	3,506	3,986	4,989	7,971	13,637
Netherlands			825		100	50
Peru	47					6
Spain	18,116	2,225	29,439	13,707	24,333	28,303
Sweden	15		1,061	680		
Switzerland				204		
United Kingdom	10			(2)	(1) 1	(2)
Yugoslavia	638	3,753	5,980	[1] 6,525	10,186	5,765
Total	33,270	96,918	60,564	[1] 44,927	68,686	85,784

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

TABLE 15.—Mercury exported from the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Year	Pounds	Flasks of 76 pounds	Value	Year	Pounds	Flasks of 76 pounds	Value
1944–48 (average)	62,395	821	$98,458	1951	18,311	241	$57,502
1949	43,860	577	54.413	1952	30,369	400	85,974
1950	33,977	447	37,985	1953	41,497	546	105,975

TABLE 16.—Mercury reexported from the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Year	Pounds	Flasks of 76 pounds	Value	Year	Pounds	Flasks of 76 pounds	Value
1944–48 (average)	124,513	1,638	$122,481	1951	51,326	675	$111,274
1949	62,945	828	53,057	1952	19,689	259	46,721
1950	67,311	886	63,839	1953	69,640	916	157,880

TECHNOLOGY

The following abstract is from an article on slime control.[8]

The distribution of a soluble mercurial, ethoxy ethyl mercury acetate, after crash dosage in a closed paper mill white water system has been determined by chemical and microbiological methods. During the same period the common fungi and bacteria of the system were determined.

[8] Mardon, J., and Pedder, D., Use of a Soluble Mercurial in Slime Control: Pulp and Paper Mag. of Canada, vol. 54, No. 11, October 1953, pp. 131–1[illegible]

Even though the compound is very soluble compared with phenyl mercuric acetate, reaching in solution to all parts of the system, it is still absorbed onto the fibres. Due to its comparative instability under acid white water conditions the mercurial in solution rapidly loses its biological activity. The ethoxy ethyl mercury acetate appears a better bactericide than phenyl mercuric acetate but in the mill studied exhibits fungistatic properties.

Mercury is being used in ballistocardiography, according to recent information.[9] The purpose of the study is to measure the movements imparted to the body by the heart beat. This is done by floating the patient on a pool of mercury by means of a very light wooden raft.

To extend the range of polarographic methods, possible analytical applications of a large polarized mercury pool electrode were investigated and were reported [10] on in 1953.

The desirability of finding an electrode combining the advantages of the high hydrogen overvoltage of a dropping mercury electrode with the convenience and sensitivity of solid electrodes prompted a study the results of which were published [11] recently.

Investigations were reported during the year as to the negative pressure of mercury, and the highest value obtained (425 bars at 28° C.) was believed to be the highest direct measurement of negative pressure so far reported for any liquid.[12]

A new type of relay making use of solid contacts maintained continuously wet with mercury was developed.[13] It has a symmetrical polar structure, resulting in improved sensitivity and speed compared with the existing neutral structure with similar contacts.

Mercury was reported[14] to be used in one of four experiments conducted for the purpose of appraising the prospect for private industrial participation in joint production of electric energy and fissionable material from reactors.

A special eutectic mercury, said to withstand freezing temperatures as low as −80° F. was reported.[15]

Mercury-vapor discharge lamps for use in photo-printing were the subject of an article [16] published during the year. Highway and other lighting were discussed in other articles [17] that appeared in 1953.

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[9] Correspondence with Benjamin M. Baker, M. D., Baltimore, Md., May 1954.

[10] Streuli, Carl A., and Cooke, W. Donald, Mercury Pool Polarography: Anal. Chem., vol. 25, No. 11, November 1953, pp. 1691–1696.

[11] Marple, Thos. L., and Rogers, L. B., Polarographic Studies With a Stationary Mercury-Plated Platinum Electrode: Anal. Chem., vol. 25, No. 9, September 1953, pp. 1351–1354.

[12] Briggs, Lyman J., The Limiting Negative Pressure of Mercury in Pyrex Glass: Jour. Appl. Phys., vol. 24, No. 4, April 1953, pp. 488–490.

[13] Brown, J. T. L., and Pollard, C. E., Balanced Polar Mercury Contact Relay: Bell System Tech. Jour., vol. 32, No. 6, November 1953, pp. 1393–1411.

[14] Reports to the U. S. Atomic Energy Commission on Nuclear Power Reactor Technology, May 1953, pp. 57–58.

[15] Western Industry, Teutonic Technology and Technicians Transplanted: vol. 18, No. 11, November 1953, pp. 61, 62, 64.

[16] Whittemore, J., High-Pressure Mercury-Vapour Discharge Lamps for Photo-Printing: Eng. (London), vol. 176, No. 4579, Oct. 30, 1953, pp. 547–548.

[17] Beggs, E. W., Mercury Lighting—Whiter, More Versatile: Westinghouse Eng., vol. 13, No. 2, March 1953, pp. 50–53.

The Short-Arc Mercury Lamp—Boon to Searchlights, Westinghouse Eng., vol. 13, No. 2, March 1953, p. 79.

Tome, Walter C., and Straus, W. Rayner, Baltimore Lights U. S. 1 and U. S. 40 Interchange: Elec. World, vol. 140, No. 22, Nov. 30, 1953, pp. 104, 108.

Harsh, M. C., Single-Ballast Street Light System Costs Less: Elec. World, vol. 140, No. 22, Nov. 30, 1953, pp. 114, 116, 125.

Photoelectric Cell Stabilizes Mercury-Arc Lamp Light Intensity: Elec. Eng., vol. 72, No. 2, February 1953, p. 169.

Pulvermacher, F. H., Lamps for Street Lighting: Elec. Rev. (London), vol. 153, No. 2, July 10, 1953, pp. 72–75.

Ferguson, H. M., Reeves, J., and Stevens, W. R., Discomfort Glare, Comparison of Mercury, Sodium, and Tungsten Light Sources: Elec. Rev. (London), vol. 153, No. 7, Aug. 14, 1953, pp. 355–358.

Binder, A. E., Mercury Lamp Starting Requirements for Outdoor Applications: Illum. Eng., vol. 49, No. 1, Sec. 1, January 1954, pp. 32–38.

Hrivnatz, H. G., A New Approach to Underpass Lighting: Illum. Eng., vol. 48, No. 3, March 1953, pp. 121–123.

Mercury cells were first used for the electrolytic production of chlorine and caustic soda in the mid-1890's, according to a recent article.[18] The article stated that nearly 89 percent of the chlorine produced in 1946 was made in plants using the diaphragm electrolytic cell, over 4 percent using mercury electrolytic cells, nearly 6 percent using the fused salt electrolytic cells, and over 1 percent using the chemical process. In 1953 the percentages were estimated, respectively, as nearly 79, over 14, nearly 6, and 1, showing a near tripling of production by mercury cells. The article contains some comparisons of two principal methods and a description of the recently constructed plant at McIntosh, Ala., where the Mathieson mercury cells are used.

An almost infallible quick field test for separating various grades of unidentified cemented-carbide blanks was reported[19] recently. Mercury floats steel-cutting grades but allows cast-iron grades to sink. Stronger magnetic pull differentiates softer, tougher grades from harder ones, it was claimed.

Contamination of apparatus and hazards to personnel from mercury vapor can be held down by control based upon either chemical-absorption or spectrum-absorption detection equipment, according to an abstract[20] from a University of California Radiation Laboratory report by C. S. Presenz furnished through the United States Atomic Energy Commission.

Tube wastage in a mercury boiler at the South Meadow Station of the Hartford Electric Light Co. became so serious after 3,076 hours of operation that it was necessary to reduce the rating from its 15,000-kw. capacity to 13,500-kw. Experiments aimed at solving the problem were the subject of a recent article.[21]

A commercial method of making diphenyl mercury was reported[22] in 1953. Diphenyl mercury, along with other mercury diaryls, owes its value as an intermediate to its atypical substitutions, ease of reaction, and high reactivity with various elements and compounds, according to the report.

WORLD REVIEW

All important mercury-producing countries except Italy had larger or virtually unchanged output in 1953. Italian production dropped 8 percent, that in Yugoslavia was at about the high rates for 1950–52, that in Japan more than doubled, and in Mexico, the United States, and Spain the output rose 33, 14, and 15 percent, respectively. The increase in output for the world as a whole, however, was relatively small at only 7 percent. Very little is known about output in the Union of Soviet Socialist Republics, although reserves are believed to be great enough to support a larger production than that estimated in table 17.

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18 Sanders, Howard, J., Gardiner, Wm. C., and Wood, Joseph L., Mercury Cell Chlorine and Caustic: Ind. Eng. Chem., vol. 45, No. 9, September 1953, pp. 1824–1835.

19 Edgar, Carroll, Mercury and Magnetism Identify Mixed Carbide Blanks: Am Mach., vol. 97, No. 19, Sept. 14, 1953, p. 187.

20 Electronics, Detector Monitors Vapor Concentration: vol. 26, No. 8, August 1953, pp. 198, 200.

21 Hall, A. M., Douglass, D., and Jackson, J. H., Corrosion of Mercury-Boiler Tubes During Combustion of a Heavy Residual Oil: Trans. Am. Soc. of Mech. Eng., vol. 75, No. 6, August 1953, pp. 1037–1049.

22 Chemical Week, Quicksilver Conquest: vol. 72, No. 14, Apr. 4, 1953, p. 54.

TABLE 17.—World production of mercury, by countries,[1] 1944–48 (average) and 1949–53, in flasks of 34.5 kilograms (76 pounds) [2]

[Compiled by Helen L. Hunt]

Country [1]	1944–48 (average)	1949	1950	1951	1952	1953
North America:						
Canada	1,937	----------	----------	----------	----------	----------
Honduras	5	----------	----------	11	----------	(3)
Mexico	13,731	5,250	3,713	8,064	8,731	11,632
United States	26,286	9,930	4,535	7,293	12,547	14,337
South America:						
Bolivia (exports)	1	----------	----------	19	----------	(3)
Chile	756	754	319	114	174	(3)
Peru	73	----------	----------	----------	----------	----------
Europe:						
Austria	(3)	6	44	31	16	(3)
Czechoslovakia	818	[4] 800	[4] 725	[4] 725	[4] 725	(3)
Germany	[4] [5] 696	----------	----------	----------	----------	----------
Italy	[6] 39,413	44,527	53,346	53,839	55,869	51,373
Spain	39,027	32,289	51,808	44,480	39,135	[4] 45,000
Sweden	4	----------	----------	----------	----------	----------
U. S. S. R. (estimate)[7]	8,412	11,600	11,600	11,600	11,600	12,000
Yugoslavia	[8] 8,347	12,764	14,368	14,649	14,620	14,272
Asia:						
China	1,421	[4] 290	[4] 1,450	[4] 4,000	[4] 4,000	[4] 5,000
Japan	2,984	2,461	1,312	1,847	3,080	6,289
Turkey	76	----------	----------	----------	----------	----------
Africa:						
Algeria	313	115	----------	----------	----------	----------
Union of South Africa	562	----------	----------	----------	----------	----------
Oceania:						
Australia	3	----------	----------	----------	----------	----------
New Zealand	24	----------	----------	----------	----------	----------
Total (estimate)	144,600	121,000	143,000	147,000	151,000	161,000

[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; estimates by authors included in totals.
[4] Estimate.
[5] Includes Austria in 1944.
[6] Output of Idria mine (Yugoslavia) included with Italy in 1944.
[7] According to the 41st annual issue of Metal Statistics (Metallgesellschaft), except 1953, which was estimated by the authors of the chapter.
[8] Average for 1945–48.

Canada.—Significant production of mercury in Canada started in 1940, when the Pinchi Lake mine of the Consolidated Mining & Smelting Co. of Canada, Ltd., began to produce. This mine supplied nearly all of Canada's production in 1940–44, and the Takla mine, 85 miles northwest of Pinchi Lake, the remainder. The peak output of these mines was 22,240 flasks in 1943; production ceased in September 1944 and has not been resumed. These British Columbia deposits average about 0.5 percent mercury and are said [23] to be capable of supplying Canadian requirements for many years, if necessary. Canadian imports were 2,600 flasks in 1953, compared with 1,900 in 1952. Consumption was 2,780 flasks in 1953 (3,690 in 1952), of which 1,820 (3,030) were for heavy chemicals, 630 (350) for pharmaceuticals and fine chemicals, 120 (100) for electrical apparatus, 80 (80) for amalgamation, and 130 (130) for miscellaneous uses.

France.—Imports of mercury into France indicate the approximate size of consumption in that country. Data for the past 3 years are as follows:

[23] Department of Mines and Technical Surveys, Ottawa, Canada: Mercury in Canada, 1953 (Preliminary) 2 pp.

TABLE 18.—Mercury imported into France in 1951–53, by countries, in flasks of 76 pounds

Country	1951	1952	1953
Italy	2,843	1,480	3,684
Spain	6,440	4,525	3,336
Yugoslavia	------	------	290
Other	2,001	116	261
Total	11,284	6,121	7,571

It was estimated [24] that 60 percent of the mercury was consumed by the chemical industry, 10 to 12 percent in the manufacture of felt hats, 10 percent in pharmaceuticals, 10 percent in precision instruments, electrical apparatus, and thermometers, and 10 percent in miscellaneous other uses.

India.—At the end of 1952 less than half of the 10,000 flasks of mercury that the Government allocated for reexportation had been licensed. In April the Government decided to reallocate the unshipped balance to shippers who had utilized their earlier licenses, the licenses being valid to August 31, 1953. Later it was reported [25] that stocks of mercury in India, previously estimated at 30,000 flasks, were then estimated at 7,000 flasks. The drop may have been caused more by a revision in estimates than by withdrawals for domestic consumption and for exportation, although the normally small domestic consumption, for which there are no figures, must have increased. According to a London report [26] "Prospects of renewed cheap offers of Indian quicksilver have been lessened by heavy exports of Indian mercury salts to Japan."

Mercury figures for India are reported in flasks of 75 pounds each. The data are rounded sufficiently, however, to apply to either 75- or 76-pound flasks.

Italy.—Production of 51,400 flasks in 1953 was 8 percent less than in 1952 and about 4 percent below both 1951 and 1950. Exports of

TABLE 19.—Exports of mercury from Italy, by countries, 1950–53, in flasks of 76 pounds [1]

Country	1950	1951	1952	1953
Brazil	1,044	261	------	------
Canada	1,711	------	------	------
Czechoslovakia	1,450	------	174	1,392
France	4,728	2,234	319	3,336
Germany	7,774	435	145	3,887
India and Pakistan	30,226	2,408	------	------
Netherlands	3,104	203	348	493
Poland	1,653	2,176	580	2,814
United Kingdom	8,122	2,901	3,713	8,499
United States	19,174	16,070	27,761	32,025
Other	3,310	812	725	2,698
Total	82,296	27,500	33,765	55,144

[1] Taken from Bureau of Mines, Mineral Trade Notes: vol. 38, No. 5, May 1954, p. 17.

[24] Robinson, Howard A. (special asst. to ambassador), Importation of Mercury Metal Into France: Enclosure with State Dept. Dispatch 3035, Paris, France, May 26, 1954, 1 p.
[25] Bureau of Mines, Mineral Trade Notes: vol. 37, No. 5, November 1953, p. 28.
[26] American Metal Market, Mercury: vol. 61, No. 16, Jan. 23, 1954, p. 5.

55,100 flasks drew upon stocks, which were 18,200 flasks at the beginning of the year. According to press statements, part of Italy's future output as well as year-end inventories had been contracted for.

Mexico.—The 1953 output (11,600 flasks) was 33 percent more than in 1952 and the largest annual total since 1946. The production trend was upward during 1953; 3,200 flasks more were produced in the second half than in the first half of the year.

TABLE 20.—Production of mercury in Mexico, in 1953, by months, in flasks of 76 pounds [1]

Month	Flasks	Month	Flasks
January	592	August	495
February	670	September	1,544
March	415	October	971
April	400	November	1,389
May	1,353	December	1,635
June	777		
July	1,391	Total	11,632

[1] Taken mainly from Boletin de Minas y Petroleo, Mexico, D. F., published monthly.

Exports exceeded production by 900 flasks in 1953 and were 12,500 flasks, of which 12,000 went to the United States. Of the 7,900 flasks exported in 1952, 7,300 went to the United States.

Spain.—Virtually all of the mercury produced comes from the Government-owned Almaden mine, Ciudad Real Province; the remainder comes from the Oviedo Province. In recent years production was erratic, conforming somewhat to world demand and ranging annually from the lowest level of 22,700 flasks in 1948 to the highest of 51,800 flasks in 1950. The estimated output in 1953 was 45,000 flasks, or 15 percent larger than in 1952. The new plant at the Almaden mine, under construction by the Pacific Foundry Co., Ltd., in 1952, was completed and put into operation in 1953. Data on mercury production and reserves, given in Minerals Yearbook, 1948, are repeated in this report because of widespread interest at the end of 1953 in mercury supplies. According to Bennett,[27] after more than 20 centuries of exploitation, intensive throughout the last 4, ore from Almaden was about 5 times as rich as that of its closest competitor. Over 228,000 metric tons (6,600,000 flasks) of metal, not allowing for production of the Romans, Visigoths, and Moors, was estimated to have been produced. Ore occurrence and reserves were described as follows:

* * * The ore-bearing veins are three; the principal and most productive is the San Pedro-San Diego, seven to nine meters wide; the San Francisco, four meters; and the San Nicolas, three meters, where seen on the lower levels. They are separated by ten to twenty meters of barren slate. The strike is westnorthwest and the dip ranges from vertical to 70° N. Vein material is massive recemented quartzite breccia.

Silicification and movement along the fault preceded and accompanied deposition of ore, which followed the fresh fracture planes and penetrated the less silicified sandstones in their process of becoming quartzites. Rich zones of one to three meters' width, of a deep red hue, occur in mid-vein, tapering in values toward the walls. Mining activity, and apparently the richer mineral, is confined to a zone between two cross faults, of which the easterly one is well defined,

[27] Bennett, Evan, Almaden, World's Greatest Mercury Mine: Min. and Met., vol. 29, No. 493, January 1948, pp. 6-9.

with a twenty-meter horizontal throw. The west fault is irregular, echeloned, and in places is rather a sharp bend in the vein. Both are pre-mineral. This zone was about 200 m long at the surface, but extended to 300 m at 200-m depth, and is only 110 m long on the fourteenth, or lowest working level, 400 m below the shaft collar.

The great stopes of the middle levels are caved and inaccessible. Records show that ore hoisted was 20 to 25 percent grade, which must have entailed sorting in the stopes. It is likely, therefore, that these stope fills contain a great deal of now valuable ore. From the twelfth down to the fourteenth levels, a distance of 50 m, there is notable diminution of grade and vein width and the three veins converge. It appears probable that the oreshoot will bottom 50 m or so below the fourteenth level. The ore mineral is invariably cinnabar, rather coarsely crystalline, with free mercury in the richer ores oozing out and forming pools in the stopes. Pyrite, calcite, sericite, and barite are also found.

In 1945, the visible proved reserves were enough for twenty years' operation at the current rate. Recent exploration beyond the end faults has disclosed considerable ore. During the Fuggar lease, shallow workings extended some 6000 m beyond the east fault, in the fracture zone, so it is likely that a great deal of ore will be found adjoining these old workings beyond these faults. In the process of extracting it, the old stope fills may also be drawn.

At Almadenejos, 11 km east of the mine, on the strike, an eight-meter vein is being explored with promising results. At Las Minetas, eighteen kilometers east of Almaden, is an old working with ruins of Bustamante furnaces, also on the strike. The Almaden reserve extends over a circle of 25 km radius with the San Teodoro shaft as a center. The mine is by no means depleted except as regards the fabulously rich ores once worked. On the other hand, statements that there are millions of tons are likewise inaccurate. The program of systematic exploration and development of new ore, recently undertaken by the Council, is definitely to assure a future ore supply. * * *

A news item published[28] during the year stated that Almaden workings had reached the 15th level.

Despite the fact that spot mercury was relatively scarce at the end of 1953, in September the spokesman for Almaden was reported[29] to have said that they were ready to consider all offers from whatever source and for any quantity, shading the price if necessary.

Exports by destinations for the past 5 years are shown in table 21.

TABLE 21.—Exports of mercury from Spain, by countries, 1949–53, in flasks of 76 pounds [1]

Country of destination	1949	1950	1951	1952	1953
United States	3,516	34,528	9,857	27,160	24,972
Argentina	775	1,410	----	----	----
Brazil	----	----	148	20	367
Belgium-Luxembourg	177	592	116	6	38
France	2,936	2,036	6,411	3,765	3,415
Germany	5,480	2,350	4,554	1,804	2,606
Netherlands	1,642	1,256	986	1,308	441
Norway	487	261	551	200	290
Sweden	400	2,712	2,176	203	320
Switzerland	----	5,155	5,416	3,878	2,451
United Kingdom	11,258	46,636	15,516	4,566	6,701
India	----	2,007	----	----	----
Japan	----	----	1,076	377	1,761
Other countries	974	566	1,736	966	306
Total	27,645	99,509	48,543	44,253	43,668

[1] Taken from Estadística del Comercio Exterior de España.

[28] Mining World, vol. 15, No. 5, Apr. 15, 1953, p. 129.
[29] Metal Industry (London), vol. 83, No. 12, Sept. 18, 1953, p. 248.

United Kingdom.—Consumption of mercury in the United Kingdom may be gaged by imports minus reexports although this calculation makes no allowance for industry and Government stocks, which are not available. The United Kingdom is the second largest mercury-consuming country in the world, surpassed only by the United States and probably followed by the U. S. S. R.

	1949	1950	1951	1952	1953
Imports	18, 800	54, 200	18, 800	9, 200	21, 300
Reexports	3, 900	14, 300	6, 100	3, 600	2, 500
Apparent consumption	14, 900	39, 900	12, 700	5, 600	18, 800

The heavy purchases in 1950, following the outbreak of war in Korea, resulted in an abnormal apparent consumption for that year, doubtless counterbalanced by the subnormal quantities for the following two years. The average for the 5-year period was 18,000 flasks.

Yugoslavia.—According to annual reports of the Statistics of Foreign Trade of the FPR, exports of mercury in 1952–53, in flasks of 76 pounds, were as follows:

Destination:	*1952*	*1953*
United States	8, 906	5, 972
United Kingdom	697	2, 667
Germany	971	2, 289
Austria	356	360
Belgium-Luxembourg	791	347
Sweden	485	336
France	731	300
Netherlands	450	300
Switzerland	565	194
Other	11	51
Total	13, 963	12, 816

Mica

By Robert D. Thomson [1] and Gertrude E. Tucker [2]

DOMESTIC mica sold or used in the United States in 1953 decreased about 3 percent in quantity and increased 39 percent in value compared with 1952. This was the second largest year tonnagewise since 1880. Quantity sales of scrap and flake mica decreased about 2,000 short tons; but sales of sheet mica, mainly as a result of expanded Government buying, increased 151 thousand pounds or 22 percent in weight and 137 percent in value. Consumption remained at a high level, but total imports of mica decreased 16 percent.

TABLE 1.—Salient statistics of the mica industry in the United States, 1944–48 (average) and 1949–53

	1944–48 (average)	1949	1950	1951	1952	1953
Domestic mica sold or used by producers:						
Total sheet mica: [1]						
Pounds	917, 279	513, 994	578, 818	594, 884	697, 989	849, 394
Value	$876, 011	$132, 097	$125, 928	$160, 322	$908, 135	$2, 153, 584
Average per pound	$0. 96	$0. 26	$0. 22	$0. 27	$1. 30	$2. 54
Scrap and flake mica:						
Short tons	49, 669	32, 856	69, 360	71, 871	75, 236	73, 259
Value	$1, 026, 019	$795, 782	$1, 742, 616	$1, 884, 087	$1, 954, 286	$1, 823, 840
Average per ton	$20. 66	$24. 22	$25. 12	$26. 21	$25. 97	$24. 90
Total sheet, scrap, and flake mica:						
Short tons	50, 127	33, 113	69, 650	72, 168	75, 585	73, 684
Value	$1, 902, 030	$927, 879	$1, 868, 544	$2, 044, 409	$2, 862, 421	$3, 977, 424
Ground mica:						
Short tons	59, 163	56, 393	72, 250	70, 122	74, 806	73, 072
Value	$2, 525, 408	$2, 860, 956	$3, 935, 697	$3, 842, 628	$4, 278, 103	$4, 192, 420
Consumption of splittings:						
Pounds	8, 351, 540	8, 114, 804	10, 783, 198	13, 379, 295	10, 220, 671	10, 346, 159
Value	$5, 062, 848	$7, 096, 365	$8, 631, 421	$11, 760, 617	$9, 729, 099	$7, 902, 232
Imports for consumption—short tons	12, 042	12, 738	18, 510	18, 917	13, 048	10, 989
Exports—do	1, 208	1, 108	1, 547	1, 894	2, 472	2, 402

[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, 1953, 117 exploration contracts for strategic mica were executed. Of these, 63 contracts were canceled or terminated, and 54 were still in force on December 31, 1953. The estimated cost of the 58 terminated contracts was $296,245, with the Government share amounting to $266,621. Certificates of discovery and

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[2] Statistical assistant.

development were issued on 13 of these contracts—12 in North Carolina and 1 in South Dakota—at a value of $77,979. Disposition of the mica contracts is shown in table 2.

In November 1953 the percentage of the total cost of the mica-exploration projects advanced by the Government was decreased from 90 percent to 75. Although this increased the exploration cost for the miner, it was anticipated that exploration for mica would continue at a high level. As of December 31, 1953, no contracts had been made at the 75-percent rate.

TABLE 2.—Defense Minerals Exploration Administration mica contracts certified or terminated in 1953, and in force, as of December 1953, by State, county, and mine

State and operator	Property	County	Government participation [1]	Disposition
ALABAMA				
Dixie Mines, Inc.	Hurst	Clay	$6,408	In force.
Smith Mica Co.	Smith, Fletcher	do	5,400	Do.
Bourne Associates	Liberty	Randolph	16,650	Do.
GEORGIA				
Empire Mica Co.	Harp, H. W.	Lamar	6,660	Do.
Howell & Anderson Mining Co.	Persons, Rev. Thaddeus	Monroe	8,100	Do.
Munday, H. C., and Thomas, C. F.	Dickens	Oconee	2,790	Do.
Burleson & Phillips	Jones-Bozeman	Pickens	3,204	Do.
Anderson, A. T.	Carter	Upson	4,959	Terminated.
Phillips, Grindstaff & Boyd	Reynolds, J. H.	do	5,985	In force.
Empire Mica Co.	Short-Mitchell	do	7,740	Do.
IDAHO				
Idaho Beryllium & Mica Corp.	Muscovite	Latah	25,830	Terminated.
NEW HAMPSHIRE				
Alstead Mica Miners, Inc.	Fitzgibbon	Cheshire	5,040	Do.
Berry, R. N.	Atwood	Grafton	13,050	Do.
Maderic, J. L.	Saunders	do	4,059	In force.
NORTH CAROLINA				
Taylor, Fred; Greene, Julian and Johonnie.	Cow Camp (South)	Avery	4,905	Do.
Vance, S. K., and Guy, R. B.	Elk	do	6,210	Certified.
Hipps, W. H.	Big Cove	Buncombe	2,610	Terminated.
Robinson & West	Swannanoa	do	8,460	Certified.
Bowman, C. H. and F. C.	Bowman	Caldwell	2,790	In force.
Blalock & Hamrick Mining Co.	Blalock	Cleveland	4,995	Do.
Boone, R. L.	Blanton, Cliff	do	5,085	Do.
Beasley, J. E.	Carpenter, Lee	do	6,300	Do.
Burns-Spangler Construction Co.	Cornwell, Lee	do	6,030	Do.
Covington, W. H.	Covington, W. H.	do	1,341	Terminated.
Blalock & Hamrick Mining Co.	Hamrick	do	2,970	In force.
Beasley, J. A.	Hubert Cook No. 2	do	4,545	Do.
Hendricks, F. B.	Mead, A. P.	do	2,160	Terminated.
Do	Mead, Glen	do	1,350	Do.
Forest City Mining Co.	Old Mauney	do	6,615	In force.
Wellmon, E. R.	Wellmon	do	4,509	Do.
Bess Gaston Mica Miners	Bess Gaston Mica	Gaston	7,470	Terminated.
Gaston Strategic Minerals Co., Inc.	Huskins	do	5,040	Certified.
Piedmont Minerals Co., Inc.	Self	do	11,160	Do.
H. R. H., Inc.	Bear Pen No. 1	Haywood	4,590	Terminated.
Conway, Revis	Grassy Knob	do	2,970	Do.
H. R. H., Inc.	Holt No. 1	do	4,995	In force.
Arrowood, Fred	Little East Fork	do	5,760	Terminated.
Poston, E. L., and Bradley, Jim	Old Sharp	do	2,943	In force.
Poston, E. L.	Old Shining Rock	do	3,753	Do.
Poston, E. L. and R. W.	Poston, E. L. and R. W.	do	9,180	Terminated.
Young, Latt	Cox	Jackson	6,570	In force.
Goodman Mining Co.	Engle Cope	do	6,075	Do.

See footnote at end of table.

TABLE 2.—Defense Minerals Exploration Administration mica contracts certified or terminated in 1953, and in force, as of December 1953, by State, county and mine—Continued

State and operator	Property	County	Government Participation [1]	Disposition
Hooper, Roscoe & Martin	Old Sheep Mt	Jackson	$8,910	In force
Dixie Minerals, Inc	Shell Ridge	do	4,140	Do.
Do	Stephens, D. H	do	4,860	Do.
Davis, Earl, and Berkmeyer, T. J	Davis, Earl	Lincoln	2,700	Terminated.
Wilson, Fred	"A" Mica	Macon	3,600	Do.
Fouts, R. H	Allman Cove	do	6,786	In force.
Bauer Mining Co	Baird Cove	do	8,190	Do.
American Mica Corp	Beasley No. 1	do	10,125	Do.
Bennett, R. E	Bennett	do	2,970	Do.
B. T. R. Mining Co	Bryson, Terrell	do	4,410	Do.
Burke, John, Mica Miners	Burke, John	do	7,290	Do.
Enloe, H. E	Enloe	do	2,934	Terminated.
Phillips, S. L	Iotla-Bowers	do	4,050	Certified.
Angel, Zeb	Kasson	do	8,280	In force.
Macon Mica Miners	Mashburn	do	4,680	Do.
Reid, A. W	May	do	1,710	Certified.
Ward, A	Miller	do	3,420	Terminated.
Toe River Mining Co	Pine Knob (Kelley)	do	4,050	Do.
Polly Miller Mining Corp	Polly Miller	do	6,930	In force.
Angel, R. C	Quisenberry	do	4,770	Do.
Reid & Hooker	Reid	do	1,170	Certified.
Roper, W. H	Roper-Ray	do	3,600	Terminated.
Cable, H. C	Turkey Knob (Passmore)	do	6,390	In force.
Byrd Mica Miners	Byrd	Mitchell	5,180	Do.
Duncan Mining Co	Connolly	do	7,920	Do.
B. & R. Mica Co	Half Moon	do	8,910	Do.
Sinkhole Miners	Sinkhole	do	32,180	Do.
Otis, L., and Buchanan, Ira	Stevenson, Joe	do	3,420	Terminated.
Wise, Dave, Wise, Ray, and Phillips, S. L.	White Oak Creek	do	6,570	Do.
Baker, Robert	Zinniman	do	6,633	In force.
Hawkins Mining Co	Hawkins	Stokes	6,120	Terminated.
Yancey Mica Mines, Inc	Autrey, J. W., Mica	Yancey	13,118	Do.
Balsam Mica Miners	Balsam	do	2,466	In force.
Hyatt, Fred, and Pressnell, Lonnie	Banks	do	6,543	Do.
Ray, B. L., and Hyde, C. E	Blevin, Wiley, Mica	do	3,645	Terminated.
Carolina-Clear Mica Co	Clear	do	8,055	In force.
Blue Ridge Mica Co., Inc	Grant Laws	do	6,750	Do.
Grigg & West Co	Grassy Knob	do	8,685	Do.
Bennett, Yates, and Mark W., and Johnson, E.	Hampton	do	6,300	Do.
Anglin & Elkins	Huskins (Mica)	do	6,750	Certified.
Twiggs, H. J	Huskins, Sam	do	4,680	In force.
Yancey Mica Mines, Inc	Presnell	do	3,690	Terminated.
S. W. Presnell Mica Miners	Presnell, S. W	do	10,080	In force.
Murphy Mining Co	Red (Bennett)	do	4,095	Do.
Chrisawn, W. B., and Gibbs, Harris.	Westall	do	2,880	Terminated.
Robinson, H. L	Zolly Shell	Wilkes	3,353	Do.
SOUTH DAKOTA				
Collingwood, L. W	Dyke No. 2 [2]	Custer	4,725	Do.
Minerals Mills, Inc	Glenwood Lode [2]	do	1,080	Certified.

[1] 90 percent of the approved project estimated costs. Total actual expenditures by the Government on terminated and certified contracts often were less than the obligated funds.
[2] Classified as a mica-beryl project.

DEFENSE MATERIALS PROCUREMENT ADMINISTRATION

In 1953, 157,780 pounds of full-trimmed muscovite block mica (over 0.007 inch thick) was obtained from purchases by General Services Administration, under authority from DMPA, at the three mica-purchasing depots (table 3). A total of 67 percent came from the Spruce Pine, N. C., depot. About 40 percent of the total quantity was Good Stained or Better quality; 46 percent Stained. The Good Stained or Better and Stained qualities are retained for the

National Stockpile, while Heavy Stained quality and other, punch, and scrap are reserved for sale to industry.

The Government broadened the purchase program in July 1953 to include domestically produced muscovite nonruby block, film, and hand-cobbed mica. As of December 31, 1953, the Spruce Pine, N. C., depot was the only depot to purchase nonruby mica; purchases totaled 5,880 pounds (tables 4 and 5).

TABLE 3.—Yield of full-trimmed muscovite ruby block mica and byproducts from domestic purchases by GSA, 1953, by quality, grade, and depot, in pounds

Depot and grade	Full-trimmed					Byproducts		
	Good-Stained or Better	Stained "A"	Stained "B"	Heavy-Stained	Total	Other	Punch	Scrap
Spruce Pine, N. C.:								
2 and larger	339.81	165.45		59.69	564.95			
3	654.94	396.52		118.81	1,170.27			
4	1,990.93	1,398.62		400.86	3,790.41			
5	7,754.82	5,925.28		1,766.45	15,446.55			
5½	6,322.66	5,363.36		1,874.31	13,560.33			
6	33,821.64	28,237.49		9,794.63	71,853.76			
Total	50,884.80	41,486.72		14,014.75	106,386.27		14.26	47.37
Franklin, N. H.:								
2 and larger	58.44	178.48	51.68	86.18	374.78			
3	150.49	357.26	66.50	95.55	669.80			
4	372.51	821.52	132.64	146.61	1,473.28			
5	1,668.87	2,921.94	369.37	361.67	5,321.85			
5½	1,423.28	2,203.61	304.44	227.60	4,158.93			
6	4,967.06	6,933.22	887.59	481.86	13,269.73			
Total	8,640.65	13,416.03	1,812.22	1,399.47	25,268.37	1,821.24	23,052.02	21,707.81
Custer, S. D.:								
2 and larger	7.68	34.47		16.15	58.30			
3	25.84	125.68		52.00	203.52			
4	83.53	526.93		233.43	843.89			
5	523.49	2,808.11		1,329.12	4,660.72			
5½	423.30	2,245.65		1,108.91	3,777.86			
6	2,180.89	10,079.65		4,320.10	16,580.64			
Total	3,244.73	15,820.49		7,059.71	26,124.93	7,994.62	193,505.00	157,505.12
Grand total	62,770.18	72,535.46		22,473.93	157,779.57	9,815.86	216,571.28	179,260.30

TABLE 4.—Yield of full-trimmed muscovite nonruby block mica and byproducts from domestic purchases by GSA at Spruce Pine, N. C., depot, 1953, by quality and grade, in pounds

Grade	Full-trimmed				Byproducts		
	Good-Stained or Better	Stained "A" "B"	Heavy-Stained	Total	Other	Punch	Scrap
2 and larger	15.37	18.45	25.30	59.12			
3	38.65	35.79	28.58	103.02			
4	134.81	103.01	54.64	292.46			
5	538.75	422.61	158.76	1,120.12			
5½	441.15	325.09	109.61	875.85			
6	1,687.91	1,322.91	365.98	3,376.80			
Total	2,856.64	2,227.86	742.87	5,827.37		1.75	

TABLE 5.—Yield of full-trimmed muscovite ruby and nonruby film mica from domestic purchases by GSA at Spruce Pine, N. C., and Franklin, N. H., depots, 1953, by grade, in pounds

Grade	Spruce Pine, N. C., depot		Franklin, N. H., depot
	Ruby	Nonruby	Ruby
2 and larger	2.87	0.06	
3	9.54	.68	
4	30.44	2.57	
5	136.86	15.28	2.77
5½	131.28	9.63	2.00
6	694.99	22.39	29.54
Total	1,005.98	50.61	34.31

Quantities of film mica were also purchased at the Spruce Pine, N. C., and Franklin, N. H., depots, as shown in table 5.

The mica purchased by the Government, if diverted to the domestic mica-fabricating industry, would have supplied 6 percent of the muscovite block and film mica, Stained or better qualities, fabricated in 1953.

DOMESTIC PRODUCTION

Sheet Mica.—Crude sheet mica sold or used by producers in 1953 increased 22 percent in quantity and 137 percent in value over 1952 (table 6). The supply of domestic sheet mica in 1953 was the largest since 1946. North Carolina maintained its rank as the State producing the largest quantity of sheet mica in 1953 by supplying 73 percent of the total domestic output. The remainder was reported from the following States, arranged in order of importance, by quantity sold or used: New Hampshire, Connecticut, Maine, Idaho, Virginia, Georgia, South Dakota, and Alabama.

North Carolina has produced the largest quantity of sheet and scrap mica of any State since 1868; the major portion of the production has come from the Spruce Pine district, in Avery, Mitchell, and Yancey Counties. Mica was the first mineral mined commercially in this district and has been an important factor in the annual mineral production from North Carolina. A description on the mineral geography of the Spruce Pine area and the importance of mica was published in 1953.[3]

The Government Mica Purchase Program, begun in 1952, encouraged resumption of operations by Idaho Beryllium & Mica Corp. at the Muscovite mine, Latah County, Idaho. Mining was by both open-pit and underground methods, and the crude mica was trucked to the trimming shop at Deary. In 1953 the company sold both full-trimmed ruby mica and hand-cobbed mica to the Government purchasing depot.[4]

[3] Vivian, C. H., The Spruce Pine Mineral Kingdom: Compressed Air Mag., vol. 58, No. 6, June 1953, pp. 152-159.
[4] Mining World, Strategic Mica From Idaho: Vol. 15, No. 1, January 1953, pp. 31-33.
Western Industry, Mica Demand Opens Idaho Mine: Vol. 18, No. 3, March 1953, p. 106.

TABLE 6.—Mica sold or used by producers in the United States, 1944–48 (average) and 1949–53

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
1944–48 (average)	709, 955	$102, 163	207, 324	$773, 848	917, 279	$876, 011	49, 669	$1, 026, 019	50, 127	$1, 902, 030
1949	450, 835	72, 576	63, 159	59, 521	513, 994	132, 097	32, 856	795, 782	33, 113	927, 879
1950	546, 433	86, 675	32, 385	39, 253	578, 818	125, 928	69, 360	1, 742, 616	69, 650	1, 868, 544
1951	544, 046	108, 429	50, 838	51, 893	594, 884	160, 322	71, 871	1, 884, 087	72, 168	2, 044, 409
1952:										
Alabama	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	378	17, 298
Georgia	11, 800	2, 463	1, 210	16, 389	13, 010	18, 852	(3)	(3)	(3)	(3)
Idaho	7, 491	2, 745	12, 529	112, 827	20, 020	115, 572	170	5, 100	180	120, 672
New Hampshire	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	187	[4] 51, 865
North Carolina	548, 723	102, 928	46, 608	561, 147	595, 331	664, 075	58, 576	1, 551, 071	58, 874	2, 215, 146
South Dakota	------	------	4, 308	32, 034	4, 308	32, 034	915	24, 148	917	56, 182
Undistributed [5]	57, 286	9, 732	8, 034	67, 870	65, 320	77, 602	15, 575	373, 967	15, 049	[4] 401, 258
Total	625, 300	117, 868	72, 689	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	(3)	(3)	(3)	(3)
Idaho	------	------	24, 216	223, 266	24, 216	223, 266	------	------	12	223, 266
Maine	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	87	33, 532
New Hampshire	62, 522	11, 343	28, 194	371, 337	90, 716	382, 680	(3)	(3)	(3)	(3)
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	182, 153	2, 055, 574	849, 394	2, 153, 584	73, 259	1, 823, 840	73, 684	3, 977, 424

[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] Included under "Undistributed" to avoid disclosure of individual company operations.
[4] Revised figure.
[5] Figures include Alabama (1953), Arizona (1952), Colorado (1952), Connecticut, Maine (1952), Pennsylvania, Virginia, a small quantity undistributed by State, and States indicated by footnote 3.

Scrap and Flake Mica.—Scrap and flake mica sold or used by grinders in 1953 decreased 3 percent in quantity compared with 1952 (table 7). The 1953 tonnage for scrap mica declined 14 percent and was less than that reported for each of the three previous years, but flake-mica output increased 33 percent and was the largest since 1943.

TABLE 7.—Scrap and flake mica sold or used by producers in the United States, 1944–48 (average) and 1949–53

Year	Scrap		Flake mica [1]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1944–48 (average) [2]	36, 279	$728, 728	13, 390	$297, 291	49, 669	$1, 026, 019
1949	24, 942	526, 268	7, 914	269, 514	32, 856	795, 782
1950	58, 250	1, 401, 411	11, 110	341, 205	69, 360	1, 742, 616
1951	59, 514	1, 475, 059	12, 357	409, 028	71, 871	1, 884, 087
1952	57, 201	1, 452, 174	18, 035	502, 112	75, 236	1, 954, 286
1953	49, 215	1, 305, 134	24, 044	518, 706	73, 259	1, 823, 840

[1] Includes finely divided mica recovered from mica and sericite schist and as a byproduct of feldspar and kaolin beneficiation.
[2] Scrap includes flake mica in 1948.

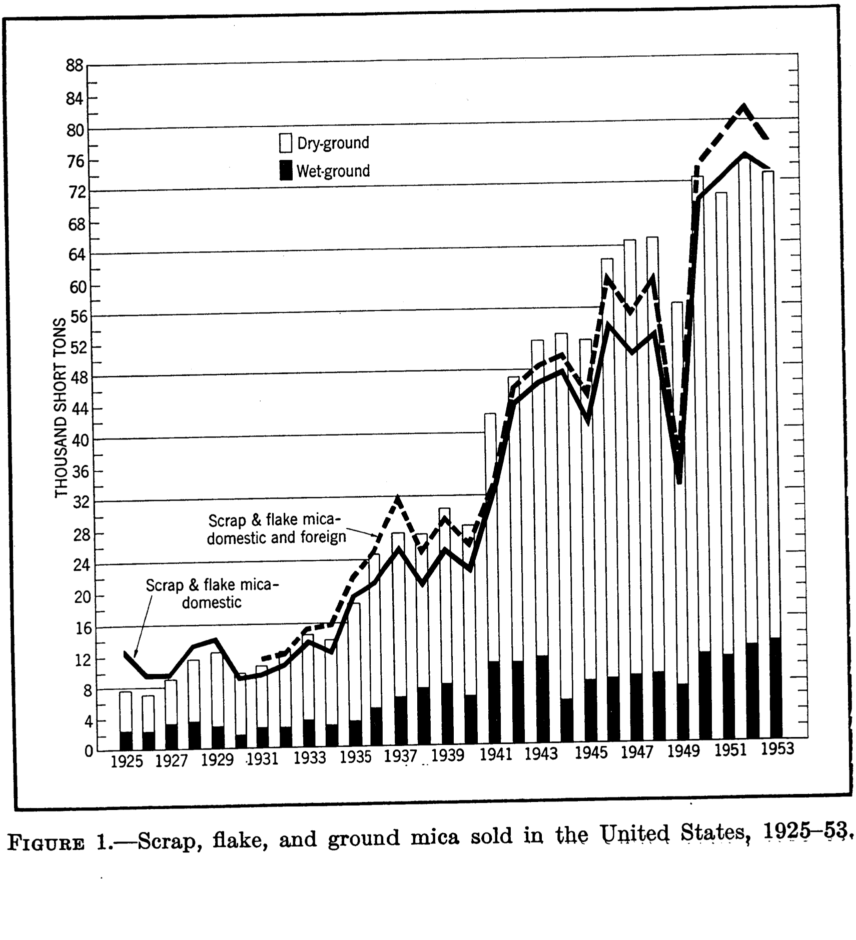

FIGURE 1.—Scrap, flake, and ground mica sold in the United States, 1925–53.

Ground Mica.—Sales of ground mica in 1953 decreased 2 percent in quantity and value compared with 1952 (table 8). Dry-ground was 82 percent of the total tonnage. Over half of the total sales of wet-ground mica were made to paint manufacturers and about 25 percent to rubber companies. Sixteen companies reported sales of dry-ground mica in 1953, and 8 companies sold wet-ground mica. Locations of the companies and methods of grinding are shown in table 9.

TABLE 8.—Ground mica sold by producers in the United States, 1944–48 (average) and 1949–53, by methods of grinding

Year	Dry-ground		Wet-ground		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1944–48 (average)	51,168	$1,619,316	7,995	$906,092	59,163	$2,525,408
1949	49,133	1,850,400	7,260	1,010,556	56,393	2,860,956
1950	61,139	2,374,089	11,111	1,561,608	72,250	3,935,697
1951	59,200	2,294,620	10,922	1,548,008	70,122	3,842,628
1952	62,465	2,526,407	12,341	1,751,696	74,806	4,278,103
1953	60,127	2,438,628	12,945	1,753,792	73,072	4,192,420

TABLE 9.—Mica grinders in 1953, by State, county, and method of grinding

State	County	Nearest town	Company	Method of grinding	
				Wet	Dry
Arizona	Maricopa	Aguila	Philip S. Hoyt	X	
Do	do	Buckeye	Buckeye Mica Co		X
Do	Mohave	Kingman	Huntley Industrial Minerals		X
Colorado	Pueblo	Pueblo	Western Non-Metallics, Inc		X
Georgia	Pickens	Tate	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	Plumtree	David T. Vance	X	
Do	Buncombe	Biltmore	Asheville Mica Co		X
Do	Cleveland	Kings Mountain	Kings Mountain Mica Co., Inc		X
Do	Macon	Franklin	Franklin Mineral Products Co	X	
Do	Mitchell	Bakersville	Consolidated Feldspar Dept., International Minerals & Chemical Corp.		X
Do	do	Spruce Pine	De-Weld Mica Co		X
Do	do	do	Diamond Mica Co	X	
Do	do	do	English Mica Co	X	
Do	do	do	Harris Clay Co		X
Do	Yancey	Newdale	Deneen Mica Co		X
Pennsylvania	York	Hokes	General Mining Associates		X
Tennessee	Washington	Johnson City	Southern Mica Co		X
Texas	Tarrant	Fort Worth	Western Mica Corp		X
Virginia		Newport News	Richmond Mica Corp	X	

CONSUMPTION

Sheet Mica.—The quantity of sheet mica (block, film, and splittings) consumed by industry in 1953 increased about 4 percent above that recorded in 1952.

Consumption of muscovite block and film mica cut or stamped to dimension by domestic fabricators totaled over 4.3 million pounds (table 11). Of the total, Stained quality ranked first at 50 percent; Lower Than Stained, 41 percent; and Good Stained or Better, 9 percent. Electronic uses consumed 69 percent of the total block and film supply. Twelve percent of the muscovite mica used for electronic applications was Good Stained or Better quality and 68 percent Stained quality. Only about 10 percent of the crude material fabricated was from domestic mines, with 97 percent of this punch and circle mica.

A total of 31 companies in 10 States reported fabrication of block and film mica in 1953. About 40 percent of the quantity fabricated was by 18 companies in New Jersey (6), New York (9), and North Carolina (3). Geographical distribution of the fabricators, the form of mica fabricated, and end-product use for which mica was fabricated are shown in table 13.

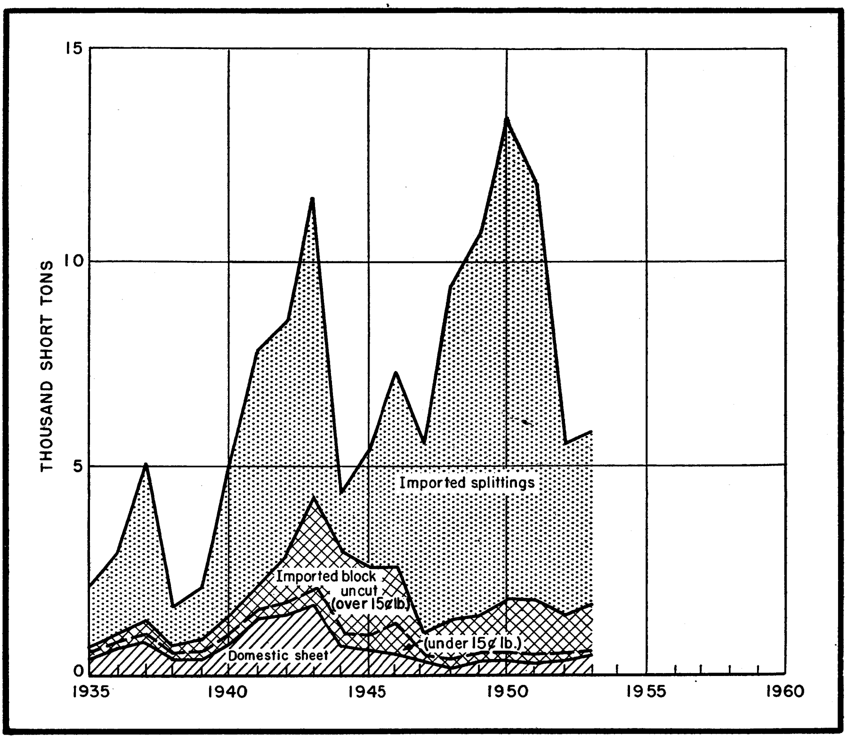

FIGURE 2.—Block mica and splittings imported for consumption in the United States and sales of domestic sheet mica, 1935–53.

TABLE 10.—Production and apparent consumption [1] of sheet mica in the United States, 1944–48 (average) and 1949–53, in pounds

Year	Production	Apparent consumption [1]
1944–48 (average)	917, 279	13, 570, 602
1949	513, 994	21, 646, 158
1950	578, 818	27, 709, 386
1951	594, 884	25, 225, 267
1952	697, 989	[2] 12, 479, 834
1953	849, 394	14, 412, 900

[1] The sum of domestic sheet-mica production and imports of unmanufactured and manufactured sheet mica minus the exports of sheet mica.
[2] Revised figure.

TABLE 11.—Fabrication of muscovite ruby and nonruby block and film mica and phlogopite block mica by quality and end-product use in the United States, 1953, 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	1,377	126,339	4,354	132,070	7,134	10,597	17,731	149,801
Stained	9,282	1,956,917	32,043	1,998,242	1,706	150,031	151,737	2,149,979
Lower Than Stained	314	540,787	32,665	573,766	1,246	[1]1,184,424	1,185,670	1,759,436
Total	10,973	2,624,043	69,062	2,704,078	10,086	[1]1,345,052	1,355,138	4,059,216
Film:								
First quality	51,954	8		51,962		2	2	51,964
Second quality	181,793		176	181,969		321	321	182,290
Other	12,129			12,129				12,129
Total	245,876	8	176	246,060		323	323	246,383
Block and film:								
Good Stained or Better [2]	235,124	126,347	4,530	366,001	7,134	10,920	18,054	384,055
Stained [3]	21,411	1,956,917	32,043	2,010,371	1,706	150,031	151,737	2,162,108
Lower Than Stained	314	540,787	32,665	573,766	1,246	1,184,424	1,185,670	1,759,436
Total	256,849	2,624,051	69,238	2,950,138	10,086	1,345,375	1,355,461	4,305,599
Phlogopite: Block (all qualities)						[1] 73,676	73,676	73,676

[1] Includes punch mica.
[2] Includes first- and second-quality film.
[3] Includes other-quality film.

TABLE 12.—Fabrication of muscovite ruby and nonruby block and film mica in the United States, 1953, 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	12,422	15,261	14,928	100,661		143,272
Stained	95,899	205,507	104,435	1,635,583		2,041,424
Lower Than Stained	184,510	273,118	94,674	411,648	654,474	1,618,424
Total	292,831	493,886	214,037	2,147,892	654,474	3,803,120
Nonruby:						
Good Stained or Better	3,799	2,127	6	597		6,529
Stained	3,204	11,143	1,125	93,083		108,555
Lower Than Stained	40,193	31,775	11,767	3,107	54,170	141,012
Total	47,196	45,045	12,898	96,787	54,170	256,096
Film:						
Ruby:						
First quality	5,024	15,281	14,025	16,188		50,518
Second quality	41,529	48,273	41,442	48,471		179,715
Other quality					11,545	11,545
Total	46,553	63,554	55,467	64,659	11,545	241,778
Nonruby:						
First quality	481	515	125	325		1,446
Second quality	625	347	24	1,579		2,575
Other quality					584	584
Total	1,106	862	149	1,904	584	4,605

[1] Figures for block mica include "all smaller than No. 6" grade and "punch" mica.

TABLE 13.—Mica fabricators by State, county, and products for which muscovite and phlogopite mica were fabricated in 1953

State	County	Nearest town	Company	Products for which mica was fabricated			
				Muscovite			Phlogopite
				Block		Film	
				Electronic uses	Nonelectronic uses	Electronic and non-electronic uses	Nonelectronic uses
Connecticut	Windham	Willimantic	William Brand			X	X
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		X	
Massachusetts	Berkshire	North Adams	Sprague Electric Co			X	
Do	Bristol	New Bedford	Aerovox Corp			X	
Do	Essex	Danvers	Vulcan Electric Co				X
Do	Suffolk	Boston	Huse-Liberty Mica Co	X			X
New Jersey	Bergen	Englewood	Industrial Mica Corp	X	X	X	X
Do	do	Rochelle Park	Mica Fabricating Co	X		X	
Do	Camden	Camden	Radio Corp. of America	X		X	
Do	Essex	Newark	Micacraft Products, Inc	X	X	X	X
Do	Hudson	North Bergen	Ecco High Frequency Electric Corp			X	
Do	Monmouth	Manasquan	American Mica Insulation Co	X		X	
New York	Kings	Brooklyn	Ford Radio & Mica Corp	X			
Do	do	do	Micamold Radio Corp			X	
Do	do	do	Reliance Mica Co	X	X	X	
Do	do	do	Victory Mica Mfg. Co., Inc	X			
Do	New York	New York	American Mica Products Co		X		
Do	do	do	The B G Corp		X	X	X
Do	do	do	Manchard Trading Corp		X		
Do	Schenectady	Schenectady	General Electric Co		X		X
Do	do	do	Mica Insulator Co	X	X	X	X
North Carolina	Avery	Plumtree	Tar Heel Mica Co		X		
Do	Buncombe	Asheville	Farnam Mfg. Co	X	X	X	X
Do	Mitchell	Spruce Pine	Spruce Pine Mica Co	X	X	X	X
Ohio	Fairfield	Lancaster	Diamond Power Specialty Corp		X		
Pennsylvania	McKean	Smethport	Sylvania Electric Products, Inc	X			
Do	Philadelphia	Philadelphia	Leeds & Northrup Co			X	
Rhode Island	Washington	Hope Valley	Cornell-Dubilier Electric Corp	X		X	
Virginia		Newport News	Asheville Mica Co	X	X	X	X

Consumption of splittings in 1953 increased slightly over 1952 (table 14). A total of 16 companies in 10 States reported consuming mica splittings for producing built-up mica (micanite). About 91 percent of the splittings, by weight, was muscovite obtained from India, and the remainder was phlogopite obtained from Canada and Madagascar.

TABLE 14.—Consumption and stocks of mica splittings in the United States, 1944–48 (average) and 1949–53, by sources

	1944–48 (average)		1949		1950	
	Pounds	Value	Pounds	Value	Pounds	Value
Consumption:						
Domestic	[1] 63,496	[1] $34,274	81,001	$45,767	[2] 200,728	[2] $105,717
Canadian	[3] 341,315	[3] 186,250				
Indian	7,538,138	4,570,505	7,462,101	6,624,447	9,847,591	8,032,918
Madagascan	367,809	244,365	571,702	426,151	734,879	492,786
Mexican	[1 3] 40,782	[1 3] 27,454			(2)	(2)
Total	8,351,540	5,062,848	8,114,804	7,096,365	10,783,198	8,631,421
Stocks (Dec. 31):						
Domestic	[4] 13,187	[4] 6,001	[2] 85,934	[2] 34,141	[2] 235,537	[2] 182,999
Canadian	[3 4] 163,535	[3 4] 99,461				
Indian	4,201,382	2,625,488	3,858,495	4,003,621	5,464,294	5,552,016
Madagascan	331,071	227,585	413,434	365,098	450,581	432,872
Mexican	[3] 33,557	[3] 21,764	(2)	(2)	(2)	(2)
Total	4,742,732	2,980,299	4,357,863	4,402,860	6,150,412	6,167,887

	1951		1952		1953	
	Pounds	Value	Pounds	Value	Pounds	Value
Consumption:						
Domestic	[2] 164,213	[2] $104,868				
Canadian			184,541	$74,197	158,343	$98,738
Indian	12,306,853	10,995,620	9,356,561	9,091,784	9,443,645	7,225,899
Madagascan	908,229	660,129	679,569	563,118	744,171	577,595
Mexican	(2)	(2)				
Total	13,379,295	11,760,617	10,220,671	9,729,099	10,346,159	7,902,232
Stocks (Dec. 31):						
Domestic						
Canadian	50,784	24,486	63,588	23,352	39,354	20,423
Indian	9,756,536	9,379,176	8,218,683	8,356,888	6,688,997	6,110,975
Madagascan	522,110	497,658	512,158	460,015	387,905	316,610
Mexican						
Total	10,329,430	9,901,320	8,794,429	8,840,255	7,116,256	6,448,008

[1] Mexican included with domestic in 1948.
[2] Mexican included with domestic and Canadian.
[3] Mexican included with Canadian in 1947.
[4] Domestic included with Canadian in 1948.

TABLE 15.—Consumption of mica splittings in the United States, 1953, by States

State	Number of consumers	Quantity (pounds)
Indiana and Pennsylvania	4	3,199,880
Massachusetts and New Hampshire	3	2,966,063
Michigan, Ohio, and Wisconsin	4	335,543
New York, North Carolina, and Virginia	5	3,844,673
Total	16	10,346,159

Built-Up Mica.—Consumption of domestically produced built-up mica in 1953 increased 7 percent by weight but decreased 3 percent in value compared with 1952. Various forms of built-up mica were produced, as shown in table 16, and were used principally for electrical insulation applications. Domestic production of built-up mica in 1953 came from 13 companies operating a total of 16 plants. About 63 percent of the built-up mica was produced by electrical companies for use in their own products, such as generators, motors, transformers, and electrical heating devices. The remaining companies are not fully integrated and produce built-up mica products for sale to electrical manufacturers.

TABLE 16.—Built-up mica [1] sold or used in the United States, 1951–53, by kind of product

Product	1951		1952		1953	
	Pounds	Value	Pounds	Value	Pounds	Value
Molding plate	2,184,654	$3,898,117	1,682,742	$3,137,011	1,704,644	$3,323,141
Segment plate	2,778,482	5,488,492	2,094,397	3,972,515	2,106,226	4,054,997
Heater plate	1,140,404	2,901,670	511,120	1,419,575	822,207	2,221,995
Flexible (cold)	917,326	2,596,787	721,037	2,002,263	559,671	1,713,996
Tape	(2)	(2)	(2)	(2)	[3] 2,254,587	[3] 8,704,367
Other	2,439,289	11,457,814	2,139,670	10,916,674	201,174	705,837
Total	9,460,155	26,342,880	7,148,966	21,448,038	7,648,509	20,724,333

[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."

Ground Mica.—Sales of ground mica in 1953 decreased 2 percent below the 1952 figures, but 1953 was the second largest year for this section of the mica industry. Manufacturers of roofing material continued to consume the greater portion of the annual ground-mica production, while ground-mica uses in paint and rubber were second and third in importance, by weight. Smaller quantities were used by numerous other industries as shown in table 17. Of special interest, since World War II, has been an increase in the use of ground mica by manufacturers of paint, rubber, and plastic products and a decline in its use for manufacturing wallpaper. The main factor in the decreased use in wallpaper was the trend for new residential houses to be built with painted interior walls of plaster and plasterboard.

PRICES

Prices offered by fabricators for domestic sheet mica changed slightly in September 1953 compared with 1952 (table 18). The minimum price for punch mica, grades 1½ x 2, 3 x 4, 4 x 6, decreased; for grades 2 x 3 and 3 x 5 increased; and for grades 2 x 2, 3 x 3, and 6 x 8 remained in the same.

In July 1953 the Government began purchasing muscovite nonruby block, film, and hand-cobbed mica at prices 20 percent lower than those for ruby mica (table 19). Prices for ruby mica were identical to those in 1952.

TABLE 17.—Ground mica sold by producers in the United States, 1952–53, by uses

Use	1952			1953		
	Short tons	Percent of total	Value	Short tons	Percent of total	Value
Roofing	30,922	41	$887,700	32,389	44	$935,208
Wallpaper	583	1	79,673	598	1	79,522
Rubber	5,126	7	457,194	5,668	8	547,654
Paint	16,566	22	1,549,671	15,258	21	1,435,294
Plastics	1,959	3	181,889	1,641	2	153,440
Pipeline enamel	2,668	4	85,537	(1)	(1)	(1)
Welding rods	1,749	2	102,934	1,538	2	85,665
Well drilling	4,847	6	245,504	4,347	6	195,152
Miscellaneous [2]	10,386	14	688,001	11,633	16	760,485
Total	74,806	100	4,278,103	73,072	100	4,192,420

[1] Included with "Miscellaneous" to avoid disclosure of individual company operations.
[2] Includes mica used for molded electric insulation, house insulation, Christmas-tree snow, manufacture of axle greases and oil, annealing, and other purposes.

North Carolina scrap mica was quoted at $32 to $35, depending on the quality and mesh size.

Dry- and wet-ground mica prices in March 1953 increased from ⅛ to ¾ cent and remained there throughout the remainder of the year (table 20).

TABLE 18.—Prices for various grades of clear sheet mica in North Carolina district, Dec. 31, 1953, 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 19.—Price for muscovite ruby and nonruby full-trimmed and half-trimmed block and film mica and hand-cobbed mica purchased by the Government, 1953, by grade and quality

	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	56.00	14.40	10.40	9.60	6.40
No. 4 and No. 5	32.00	6.40	4.80	4.00	3.20
No. 5½ and No. 6	12.00	4.00	2.40	2.40	1.60
Hand-cobbed mica:					
Ruby	$600 per short ton.				
Nonruby	$480 per short ton.				

TABLE 20.—Price of dry- and wet-ground mica in the United States, December 1953, in cents per pound [1]

[Oil, Paint and Drug Reporter]

	Price per pound
Dry-ground:	
Paint, 100-mesh	4¼
Plastic, 100-mesh	4¼
Roofing, 20- to 80-mesh	3–4
Wet-ground: [2]	
Biotite	6¼
Biotite, less than carlots [3]	7
Paint or lacquer	7¾
Paint or lacquer, less than carlots [3]	8½
Rubber	7½
Rubber, less than carlots [3]	8½
Wallpaper	7¾
Wallpaper, less than carlots [3]	8¼
White, extra fine	7¾
White, extra fine, less than carlots [3]	8½

[1] In bags at works, carlots, unless otherwise noted.
[2] Freight allowed east of the Mississippi River.
[3] Ex-warehouse or freight allowed east of the Mississippi River.

FOREIGN TRADE [5]

Imports.—In 1953 imports of mica of all varieties decreased 16 percent in quantity, but total value increased 4 percent (tables 21 and 22). The largest factor in the decline in quantity of imports was the large decrease in scrap imports, while the increase in value for uncut sheet contributed to the rise in total value.

Imports of muscovite block and film mica increased 26 percent in 1953 compared with 1952 (table 23). India and Brazil were the principal sources of supply, with half of the total imports coming from India. A total of 57 and 39 percent of the higher qualities of block and film mica (Stained or Better) was supplied by India and Brazil, respectively.

Tariff Commission and United States Department of Commerce data for imports of muscovite block, film, and splittings and phlogopite splittings are compared in table 25. They should be compared with figures reported as exports by the Indian Government in tables 31 and 32.

TABLE 21.—Mica imported into and exported from the United States, 1944–48 (average) and 1949–53

[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
1944–48 (average)	3, 665, 908	$2, 797, 886	4, 893	$64, 886	5, 317	$5, 972, 387	12, 043	$8, 835, 159	1, 208	$659, 378
1949	2, 466, 546	2, 111, 095	1, 758	21, 740	9, 747	17, 212, 419	12, 738	19, 345, 254	1, 108	676, 752
1950	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	[1] 2, 481, 669	[1] 3, 520, 922	6, 531	106, 475	[1] 5, 276	[1] 11, 053, 579	13, 048	[1] 14, 680, 976	2, 472	911, 076
1953	2, 599, 007	4, 279, 273	3, 927	72, 100	5, 763	10, 911, 101	10, 990	15, 262, 474	2, 402	1, 109, 865

[1] Revised figure.

[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 22.—Mica imported for consumption in the United States, 1944–48 (average), 1949–52 (totals) and 1953, 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				Value 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
1944–48 (average)	4,179,256	$28,942	5,606,635	$35,944	399,914	$64,463	602,748	$64,693	2,663,246	$2,668,730
1949	981,156	5,658	2,534,919	16,082	28,304	4,238	635,313	94,182	1,802,929	2,012,675
1950	896,400	6,988	7,908,526	52,026	129,400	21,755	429,269	41,384	2,775,983	3,031,477
1951	494,740	4,284	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	[1] 2,009,724	[1] 3,472,710
1953:										
Angola	-------	-------	182,444	1,284	-------	-------	-------	-------	25,435	75,311
Argentina	-------	-------	-------	-------	-------	-------	-------	-------	37,391	32,897
Australia	-------	-------	-------	-------	-------	-------	-------	-------	50	162
Bolivia	-------	-------	-------	-------	-------	-------	-------	-------	770	1,309
Brazil	-------	-------	-------	-------	-------	-------	101,233	8,613	1,090,750	1,858,091
British East Africa	-------	-------	-------	-------	-------	-------	-------	-------	19,192	52,510
Canada	1,205,633	13,793	73,078	1,125	251,811	46,727	18,240	1,495	15,277	30,826
French Morocco	-------	-------	-------	-------	-------	-------	8,928	1,296	1,102	804
India	-------	-------	3,911,581	32,361	-------	-------	-------	-------	1,016,540	2,159,309
Madagascar	-------	-------	-------	-------	-------	-------	-------	-------	7,165	6,742
Mexico	-------	-------	-------	-------	-------	-------	-------	-------	100	92
Mozambique	-------	-------	-------	-------	-------	-------	-------	-------	4,410	1,858
Southern Rhodesia	-------	-------	360,650	3,450	-------	-------	-------	-------	-------	-------
Union of South Africa	-------	-------	2,119,480	20,087	-------	-------	-------	-------	613	1,231
Total	1,205,633	13,793	6,647,233	58,307	251,811	46,727	128,401	11,404	2,218,795	4,221,142

Country	Manufactured-films and splittings							
	Not cut or stamped to dimensions				Cut or stamped to dimensions		Total films and splittings	
	Not over 12/10,000 inch thick		Over 12/10,000 inch thick					
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1944–48 (average)	8,645,400	$4,909,583	719,441	$819,047	42,973	$110,106	9,407,814	$5,838,736
1949	18,402,145	16,208,432	447,884	701,346	18,722	154,641	18,868,751	17,064,419
1950	23,086,329	18,387,967	1,090,082	1,505,827	27,799	363,097	24,204,210	20,256,891
1951	19,665,057	13,533,318	1,823,938	3,848,677	43,405	729,059	21,532,400	18,111,054
1952	7,986,592	6,426,616	[1] 1,908,735	[1] 3,220,505	59,560	971,756	[1] 9,954,887	[1] 10,618,877
1953:								
Angola	59	16	-------	-------	-------	-------	59	16
Argentina	-------	-------	3,748	2,942	-------	-------	3,748	2,942
Austria	-------	-------	300	943	-------	-------	300	943
Belgium-Luxembourg	4,400	1,840	-------	-------	-------	-------	4,400	1,840
Brazil	2,030	3,842	1,035,748	1,159,432	7,040	8,879	1,044,818	1,172,153
France	4,072	2,282	-------	-------	217	4,310	4,289	6,592
Germany, West	-------	-------	-------	-------	11,597	296,797	11,597	296,797
India	7,599,952	3,651,412	1,298,890	3,648,174	7,953	108,362	8,906,795	7,407,948
Italy	-------	-------	-------	-------	3,038	51,802	3,038	51,802
Japan	-------	-------	-------	-------	9,384	216,013	9,384	216,013
Macao	1,250	419	-------	-------	-------	-------	1,250	419
Madagascar	739,018	367,110	272,465	212,293	-------	-------	1,011,483	579,403
Mexico	2,107	4,526	34,179	46,069	19,529	230,366	55,815	280,961
Netherlands	-------	-------	-------	-------	448	13,626	448	13,626
United Kingdom	24,985	10,525	-------	-------	10,143	288,566	35,128	299,091
Total	8,377,873	4,041,972	2,645,330	5,069,853	69,349	1,218,721	11,092,552	10,330,546

See footnote at end of table.

TABLE 22.—Mica imported for consumption in the United States, 1944–48 (average), 1949–52 (totals) and 1953, 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		All mica manufactures of which mica is the component material of chief value		Ground or pulverized	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1944–48 (average)	135,738	$96,670	1,245	$2,343	5,765	$7,688	1,081,843	$26,950
1949	81,551	102,083	4,002	11,989	5,247	16,935	533,833	16,993
1950	82,353	112,136	9,779	25,619	25,590	86,314	560,000	25,814
1951	106,176	119,008	25,840	79,568	55,566	217,281	779,910	41,237
1952	53,612	87,935	28,174	141,344	36,886	177,768	479,498	27,655
1953:								
Belgium-Luxembourg			30	1,141				
Brazil	1,135	880	20,361	97,174	12,435	49,228		
Canada							320,000	19,156
Denmark					13	181		
France					7,464	8,484		
Germany, West	61	753	9,109	20,532	1,646	3,654		
India	35,840	66,235	1,550	3,163	216	2,270		
Italy			807	63,411	91	2,796		
Mexico	8,108	12,655	6,445	30,495	3,484	12,706		
United Kingdom	42	2,156	4,333	158,196	1,193	25,289		
Total	45,186	82,679	42,635	374,112	26,542	104,608	320,000	19,156

[1] Changes in Minerals Yearbook, 1952, should read as follows: Unmanufactured (other), valued above 15 cents per pound—Southern Rhodesia, 15,663 pounds ($15,923); manufactured (films and splittings): Not cut or stamped to dimensions and over 12/10,000 inch in thickness—India, 788,734 pounds ($1,878,217); total—India, 8,046,921 pounds ($8,006,507).

TABLE 23.—Muscovite block and film mica, United States general imports, 1952–53, by quality and principal source,[1] [2] in pounds

Quality	Countries						Total	
	India		Brazil		Other			
	1952	1953	1952	1953	1952 [3]	1953 [4]	1952	1953
Block:								
Good Stained or Better	117,589	298,387	197,459	191,402	37,189	38,178	352,237	527,967
Stained	599,870	1,189,206	1,389,055	1,135,899	30,618	70,167	2,019,543	2,395,272
Heavy Stained	37,933	276,062	524,757	675,425	10,537	38,089	573,227	989,576
Lower	118,291	236,541	510,006	296,753	37,304	18,059	665,601	551,353
Total	873,683	2,000,196	2,621,277	2,299,479	115,648	164,493	3,610,608	4,464,168
Film								
First quality	101,363	116,210			31	2	101,394	116,212
Second quality	196,360	327,003	330	1,267	119	1,156	196,809	329,426
Other quality	3,932	4,976	235	200			4,167	5,176
Total	301,655	448,189	565	1,467	150	1,158	302,370	450,814
Block and film:								
Good Stained or Better [5]	415,312	741,600	197,789	192,669	37,339	39,336	650,440	973,605
Stained [6]	603,802	1,194,182	1,389,290	1,136,099	30,618	70,167	2,023,710	2,400,448
Heavy Stained	37,933	276,062	524,757	675,425	10,537	38,089	573,227	989,576
Lower	118,291	236,541	510,006	296,753	37,304	18,059	665,601	551,353
Total	1,175,338	2,448,385	2,621,842	2,300,946	115,798	165,651	3,912,978	4,914,982

[1] Compiled by U. S. Tariff Commission from official documents of U. S. Bureau of Customs.
[2] Does not include imports of mixed grades and qualities from Angola, Austria, Port of East Africa, and Northern Rhodesia in 1952 because detailed breakdown from these sources is not available; imports from these sources totaled 48,350 pounds. For 1953 does not include imports from Angola, Australia, Brazil, Canada, and Union of South Africa; imports from these sources totaled 32,359 pounds.
[3] Includes imports from Angola, Argentina, Canada, Colombia, Southern Rhodesia, Tanganyika, and United Kingdom.
[4] Includes imports from Argentina, Canada, Mexico, Northern Rhodesia, Southern Rhodesia, and Tanganyika.
[5] Includes first- and second-quality film.
[6] Includes other-quality film.

TABLE 24.—Muscovite splittings, United States general imports, 1952–53, by form and principal sources,[1] in pounds

Country	Form						Total	
	Book		Loose		Loose-dusted			
	1952	1953	1952	1953	1952	1953	1952	1953
India	894,916	362,914	4,843,051	6,139,225	1,021,234	1,117,464	6,759,201	7,619,603
Other [2]	5,691	827	10,756	5,374	153	44	16,600	6,245
Total	900,607	363,741	4,853,807	6,144,599	1,021,387	1,117,508	6,775,801	7,625,848

[1] Compiled by U. S. Tariff Commission from official documents of U. S. Bureau of Customs.
[2] Includes imports from Brazil and Mexico.

TABLE 25.—Mica block, film, and splittings imported in the United States, 1952–53, by variety and principal sources, in pounds

	U. S. Tariff Commission data		U. S. Department of Commerce data	
	1952	1953	1952	1953
Muscovite block:				
India	873,683	2,000,196	524,174	1,016,540
Brazil	2,621,277	2,299,479	2,432,275	2,126,498
Other	[1] 115,648	[1] 164,493	[2] 154,396	96,541
Total	3,610,608	4,464,168	[2 3] 3,110,845	[3] 3,239,579
Muscovite film:				
India	301,655	448,189	[2 4] 788,734	[4] 1,298,890
Brazil	565	1,467		
Other	150	1,158		
Total	302,370	450,814	[2] 788,734	1,298,890
Muscovite splittings:				
India	6,759,201	7,619,603	[5] 7,245,780	[5] 7,599,952
Other	[6] 16,600	[6] 6,245		
Total	6,775,801	7,625,848	7,245,780	7,599,952
Phlogopite splittings:				
Madagascar	677,688	703,281	697,712	739,018
Other	[7] 1,084	[8] 2,795	[2] 5,613	6,179
Total	678,772	706,076	[3 9] 703,325	[10] 745,197

[1] Includes imports from Angola (1952), Argentina, Canada, Colombia (1952), Mexico (1953), Northern Rhodesia (1953), Southern Rhodesia, Tanganyika, and United Kingdom (1952).
[2] Revised figure.
[3] Includes imports of unmanufactured mica valued above 15 cents per pound, minus phlogopite valued above 15 cents per pound, plus imports from Brazil of manufactured films and splittings, not cut or stamped to dimension, over 12/10,000 inch thick.
[4] Manufactured films and splittings, not cut or stamped to dimensions, over 12/10,000 inch thick, from India.
[5] Manufactured films and splittings, not cut or stamped to dimensions, not over 12/10,000 inch thick from India.
[6] Includes imports from Brazil and Mexico.
[7] Includes imports from Canada and Mexico.
[8] Includes imports from Mexico.
[9] Manufactured films and splittings, not cut or stamped to dimension, not over 12/10,000 inch thick, from Canada, Madagascar, and Mexico.
[10] Manufactured films and splittings, not cut or stamped to dimension, not over 12/10,000 inch thick, from France, Madagascar, and Mexico.

Exports.—Exports of mica and mica products decreased 3 percent in 1953 compared with 1952 (table 26). Exports of ground mica and other manufactured mica increased, while exports of unmanufactured mica decreased 92 percent.

TABLE 26.—Mica and manufactures of mica exported from the United States, 1944–48 (average), 1949–52 (totals), and 1953, by countries of destination

[U. S. Department of Commerce]

Country	Unmanufactured		Manufactured			
			Ground or pulverized		Other	
	Pounds	Value	Pounds	Value	Pounds	Value
1944–48 (average)	292,611	$39,795	1,848,811	$89,828	273,442	$529,755
1949	113,776	43,140	1,922,179	102,147	180,157	531,465
1950	335,941	98,614	2,567,807	158,947	190,075	602,235
1951	398,662	93,572	3,136,548	189,836	254,179	818,509
1952	592,901	40,700	4,172,951	234,082	180,482	636,294
1953:						
North America:						
Canada	7,941	7,968	1,962,450	81,786	145,768	640,571
Cuba			170,440	9,349	2,119	6,236
Mexico	8,600	3,465	98,550	4,733	13,814	22,141
Other North America					12	471
South America:						
Argentina			26,100	1,826	113	969
Brazil			22,000	1,485	1,907	5,018
Chile					1,734	7,758
Colombia			21,000	2,021	1,320	5,708
Peru			40,400	3,482	4,204	11,413
Venezuela			677,053	33,714	99	475
Other South America					192	3,981
Europe:						
Belgium-Luxembourg			292,100	21,433	11,523	40,908
France			164,100	13,616	7,605	43,047
Germany, West			363,600	30,302		
Iceland			20,100	1,497		
Italy			307,200	16,178	2,075	33,649
Norway			44,000	3,520		
Spain			16,000	864	210	546
Sweden			23,200	1,515	1,222	5,093
Switzerland			2,000	152	835	550
Other Europe					370	3,070
Asia:						
India	22,565	11,793	49,000	3,366		
Indonesia			12,000	1,100		
Israel and Palestine			22,000	698	100	332
Japan	5,940	4,752				
Philippines					839	2,217
Other Asia					51	947
Africa:						
Belgian Congo					161	1,119
Union of South Africa			225,300	7,438	829	2,757
Other Africa			490	150	96	701
Oceania:						
Australia					172	1,854
New Zealand			1,800	131		
Total	45,046	27,978	4,560,883	240,356	197,370	841,531

TECHNOLOGY

In September 1947 the Bureau of Mines, at the Electrotechnical Laboratory, Norris, Tenn., began a research program on the synthesis of mica and related mineral systems. Major accomplishments at the end of 1953 included: (1) Development of the direct internal-electric-resistance melting process for producing large quantities of synthetic mica crystals 2 inches in diameter or less; (2) synthesis of mica by solid-state reaction; (3) development of machinable synthetic mica dielectrics by hot pressing and phosphate bonding; (4) development of synthetic mica-metal cermets; and (5) development of reconstituted synthetic mica sheet of controllable thickness and uniformity. The internal electric resistance method for growing crystals of synthetic mica from a fluorosilicate melt, furnace design, and characteristics of synthetic mica and hot-pressed mica were described in detail.[6]

Progress was made in classifying pegmatite bodies according to internal structure, mineralogy, and origin. Some pegmatites lack systematic orientation. Perfect zoning would comprise a series of concentric shells surrounding a central zone or core. No pegmatite will contain all 11 possible zones but will consist of 1 or more zones and will contain 1 or more of the following minerals: Feldspar, mica, beryl, lithium minerals, columbium-tantalum, quartz, etc.[7] An article was published on the evaluation of pegmatite bodies.[8]

The Bureau of Mines conducted an experimental mining program from September 1947 to March 1949 at the Morefield pegmatite mine, Amelia County, Va. The composition of drill-core samples, beneficiation tests, and results of selective mining experiments using a diamond drill and a mounted hammer drill for drilling blast holes were published.[9]

The New Anniversary-Bucky pegmatite is one of the largest dikes in the Quartz Creek district, Gunnison County, Colo. A small quantity of beryl and muscovite mica has been produced from this pegmatite. The Bureau of Mines in 1950 drilled two diamond-drill holes to investigate the most promising core area. Detailed logs of the diamond-drill holes were published in 1953.[10]

The Federal Geological Survey released several reports on the distribution, geology, mineralization, and economic possibilities of mica and other minerals of the pegmatitic bodies in the southeastern Piedmont area extending over parts of Virginia, North Carolina, South Carolina, Georgia, and Alabama [11] and in the Black Hills area of South Dakota.[12]

[6] Comeforo, J. E., Hatch, R. A., Humphrey, R. A., and Eitel, Wilhelm, Synthetic Mica Investigations: I, Hot-Pressed Machinable Ceramic Dielectric: Jour. Am. Ceram. Soc., vol. 36, No. 9, September 1953, pp. 286–294.
Eitel, Wilhelm, Hatch, R. A., and Denny, M. V., Synthetic Mica Investigations: II, Role of Fluorides in Mica Batch Reactions: Jour. Am. Ceram. Soc., vol. 36, No. 10, October 1953, pp. 341–348.

[7] Tyler, P. M., Economics of Pegmatites: Mining Eng., vol. 5, No. 9, September 1953, pp. 894–898.

[8] Rowe, R. B., Evaluation of Pegmatitic Mineral Deposits: Canadian Min. and Met. Bull., vol. 46, No. 499, November 1953, pp. 700–705.

[9] Geehan, R. W., Morefield Pegmatite Mine, Amelia County, Va.: Bureau of Mines Rept. of Investigations 5001, 1953, 41 pp.

[10] Wilson, S. R., and Young, W. A., Investigations of the New Anniversary-Bucky Pegmatite, Gunnison County, Colo.: Bureau of Mines Rept. of Investigations 4939, 1953, 7 pp.

[11] Griffitts, W. R., Jahns, R. H., and Lemke, R. W., Mica Deposits of the Southeastern Piedmont, Part 3, Ridgeway-Sandy Ridge District, Va. and N. C., and Part 4, Outlying Deposits in Va.: Geol. Survey Prof. Paper 248–C, 1953, pp. 141–202.
Griffitts, W. R. and Olson, J. C., Mica Deposits of the Southeastern Piedmont, Part 5, Shelby-Hickory District, N. C., and Part 6, Outlying Deposits in N. C.: Geol. Survey Prof. Paper 248–D, 1953, pp. 203–293. Mica Deposits of the Southeastern Piedmont, Part 7, Hartwell District, Ga. and S. C., and Part 8, Outlying Deposits in S. C.: Geol. Survey Prof. Paper 248–E, 1953, pp. 293–324.
Heinrich, E. M., Klepper, M. R., and Jahns, R. H., Mica Deposits of the Southeastern Piedmont, Part 9, Thomaston-Barnesville District, Ga., and Part 10, Outlying Deposits in Georgia: Geol. Survey Prof. Paper 248–F, 1953, pp. 327–400.
Heinrich, E. M. and Olson, J. C., Mica Deposits of the Southeastern Piedmont, Part 11, Alabama District: Geol. Survey Prof. Paper 248–G, 1953, pp. 401–462.

[12] Lang, A. J., Jr., and Redden, J. A., Geology and Pegmatites of Part of the Fourmile Area, Custer County, S. Dak.: Geol. Survey Circ. 245, 1953, 20 pp.
Page, L. R., and others, Pegmatite Investigations, 1942–45, Black Hills, S. Dak.: Geol. Survey Prof Paper 247, 1953, 228 pp.

The North Carolina Department of Conservation and Development conducted an economic study in 1953 on the scrap-mica resources in North Carolina. Geologic and economic aspects of the Spruce Pine, Franklin-Sylva, and Shelby districts and descriptions of over 40 deposits were summarized in a report.[13]

Research by Horizons, Inc., under contract to the Office of Naval Research, United States Department of the Navy, on the growth of oriented crystals of layer materials was completed. Techniques gained by growing cadmium iodide were applied to the growth of synthetic fluorphlogopite, and the similarities and differences in orientation habits were noted. Of the various crucible materials tested graphite proved the most successful, but its high porosity created problems arising from excessive permeability to vapors. It was concluded from this research that pure graphite, properly treated to minimize porosity, may be used successfully as a crucible material for growing synthetic mica; under the correct environmental conditions continuous sheets of synthetic mica in either single or multi-crystal form possibly may be grown.[14]

Results of investigations by Brush Beryllium Co., Cleveland, Ohio, under contract to the Office of Naval Research, showed: The slip-casting technique is feasible for producing synthetic mica radomes (protective covering for radiating and receiving system of radar installations); cermets of stainless steel powder and synthetic mica were superior to nickel powder and synthetic mica cermets; and hot-pressed normal fluorphlogopite was tested as tube-spacer material and found to have good vacuum properties, be readily machinable, and have low power loss. Blending studies were conducted on mica mixes, using a twin-shell double-cone blender and a roll blender.[15]

In 1953 the Brush Beryllium Co. began to market four synthetic micas—normal phlogopite, boron phlogopite, barium disilicic, and barium lithium trisilicic—in trial and semiproduction lots. The refractive indices of the following synthetic phlogopites were calculated by the Bragg method: Barium, beryllium, boron, cobalt, manganese, nickel, sodium, zinc, barium-lithium, calcium-lithium, and strontium-lithium, and the correlation between the calculated indices and the observed values were fairly good.[16]

Some effects of mica dust on the respiratory system were outlined in an article.[17]

The importance of built-up mica, made from imported splittings, as an electrical insulator lies in its high insulation resistance, resistance to changes in temperature, complete resistance to water and oils, and its mechanical characteristics. Electrical characteristics of the finished built-up mica product are determined mainly by the

[13] Broadhurst, S. D., and Hash, L. J., The Scrap-Mica Resources of North Carolina: North Carolina Dept. of Conservation and Development, Div. of Min. Resources, Bull. 66, 1953, 66 pp.

[14] Horizons, Inc. (Cleveland, Ohio), Growth of Oriented Crystals of Layer Minerals (Mica): Final Rept., June 1, 1953, 45 pp. (Technical Rept. to Office of Naval Research).

[15] Beaver, W. W., and Theodore, J. G., Fabrication of Synthetic Micaceous Materials: Brush Beryllium Co., Cleveland, Ohio, Quarterly Status Rept., Dec. 15, 1952 to Mar. 14, 1953, 8 pp.; March 15 to June 14, 1953, 6 pp.; June 15 to Sept. 14, 1953, 9 pp.; Sept. 15 to Dec. 15, 1953, 7 pp.

[16] Daimon, Nobutoshi, Refractive Indices of Various Synthetic Micas: Jour. Ceram. Assoc. Japan, vol. 61, No. 683, 1953, pp. 203-206.

[17] Heimann, Harry, Moskowitz, Samuel, Iyer, C. R. H., Gupta, M. N., and Mankiker, N. S., Note on Mica-Dust Inhalation: Arch. Ind. Hygiene and Occupational Medicine, vol. 8, December 1953, pp. 531-532.

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binder (organic binders, such as shellac, and synthetic resins, phenolic and alkyd or silicone compounds). A discussion of electrolytic conduction, surface resistivity, water absorption, and dielectric properties of built-up mica, in relation to high-temperature applications, appeared in an engineering publication.[18]

An article was published on electrical insulating materials in which the merits of reconstituted mica (micamat, isomica, and integrated mica) were discussed. Reconstituted mica has the advantage over built-up mica from splittings of more uniform binder content, giving greater freedom from spots of low dielectric breakdown, more uniform thickness, greater flexibility, and more uniform dielectric strength.[19]

Research was in progress during the year at the North Carolina State College Minerals Research Laboratory, Asheville, N. C., in cooperation with Farnum Mfg. Co., for developing methods for producing mica sheets from ground mica.[20]

It was reported in 1953 that glass-bonded mica (a moldable compound consisting of glass and mica) was being used in high-frequency, high-temperature applications. The high heat-distortion point (650° F.), moldability, long-term dimensional stability, and low dielectric loss make glass-bonded mica suitable for thermal, electronic, and high-voltage applications in which Teflon (polytetrafluorethylene), trifluorochloroethylene, and silicone glass are being used.[21]

Kings Mountain Mica Co., Kings Mountain, N. C., operated 2 washing plants and 1 dry-grinding plant in closed circuit. All mica recovered in washer plant 1 was sold to wet grinders for finer grinding or for blending. The waste material from plant 1 was processed further in plants 2 and 3 and marketed as dry-ground mica, sized and bagged to customers' specifications.[22]

The first commercial installation of Humphreys spirals in the mica industry was by the Funkhouser Co., Hartwell, Ga., and by the end of 1953 four mica companies were known to be using Humphreys spirals for mica concentration. Compared to other gravity methods, or flotation, spirals increase mica recovery, decrease labor requirements, and reduce operating costs.[23] A commercially desirable mica concentrate was produced by removal of slimes from Humphreys spirals used for heavy-mineral recovery in production of spodumene by Foote Mineral Co. at Kings Mountain, N. C. However, the recovery of mica by this method impaired heavy-mineral production, and mica production was temporarily abandoned.[24]

Biotite, muscovite, and vermiculite samples were ground to determine the effect of grinding on the cation-exchange capacity and breakdown of the crystal structure. Biotite has a higher initial cation-

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[18] Dawes, C. L., and Mansfield, W. R., Built-up Mica Plate for High-Temperature Applications Elec. Eng., vol. 72, No. 2, February 1953, pp. 145–150.

[19] Javits, A. E., New Nonrigid Materials for the Functional Design of Electrical Insulating Systems Elec. Mfg., vol. 52, No. 3, September 1953, pp. 123–138.

[20] Tennessee Valley Authority, Annual Report for Fiscal Year Ended June 30, 1953, p. 36.

[21] Materials and Methods, Materials at Work: Vol. 38, No. 2, August 1953, p. 104.
Chemical and Engineering News, Glass-Bonded Mica: Vol. 31, No. 5, Feb. 2, 1953, p. 425.

[22] White, E. D., Kings Mountain Mica Operation: Eng. and Min. Jour., vol. 154, No. 3, March 1953, pp. 94–96.

[23] Hubbard, J. S., Humphreys, I. B., and Brown, W. E., How Humphreys Spiral Concentrator Is Used in Modern Ore-Dressing Practice: Min. World, vol. 15, No. 6, May 1953, pp. 40–45.

[24] Goter, E. R., Hudspeth, W. R., and Rainey, D. L., Mining and Milling of Lithium Pegmatites at Kings Mountain, N. C.: Min. Eng., vol. 5, No. 9, September 1953, pp. 890–893.

exchange capacity, possibly as a result of hydration or presence of trioctahedral illite, but total increase appears to be due to crystal fracture and breaking of bonds.[25] After 8 to 9 hours of grinding, recrystallization of muscovite occurs.[26]

The Wet-Ground Mica Association, Inc., New York, N. Y., issued pamphlets on the effect of a wet-ground mica extender on the behavior of a paint system comprised of vinyl primers and vinyl-alkyd paint and on the use of wet-ground mica as a pigment in latex paints.[27] Tests on wet-ground mica in a three-coat system with gray vinyl-alkyd paint, red lead vinyl primer, and "wash" primer showed that mica delayed spreading of moisture and was helpful in promoting uniformity and corrosion resistance to salt water and fog.[28]

In 1953, specifications for classifying the quality of natural muscovite mica by visual methods were accepted by the American Society for Testing Materials as a tentative standard.[29]

Patents were issued for producing synthetic fluorphlogopite by passing a micaceous melt, in electrical carbon or platinum molds, through an elongated furnace or lehr,[30] for improvement of apparatus and methods for producing a continuous sheet of integrated mica as disclosed in United States patents 2,405,576 and 2,490,129 by Moses D. Heyman,[31] and for the flotation of mica by a water solution of sulfonated petroleum hydrocarbon.[32]

WORLD REVIEW

The estimated world production of mica in 1953 decreased for the second successive year. Data for 1944–48 (average) and 1949–53 are shown in table 27.

Argentina.—The legal monopoly of the Argentina Trade Promotion Institute in the purchase and export of domestically produced mica expired April 27, 1953. Under new regulations, the institute must purchase all mica of suitable qualities and grades offered to it by domestic producers, but producers can trade freely within the country and abroad.[33]

Australia.—Mica production in the Hart's Range and Plenty River districts, Northern Territory, declined in 1953.[34] In December the Government extended the Commonwealth Mica Pool for 1 year in an effort to encourage mining. All block mica produced in Australia was purchased at controlled prices by the Government. Data for 1953 are not available, but figures for 1950–52 are shown in table 28.

[25] Mackenzie, R. C., and Milne, A. A., Effect of Grinding on Micas: Clay Minerals Bull., vol. 2, No. 9, 1953, pp. 57–62.

[26] Mackenzie, R. C., and Milne, A. A., Effect of Grinding on Micas; Muscovite: Mineral. Mag. (London), vol. 30, No. 222, 1953, pp. 178–185.

[27] Wet-Ground Mica Assoc., Inc., An Investigation of the Effect of Platy Mica Extender on the Behavior of a Paint System Comprised of Vinyl Primers and a Vinyl-Alkyd Paint: Tech. Bull. 13, January 1953, 4 pp. Studies on the Behavior of Mica as a Pigment Material in Latex Paints: Tech. Bull. 14, June 1953, 4 pp.; No. 15, October 1953, 4 pp.

[28] Kronstein, Max, DeLong, L. F., and Norman, A. W., Effect of Platy Mica on Vinyl Systems: Paint and Varnish Production, vol. 43, No. 5, May 1953, pp. 22–24.

[29] American Society for Testing Materials, Natural Muscovite Mica Based on Visual Quality: D-351-53T, June 1953, pp. 1084–1092.

[30] Waggoner, J. H. (assigned to Owens-Corning Fiberglass Corp.), Method of Producing Synthetic Mica: U. S. Patent 2,645,060, July 14, 1953.

[31] Heyman, M. D., Means and Method for Producing a Continuous Sheet of Integrated Mica: U. S. Patent 2,659,412, Nov. 17, 1953.

[32] Gieseke, E. W. (assigned to American Cyanamid Co.), Flotation of Mica With Sulfonates: U. S. Patent 2,643,770, June 30, 1953.

[33] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 5, November 1953, pp. 65–66.

[34] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 5, May 1953, p. 39.
Chemical Engineering and Mining Review (Australia), Mica in 1952: Vol. 45, No. 10, July 1953, p. 406.
Mining Mag. (London), vol. 88, No. 6, June 1953, p. 355.

TABLE 27.—World production of mica, by countries,[1] 1944–48 (average) and 1949–53, in metric tons [2]

[Compiled by Helen L. Hunt]

Country [1]	1944–48 (average)	1949	1950	1951	1952	1953
North America:						
Canada (sales):						
Block		51	129	279	83	
Splittings		4	1	3	3	
Ground	3,508	841	1,005	936	448	842
Scrap		689	624	1,033	380	
Mexico (exports)	180	13	176	33	(3)	(3)
United States (sold or used by producers):						
Sheet	416	233	262	270	317	385
Scrap	45,059	29,806	62,922	65,200	68,253	66,459
South America:						
Argentina:						
Sheet [4]		300	300	300	300	300
Scrap [4]	725	1,100	1,100	1,100	1,100	1,100
Brazil	1,448	1,363	1,813	1,658	1,260	1,196
Peru	163	-------	-------	-------	-------	(3)
Uruguay	5	2	1	1	1	1
Europe:						
Austria	54	253	368	307	-------	-------
Italy	30	-------	-------	-------	-------	-------
Norway, including scrap	384	331	553	985	531	(3)
Portugal	502	-------	-------	-------	-------	(3)
Spain	57	9	14	11	8	13
Sweden:						
Block		11	2	42	8	
Ground	150	50	165	173	157	(3)
Asia:						
Ceylon	1	-------	-------	(5)	9	6
India (exports):						
Block		418	773	1,637	1,479	
Splittings	9,475	9,161	12,070	13,939	5,738	11,182
Scrap		4,164	3,736	9,351	8,399	
Korea:						
Korea, Republic of		-------	-------	-------	6	-------
North Korea	[4] 130	(3)	(3)	(3)	(3)	(3)
Taiwan (Formosa):						
Sheet		-------	-------	15	1	
Scrap	15	-------	-------	470	13	23
Africa:						
Angola:						
Sheet		12	15	15	29	19
Scrap and splittings	50	45	154	121	200	10
Eritrea	1	(5)	1	-------	-------	-------
French Morocco:						
Sheet		-------	1	12	-------	(5)
Scrap	[6] 50	198	74	25	6	13
Kenya	(5)	4	6	1	2	-------
Madagascar:						
Block (phlogopite)		126	57	958	41	52
Splittings	508	833	762	-------	1,028	764
Mozambique, including scrap	2	103	41	11	2	1
Northern Rhodesia, sheet	5	3	2	6	16	8
Southern Rhodesia:						
Block		87	76	94	95	67
Scrap	274	216	331	254	664	91
South-West Africa, scrap	-------	-------	59	114	-------	-------
Tanganyika (exports):						
Block		60	50	70	108	75
Ground	172	36	60	-------	15	-------
Scrap		-------	25	-------	1	52
Uganda	4	2	(5)	(5)	(5)	-------
Union of South Africa:						
Sheet		1	14	5	5	5
Scrap	1,483	1,065	1,357	1,774	2,663	1,943
Australia [7]	266	736	738	536	501	446
Total (estimate) [1]	76,000	70,000	105,000	125,000	120,000	115,000

[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] Data not available; estimate by senior author of chapter included in total.
[4] Estimate.
[5] Less than 1 ton.
[6] Average for 1946–48.
[7] These figures include the following tonnages of damourite produced in South Australia: 1949, 703 tons; 1950, 707 tons; 1951, 513 tons; 1952, 468 tons; 1953, 413 tons.

TABLE 28.—Salient statistics for mica in Australia, 1950–52, in pounds

	1950	1951	1952
Block:			
Pool sales	69, 670	61, 211	27, 666
Imports [1]	60, 906	65, 056	20, 224
Exports	3, 638	8, 288	----------
Apparent consumption	126, 938	117, 979	47, 890
Splittings: Imports (apparent consumption)	152, 800	154, 425	68, 770
Scrap and ground mica:			
Imports	177, 651	290, 128	102, 752
Exports	----------	2, 840	10, 205
Apparent consumption	177, 651	287, 288	92, 547

[1] Includes condenser films.

The principal mines in 1952 were as follows:

Mine:	*Pounds*	*Value*
Spotted Tiger	12, 462	$24, 789
Disputed	9, 735	33, 887
Last Chance	6, 716	17, 517
Blackfellows Bones	4, 412	9, 763
Delma	3, 612	12, 727
Black Diamond	3, 232	6, 248
Eldorado	2, 826	9, 919
Billy Hughes	2, 278	4, 730
Queen	2, 260	6, 712
Mirror Finish	2, 023	7, 620
Central	2, 003	8, 514
Dinkum	1, 713	5, 227
Elizabeth	1, 709	6, 063
Pasqualina	1, 375	5, 428
New Mine	1, 223	5, 301
Young Queen	1, 021	4, 395
PA. 206 H	972	4, 119

Peerless Mica Co. Pty., Ltd. secured the rights to manufacture Samica in British Commonwealth countries (except India, Pakistan, and Canada). The company planned to build a plant in Australia to treat scrap mica produced in the Northern Territory.[35]

Canada.—Production of mica in 1953 decreased 8 percent in volume and 12 percent in value below 1952. All Canadian phlogopite production came from Quebec and Ontario. In Quebec mica was mined from numerous scattered deposits in the area of the Gatineau and Lievre Rivers, in Buckingham, Templeton, Portland, and Blake Townships. Phlogopite production in Ontario came mainly from the Stanleyville area, North Burgess Township, Leeds County. The North Bay Mica Co., Ltd., operating the Purdy mine near Eau Claire, Nipissing district, Ontario, and Craft Mining Co., operating in Craft and Chapman Townships, Hastings County, Ontario, were the only producers of muscovite mica in Canada. Geo. W. Richmond Co., Ltd., and Fairey & Co., Ltd., continued to grind mica schist near Albreda, British Columbia, for the roofing industry.[36] Salient statistics on the Canadian mica industry in 1953 and 1952 are shown in table 29.

[35] Rhodesian Mining Review, Sheet Mica from Scrap: Vol. 18, No. 1, January 1953, p. 23.
[36] Bruce, C. G., Mica in Canada, 1953 (Preliminary), Canadian Department of the Mines and Technical Surveys, 1953, 8 pp.

TABLE 29.—Salient statistics of the Canadian mica industry, 1952–53

	1952		1953	
	Pounds	Value	Pounds	Value
Production (primary sales):				
Trimmed	61, 625	$111, 830	(1)	(1)
Splittings	6, 900	10, 849	(1)	(1)
Sold for mechanical splittings	105, 795	19, 756	(1)	(1)
Rough, mine-run, or rifted	14, 350	850	(1)	(1)
Ground or powdered	988, 051	41, 545	(1)	(1)
Scrap	838, 220	9, 276	(1)	(1)
Total	2, 014, 941	194, 106	1, 856, 713	$171, 372
Imports (including manufactures), from:				
United States	(1)	438 697	(1)	472, 004
India	(1)	265, 244	(1)	231, 519
United Kingdom	(1)	20, 342	(1)	16, 021
Other countries	(1)	4, 606	(1)	----------
Total	(1)	728, 889	(1)	719, 544
Exports, unmanufactured:				
Rough, to:				
United States	178, 700	31, 291	240, 500	43, 704
Japan	100	28	----------	----------
Total	178, 800	31, 319	240, 500	43, 704
Trimmed, to:				
Japan	28, 900	23, 905	57, 800	55, 775
United States	21, 700	61, 729	21, 600	37, 785
Total	50, 600	85, 634	79, 400	93, 560
Scrap, to: United States	889, 000	8, 434	1, 354, 700	19, 583
Ground, to: United States	440, 400	26, 020	320, 000	19, 158
Splittings, to:				
Japan	3, 100	4, 689	(1)	(1)
United States	400	400	(1)	(1)
Total	3, 500	5, 089	(1)	(1)
Total exports of unmanufactured mica	1, 562, 300	156, 496	1, 994, 600	176, 005
Exports, mica manufactures, to:				
United States	(1)	277	(1)	123
Brazil	(1)	86	(1)	----------
Total	(1)	363	(1)	123

[1] Data not available.

Ceylon.—Mica production totaled 6 long tons valued at $90 in 1953.[37]

Finland.—Only small quantities of mica have been recovered as a byproduct in the refining of feldspar and quartz in Finland. Mica deposits of commercial value have not been found in Finland; however, small deposits are known to exist, notably at Kitee and near the city of Kajaani.[38]

India.—The Indian Government was taking action to create a central organization to regulate mica exports. Industry representatives advised the Government that the quality of exports must be improved by adopting universal standards, exports of scrap must be

[37] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 4, April 1954, p. 45.
[38] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 2, February 1954, p. 63.

banned, and research must be promoted to encourage domestic consumption in order to stabilize the Indian mica industry.[39] Several articles describing the Indian mica industry were published during the year.[40]

Plans were made in 1953 by the Bihar Government to make electricity available to the mica belt of the State, where about 80 percent of the world's mica is produced. This area covers about 1,000 square miles, mainly in the Hazaribagh district. Power supply was to be furnished first from the Damodar Valley Corp. at Tilaiya to the mica town of Jhumri Tilaiya and two mines at Sugti and Charki.[41]

Data on mica production and exports in 1951 and 1952 and exports in 1953 are shown in tables 30, 31, and 32.

Madagascar.—The export duty on mica was decreased from 5 to 0.5 percent of the f. o. b. value. At the same time, the import duty on explosives needed for mica mining was reduced from 15 to 9 percent ad valorem. Mica mining was becoming unprofitable as a result of rising production costs and increasing competition from India muscovite. The reduction of the custom duties should aid the industry.[42]

TABLE 30.—Production of mica in India, 1951–52, by districts [1]

Districts	1951		1952	
	Pounds	Value	Pounds	Value
Ajmer-Merwara	2, 102, 352	$547, 625	501, 312	$140, 479
Bihar:				
Bhagalpur	82, 880	24, 112	123, 312	24, 574
Gaya	1, 389, 808	433, 074	2, 464, 784	518, 858
Hazaribagh	11, 337, 200	3, 043, 708	9, 714, 768	2, 505, 822
Manbhum	6, 608	1, 357	----------	----------
Monghyr	796, 656	114, 000	295, 232	58, 042
Bombay: North Kanara	----------	----------	224	12
Madras:				
Coimbatore	56	73	----------	----------
Nellore	2, 183, 104	673, 180	1, 452, 192	453, 457
Nilgiris	66, 416	51, 186	17, 472	16, 185
Salem	9, 184	6, 604	2, 800	2, 165
Mysore:				
Hassan	384, 496	10, 749	104, 048	7, 516
Mandya	224	15	7, 840	756
Mysore	19, 600	353	5, 600	168
Rajputana:				
Jaipur	363, 552	116, 528	101, 696	18, 901
Mewar (including Shahpura and Pali)	3, 010, 672	935, 568	2, 170, 560	868, 714
Tonk	696, 304	184, 342	80, 640	16, 284
Punjab: Narnaul	----------	----------	4, 368	819
Total	22, 449, 112	6, 142, 474	17, 046, 848	4, 632, 752

[1] Adapted from India Geological Survey, The Mineral Production of India During 1952: October 1953, as reported in Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 3, March 1954, p. 55.

[39] Mining World, vol. 15, No. 6, May 1953, p. 68; No. 8, July 1953, p. 79; No. 9, August 1953, p. 72. South African Mining and Engineering Journal, vol. 64, No. 3148, part I, June 1953, p. 595.
[40] Capital (Calcutta), Mica as a Dollar Earner: Suppl. ed., June 25, 1953, pp. 53–55.
Ghosh, Arabinda, Mica Mines: Indian Min. Jour. (Calcutta), vol. 1, No. 9, September 1953.
Indian Mining Journal (Calcutta), vol. 1, No. 2, February 1953, pp. 31–32.
[41] Mining World, vol. 15, No. 10, September 1953, pp. 75-76.
[42] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 2, August 1953, p. 54.

TABLE 31.—Exports of mica from India, 1951–52, by destination and point of export [1]

Destination	1951						1952					
	Block		Splittings		Scrap or waste		Block		Splittings		Scrap or waste	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
Aden and Dependencies					1,120	$37						
Australia	59,584	$240,979	184,240	$61,600	273,056	3,446	17,136	$58,254	67,424	$18,998	76,160	$1,357
Austria	4,144	10,397					4,816	10,602	(2)	1,120		
Belgium	29,792	89,734	175,728	239,096	441,952	7,448	22,176	100,814	68,208	89,742		
Burma							(2)	661				
Canada			365,792	477,180					157,472	213,079		
Ceylon	224	1,018										
China	1,120	16,421					1,008	15,736				
Costa Rica	(2)	113										
Czechoslovakia	71,120	167,896	182,784	350,915			55,664	133,373	127,008	234,381		
Denmark							224	2,076	1,008	3,411		
Egypt	(2)	23					112	910				
Finland							112	630				
France	248,528	399,565	1,200,976	598,600	246,400	4,309	147,392	444,270	588,448	504,934	184,576	4,354
Germany, West	246,288	374,075	1,340,192	778,679	413,504	5,503	67,984	148,648	1,207,472	529,193	16,352	335
Greece							224	870				
Hong Kong	4,928	25,375	448	1,356								
Hungary							5,488	19,775				
Italy	55,888	72,245	357,392	529,119			101,584	151,042	303,632	367,940		
Japan	127,568	246,514	434,896	363,891	44,800	787	195,440	562,009	582,960	632,418	397,600	7,287
Netherlands	116,256	237,349	11,984	27,064			121,744	355,991	(2)	119		
New Zealand	7,504	22,440	336	1,180			3,584	11,569				
Norway	4,480	9,376	22,848	21,972	2,928,912	27,871	(2)	101			1,482,096	18,120
Pakistan							(2)	81				
Poland	18,368	61,561	84,224	89,587			7,504	27,462	50,176	70,389		
Portugal			336	2,385			(2)	670				
Sweden	10,304	27,556	203,280	136,114			5,488	10,926	167,328	292,063	224,000	2,440
Switzerland	11,312	61,008	314,496	269,728			6,048	35,973	74,704	76,002		
United Kingdom	1,034,880	2,494,416	7,802,368	4,192,962	8,022,336	79,004	1,129,520	2,908,115	3,007,088	2,731,665	6,736,240	81,891
United States	1,557,360	3,693,211	18,047,680	12,265,463	8,128,512	104,364	1,367,632	3,619,875	6,247,920	5,521,885	9,400,272	99,375
Total	3,609,648	8,251,272	30,730,000	20,406,891	[3] 20,614,832	[3] 233,875	3,260,880	[4] 8,620,418	12,650,848	11,287,339	18,517,296	215,159
Source of export:												
Calcutta	3,024,784	7,004,597	23,444,512	15,801,045	12,087,040	154,989	2,401,280	6,890,713	9,451,904	8,545,716	13,405,056	145,808
Cochin											66,976	1,258
Madras	568,176	1,142,150	7,285,488	4,605,846	8,526,672	78,849	829,696	1,683,462	3,192,672	2,729,238	5,045,264	68,093
Bombay	2,240	13,492			1,120	37	29,904	46,243	6,272	12,385		
Delhi	14,448	91,033										
Total	3,609,648	8,251,272	30,730,000	20,406,891	20,614,832	233,875	3,260,880	8,620,418	12,650,848	11,287,339	18,517,296	215,159

[1] Adapted from Daily List of Exports, issued by the Collector of Customs, Calcutta and Madras Customhouse, as reported in Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 3, March 1954, pp. 56–57.
[2] Figures not available.
[3] These totals are given as they appear in the publication. They actually add to 20,500,592 pounds of waste or scrap mica valued at $232,769.
[4] This total is given as it appears in the publication. It actually adds to $8,620,433.

TABLE 32.—Exports of mica from Calcutta and Madras, 1953, by kinds and destinations [1]

Destination	Calcutta		Madras	
	Pounds	Value	Pounds	Value
Block: [2]				
Australia	20,384	$43,676	3,360	$7,708
Austria	448	1,567	224	371
Belgium	19,264	91,019	23,184	30,498
Ceylon	(3)	121		
Chile	224	1,193		
Czechoslovakia	25,312	119,436		
Denmark	112	661		
Egypt	224	777		
France	65,968	127,238	10,864	16,699
Germany, West	148,064	330,766	8,848	21,407
Greece	2,576	7,149		
Hong Kong	672	1,196		
Hungary	6,720	25,074		
Italy	54,544	51,587	28,336	26,352
Japan	148,288	324,857	136,752	183,039
Madras (India)	448	567		
Netherlands	58,464	170,384	70,672	155,841
New Zealand	224	631		
Pakistan, East	112	1,562		
Pakistan, West	112	387		
Poland	4,928	25,737		
Singapore (Malaya)	224	600		
Suez	112	629		
Sweden	2,464	4,725		
Switzerland	8,624	48,742	896	4,107
United Kingdom	259,728	537,702	334,544	516,832
United States	1,092,560	2,133,260	269,696	354,092
Others	(3)	1,157		
Total	1,920,800	4,052,400	887,376	1,316,946
Film:				
Belgium	112	1,063		
Finland	112	331		
France	9,632	45,654		
Genoa (Italy)	784	7,104		
Germany, West	19,936	85,062		
Italy	9,296	32,007		
Japan	8,176	52,804		
Sweden	(3)	122		
Switzerland	2,128	21,033		
United Kingdom	83,888	437,747		
United States	435,792	2,205,440		
Total	569,856	2,888,367		
Splittings:				
Australia	46,032	13,554	48,272	11,113
Austria	112	186		
Belgium	143,136	104,339	26,880	31,708
Bretonback	2,464	3,946		
Canada	217,952	146,213	43,904	18,989
Czechoslovakia	28,896	48,950		
Denmark	3,584	5,606		
France	276,864	351,610	20,720	7,617
Germany, West	726,096	451,138	479,472	366,326
Italy	67,088	86,625	111,328	78,862
Japan	234,416	282,939	404,320	407,453
Netherlands	3,472	8,564	672	3,189
Poland	71,232	62,978		
Sweden	178,976	305,811	4,256	5,544
Switzerland	40,656	35,882		
United Kingdom	977,648	1,301,576	578,592	508,732
United States	6,562,752	2,989,927	951,776	696,352
Total	9,581,376	6,199,844	2,670,192	2,135,885
Scrap or waste: [4]				
France	263,648	2,723		
Germany, West	308,336	3,948	233,520	3,584
Italy	103,040	841	12,992	3,099
Japan	1,159,424	11,927	186,368	6,407
Norway	716,800	7,981	784,000	7,178
Sweden	212,800	2,268		
United Kingdom	980,896	9,089	1,676,192	21,615
United States	3,919,664	40,928		
Total	7,664,608	79,705	2,893,072	41,883

See footnotes at end of table.

TABLE 32.—Exports of mica from Calcutta and Madras, 1953, by kinds and destinations [1]—Continued

Destination	Calcutta		Madras	
	Pounds	Value	Pounds	Value
Mica, miscellaneous: [5]				
Australia	1,008	$908		
Austria	1,680	1,056		
Belgium	7,168	23,495		
Denmark	1,120	1,315		
France	560	4,813		
Germany	1,008	5,501		
Germany, West	19,040	1,892		
Japan	115,584	46,132		
Switzerland	2,016	13,527		
United Kingdom	39,312	39,768		
United States	195,216	319,170		
Total	383,712	457,577		

[1] Adapted from Daily List of Exports, issued by the Collector of Customs, Calcutta and Madras Customhouse, as reported in Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 3, March 1954, pp. 59–60.
[2] Additional exports over the fiscal year Apr. 1, 1952–Mar. 31, 1953, totaled 10,976 pounds valued at $12,461.
[3] Figures not available.
[4] Includes ground mica from Madras.
[5] Includes mica washers, wrappers, dust, sheet, stained, gaskets, loose, disks, cuttings, and unspecified.

Northern Rhodesia.—Production of sheet mica totaled 35,115 pounds valued at $27,516 in 1952 and 16,439 pounds at $13,555 in 1953. Exports for 1952–53 were as follows:[43]

Destination	1952		1953	
	Pounds	Value	Pounds	Value
United Kingdom	32,448	$47,835		
United States	745	3,130		
Germany, West			2,451	$3,959
Union of South Africa			705	972
Total	33,193	50,965	3,156	4,931

Southern Rhodesia.—Production of block mica in 1953 totaled 147,068 pounds valued at $133,217 compared with 208,000 at $183,083 in 1952. Exports in 1952–53 were as follows: [44]

Unmanufactured sheet mica	1952		1953	
	Short tons	Value	Short tons	Value
United Kingdom	109	$122,102	63	$66,628
Union of South Africa	(N. A.)	1,211	8	24,326
Italy			3	790
Tanganyika	12	10,359		
Total	121	133,672	74	91,744

[43] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 2, August 1954, p. 62.
[44] Bureau of Mines Mineral Trade Notes: Vol. 37, No. 1, July 1953, pp. 51–52; vol 39, No. 4, October 1954, p. 61.

Tanganyika.—A second mica-processing plant was built in 1952 by the New African Mica Co. in the Marogoro area about 140 miles inland from Dar-es-Salaam. New African Mica Co. is a joint venture of Van Eegagn & Maclaine (East Africa) and The Otto Gerdau Co. (New York), and 1953 was its second year of mica production.[45]

[45] Mining World, Mica-Processing Plant Opened in Tanganyika: Vol. 15, No. 10 ,September 1953, p. 41. Refractories Journal (London), vol. 29, No. 7, July 1953, p. 322.

Molybdenum

By Robert W. Geehan[1]

DOMESTIC production of molybdenum concentrates in 1953 was more than in any prior year except 1943; construction and development, nearly completed at the Climax mine—the world's largest producer—were expected to lead to a still greater output in 1954. The United States produced 92 percent of the estimated world production in 1953. Domestic output declined slightly in November and December from the peak established in August, September, and October; consumption of concentrates and shipments of primary products[2] were greatest during the first 6 months, and 1953 totals were slightly less than those for 1952. Production of molybdenum concentrates in Canada and Chile declined in 1953, while that in Japan increased.

Government Regulations and Programs.—During 1953 the following changes in Government regulations were important to producers and consumers of molybdenum-bearing materials:

MO–8. Defense Materials Procurement Agency. Allocations of molybdenum concentrates. Amended February 13 to terminate domestic allocations, and entire order revoked August 11, 1953.

M–80. National Production Authority. Allocations and end-use restrictions, molybdenum products. Terminated June 30, 1953.

M–81. National Production Authority. Pure molybdenum allocations, end use, and reporting procedures. Revoked April 16, 1953.

TABLE 1.—Salient statistics of molybdenum in the United States, 1944–48 (average) and 1949–53

[Thousand pounds of contained molybdenum]

	1944–48 (average)	1949	1950	1951	1952	1953
Concentrates:						
Production of concentrates	28,290	22,530	28,480	38,855	43,259	57,243
Shipments of concentrates [1]	28,350	23,280	44,544	37,955	42,717	53,823
Value of shipments [2] thousand dollars	19,820	19,332	37,729	36,177	40,845	52,362
Shipments for export	[3] 3,307	4,287	5,386	3,270	5,290	5,893
Consumption of concentrates	24,917	19,960	26,029	33,691	32,715	31,193
Imports for consumption	512	48	3	4	50	--------
Stocks of concentrates end of year [4]	20,069	19,159	4,326	5,058	6,856	11,326
Primary products: [5]						
Production of products	24,626	19,624	25,348	32,775	32,383	30,283
Shipments to domestic destinations	23,661	15,019	32,736	29,845	30,211	29,595
Shipments for export [6]	1,086	1,314	1,955	1,388	1,844	1,107
Total shipments of primary products	24,747	16,333	34,691	31,233	32,055	30,702
Stocks of primary products [7]	8,026	10,838	1,495	3,037	3,373	3,894

[1] Including exports.
[2] Largely estimated by Bureau of Mines.
[3] Actual exports; includes roasted concentrates.
[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.

[1] Assistant chief, Ferrous Metals and Alloys Branch.
[2] Includes ferromolybdenum, molybdic oxide, and molybdenum salts and metal.

DOMESTIC PRODUCTION OF ORES AND CONCENTRATES

Domestic production of molybdenum in concentrates increased from 3,677 thousand pounds in January to 5,618 thousand in August and declined to 4,685 thousand in December. Total production in 1953 was 32 percent more than that of 1952. Facilities nearly completed at the end of 1953 were expected to lead to an alltime high in production during 1954.

The most important molybdenum-bearing mineral is molybdenite (MoS_2), the source of virtually all molybdenum mined in 1953. Wulfenite ($PbMoO_4$), once mined from several deposits in southwestern United States, has not been reported as produced since 1944. Powellite [$Ca(Mo, W)O_4$] was the source of a relatively small quantity of molybdenum in 1953. Some molybdenum contained in tungsten concentrates is recovered at steel plants; this material is not included in the statistical tables.

Molybdenite is produced at mines operated chiefly for molybdenum and as a byproduct at mines operated mainly for copper or tungsten. The molybdenite content of raw ore mined at the former ranges from about 0.4 to 2.75 percent; at the latter the range is about 0.01 to 0.09 percent. In both instances a molybdenite concentrate is produced; the molybdenite content of the concentrate shipped ranges from about 54 to 92 percent, while 90 percent is considered a standard grade for price quotations. The output of mines operated solely or almost solely for molybdenum was 37,421 thousand pounds (metal content) in 1953, a 56-percent increase from 1952; byproduct concentrates from copper and tungsten operations totaled 19,822 thousand pounds, an increase of 3 percent.

Molybdenum was produced in six States in 1953. Colorado led, followed in order by Utah, Arizona, New Mexico, Nevada, and California. Shipments of molybdenum concentrates (metal content) comprised 47,930 thousand pounds to domestic destinations and 5,893 thousand pounds for export; total shipments increased 26 percent compared with 1952. Nearly all of the concentrates consumed are shipped to plants in Pennsylvania for conversion to primary products; however, the output of Miami Copper Co. is roasted before shipment.

Molybdenum Mines.—Ores that contained molybdenum as the chief value were worked at 2 domestic mines in 1953; their combined output represented 65 percent of the molybdenum in concentrates produced during the year. The Climax, Colo., mine of Climax Molybdenum Co. was the world's leading producer of molybdenite concentrates. This firm completed construction of facilities for production from the new Storke level. Development and construction required for output from submarginal areas developed from the upper Philipson level were nearly completed at the end of the year; this output is covered by a contract with the Government negotiated in 1952.

The Molybdenum Corp. of America produced molybdenite concentrates at the Questa mine, Questa, N. Mex. This mine was opened in 1919 and since 1923 has been a regular producer. Production of concentrates was 3 percent less than in 1952.

Byproduct Sources.—During 1953 molybdenite concentrates were also produced as a byproduct of copper and tungsten mining. Output of this group represented 35 percent of the molybdenum (contained in concentrates) produced in 1953.

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 for recovering molybdenum concentrates from copper ore. Except for the Nevada and Utah units, the molybdenum output of all plants in this group declined during 1953.

In May 1953 a contract between the Banner Mining Co., Tucson, Ariz., and the United States Government was announced, which provided for the purchase of copper from the Mineral Hill and Plumed Knight group in Pima County, Ariz.; the Government also has an option on all molybdenum produced. Production was scheduled to begin in 1954.

United States Vanadium Corp. recovered molybdenum concentrates and oxide as byproducts of tungsten ores and concentrates at its Pine Creek mill and chemical treatment unit near Bishop, Calif. The plant treats tungsten ores produced at the Pine Creek mine and tungsten ores and concentrates produced by others.

CONSUMPTION AND USES

Consumption, as measured by shipments to domestic consumers of molybdenum primary products, was 2 percent less in 1953 than in 1952. About 90 percent of the molybdenum is used in ferrous alloys, to which it is added as molybdic oxide, calcium molybdate, or ferromolybdenum. A relatively small quantity of molybdenite is used by a few steel companies as an addition in the ladle when both sulfur and molybdenum are required in the product to improve machinability. Molybdenum is also used in metallic form in the electrical industry and alone or in nonferrous alloys for certain high-temperature applications; molybdenum disulfide (molybdenite) is used in special lubricants, and various molybdenum compounds are used as fertilizers, in pigments, for ceramics, and as catalysts.

Molybdenum is widely employed in alloy steels. Modern usage ordinarily calls for remarkably small quantities of this element per ton of steel; an exception is high-speed steel, where 6 percent molybdenum is a common composition. A typical steel of this type contains 6 percent molybdenum, 6 percent tungsten, 4 percent chromium, and 3 percent vanadium; some firms use this for the same purposes as the tungsten type containing 18 percent tungsten, 4 percent chromium, and 1 percent vanadium. Additions in the range 0.1 to 0.5 percent molybdenum are common in many alloy steels that also contain chromium and nickel. Molybdenum is used in steels to promote uniform hardness and strength, to reduce softening when tempering, to reduce the tendency of certain steels to become brittle after tempering, to increase strength and creep resistance at elevated temperatures, to retard embrittlement in steels subjected to stress at temperatures ranging from 600° to 1,000° F., to aid corrosion resistance, to impart red hardness to high-speed steels, and, along with other alloying elements, for many special applications. In cast irons molybdenum increases the tensile strength, promotes uniform strength in castings with light and heavy sections, improves high-temperature strength, improves resistance to chipping, and improves hardenability of heat-treated castings. In both iron and steel the ability to use a very small quantity of molybdenum to yield the desired effect minimizes the cooling action at the time the alloying element is added to the melt.

STOCKS

Industry stocks of both concentrates and products increased during the year; details are listed in table 1.

PRICES

The prices quoted for molybdenum concentrates or primary products did not change during 1953. The published price, f. o. b. mines, of molybdenite in concentrates containing 90 percent MoS_2 was 60 cents a pound (equivalent to $1 a pound of molybdenum contained). The prices of the principal molybdenum products are based on 1 pound of contained molybdenum, f. o. b. producer's plant. During 1953 the prices quoted were as follows: Molybdic oxide $1.14, calcium molybdate $1.15, ferromolybdenum $1.32, and molybdenum metal $3. These prices have remained unchanged since December 1, 1950.

FOREIGN TRADE [3]

Many restrictions regarding foreign trade in molybdenum products were removed in 1953. The International Materials Conference terminated allocations and disbanded the Tungsten Molybdenum Committee. Domestic allocations required before shipment for export were revoked; restrictions on the use of molybdenum in alloy steels were removed by the United Kingdom in September,[4] and the Council of the Organisation for European Economic Cooperation recommended termination of restrictions on the use of molybdenum by member nations.[5]

In spite of these actions, total domestic shipments for export of concentrates and primary products declined 2 percent compared to the prior year. United Kingdom, France, Federal Republic of Germany, Canada, Japan, and Sweden were the chief foreign markets in 1953. No imports were received during the year.

Exports of ferromolybdenum totaled 646,411 pounds, gross weight,[6] in 1953 compared with 1,090,100 pounds in 1952. Canada (201,626 pounds), Italy (106,277 pounds), Japan (88,160 pounds), Austria (65,044 pounds), Spain (45,974 pounds), and Belgium-Luxembourg (41,407 pounds) were the most important markets for ferromolybde-

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

[4] Iron and Coal Trade Review (London), vol. 167, No. 4458, Sept. 18, 1953, p. 685.

[5] Metal Bulletin, (London), No. 3828, Sept. 22, 1953, p. 25.

[6] Ferromolybdenum contains about 60-65 percent molybdenum.

num in 1953. Exports also included the following products:

	Pounds gross weight	
	1952	*1953*
Metals and alloys	172,285	21,826
Wire	14,605	15,980
Powder	4,096	17,290
Primary forms, mainly rods, sheets, and tubes	8,040	13,078

Combined exports of molybdenum ores and concentrates, and roasted concentrates are listed as table 2. Details regarding raw concentrate shipments, along with products, as reported to the Bureau of Mines are listed below; because of the time lag between shipment from mine or plant and an actual export, this information is not directly comparable to the data in table 2.

Shipments for export; molybdenum content, thousands of pounds:	*1951*	*1952*	*1953*
Concentrates (not roasted)	3,270	5,290	5,893
Roasted concentrates (oxide)	751	1,173	796
All other primary products	637	671	311
Total	4,658	7,134	7,000

Tariff.—The tariff on molybdenum concentrates and products remained unchanged in 1953. The duty on ore and concentrate was 35 cents a pound on the metallic molybdenum contained and was 25 cents a pound of molybdenum contained plus 7.5 percent ad valorem on ferromolybdenum, molybdenum metal and powder, calcium molybdate, and other compounds and alloys of molybdenum.

TECHNOLOGY

Mining.—Molybdenum ores are mined in large, low-grade deposits and in relatively small quantities from small, high-grade ore bodies. In addition, significant quantities of molybdenite concentrate are produced as a byproduct of copper mining. Mining methods range from large-scale opencut or underground caving to nonsystematic workings following small ore showings. A significant development in 1953 was that of Climax Molybdenum Co., which began large-scale production from the Storke level. Output from the Philipson level 300 feet higher was continued, and development of a low-grade area was begun. Large quantities of concrete were used at the Climax mine, principally in slusher drifts. Methods for placing concrete in these workings were described.[7]

Milling and Production of Primary Products.—Molybdenum ores of all types require concentration before a useful product can be made. Flotation is standard practice at both molybdenum mines and mines where molybdenum concentrate is recovered as a byproduct. The practice at the Arthur and Magna mills of the Utah Copper Division, Kennecott Copper Corp., was described.[8] The power distribution system and the flotation cells for molybdenum recovery were being replaced with more efficient equipment. Power for milling, obtained from a steam plant of 100,000 kw. capacity, will be distributed at

[7] Cooley, Charles M., Storke Level: Key to $25 Million Climax Project: Min. Eng., vol. 5, No. 1, January 1953, p. 38.
[8] Corfield, R. J., and Johnson, A. G., Electrical and Metallurgical Improvements at Kennecott's Utah Copper Division Mills: Min. Eng., vol. 5, No. 3, March 1953, pp. 274–276.

TABLE 2.—Molybdenum ore and concentrates (including roasted concentrates) exported from the United States 1944–48 (average) and 1949–53, by countries of destination

[U. S. Department of Commerce]

Country	1944–48 (average)		1949		1950	
	Molybdenum content (pounds)	Value	Molybdenum content (pounds)	Value	Molybdenum content (pounds)	Value
Argentina	410	$362				
Australia						
Austria	3,318	2,094	5,334	$7,952	20,918	$19,515
Belgium-Luxembourg						
Canada	370,084	272,272	62,289	50,332	226,297	194,187
Canal Zone					465	458
Cuba	388	163				
Czechoslovakia	4,364	3,084				
Denmark						
Finland						
France	500,238	362,364	1,525,564	1,283,495	674,296	591,249
Germany	26,212	14,989	267,285	246,731	1,105,577	956,329
Italy	91,116	68,676	64,906	61,262	43,420	38,638
Japan					40,677	34,197
Mexico			5,370	3,250	345	247
Netherlands	5,186	4,133	14,700	13,680	61,200	65,000
New Zealand						
Norway			60,000	56,419		
Spain						
Sweden	156,976	108,936	545,761	459,279	274,406	211,195
Switzerland						
Taiwan						
U. S. S. R.	1,139,168	776,976				
United Kingdom	1,009,267	725,791	2,768,571	2,441,723	3,786,920	3,342,637
Venezuela	160	147				
Total	3,306,887	2,339,987	5,319,780	4,624,123	6,234,521	5,453,652

Country	1951		1952		1953	
	Molybdenum content (pounds)	Value	Molybdenum content (pounds)	Value	Molybdenum content (pounds)	Value
Argentina						
Australia			59,085	$67,567	1,100	$1,254
Austria	9,996	$11,397	34,965	39,859	80,020	91,823
Belgium-Luxembourg			23,154	27,971	13,400	15,745
Canada	294,687	313,957	535,800	609,414	404,626	454,294
Canal Zone	700	712	450	352	590	881
Cuba						
Czechoslovakia						
Denmark			3,000	3,900		
Finland	2,957	7,841	4,400	5,720		
France	420,161	397,125	1,735,176	1,958,951	1,368,112	1,386,909
Germany	761,731	786,750	[1] 1,986,670	[1] 2,121,494	[1] 1,028,275	[1] 1,087,912
Italy	135,712	147,408	192,994	225,967	7,056	8,700
Japan	62,340	51,476	199,035	250,192	366,547	406,368
Mexico			12,622	13,082	3,119	3,050
Netherlands	41,524	50,000			4,410	5,027
New Zealand			10,080	11,491		
Norway						
Spain			9,990	13,447		
Sweden	241,349	257,051	479,680	546,475	339,208	379,062
Switzerland			2,476	3,120	595	1,050
Taiwan					350	578
U. S. S. R.						
United Kingdom	1,758,108	1,711,739	882,355	892,693	3,420,028	3,465,136
Venezuela						
Total	3,729,265	3,735,456	6,171,932	6,791,695	7,037,436	7,307,789

[1] West Germany.

each mill from a primary substation, with a capacity of 40,000 kv.-a., to 15 unit substations rated at 2,500 kv.-a. About 15 percent of the total power used at the mills drives flotation units. The new flotation cells have agitating mechanisms powered by individual 15-hp. vertical-type induction motors.

A patent was issued [9] covering a process for recovering molybdenite from a flotation concentrate containing a small quantity of molybdenite and larger quantities of sulfides of other metals. The process comprises subjecting the concentrate to a succession of flotations with a water-soluble iron cyanide compound in a mildly alkaline medium, and to a final flotation with a water-soluble cyanide in a strongly alkaline medium.

Milling practice at the Climax mine was outlined, with special reference to the recent construction.[10] The use of a coarse-ore bin comprising a circular earth-fill structure covered with an inverted cone of steel and corrugated iron is of special interest. The bin provides surge capacity between the discharge of a 60-inch gyratory crusher and two 7-foot short-head cone crushers. Construction of a mill unit to treat 5,000 tons of low-grade ore a day was nearly completed in 1953. This unit will bring the total mill capacity to 27,000 tons a day; work completed in 1953 provided capacity of 22,000 tons a day.

Molybdenite concentrates are converted to oxide by roasting; this product is used as a raw material for nearly all other primary molybdenum products and for direct charging to steel furnaces.

Metal.—Molybdenum metal is produced by reduction of a purified oxide. In recent years, there has been a tremendous interest in this metal because of its high melting point and good thermal conductivity. A summary of developments regarding the uses of molybdenum metal was published.[11] Protection from oxidation is required if the metal is to be used at high temperatures. At about 1,375° F., molybdenum oxide was reported to form a liquid phase, which then vaporizes.[12] Because of the nature of the oxidation, a protective coating must be continuous without cracks or pinholes. Data regarding the properties of molybdenum trioxide at high temperatures were published.[13]

Molybdenum wire coated with silicon was reported to resist oxidation at high temperatures.[14]

A patent was granted covering a process for welding molybdenum to itself or to tungsten by coating the metals with a mixture of equal parts of molybdenum and nickel powders in nitrocellulose and heating at 950° to 1,150° C. before spot welding.[15]

The tensile properties of annealed molybdenum were investigated in the temperature range between −195° and +970° C.; properties of the metal in a brittle zone below −75° C., a transition zone from −75° to +150° C., a ductile zone from 150° to 900° C., and an un-

[9] Barker, Lyle M. and Young, Orel E. (assigned to Phelps Dodge Corp.), Recovery of Molybdenite: U. S. Patent 2,664,199, Dec. 29, 1953.
[10] Work cited in footnote 7. pp. 38–41.
[11] Industrial and Engineering Chemistry, Molybdenum: Vol. 45, No. 10, October 1953, pp. 2267–2268.
[12] Jones, W. E., How to Reduce Failures in High-Temperature Alloys: Iron Age, vol. 172, No. 2, July 9, 1953, p. 141.
[13] Cosgrove, L. A. and Snyder, P. E., High-Temperature Thermodynamic Properties of Molybdenum Trioxide: Jour. American Chem. Soc., vol. 75, Mar. 5, 1953.
[14] Campbell, Ivor E., Gosner, Bruce W., and Powell, Carroll F. (assigned to Fansteel Metallurgical Corp.), Method of Preparing Highly Refractory Bodies: U. S. Patent 2,665,998, Jan. 12, 1954.
[15] Watrous, Ward W. Jr. (assigned to Chatham Electronics Corp.), Method of Welding Molybdenum, U. S. Patent 2,623,975, Dec. 30, 1952.

stable zone above 900° C. were listed.[16] Physical properties of crystals were investigated.[17] The effect of processing variables on the transition temperature, strength, and ductility of high-purity sintered, wrought molybdenum metal was published.[18]

Compounds.—Molybdenum disilicide has outstanding resistance to oxidation at temperatures ranging from 2,000° to 2,850° F. because of formation of a protective coating. Results of research covering this compound were released;[19] it may be used as a heating element in ceramic and glassmaking furnaces.[20]

The application of molybdenum disulfide as a lubricant was the subject of several short papers.[21]

The following is quoted from the 1953 Climax Molybdenum Annual Report to the Stockholders:

MOLY-SULFIDE:

This name is applied to special grades of molybdenum disulfide prepared and sold by Climax for use as lubricants. Some two or three dozen concerns purchase Moly-sulfide from Climax and resell it, either as a dry lubricant or blended with various vehicles or other ingredients. The following table shows the rate at which dollar sales have increased during the past few years, with 1950 as a base:

1950	100
1951	184
1952	474
1953	546

The sharp increase from 1951–52 was due in part to a perhaps premature use of certain automobile crankcase additives containing Moly-sulfide. This use has declined, at least for the time being. Increased sales for a wide variety of industrial applications have more than made up for this decline. Sales in the first quarter of 1954 have been at a higher rate than for the year 1953. Such sales, however, still do not constitute a large percentage of the total sales of molybdenum products.

Alloys.—Improving the surface properties of steels by increasing the molybdenum content, followed by carburizing, nitriding, or siliconizing was described.[22] Salt bath methods using molybdenum salts and various reducing agents were used to apply the metal and to encourage diffusion into the steel.

The properties of molybdenum type stainless steels with regard to corrosion resistance were listed in considerable detail for AISI type 316 steel and some information was listed for AISI type 317.[23]

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[16] Bechtold, J. H., Effects of Temperature on the Flow and Fracture Characteristics of Molybdenum: Jour. Metals, vol. 5, No. 11, November 1953, pp. 1469–1476.

[17] Aust, K. T., Maddin, R., and Chin, N. K., Bending of Molybdenum Single Crystals: Jour. Metals, vol. 5, No. 11, November 1953, pp. 1477–1482; Chin, N. K., and Maddin R., Cold-Rolling and Annealing Textures of Molybdenum Single Crystals: Jour. Metals, vol. 5, No. 2, February 1953, pp. 300–304.

[18] Dike, K. C. and Long, R. A., Effect of Processing Variables on Transition Temperature, Strength, and Ductility of High Purity Sintered Wrought Molybdenum Metal: Nat. Advisory Committee for Aeronautics, TN 2915, March 1953.

[19] Maxwell, W. A., Oxidation-Resistance Mechanism and Other Properties of Molybdenum Disilicide: National Advisory Committee for Aeronautics, RM-E52A04, March 1952. (Restricted classification changed to unclassified Dec. 11, 1953.) Iron Age, Moly-Based Metal Ceramic Designed for High-Temperature Use: Vol. 170, No. 16, Oct. 16, 1952.

[20] Chemical Engineering, vol. 60, No. 12, December 1953, p. 343.

[21] Sonntag, A., Molybdenum Disulfide as a Lubricant: Tool Eng., vol. 31, No. 9, September 1953, pp. 135–136.

Davidson, L. M., How To Use Molybdenum Disulfide as a Lubricant: Am. Machinist, vol. 96, Dec. 22, 1952.

Diesel Power, Molybdenum Disulfide as a Lubricant: Vol. 31, No. 4, April 1953, pp. 90–93.

Ballow, E. V., and Ross, S., Absorption of Benzene and Water Vapor by Molybdenum Disulfide: Jour. Phys. Chem., vol. 57, No. 10, October 1953, pp. 53–57.

Chemical and Engineering News, Molybdenum Disulfide Packing Compound: vol. 31, No. 15, April 13, 1953, p. 1578.

Chemical Engineering, Molybdenum Disulfide in Cutting and Coolant Oils: Vol. 60, No. 3, March 1953, p. 270.

[22] Fitzer, E., Archiv für das Eisenhüttenwesen, September 1952, pp. 369–375; October 1952, pp. 377–382. Transl. in Materials and Methods, vol. 37, No. 3, March 1953, pp. 94–97.

[23] Chemical Engineering, Molybdenum Stainless Steels: Vol. 60, No. 6, June 1953, pp. 302–311.

WORLD REVIEW

Austria.—A small production of molybdenum is obtained as a byproduct of lead-zinc mining. The Bleiberg-Kreuth and Scheinitzen mines in Carinthia and the Dirstentritt in Tyrol have been most productive.

Canada.—An agreement signed in May of 1953 between Molybdenite Corp. of Canada, Ltd., and the United States Government provides for an expansion of the mining facilities at the La Corne mine, Quebec, and for the purchase of molybdenite concentrates. Two methods of purchase were specified. The first gives the Government the option to purchase up to 6 million pounds at the producer's lowest actual selling price during the 2-month period preceding any Government call. The second provides a floor price of 63 cents a pound for molybdenite contained in 90-percent concentrates for any portion of the 6 million pounds that the Government does not buy under its option or that the company cannot sell at a higher price.

Chile.—Molybdenite is produced as a byproduct of copper mining in Chile; this country had the second largest production reported during 1953.

Japan.—Molybdenum has been produced from several small mines; however, output is less than consumption. Ferromolybdenum and molybdenum oxide were imported during 1953.

Mexico.—During 1953 molybdenite production was resumed in Mexico; formerly production was from byproduct sources that have reported no output since 1947. The El Canutillo and Guadalupe

TABLE 3.—World production of molybdenum in ores and concentrates, by countries,[1] 1944–48 (average) and 1949–53, in metric tons [2]

[Compiled by Berenice B. Mitchell]

Country [1]	1944–48 (average)	1949	1950	1951	1952	1953
Australia	3	3	3	(3)	(3)	(3)
Austria	6	9	18	19	22	(4)
Canada	242		28	104	138	42
Chile	677	558	992	1,725	1,644	1,375
China:						
Manchuria	[5] 273	(4)	(4)	(4)	(4)	(4)
Other Provinces	(4)	(4)	(4)	(4)	(4)	(4)
Finland	74					(4)
France	1					(4)
French Morocco	14					
Hong Kong				(3)	(3)	1
Indochina	(3)					
Italy	(3)					
Japan	74		13	54	87	170
Korea, Republic of	91	11		5	7	9
Mexico	428					(4)
Norway	102	71	67	125	122	(4)
Peru	20	2	1	3	3	(4)
Sweden	5	5	6	2		(4)
United States	12,833	10,219	12,918	17,625	19,622	25,965
Total (estimate)	15,200	11,400	14,500	20,300	22,200	28,200

[1] Molybdenum is also produced in North Korea, Rumania, Spain, U. S. S. R., and Yugoslavia, but production data are not available. Estimates by author of chapter are included in total.
[2] This table incorporates a number of revisions of data published in previous Molybdenum chapters.
[3] Less than 0.5 ton.
[4] Data not yet available; estimate by author of chapter included in total.
[5] Average for 1944–45 of exports to Japan proper.

molybdenum mines were active in 1953; ore was treated at the Churanbabi mill.[24]

Norway.—The Knaben mine near Egersund on the southwestern coast of Norway has been the most important source of molybdenum production. Output and shipments for 1952 were published.[25]

Sweden.—Molybdenum ores have been located in the Pajala district in north Sweden; however, further investigation will be needed to establish the importance of the deposits.[26]

Union of Soviet Socialist Republics.—Important quantities of molybdenum are probably produced from the deposit east of Kounrad near Lake Balkhash; however, no reliable information is available regarding the output.

[24] Mining World, vol. 15, No. 11, October 1953, p. 98.
[25] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 2, August 1953, p. 31.
[26] Metal Industry, vol. 82, No. 20, May 15, 1953, p. 408.

Natural and Manufactured Iron Oxide Pigments

By Robert D. Thomson [1] and Eleanor V. Blankenbaker [2]

DEMAND for natural and manufactured iron oxide pigments increased slightly in 1953. Natural iron oxide pigments composed over half of the tonnage sold and natural red oxides 29 percent of the total iron oxide pigment sales. Imports also increased during the year.

DOMESTIC PRODUCTION

Sales of natural and manufactured iron oxide pigments in 1953 increased 3 percent in quantity and 7 percent in value compared with 1952 (tables 1 and 2). Natural iron oxide pigments represented 51 percent of the total tonnage and 24 percent of the value, while the remainder was manufactured (synthetic) iron oxide pigments, consisting of manufactured magnetic black (pure), brown iron oxide (pure), red iron oxide (pure), other red oxides, and yellow iron oxide (pure); and Venetian red.

Twenty-four companies reported sales of finished natural and manufactured iron oxide pigments in 1953 (table 3). Over 31 percent of the tonnage sold was from 6 plants in Pennsylvania, but Illinois, Ohio, and Wisconsin, as a group, ranked first in total sales.

Raw materials for producing natural iron oxide pigments were mined in California, Georgia, Michigan, Minnesota, New York, Pennsylvania, and Virginia. These pigment materials are prepared for market by washing, drying, grinding, and calcining.

TABLE 1.—Natural and manufactured iron oxide pigments sold by processors in the United States, 1944–48 (average) and 1949–53 [1]

Year	Short tons	Value	Year	Short tons	Value
1944–48 (average)	107,963	$9,794,072	1951	126,432	$14,987,075
1949	104,322	10,573,338	1952	[2] 105,242	[2] 13,267,766
1950	129,256	14,762,782	1953	108,350	14,246,726

[1] For 1944–51 includes mineral blacks.
[2] Revised figure.

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

TABLE 2.—Natural and manufactured iron oxide pigments sold by processors in the United States, 1952–53, by kinds

Pigment	1952		1953	
	Short tons	Value	Short tons	Value
Blacks: Manufactured magnetic black (pure)	2,319	$545,258	2,220	$542,122
Browns:				
Natural metallic brown	7,335	551,446	8,792	713,787
Umbers:				
Raw	661	75,625	580	67,922
Burnt	2,587	316,573	3,026	387,258
Manufactured brown iron oxide (pure)	1,156	299,256	1,139	311,196
Vandyke brown	128	24,528	67	12,610
Reds:				
Natural red iron oxide	27,140	1,097,470	31,523	1,462,268
Siennas, burnt	866	149,915	966	173,134
Pyrites cinder	1,238	100,231	1,483	131,750
Manufactured red iron oxide (pure)	21,841	4,996,461	24,265	5,670,748
Manufactured other red oxides	12,255	1,539,182	9,031	1,262,358
Venetian reds	4,625	454,370	4,067	442,585
Yellows:				
Natural yellow iron oxide	4,319	116,638	3,594	92,815
Ocher	2,573	83,640	2,632	114,872
Siennas, raw	1,014	159,738	1,068	178,341
Manufactured yellow iron oxide (pure)	13,001	2,610,861	12,638	2,629,848
Other	2,184	146,574	1,259	53,112
Total	[1] 105,242	[1] 13,267,766	108,350	14,246,726

[1] Revised figure.

TABLE 3.—Sales of natural and manufactured iron oxide pigments in the United States, 1953, by States

State	Number of producers	Quantity (short tons)
Georgia	1	2,142
Pennsylvania	6	33,824
Illinois, Ohio, Wisconsin	7	40,258
Maryland, New Jersey, New York, Virginia	7	17,187
Other [1]	3	14,939
Total	24	108,350

[1] Includes California, North Dakota, and a quantity unspecified by State.

Manufactured yellow iron oxide pigments are produced by rapid oxidation of scrap iron in a ferrous sulfate (copperas) solution. The reaction is begun by precipitating ferric hydrate, usually with hydrated lime. Red iron oxides are made by calcining ferrous sulfate or precipitated ferric hydrate (yellow iron oxide). Black iron oxide is a precipitated ferro-ferric oxide obtained under controlled conditions by reaction between an iron salt and alkali plus subsequent oxidation. Brown oxide usually is prepared by blending red, black, and yellow iron oxides, and Venetian red is made by roasting a mixture of ferrous sulfate with hydrated calcium oxide.

PRICES

According to the Oil, Paint and Drug Reporter, prices were quoted as follows during December 1953 (in cents per pound, bags, works, carlots, unless otherwise noted):

Blacks: Manufactured magnetic black (pure), 12.75

Browns:
- Natural metallic brown, 4
- Umber, raw; Turkey, 6.75
- Umber, burnt; American, 6
- Manufactured brown iron oxide (pure), 13.75
- Vandyke brown (bbl.), 9.50–12.00
- Sap brown, crystals, 12
- Sap brown, powdered, 13

Reds:
- Natural red iron oxide, 6
- Persian Gulf oxide, 6.75
- Spanish oxide (bbl.), ex dock, 6
- Sienna, burnt, 4.50–15.25
- Manufactured red iron oxide (pure), 12.75
- Manufactured red iron oxide (special high color), 6
- Venetian reds, 3.50–6.25
- Metallic red (bbl.), 2.50

Yellows:
- Natural yellow iron oxide:
  - French type, 5.25
  - Peruvian type, 3.80
- Sienna, raw, 4.50–13.00
- Manufactured yellow iron oxide (pure), 10.50

FOREIGN TRADE[3]

Imports of iron oxide pigments in 1953 increased 25 percent in quantity and 15 percent in value compared with 1952 (table 4).

About 92 percent of the natural iron oxide pigments n. e. s. were imported from Spain; 5 percent from United Kingdom; and 2 percent from French Morocco. West Germany supplied 71 percent of the manufactured (synthetic) iron oxide pigments and Canada 25 percent. Ocher was imported from French Morocco and Union of South Africa. About 94 percent of the crude-umber imports came from Malta and the remainder from Turkey, and 86 percent of the refined umber was from Malta and the remainder from United Kingdom. West Germany supplied 99 percent of the Vandyke brown imports. Sienna was imported from Italy (64 percent), Malta (35 percent), and United Kingdom (1 percent).

Exports, as shown in table 5, increased 8 percent in quantity and 9 percent in value in 1953 compared with 1952. Canada continued to receive the major portion of the iron oxide pigment exports.

TECHNOLOGY

The reduction of natural hematite and magnetite crystals by hydrogen and carbon monoxide was studied, and the mechanism of the reduction and the causes of the different pore formation tendencies were discussed in an article.[4]

The following patents on iron oxide pigments were issued recently:

Bennetch, L. M. (assignor, by mesne assignments, to Reconstruction Finance Corp.), Preparation of Black Oxide of Iron: U. S. Patent 2,631,085, Mar. 10 1953.

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

[4] Edstrom, J. O., The Mechanism of Reduction of Iron Oxides: Jour. Iron and Steel Inst. (London), vol. 175, part 3, November 1953, pp. 289–304.

TABLE 4.—Selected iron oxide pigments imported for consumption in the United States, 1950–53

[U. S. Department of Commerce]

Pigments	1950		1951		1952		1953	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Iron oxide pigments:								
Natural	2,803	$143,894	3,476	$160,015	2,388	$118,914	2,716	$123,432
Synthetic	2,220	294,017	5,303	643,918	3,317	432,451	4,531	522,618
Ocher, crude and refined	157	6,759	815	37,494	798	46,777	177	9,122
Siennas, crude and refined	474	33,433	779	62,421	566	49,702	700	59,747
Umber, crude and refined	3,259	88,168	3,457	93,761	1,603	44,435	2,725	78,310
Vandyke brown	261	18,562	174	10,765	119	6,685	164	8,958
Total	9,174	584,833	14,004	1,008,374	8,791	698,964	11,013	802,187

TABLE 5.—Iron oxide pigments exported from the United States, 1950–53, by countries

[U. S. Department of Commerce]

Country	1950		1951		1952		1953	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Argentina	(1)	$1,082	(1)	$600	46	$20,250		
Austria	41	10,274	6	1,548				
Belgian Congo	6	856	9	1,839	2	460	6	$2,569
Belgium-Luxembourg	85	15,035	39	9,859	8	2,912	15	4,504
Bolivia	2	900	25	8,819	1	187	2	526
Brazil	27	16,056	93	18,185	41	11,786	3	912
Canada	2,945	274,311	2,528	282,136	2,545	288,382	2,886	351,393
Chile			37	8,322	18	4,950	45	8,750
China	13	7,970						
Colombia	114	39,986	120	46,179	93	31,728	94	31,450
Cuba	284	54,724	294	61,885	297	59,502	293	69,652
Domican Republic	18	4,566	29	8,302	33	9,693	35	11,529
France	17	8,646	17	10,874	9	12,179	47	13,864
Greece	14	2,657	7	2,279	2	652		
Guatemala	53	13,955	49	13,180	23	5,877	42	13,515
Haiti	63	6,133	52	12,761	45	5,049	23	4,615
Honduras	4	1,468	5	1,512	20	4,559	2	527
Hong Kong	5	1,295	2	702	(1)	136	3	720
Indonesia	27	10,099	11	4,016	31	9,284		
Israel and Palestine	3	773	17	4,783	4	895	(1)	106
Italy	51	12,754	37	5,197	6	14,942	13	6,520
Japan	18	4,450	17	4,186	24	8,108	14	4,327
Mexico	85	25,323	106	48,629	90	31,787	181	47,474
Netherlands	227	9,029	341	13,766	135	5,292	75	3,006
Netherlands Antilles	11	2,266	21	6,354	10	3,657	3	990
Panama, Republic of	61	5,965	17	3,456	11	2,900	7	1,686
Peru	12	3,760	29	9,694	10	2,954	32	9,507
Philippines	85	17,729	93	24,362	47	10,321	27	8,219
Portugal	7	1,587	2	1,126	5	1,356	7	1,740
Sweden	5	1,341	24	5,276	6	1,578	10	2,230
Switzerland	3	801	27	7,496	14	3,934	4	3,746
Union of South Africa	82	20,776	127	36,635	87	23,690	94	25,726
United Kingdom	809	30,926	275	14,867	3	720	1	252
Uruguay	39	9,066	7	2,078	6	1,602		
Venezuela	257	70,111	104	29,785	133	33,842	137	35,489
Other countries	90	25,020	85	27,478	65	18,603	72	22,787
Total	5,563	711,690	4,652	738,166	3,870	633,767	4,173	688,331

[1] Less than 1 ton.

Clarke, C. C. (assignor to Wheatland Tube Co.), Iron Oxide Pigment: U. S. Patent 2,656,282, Oct. 20, 1953.
Marsh, D. W. (assignor to Minerals Pigments Corp.), Process for Producing Red Unhydrated Iron Oxide: U. S. Patent 2,633,407, Mar. 31, 1953.
Naponen, G. E. (assignor to Minnesota Mining & Manufacturing Co.), Method of Making Iron Oxide Pigments: U. S. Patent 2,634,193, Apr. 7, 1953.
Sawyer, R. H. (assignor to E. I. du Pont de Nemours & Co.), Process for Oxidizing Iron Halides to Produce Iron Oxide and Chloride: U. S. Patent 2,642,339, June 16, 1953.
Toxby, Thomas (assignor to C. K. Williams & Co.), Method of Making Iron Oxide Pigment: U. S. Patent 2,620,261, Dec. 2, 1952.

WORLD REVIEW

Australia.—Investigations were conducted with respect to the concentration of the iron oxide content of dumps from Sebastopol, Ballarat, Victoria, to obtain material suitable for use in paints.[5]

Cyprus.—Exports of iron oxide pigments increased 40 percent in 1953 compared with 1952. Umber Corp. of Larnaca, Ltd., mined 7,099 long tons of umber from shallow surface and underground workings, mainly in the Troulli area, of which 4,773 long tons was exported; this company also exported 565 tons of ocher. Limassol Chemical Products Co., Ltd., continued to have difficulties in obtaining markets and only exported 126 tons of umber and 21 tons of ocher.[6]

Egypt.—A total of 398 metric tons of iron oxide pigments was reported produced in 1953.[7]

Israel.—An umber deposit near Rosh Haáyin was described in a recent report.[8]

Pakistan.—Production of ocher totaled 510 long tons in 1953, an increase of 25 percent compared with 1952. About 111 tons was produced in Sind and 399 tons in Punjab.[9]

Union of South Africa.—Statistics on the production of iron oxide pigments in 1951–53 follow:

Pigment	Production (short tons)		
	1951 [1]	1952 [1]	1953 [2]
Ocher	7,994	6,239	4,385
Oxides	2,774	2,306	1,536
Umber	1,015	1,291	787
Total	11,783	9,836	6,708

[1] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 4, October 1953, p. 63.
[2] American Embassy, Johannesburg, Union of South Africa, State Department Dispatch 209, April 12, 1954, p. 1.

The ocher was exported mainly to the United Kingdom, United States, and Australia, while the pigments classified as "oxides" were shipped mainly to Indonesia; however, the domestic industry consumed the major portion of the production of oxides and umber.

[5] Woodcock, J., and Dunkin, H. H., Treatment of Red Oxide Dump From Sebastopol, Ballarat, Victoria: Commonwealth Sci. and Ind. Research Organization and Mining Dept., Univ. of Melbourne, Investigation 417, Mar. 21, 1952, 9 pp.
[6] Ingham, F. T., Annual Report of the Inspector of Mines for the Year 1953: Cyprus Dept. of Mines 1954, p. 5.
[7] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 4, October 1954, p. 59.
[8] Loehnberg, A. and Loehnberg, E., Occurrence of Terra Umber Near Rosh Haáyin: Bull. Research Council Israel, vol. 2, No. 3, 1952, pp. 255–259.
[9] American Embassy, Karachi, Pakistan, State Department Dispatch 719, May 1, 1954, 1 pp.

Nickel

By Hubert W. Davis [1]

EXPANSION of nickel-producing facilities in Canada and the United States and search for new sources of nickel in many parts of the world were carried on intensively in 1953. Activities included much exploration work, development and equipment of several new mines, erection of plants to treat nickel-bearing pyrrhotite, additional matte-producing capacity, and construction of new refining plants. Although established producers made progress in expanding output and new producers in installing facilities, no new refining units were completed in 1953. Refining plants scheduled for completion in 1954 will have capacity to produce about 17,000 short tons of refined metal. As a consequence, equipped mines outside the U. S. S. R. were to have capacity to produce about 200,000 short tons of nickel annually by the end of 1954. Further expansions contemplated, plus a refinery planned to serve a newly developed deposit in Cuba, will increase annual capacity to 235,000 tons.

Total world mine production of nickel outside the U. S. S. R. was about 16,000 short tons greater in 1953 than in 1952. Canada, Cuba, New Caledonia, and Union of South Africa showed gains, but output in Finland and the United States declined slightly. Canada produced 80 percent of the total (excluding the U. S. S. R.) in 1953.

Despite the increased world production in 1953, insufficient nickel was available for many civilian needs, and manufacturers continued to downgrade nickel-alloy steels and to use substitute materials. Although nickel continued in short supply, NPA Order M-80, which controlled the distribution and end use in the United States, was revoked, effective November 1. However, priority for the needs of the military and atomic energy services and for stockpiling remained in effect.

TABLE 1.—Salient statistics for nickel, 1944–48 (average) and 1949–53

	1944–48 (average)	1949	1950	1951	1952	1953
United States:						
Production:						
Primary..short tons..	805	790	913	756	633	602
Secondary......do....	7,489	5,680	8,795	8,602	7,479	8,352
Imports (gross weight) [1] short tons....	[2] 111,247	95,711	96,640	101,620	[3] 118,372	131,169
Exports (gross weight) [4] short tons....	8,001	4,471	3,645	4,622	6,941	15,168
Consumption.......do....	[5] 87,668	[3] 69,634	[3] 99,989	[3] 86,683	[3] 101,397	105,681
Price per pound [6]..cents..	31½–40	40	40–50½	50½–56½	56½	56½–60
Canada:						
Production...short tons..	121,259	128,690	123,659	137,903	[3] 140,559	143,643
Exports............do....	120,331	127,141	119,984	130,239	142,022	143,818
World production.......do....	157,000	161,000	[3] 162,000	[3] 184,000	[3] 205,000	224,000

[1] Comprises refined metal, matte, oxide, and oxide sinter.
[2] Figures for 1944–47 include nickel scrap.
[3] Revised figure.
[4] Excludes "Manufactures" for 1944–52, weight of which is not recorded.
[5] 1945–48 average.
[6] 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, 1944–47, and 1¼ cents, 1948–53.

[1] Commodity-industry analyst.

Concerning the large expansion in nickel-producing facilities, an outlook for ready disposal of the output was expressed by the International Nickel Co. of Canada, Ltd.,[2] as follows:

We are also entering a period when the world will have at its disposal nickel from new producers as well as increased amounts from established producers. In past periods of expanded capacity, the Company energetically sought and developed markets for nickel. It will continue to do so. With all producers contributing to the enlargement of the market the same energy they have demonstrated in developing sources of nickel, it is our belief that there will be profitable use for both the established and the new nickel production.

Imports of new nickel into the United States were 9 percent more than in 1952 and the second highest of record.

Consumption of nickel in the United States was 4 percent more than in 1952 and the largest since 1944. The steel industry continued to be the chief consumer; 39 percent of all nickel consumed in 1953 was used in stainless and engineering alloy steels. Consumption for the latter was 5 percent larger but that for stainless steel 19 percent smaller. More nickel was also utilized in cast irons, electroplating, high-temperature and electrical-resistance alloys, ceramics, and magnets, but less was used in nonferrous metal alloys and catalysts.

Prices of electrolytic nickel, nickel oxide, and nickel oxide sinter were increased 3½ cents a pound, effective January 14, 1953.

Allocation of primary nickel (excluding nickel salts) to the Free-World countries by the International Materials Conference was discontinued after the third quarter, 1953. The United States was allocated 68.6 percent of the total for the 9 months. Distribution by the nickel industry in the last 3 months of 1953 followed the pattern established by the conference.

TABLE 2.—Nickel allocations to the Free-World countries by the International Materials Conference, January–September 1953

Country	Metric tons	Country	Metric tons
Argentina	40.4	Korea	1.0
Australia	459.4	Mexico	12.0
Austria	637.7	Netherlands	200.0
Belgium-Luxembourg	354.0	New Zealand	4.0
Bolivia	.2	Norway	210.9
Brazil	88.3	Pakistan	4.0
Canada	3,016.0	Philippines	.4
Chile	37.0	Portugal	7.5
Colombia	5.0	Southern Rhodesia	3.6
Cuba	1.5	Spain	66.5
Denmark	60.3	Sweden	2,176.4
Egypt	1.5	Switzerland	469.2
Finland	75.3	Trieste	2.1
Formosa	12.0	Turkey	18.1
France	4,066.4	Union of South Africa	60.6
Germany, West	4,291.6	United Kingdom	16,430.3
Greece	1.2	United States	75,586.4
India	301.0	Uruguay	2.6
Israel	2.0	Yugoslavia	65.2
Italy	1,014.9		
Japan	476.5	Total	110,263.0

[2] International Nickel Co. of Canada, Ltd., Annual Report: 1953, p. 17.

PRODUCTION

Domestic production of nickel (other than from imported matte and oxide) is small and comprises chiefly metal recovered from scrap (nickel anodes and nickel-silver and copper-nickel alloys, including Monel metal) and primary nickel recovered in copper refining. In 1953 a small quantity of nickel contained in the cobalt ore of the Blackbird mine in Idaho was recovered.

Substantial quantities of nickel-bearing ferrous scrap are recovered and used chiefly in the production of engineering alloys and stainless steels. No figures are available on the quantity of low-alloy nickel-bearing scrap used, but 84,000 short tons of chromium-nickel stainless-steel scrap was consumed during the first 9 months of 1953.

A total of 1,182,000 pounds of nickel, in the form of both crude and refined nickel sulfate, was recovered in 1953 as a byproduct of copper refining at Baltimore, Md.; Carteret and Perth Amboy, N. J.; Laurel Hill, N. Y.; and Tacoma, Wash. Shipments were 1,177,000 pounds, the bulk of which was crude nickel sulfate sold to refiners for use as an intermediate in the manufacture of refined nickel salts. Although all the nickel recovered as a byproduct of copper refining is credited to domestic production, some is actually recovered from imported blister copper.

In addition to the nickel recovered as a byproduct of copper refining in 1953, 3,674,000 pounds (nickel content) of refined nickel salts (chiefly sulfate) was produced in the United States from crude nickel sulfate and from refined nickel, oxide, and nickel scrap.

The total production of refined nickel salts in the United States was 3,854,000 pounds (nickel content) in 1953; shipments to consumers for electroplating, catalysts, and ceramics totaled 3,847,000 pounds.

TABLE 3.—Nickel produced in the United States, 1944–48 (average) and 1949–53

Year	Primary (short tons) [1]	Secondary	
		Short tons	Value
1944–48 (average)	[2] 805	7,489	$5,503,862
1949	790	5,680	4,877,984
1950	913	8,795	8,408,020
1951	756	8,602	9,759,829
1952	633	7,479	8,799,791
1953	[2] 602	8,352	10,399,910

[1] Byproduct of copper refining. Value withheld to avoid disclosing individual company operations.
[2] Includes some production from ore.

The United States will become a producer of nickel from domestic ore in 1955, when the smelter of the Hanna Nickel Smelting Co. at Riddle, Oreg., and the refinery of National Lead Co. at Fredericktown, Mo., are scheduled to begin operating. Ore for the Hanna operation will come from the deposit near Riddle; it averages about 1.5 percent nickel and will be mined by open-pit methods. Ultimately the smelter will have 4 furnaces for producing ferronickel averaging about 40 percent nickel. Annual capacity of the smelter will be 7,000 to 9,000 short tons of nickel contained in ferronickel. The plant of National Lead Co. will treat an iron concentrate reject, which carries values in nickel, cobalt, and copper. An annual production of about 900 short tons of nickel is contemplated.

CONSUMPTION AND CONSUMERS' STOCKS

Tables 4, 5, and 6 give data on the consumption of nickel, as determined by a Bureau of Mines survey. The data cover all known consumers of nickel in the form of new metal, oxide, oxide sinter, and matte. The figures for nickel salts, however, represent only about 80 percent of the total.

Total consumption of nickel in 1953 was 4 percent more than in 1952 and the largest since 1944. Of the 1953 total consumption about 39 percent was utilized in stainless and engineering alloy steels. Five percent more nickel was used in engineering alloy steels than in 1952, but 19 percent less was used for stainless steel.

Consumption of nickel in cast irons, electroplating, high-temperature and electrical-resistance alloys, ceramics, and magnets increased 16, 115, 3, 26, and 34 percent, respectively; but usage for nonferrous-metal alloys and catalysts declined 4 and 2 percent, respectively.

As heretofore, most nickel consumed in 1953 was in the form of metal, but the proportion of oxide and oxide sinter was appreciably larger in 1953 than in 1952.

TABLE 4.—Nickel (exclusive of scrap) consumed and in stock in the United States, 1952–53, by forms, in pounds of nickel

Form	1952			1953		
	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]	[2] 150,014,474	[2] 10,274,585	182,560	147,545,164	12,696,389	510,837
Oxide and oxide sinter	[2] 30,944,862	3,613,557	1,344	39,993,018	5,538,607	382,606
Matte	19,531,663	1,584,575		20,940,314	705,671	
Salts [3]	[2] 2,303,750	[2] 798,752	919	2,882,967	865,437	11,451
Total	[2] 202,794,749	[2] 16,271,469	184,823	211,361,463	19,806,104	904,894

[1] Includes a relatively small but undetermined quantity of secondary nickel (ingot or shot remelted from scrap nickel and scrap-nickel alloys).
[2] Revised figure.
[3] Figures for consumption estimated to represent about 80 percent of total.

TABLE 5.—Nickel (exclusive of scrap) consumed in the United States, 1949–53, by forms, in pounds of nickel

Form	1949 [1]	1950 [1]	1951 [1]	1952 [1]	1953
Metal	100,421,479	148,858,747	136,001,818	150,014,474	147,545,164
Oxide and oxide sinter	19,806,104	29,603,851	17,596,637	30,944,862	39,993,018
Matte	15,654,621	17,843,880	17,481,384	19,531,663	20,940,314
Salts [2]	3,384,948	3,671,499	2,286,471	2,303,750	2,882,967
Total	139,267,152	199,977,977	173,366,310	202,794,749	211,361,463

[1] Revised figures (except for matte).
[2] Figures estimated to represent about 80 percent of total.

TABLE 6.—Nickel (exclusive of scrap) consumed in the United States, 1949–53, by uses, in pounds of nickel

Use	1949	1950	1951	1952	1953
Ferrous:					
Stainless steels	23,817,187	41,822,486	43,584,274	54,685,711	44,548,548
Other steels	26,948,418	35,554,167	32,850,461	35,956,787	37,918,877
Cast iron	6,792,472	9,761,622	7,430,972	7,276,976	8,428,079
Nonferrous [1]	[2] 39,643,277	[2] 58,818,365	[2] 53,903,848	[2] 64,035,398	61,614,181
High-temperature and electrical-resistance alloys	8,107,918	11,407,174	14,815,616	16,040,189	16,442,108
Electroplating:					
Anodes [3]	[2] 25,920,038	[2] 32,357,201	[2] 10,820,921	[2] 12,278,313	26,547,805
Solutions [4]	[2] 2,399,369	[2] 2,453,419	[2] 909,883	[2] 968,885	1,943,572
Catalysts	[2] 2,367,000	[2] 2,400,000	2,768,905	2,920,062	2,870,455
Ceramics	[2] 536,940	[2] 786,838	[2] 498,091	[2] 398,067	501,427
Magnets	} [2] 2,734,533	1,946,971	1,291,856	1,190,624	1,595,439
Other		[2] 2,669,734	[2] 4,491,483	[2] 7,043,737	8,950,972
Total	[2] 139,267,152	[2] 199,977,977	[2] 173,366,310	[2] 202,794,749	211,361,463

[1] Comprises copper-nickel alloys, nickel-silver, brass, bronze, beryllium alloys, magnesium and aluminum alloys, Monel, Inconel, and malleable nickel.
[2] Revised figure.
[3] Figures represent quantity of nickel put into process for producing rolled anode bars, plus nickel used in casting anodes and nickel cathodes used as anodes in plating operations. Therefore, figures do not represent quantity of nickel anodes consumed by platers.
[4] Figures estimated to represent about 70 percent of total.

SUBSTITUTES AND ALTERNATES

Because of the scarcity, efforts to conserve nickel and search for substitutes were continued. The use of various types of stainless steel as suitable alternates for versatile 18–8 (18 percent chromium–8 percent nickel) stainless steels has been reviewed in trade magazines.[3]

An iron-base nickel-free alloy, which may be substituted for nickel stainless steel in certain applications, was reported to have been developed by Battelle Memorial Institute.[4]

A new alloy containing only 15 percent nickel and 5 percent tin, which has been produced experimentally at the Tin Research Institute, was reported to compare well in brightness and to have the other qualities of toughness and durability needed in coins.[5]

Platers continued to use alternate plating processes and lighter strikes of nickel. The substitute plating method most used, especially by appliance makers, was chrome over a heavy strike of copper, either direct or with a bare minimum of nickel.[6] Experiments with white brass (80 percent zinc and 20 percent copper) have proved so promising that an installation was under way to explore further the potential of the finish.

A plated tin-copper alloy containing 10 to 12 percent tin has been suggested as a substitute for nickel under chromium.[7]

[3] Gray, A. G., New Stainless Stretches Nickel: Steel, vol. 132, No. 10, Mar. 9, 1953, pp. 94–97.
Lincoln, R. A., Nickel Restrictions Bring Use of New Stainless Steels: Iron Age, vol. 171, No. 20, May 14, 1953, pp. 129–132.
Steel, Nickel-Stretching and Special-Purpose Alloys Brighten Outlook for Stainless Steels: Vol. 133, No. 15, Oct. 12, 1953, pp. 146–150.
[4] Iron Age, vol. 172, No. 21, Nov. 19, 1953, p. 100.
[5] E&MJ Metal and Mineral Markets, vol. 24, No. 38, Sept. 17, 1953, p. 7.
[6] Steel, Platers Continue Search for Substitutes: Vol. 132, No. 24, June 15, 1953, p. 54.
[7] Steel, vol. 133, No. 6, Aug. 10, 1953, p. 95.

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PRICES

Effective January 14, 1953, the contract price to United States buyers for electrolytic nickel in carlots f. o. b. Port Colborne, Ont., was advanced to 60 cents a pound, including duty of 1¼ cents. For nickel oxide sinter (no duty) the price was raised to 56¼ cents a pound (nickel content) f. o. b. Copper Cliff, Ont. Former prices, which had been in effect since June 1, 1951, were 56½ and 52¾ cents, respectively. Cuban nickel oxide was priced at 54¼ cents a pound (nickel content) in bags f. a. s. Nicaro, Cuba, in 1953. The former price was 50¾ cents.

FOREIGN TRADE [8]

The quantity of new nickel imported into the United States in 1953 was 9 percent more than in 1952 and the second highest 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., Huntington, W. Va.

The nickel content of refined nickel, oxide, oxide sinter, matte, and residues imported into the United States is estimated at 237,474,000 pounds in 1953 compared with 217,700,000 pounds (revised figure) in 1952.

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. Exports of alloys and scrap, which comprise the bulk of the foreign shipments, nearly doubled in 1953 compared with 1952; those of metal in ingots, bars, sheets, etc., were 3.3 times greater and those of nickel-chrome electric-resistance wire were 33 percent more. Canada (15,520,242 pounds), United Kingdom (6,575,318 pounds), West Germany (4,911,410 pounds), and Japan (1,867,704 pounds) were the chief foreign markets for nickel, Monel metal, alloys, and scrap in 1953.

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[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 7.—New nickel products imported for consumption in the United States, 1952–53, by countries, gross weight in pounds

[U. S. Department of Commerce]

Country	Metal		Ore and matte		Oxide and oxide sinter		Nickel residues [1]	
	1952	1953	1952	1953	1952	1953	1952	1953
Austria				220				
Canada	[2] 146,782,714	148,765,737	28,835,464	28,994,013	29,129,416	27,212,033	1,348,011	1,032,120
Cuba					[2] 19,677,720	36,471,202		
France		497,400						
Germany, West	1,120	76,745				7,200		
Japan		917,227						
New Caledonia [3]			24,229	215,716				
Norway	[2] 11,971,098	18,753,591						
United Kingdom	321,953	416,898				9,630		
Total	[2] 159,076,885	169,427,598	28,859,693	29,209,949	[2] 48,807,136	63,700,065	1,348,011	1,032,120

[1] Reported to Bureau of Mines by importers.
[2] Revised figure.
[3] Assumed source; classified in import statistics under "French Pacific Islands."

TABLE 8.—Nickel products (excluding residues) imported for consumption in the United States, 1951–53, by classes

[U. S. Department of Commerce]

Class	1951		1952		1953	
	Pounds	Value	Pounds	Value	Pounds	Value
Nickel ore and matte	25,657,660	$5,561,034	28,859,693	$4,994,511	29,209,949	$5,794,264
Nickel pigs, ingots, shot, cathodes, etc.[1]	153,609,114	81,521,060	[2]159,076,885	[2] 89,322,904	169,427,598	102,461,751
Nickel scrap [1]	1,581,742	150,898	1,093,455	126,800	1,730,580	288,518
Nickel oxide and oxide sinter	23,972,578	8,793,383	[2] 48,807,136	18,558,457	63,700,065	26,286,337
Total		96,026,375		[2]113,002,672		134,830,870

[1] Separation of metal from scrap is on basis of unpublished tabulations.
[2] Revised figure.

TABLE 9.—New nickel products imported for consumption in the United States, 1944–48 (average) and 1949–53, in pounds [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)
1944–48 (average)	[3]148,634,115	43,595,653	30,264,341	(4)	[5]222,494,109	[6]197,993,000
1949	144,680,899	22,256,644	24,483,602	(4)	[5]191,421,145	[7]182,146,000
1950	138,397,272	22,270,886	32,612,122	356,561	193,636,841	[8]182,694,000
1951	153,609,114	25,657,660	23,972,578	564,246	203,803,598	[8]186,380,000
1952	[8]159,076,885	28,859,693	[8] 48,807,136	1,348,011	238,091,725	[8]217,700,000
1953	169,427,598	29,209,949	63,700,065	1,032,120	263,369,732	237,474,000

[1] Figures, by years, for 1926–48 in Minerals Yearbook, 1948, p. 885.
[2] Reported to Bureau of Mines by importers.
[3] Figures for 1944–47 include nickel scrap.
[4] Not available.
[5] Excludes "Residues."
[6] Figures for 1944–47 include nickel content of nickel scrap and those for 1947–48 include nickel content of "Residues."
[7] Includes nickel content of "Residues."
[8] Revised figure.

TABLE 10.—Nickel products exported from the United States, 1951–53, by classes

[U. S. Department of Commerce]

Class	1951		1952		1953	
	Pounds	Value	Pounds	Value	Pounds	Value
Ore, concentrates, and matte	35,578	$2,000				
Alloys and scrap containing nickel (including Monel metal)	7,984,503	4,783,015	11,648,169	$6,162,695	22,846,005	$8,867,989
Metal in ingots, bars, sheets, etc	386,310	376,946	1,966,621	364,301	6,578,740	805,587
Manufactures [1]	(2)	1,044,485	(2)	503,110	555,993	935,722
Nickel-chrome electric-resistance wire	393,599	712,186	267,473	482,530	356,222	609,110
Nickel-silver or German silver, crude, scrap, or bars, rods, etc	443,175	185,089	(3)	(3)	(3)	(3)
Total		7,103,721		7,512,636		11,218,408

[1] Due to change in classification, 1952 and 1953 data not strictly comparable to earlier years.
[2] Quantity not recorded.
[3] Beginning Jan. 1, 1952, not separately classified.

TECHNOLOGY

Bureau of Mines.—The Bureau of Mines continued research on nickel in 1953. The results of continuous selective reduction tests on Brazilian, Riddle (Oreg.), and Cle Elum (Wash.) nickel ores at its Albany (Oreg.) Station have been described.[9] The Albany Station conducted a continuous test on direct-smelting the low-grade nickel ore from the Red Flats deposit near Gold Beach, Curry County, Oreg. In a 73-hour smelting test, 18 tons of ore containing 0.79 percent nickel were smelted to produce 0.57 ton of ferronickel and 10.7 tons of slag. The ferronickel analyzed 9.39 to 14.0 percent nickel and the slags 0.03 to 0.23 percent nickel.

At the Salt Lake City Experiment Station tests were continued in the fluidizing reactor to determine the optimum conditions for reductive roasting of a nickeliferous laterite and serpentine before leaching to recover the nickel and other values. The laterite and serpentine assayed, respectively, 1.17 and 1.24 percent Ni, 53.2 and 26.6 percent Fe, 0.05 percent Co, 2.0 and 1.3 percent Cr, and 3.3 and 34.8 percent SiO_2. In a batch test on the laterite an 86-percent extraction of the nickel was obtained by leaching the reductive roasted product 5 hours in a 7-percent ammonia leach solution. Exploratory batch tests on the serpentine ore showed a progressive increase in extraction with increase in temperature.

Research at the Mississippi Valley Experiment Station (Rolla, Mo.) on the recovery of nickel and cobalt from sulfide-ore concentrates from the operations of the National Lead Co. at Fredericktown, Mo., and from smelter matte produced by the St. Joseph Lead Co. at Herculaneum, Mo., has been described.[10]

The Ferrous Pyrometallurgy Section (Pittsburgh, Pa.) developed a low-cost process for converting Cuban nickel oxide to metal. The metal analyzed 97 to 98 percent nickel (plus cobalt), 0.05 percent carbon, and 0.013 percent sulfur.

Industry.—International Nickel Co. of Canada, Ltd.,[11] continued research both to establish new processes to counteract increasing production costs and also to develop new and improved products to widen the usefulness of nickel. In September 1953 the company began to construct a plant near Copper Cliff, Ontario, which will treat initially 1,000 tons a day of nickel-bearing pyrrhotite to recover both nickel and iron ore. This process represents a major advance in treating nickel ores. Heretofore, world nickel production has been based almost entirely on processes in which the iron content of the nickel ore is rejected in slag and tailings. The new process recovers the iron content in the form of high-grade iron ore. No details have been published, but, according to Bailey,[12] British Patent 659,283 describes a process suitable for the purpose:

> Briefly, this process consists in concentrating the pyrrhotite part of the ore into a separate concentrate by successive flotation operations, and desliming, combined when suitable with magnetic separation. The pentlandite, chalcopyrite, and precious metals are separated into other products. The pyrrhotite contains

[9] Cremer, Herbert. Continuous Electric Smelting of Low-Grade Nickel Ores: Bureau of Mines Rept. of Investigations 5021, 1954, 36 pp.

[10] Kenworthy, H., and Kershner, K. K., Metallurgical Investigations of Southeastern Missouri Cobalt-Nickel Resources: Bureau of Mines Rept. of Investigations 4999, 1953, 37 pp.

[11] International Nickel Co. of Canada, Ltd., Annual Report: 1953, pp. 12-13.

[12] Bailey, A. R., Nickel Production: Metal Industry (London), vol. 84, No. 2, Jan. 8, 1954, p. 23.

small amounts of nickel, for example, under 1 percent, either as an extremely fine dispersion or in solid solution. It is therefore dried and then carefully roasted at a temperature of 650°–870° C. to a porous oxide with a sulphur content of less than 0.5 percent. The material is next subjected to a roast under reducing conditions of such character as to reduce the nickel oxide present while not affecting the more stable iron oxide. The nickel can then be leached out with ammonia solution in the presence of oxygen, leaving essentially pure iron oxide.

Inco developed a special type of nickel powder now being commercially employed in a sintered nickel-cadmium battery. It also developed a new procedure for producing a heat-treatable nickel-phosphorus alloy for hard-surface nickel electroplating and entered into a 10-year cooperative research program with alluminum-alloy producers [13] "which developed a nickel plating that bonds so strongly with appropriate alloys that the composite materials may be deep drawn and later finished with chromium plate." This latter development was expected to open a new market in the plating of aluminum appliances and furniture when nickel becomes more freely available.

In 1953 was recorded the end of the historic Orford nickel-copper separation process, dating back more than 60 years and on which the Canadian nickel industry was founded.[14]

Falconbridge Nickel Mines, Ltd., continued to give attention to metallurgical research. During 1953 research on a pyrrhotite process reached the point where it appeared desirable to construct a pilot plant with units of full commercial size.[15] Construction of this plant at Falconbridge, Ontario, was under way at the year end, and it was hoped that it would be operating on an experimental basis before the end of 1954.

Additional details on the hydrometallurgical process for recovering nickel, copper, and cobalt from sulfide concentrates by Sherritt Gordon Mines, Ltd., at its refinery at Fort Saskatchewan, Alberta, were made available.[16]

Patents were issued for a process for recovering nickel and/or cobalt ammonium sulfate from solutions containing nickel and/or cobalt; [17] recovery of nickel from ammonia liquors; [18] and separation of nickel contained in nickeliferous cobalt alloys.[19]

The development of a new nickel-plating process, reported to "produce better and brighter nickel coatings, is cheaper to operate and is easier to control than other commercial bright-nickel processes now available," was announced by Hanson-Van Winkle-Munning Co.[20]

A method of saving nickel solutions in plating operations has been described.[21]

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[13] Thompson, J. F., The International Nickel Co. of Canada, Ltd., address to Shareholders: Apr. 28, 1954, pp. 19–20.
[14] Work cited in footnote 13, p. 17.
[15] Falconbridge Nickel Mines, Ltd., 25th Annual Report: 1953, p. 11.
[16] Mining Engineering, Sherritt Gordon Uses Ammonia Leach for Lynn Lake Ni-Cu-Co Sulphides: Vol. 5, No. 6, June 1953, pp. 576–581.
[17] Forward, F. A. (assigned to Sherritt Gordon Mines, Ltd.), Process for Recovering Nickel and/or Cobalt-Ammonium Sulfate From Solutions Containing Nickel and/or Cobalt Values: U. S. Patent 2,647,820, Aug. 4, 1953.
[18] McGauley, P. J. (assigned to Chemical Construction Corp.), Recovery of Nickel From Ammonia Liquors: U. S. Patent 2,647,828, Aug. 4, 1953.
[19] De Merre, Marcel (assigned to Société Générale Métallurgique de Hoboken), Separation of Nickel Contained in Nickeliferous Cobalt Alloys: U. S. Patent 2,651,562, Sept. 8, 1953.
[20] Chemical and Engineering News, Organic Process Produces Cheap, Bright Nickel Coatings: Vol. 31, No. 42, Oct. 19, 1953, p. 4313.
[21] Iron Age, Small Plating Plants: How to Save Nickel Solution: Vol. 171, No. 16, Apr. 16, 1953, p. 117.

WORLD REVIEW

Table 11 shows world production of nickel by countries, 1944–48 (average) and 1949–53, insofar as statistics are available. Despite the fact that nickel is produced in several countries, 1 country—Canada—has supplied 89.5 percent of the world output outside the U. S. S. R. since 1949.

TABLE 11.—World mine production of nickel, by countries, 1944–48 (average) and 1949–53, in metric tons of contained metal [1]

[Compiled by Berenice B. Mitchell]

Country	1944–48 (average)	1949	1950	1951	1952	1953
Brazil (content of ore)	13	7	(2)	(2)	[3] 30	[3] 50
Canada [4]	110,003	116,745	112,181	125,103	127,512	130,310
Cuba (content of oxide)	5,767	----------	----------	----------	8,096	12,559
Finland (content of concentrates)	475	----------	----------	85	405	379
French Morocco (content of cobalt ore)	9	----------	----------	----------	182	120
Indonesia (content of ore)	[3] 480	----------	----------	----------	----------	----------
Italy	[3] 5	----------	----------	----------	----------	----------
Japan (content of ore)	474	----------	----------	----------	----------	----------
New Caledonia (content of ore)	3,840	2,475	4,250	6,700	10,500	17,000
Norway (content of ore)	220	----------	----------	----------	----------	----------
Sweden (content of ore)	218	----------	----------	----------	----------	----------
Union of South Africa (content of matte)	493	567	843	1,138	1,310	1,715
U. S. S. R.[3]	19,280	25,000	29,000	33,000	37,000	40,000
United States [5]	[6] 730	717	828	686	574	[6] 546
Total (estimate)	142,000	146,000	147,000	167,000	186,000	203,000

1 This table incorporates a number of revisions of data published in previous Nickel chapters.
2 Data not available.
3 Estimate.
4 Comprises refined nickel, nickel in oxide, and recoverable nickel in matte, etc., exported.
5 Byproduct in electrolytic refining of copper.
6 Includes some production from ore.

Brazil.—Production of 4,500,000 pounds of nickel annually was scheduled by Cia. Niquel Tocantins from its deposit at Niquelandia, Minas Gerais.[22] A highway linking Niquelandia with Anapolis in the State of Goias was almost completed.

Canada.—Virtually all the Canadian output is derived from copper-nickel ores of the Sudbury district, Ontario. A small quantity was produced in the Lynn Lake area, Manitoba. Some nickel is also recovered as a byproduct from silver-cobalt ores of Cobalt, Ontario. Two companies—International Nickel Co. of Canada, Ltd., and Falconbridge Nickel Mines, Ltd.—are the principal producers. Nickel production in Canada was 143,643 short tons in 1953, a 2-percent gain over 1952 and the second highest of record. Exports of nickel from Canada were 143,818 short tons in 1953 compared with 142,022 tons in 1952.

Sales of nickel in all forms by the International Nickel Co. of Canada, Ltd., were 251,417,772 pounds in 1953 compared with 249,017,358 pounds in 1952.[23]

Reflecting the progress in Inco's program of underground mining expansion, which has been under way for more than a decade, ore was produced underground at a new high of 11,095,199 short tons in 1953

22 Chemical and Engineering News, Brazil To Be Self-Sufficient in Nickel: Vol. 31, No. 45, Nov. 9, 1953, p. 46.
23 International Nickel Co. of Canada, Ltd., Annual Report: 1953, p. 6.

compared with 10,196,068 tons in 1952. Open-pit ore mined totaled 2,571,896 tons compared with 3,052,525 tons in 1952. A total of 13,667,095 tons—the highest in any year—was mined in 1953 compared with 13,248,593 tons in 1952. According to the company, proved ore reserves at the end of 1953 were 261,541,000 tons containing 7,817,000 tons of nickel-copper compared with 256,356,000 tons containing 7,795,000 tons of nickel-copper at the end of 1952. Underground development in the producing mines advanced 142,302 feet (27 miles) in 1953, bringing the total footage to 1,860,283 or 352 miles. Concerning progress made in expanding certain mines, the company reported as follows:[24]

A second crusher installation to serve the caving area at Creighton Mine was put into operation. Daily production from the Stobie section of the Frood-Stobie Mine attained a rate of 7,000 tons of ore, compared with 4,500 tons at the end of 1952. Regular ore hoisting operations were begun in the new No. 8 shaft at Stobie Mine.

Extension of the No. 2 shaft at Garson Mine below the 3,200-foot level was completed to a depth of 4,243 feet, while shaft stations were established on the 3,800- and 4,000-foot levels and ore-loading and spillage stations were excavated and concreted below the 4,000-foot level. At the Levack Mine, excavations at the 2,650-foot level for temporary hoist rooms for sinking to the 4,000-foot level were completed at the No. 3 shaft and started at No. 2 shaft. Construction of crusher and pumping stations was begun at the 2,650-foot level. Production was maintained and development work extended at the Frood section of the Frood-Stobie Mine and at the Murray Mine.

The company also continued its search for new sources of nickel. In the Sudbury district extensive exploratory drilling was continued in its operating mines, and further work was carried on at the Crean Hill mine. Surface exploration at its nonoperating mining properties involved nearly 300,000 feet of diamond drilling. Outside the Sudbury Basin exploration activities were again centered in western Canada, particularly Manitoba and the Northwest Territories. New areas in Canada were examined, and prospecting and geological and geophysical work were carried on in a number of locations as well as in other countries. The cost of the program was $6,084,742 compared with $4,967,450 in 1952.

Falconbridge Nickel Mines, Ltd., established new records in production of ore and matte in 1953. Ore produced at the Falconbridge mine was 883,190 short tons (888,082 tons in 1952), at the McKim mine 262,957 tons (224,774 tons in 1952), and at the Hardy mine 17,839 tons (none in 1952). Ore treated was 1,298,116 tons—1,164,599 tons from company mines and 133,517 tons from the East Rim, Milnet, and Nickel Offset mines—in 1953 (1,129,489 tons in 1952). In addition to the ore, these 3 mines provided 6,388 tons of magnetic and 818 tons of flotation concentrates.

The following information concerning developments, exploration, expansions, and reserves was taken from the 25th Annual Report of Falconbridge Nickel Mines, Ltd., for 1953.

At the Falconbridge mine deepening the main production shaft was completed to 4,347 feet; this shaft will permit a single lift of ore from the 4,200 loading pocket. Six new mines—Falconbridge East, Mount Nickel, Hardy, Boundary, Fecunis Lake, and Longvack—were under

[24] Work cited in footnote 23, p. 12.

development simultaneously in 1953. Mount Nickel and Longvack are low-grade mines with small ore reserves, but they will play an important role in maintaining production until the big Fecunis ore body is fully developed in 1958. At Mount Nickel mine the shaft was completed to 327 feet in September; development headings reached the ore body by year end; and all the major mine surface plant was completed. At Longvack mine 19,590 feet of shallow drilling was completed to define and sample this open-pit ore body in detail.

At Hardy mine all the surface mining plant, ore-pass system, loading pocket, fill pass and ventilation systems, pump and crusher stations, and installations were completed. Underground development included 11,842 feet of drifting, 3,665 feet of raising, and 28,864 cubic feet of station excavation.

At Falconbridge East mine the shaft was completed to 2,720 feet below collar, development was advanced 11,506 feet, and several stopes were being readied for production.

The Hardy, Falconbridge East, and Mount Nickel mines will probably begin production during 1954.

There was intense activity at the Fecunis Lake mine. The main production shaft (No. 1) is of unique design, as access is by means of an adit in the side of a hill, which will act as the headframe. There will be no conventional hoisthouse, as the shaft will be equipped with a friction-winding hoist set directly over the top of the vertical shaft opening. The permanent headframe over the service shaft and its 8-foot hoist installation were nearly completed in 1953. Sinking these shafts will take about 2½ years.

In the Sudbury district 112,000 feet of surface diamond drilling was completed, along with airborne and ground geophysical surveys. Drilling yielded some encouraging results, particularly at depth, between Fecunis and Boundary ore bodies in the Levack area. In the concession area in Newfoundland, a large program of surface investigation was carried on; a considerable number of new mineralized showings were found, but subsequent testing or drilling proved disappointing. At the Tilt Cove property diamond-drilling results were encouraging but inconclusive. A number of nickel prospects in the Yukon, Northwest Territories, Quebec, Manitoba, and Ontario were given preliminary examination, and options were taken up on a few to permit further examination.

At the smelter a third blast furnace and a new matte casting unit were completed and put into operation.

Ore reserves totaled 34,571,000 short tons on December 31, 1953, and comprised 13,560,000 tons of developed ore averaging 1.58 percent nickel and 0.83 percent copper in the Falconbridge, Falconbridge East, McKim, and Hardy mines and 21,011,000 tons of indicated ore averaging 1.57 percent nickel and 0.83 percent copper in Sudbury-district holdings. Despite the extraction of 1,164,000 tons during 1953, total ore reserves were increased by 1,584,000 tons.

The Sherritt Gordon Mines, Ltd., progressed satisfactorily toward completion of its construction program in 1953. At its chemical metallurgical plant at Fort Saskatchewan, Alberta, most of the buildings were completed or nearing completion, and much equipment had been installed. Due to continued delays in deliveries of structural steel and process equipment the first production of nickel powder was not contemplated until July 1954.[25] The pilot plant at Ottawa was built up to a point where it was a small-scale replica of the Fort Saskatchewan metallurigcal plant. It was placed in operation early in April and continued until late September; meanwhile, 130 tons of Lynn Lake concentrate was treated successfully and produced 12 tons of nickel metal. As a result of improved processing methods, the estimated recovery of nickel at the Fort Saskatchewan plant has been increased from 90 percent to 94.

At Lynn Lake, Manitoba, Sherritt Gordon continued to develop its A and EL mines. At the A mine the permanent hoists and new headframe were put into service, the shaft loading pocket was completed and the ore pocket cut, excavation of the crusher station was finished, the crusher and conveyor were installed, and all electric installations underground were operating. The concentrator building was virtually completed; 1 ball-mill unit was started November 7, and 3 were ready for operation at the year end; all necessary pumps and flotation units were installed. The combined filter, drier, and boiler building was finished, and all drying and heating units were in full operation. At the EL mine the shaft, loading pocket, ore pocket, crusher and conveyor, and all surface installations were completed. The development, with the diamond drilling done to outline the ore bodies for mining, confirmed previous ore information in both mines. The ore reserves remain at 14,055,000 tons assaying 1.223 percent nickel and 0.618 percent copper. During 1953 the company treated 13,324 tons of ore averaging 1.36 percent nickel and 0.58 percent copper, from which were recovered 966 tons of nickel concentrate averaging 15.95 percent nickel and 1.84 percent copper and 173 tons of copper concentrate averaging 30.55 percent copper and 0.54 percent nickel. On November 9 the 144-mile railway extension from Sherridon to Lynn Lake was completed, and the first nickel concentrate was loaded.

According to the Hudson Bay Mining & Smelting Co., Ltd.,[26] at its Wellgreen property in the Kluane Lake district, Yukon Territory, an adit was driven 300 feet below the discovery outcrop; and this, with additional drilling, developed up to the end of 1953, 257,600 tons of ore averaging 1.83 percent nickel, 1.14 percent copper, 0.059 percent cobalt, 0.004 ounce of gold, 0.063 ounce of platinum, and 0.051 ounce of palladium. Development both as to length and depth has covered but a limited portion of the known mineralized area. The company now holds 660 claims in the Yukon on which an active exploration program is planned.

Another discovery of nickel-copper ore was reported made by Prospectors Airways Co., Ltd., about 40 miles southwest of the Hudson Bay property.[27]

Among the smaller companies, East Rim Nickel Mines, Ltd., and Nickel Offsets, Ltd., completed concentrating plants, and both companies and Milnet Mines, Ltd., all in the Sudbury district, made shipments to Falconbridge Nickel Mines, Ltd. Elsewhere in Canada exploration was carried on by many companies, including Western

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[25] Sherritt Gordon Mines, Ltd., Annual Report: 1953, p. 14.
[26] Hudson Bay Mining & Smelting Co., Ltd., 26th Annual Report: 1953, pp. 1, 8.
[27] Canada Department of Mines and Technical Surveys, Nickel in Canada, 1953—Preliminary: Ottawa, 1954, p. 4.

Nickel, Ltd., at a property near Choate, British Columbia; Quebec Nickel Corp. at its property northwest of Kenora, western Ontario; Ontario Nickel Mines, Ltd., at the Bonter property in Hastings County, eastern Ontario; Eastern Metals Corp., Ltd., in Rolette Township, Montmagny County, Quebec; Rankin Inlet Nickel Mines, Ltd., on the west shore of Hudson Bay; and Canalask Nickel Mines, Ltd., at a property in the Kluane Lake district, Yukon Territory.

Cuba.—Production of nickel in Cuba established a new high in 1953 and was 12 percent greater than in 1946, the former record year. Output of oxide was 17,834 short tons (13,844 tons nickel plus cobalt content) in 1953 compared with 11,604 tons (8,924 tons nickel plus cobalt content) in 1952 and 16,040 tons (12,391 tons nickel content) in 1946. In 1952 all furnaces were not put into operation until July 7. Sintering equipment was being installed at the Nicaro plant in 1953; completion was scheduled in January 1954.

Production of ore was 1,330,224 dry short tons averaging 1.37 percent nickel in 1953 compared with 918,533 tons averaging 1.40 percent nickel in 1952.

Under its agreement with General Services Administration the Bureau of Mines continued drilling in the Levisa Bay district, Cuba. An estimate of the ore developed by this drilling was 34,700,000 dry short tons containing about 1.39 percent nickel and 0.10 percent cobalt.

The Nicaro Nickel Co., a subsidiary of Freeport Sulphur Co., completed a development program on its holdings in the Moa Bay area, Cuba, in 1953. Drilling on 100-meter (328-foot) centers has developed 40 million dry tons of ore averaging 1.35 percent nickel, 0.14 percent cobalt, and 46.5 percent iron. The average thickness of the ore is about 25 feet, with a maximum thickness of 80 feet developed in limited areas. The ore bodies are about 40 miles east of the company's Levisa Bay area deposits, which supply ore for the United States Government-owned nickel plant at Nicaro, Cuba.

The company proposes to treat its Moa Bay ores with a sulfuric acid leaching process and to recover nickel and cobalt metal from the acid leaching solutions by a process similar to that developed for use in connection with project of Sherritt Gordon Mines, Ltd. Upon completion of a pilot-plant program, facilities will be constructed in Cuba and in the United States to produce approximately 30 million pounds of nickel metal and 3 million pounds of cobalt metal annually. The Cuban facility will be in the vicinity of the mine site and will handle leaching and purification. The nickel-cobalt concentrate resulting from this process will be shipped to the United States to a second facility for separation and final processing of the metals. The location of this second facility has not been finally decided.

Finland.—Small quantities of nickel are present in 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 and is used for manufacturing nickel sulfate and nickel matte. Nickel sulfate production was 350 metric tons containing 69 tons of nickel in 1953 compared with 281 tons (gross weight) in 1952; all was exported. Production of matte was about 300 tons containing 149 tons of nickel in 1953; all was exported.

Production of ore at the Nivala mine was 77,273 metric tons in 1953 compared with 76,247 tons containing 0.73 percent nickel and 0.44

percent copper in 1952. Production of concentrates was 7,115 tons in 1953 compared with 7,574 tons containing 5.32 percent nickel and 3.44 percent copper in 1952. The nickel and copper content of the ore and concentrates produced in 1953 is not available.

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 metal was 3,210 metric tons in 1953 compared with 3,218 tons in 1952.

Greece.—A small amount of nickel ore was produced from the Karditsa mine in the Atalante-Larymna district in northern Greece for many years up to World War II, when the mine was wrecked by occupying forces in 1943. It is reported [28] that the mine was being reopened, a preliminary refining plant was being installed to raise the nickel content of the exportable product, and an annual output of 60,000 tons was contemplated.

New Caledonia.—Production of nickel ore (containing about 25 percent moisture) in New Caledonia was 628,220 metric tons in 1953 compared with 392,050 tons in 1952. The nickel content (dried) of the ore ranged from 3 to 6 percent in 1953 and averaged 3.6 percent in 1952. Exports of ore were 207,910 wet tons in 1953 compared with 109,840 tons in 1952.

Production of nickel matte, fonte, and ferronickel by Société le Nickel in 1953 exceeded that in 1952 by 9 percent.

TABLE 12.—Production of nickel matte, fonte, and ferronickel by Société le Nickel in 1952 and 1953, in metric tons

Product	1952		1953	
	Gross weight	Nickel content	Gross weight	Nickel content
Matte	4,054	3,132	5,718	4,400
Fonte	9,488	3,140	7,634	2,510 (fonte and ferronickel)
Ferronickel	201	74	2,419	
	13,743	6,346	15,771	6,910

Norway.—At the refinery of Falconbridge Nickel Mines, Ltd., Kristiansand, the first full year of operation with the new chloride process proved successful, and the many difficulties accompanying a process changeover were largely overcome.[29] Up to September the refinery increased production and consumed all available matte from the smelter, as well as a fairly substantial matte inventory accumulated in 1952 as a result of the process change. After September the refinery lowered production to the level of the smelter output.

At the end of 1953 the refinery had an annual capacity of 36 million pounds of nickel. As a result of the upward revision in expansion plans, Falconbridge was proceeding with additions to provide an annual capacity of 45 million pounds of nickel. Corresponding capacity will be added for copper, cobalt, and precious metals.

[28] Engineering and Mining Journal, vol. 154, No. 11, November 1953, p. 184
[29] Falconbridge Nickel Mines, Ltd., 25th Annual Report: 1953, p. 9.

The output of nickel established a new high of 14,934 metric tons in 1953 compared with 12,159 tons in 1952.

Southern Rhodesia.—The Mining World reported [30] that the Noel nickel mine at Gwanda was being reopened by the Gwanda Nickel Syndicate. The mine ceased operating in 1939, when about 500 tons (nickel content) of ore was produced.

Union of South Africa.—Since 1938 a small amount of nickel in the form of matte has been produced annually by Rustenburg Platinum Mines, Ltd., from the sulfide ore in the Rustenburg district. Production was 1,891 short tons in 1953 compared with 1,444 tons in 1952. The matte is exported to England for refining.

United Kingdom.—At the nickel refinery of Mond Nickel Co., Clydach, Wales, a new, improved, wet-treatment process was used to treat residues in place of the Orford process, which was discontinued during 1953.

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[30] Mining World, Syndicate Reopens Rich Rhodesian Nickel Mine: Vol. 16, No. 1, January 1954, p. 37.

Nitrogen Compounds

By E. Robert Ruhlman[1]

DESPITE continued expansion of nitrogen facilities, anhydrous ammonia and ammonium nitrate were in short supply during 1953. At the end of 1953 the total productive capacity of the domestic synthetic nitrogen industry was estimated to exceed 2.5 million short tons of nitrogen per year.

Ammonium phosphate, nitrogenous chemical materials (except urea), and ammonium sulfate were removed from the positive list of the Office of International Trade during 1953, permitting export without licenses.

DOMESTIC PRODUCTION

Synthetic anhydrous ammonia production reached a new high in 1953—11 percent more than in 1952, the previous record year. Domestic production of ammonium sulfate in 1953 was 6 percent below that in 1952. Ammonium sulfate produced in byproduct coking plants was 18 percent greater than in 1952. Ammonium nitrate production reached a new alltime high in 1953, 6 percent above the former high established in 1952. Synthetic sodium nitrate continued to be produced by only Allied Chemical & Dye Corp., Hopewell, Va., and Olin Mathieson Chemical Corp. (formerly Mathieson Chemical Corp.), Lake Charles, La.

TABLE 1.—Principal nitrogen compounds produced in the United States, 1944–48 (average) and 1949–53, in short tons

Commodity	1944–48 (average)	1949	1950	1951	1952	1953
Ammonia (NH_3):						
Synthetic plants:						
Anhydrous ammonia [1]	804, 326	1, 294, 057	1, 565, 569	1, 777, 074	2, 052, 114	2, 287, 785
Byproduct coking plants (NH_3 content):						
Aqua ammonia	26, 946	22, 750	23, 387	24, 878	22, 060	24, 846
Ammonium sulfate	193, 321	189, 202	207, 754	224, 566	200, 603	236, 533
Subtotal	220, 267	211, 952	231, 141	249, 444	222, 663	261, 379
Grand total	1, 024, 593	1, 506, 009	1, 796, 710	2, 026, 518	2, 274, 777	2, 549, 164
Principal ammonium compounds:						
Ammonium sulfate:						
Synthetic plants [1] [2]	158, 768	846, 195	1, 137, 721	[3] 622, 084	[3] 812, 795	576, 232
Byproduct coking plants	773, 282	756, 807	831, 016	898, 263	802, 412	946, 133
Total	932, 050	1, 603, 002	1, 968, 737	[3]1,520,347	[3]1,615,207	1, 522, 365
Ammonium nitrate, basis solution, 100 percent NH_4NO_3 [1]	[4] 805, 399	1, 018, 706	1, 213, 911	1, 346, 443	1, 467, 341	1, 558, 457

[1] Data from Bureau of Census Facts for Industry series.
[2] Includes ammonium sulfate produced at byproduct coking plants from purchased ammonia.
[3] Revised figure.
[4] Average of 1945–48 only.

[1] Commodity-industry analyst.

Construction by the Nitrogen Division of Allied Chemical & Dye Corp. included a new ammonia plant at La Platte, Nebr., expansion of the Hopewell, Va., ammonia plant, and expansion of the urea plant at South Point, Ohio.[2] The American Cyanamid Co. announced plans to double the capacity of the ammonia plant under construction at Fortier, La., to 300 tons of anhydrous ammonia per day.[3] The 200-ton-per-day anhydrous ammonia plant of Brea Chemicals, Inc., a wholly owned subsidiary of Union Oil Co., under construction at Brea, Calif., was scheduled for completion early in 1954. The plant will use natural gas from nearby wells as a source of raw material.[4] Columbia-Southern Chemical Corp. was constructing an ammonia plant at Natrium, W. Va., to utilize hydrogen obtained from electrolytic production of chlorine and caustic soda. The plant was scheduled to be completed by late 1954.[5] The expansion program of Commercial Solvents Corp. at Sterlington, La., was completed about July 1953. New ammonium nitrate facilities employed the Stengel, process which permits particle-size control of the product.[6] Construction of an ammonium and urea plant for Grace Chemical Co., near Memphis, Tenn., was begun about midyear.[7] Expansion of the ammonia plant of the Mississippi Chemical Corp. at Yazoo City, Miss., operating since 1951, was underway to increase capacity to 180 short tons of anhydrous ammonia per day.[8] National Distillers Products Corp. announced plans to construct an ammonia plant at Tuscola, Ill. The plant will obtain hydrogen from the ethylene plant of the National Petro-Chemical Corp., and production was projected for January 1955.[9] The plant at Etter, Tex., leased by Phillips Chemical Co. from the Government was undergoing further expansion. The plant produces ammonia, nitric acid, ammonium nitrate, and nitrogenous solutions.[10] The second anhydrous ammonia plant of the Shell Chemical Co., at Ventura, Calif., was completed late in 1953 and, with a rated capacity of 150 tons per day, maintains Shell's position as the largest ammonia producer in the Far West.[11] The Government-owned plant at St. Louis, Mo., was offered for sale or lease, following the shutdown of the synthetic liquid fuels demonstration plants operated by the Bureau of Mines.

Other companies that announced tentative plans to build ammonia plants during 1953 included: Alabama By-Products Co., Birmingham, Ala.; Columbia River Chemical Co., Pasco, Wash.; Northern Chemical Industries, Sandy Point, Maine; Pacific Chemical Co., in the Pacific Northwest; and the Utah Chemical Co., in south-central Utah.

CONSUMPTION AND USES

Agriculture continued to be the major consumer of nitrogen and its compounds. The chemical industry, while using a small quantity

[2] Agricultural Chemicals, vol. 8, No. 7, July 1953, p. 102C.
Chemical Engineering, vol. 60, No. 3, March 1953, p. 110.
[3] Oil and Gas Journal, vol. 52, No. 34, Dec. 28, 1953, p. 123.
[4] Chemical Engineering, vol. 60, No. 3, March 1953, p. 331.
Industrial and Engineering Chemistry, vol. 45, No. 2, February 1953, p. 8-A.
[5] Chemical Age (London), vol. 60, No. 10, October 1953, p. 112.
[6] Chemical Week, vol. 73, No. 6, Aug. 8, 1953, p. 16.
Oil and Gas Journal, vol. 52, No. 25, Oct. 26, 1953, p. 68.
[7] Chemical and Engineering News, vol. 31, No. 14, Apr. 6, 1953, p. 1418.
[8] Oil, Paint, and Drug Reporter, vol. 163, No. 14, Apr. 6, 1953, p. 5.
[9] Agricultural Chemicals, vol. 8, No. 7, July 1953, p. 74.
Chemical Engineering, vol. 60, No. 10, October 1953, p. 114.
[10] Chemical Engineering, vol. 60, No. 5, May 1953, p. 114.
[11] Chemical and Engineering News, vol. 31, No. 51, Dec. 21, 1953, pp. 5276-5277.

of elemental nitrogen, requires the major part of its nitrogen in various compounds. Over 1.6 million tons of contained nitrogen was consumed by agriculture during the fiscal year ended June 30, 1953, a 15-percent increase above the previous fiscal year. The principal chemical nitrogen materials, in order of importance, were: (1) Ammonium nitrate and ammonium nitrate-limestone mixtures, (2) sodium nitrate, (3) ammonium sulfate, (4) anhydrous and aqua ammonia, (5) calcium cyanamide, and (6) calcium nitrate.

According to the United States Department of Agriculture, consumption of calcium cyanamide, ammonium nitrate-limestone, anhydrous ammonia, and ammonium sulfate increased 95, 63, 29, and 10 percent, respectively, whereas consumption of calcium nitrate and sodium nitrate was 3 and 5 percent less than in 1951–52.

PRICES

Prices of nitrogen compounds were decontrolled by the Office of Price Stabilization early in 1953. The prices for various nitrogen compounds, in effect at the beginning and end of 1953, 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 1953, per short ton [1]

Commodity	Jan. 3, 1953	Dec. 28, 1953	Effective date of change
Chilean nitrate, port, warehouse, bulk	$57.00	$53.00	Aug. 31.
Sodium nitrate, synthetic, domestic, c. l. works, crude, bulk	47.50	43.50	Sept. 28.
Ammonium sulfate, coke ovens, bulk	44.00–49.50	44.00–47.00	Oct. 19.
Cyanamide, fertilizer mixing grade, 20.6% N, granular, Niagara Falls, Ontario, bagged	62.50	55.00	June 8.
Ammonium nitrate, fertilizer grade:			
Canadian, eastern, 33.5% N, c. l., shipping point, bags	72.50	77.50	June 8.
Western, domestic, works, bags	64.00	68.00–70.00	June 8.
Anhydrous ammonia, fertilizer, tanks, works	79.00–82.00	85.00–88.00	Sept. 28.
Ammonium-nitrate-dolomite compound, 20.5% N, Hopewell, Va., bags	51.00	51.00	

[1] Quotations from Oil, Paint and Drug Reporter of the dates listed.

FOREIGN TRADE [12]

Total imports of nitrogen compounds were 30 percent more in 1953 than in 1952. For the first time imports of the higher grade ammonium nitrate (more than 20 percent N) exceeded the imports of any other nitrogenous material. The bulk of this higher grade material originated in Canada (33 percent), the Netherlands (27 percent), and West Germany (26 percent).

The tonnage of sodium nitrate imported from Chile decreased 16 percent, and the average value per ton remained unchanged during 1953. Imports of Chilean potassium-sodium nitrate were 24 percent below those of 1952.

Total exports of nitrogen compounds decreased 35 percent in 1953.

[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.

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TABLE 3.—Major nitrogen compounds imported for consumption into and exported from the United States, 1950–53, in short tons

[U. S. Department of Commerce]

	1950	1951	1952	1953
Imports:				
Industrial chemicals: Ammonium nitrate		4		
Fertilizer materials:				
Ammonium nitrate mixtures:				
Containing less than 20 percent nitrogen	1,523	361	624	8,294
Containing 20 percent or more nitrogen	221,299	342,757	[1] 467,166	755,087
Ammonium phosphates	107,695	134,962	[1] 133,288	166,497
Ammonium sulfate	144,732	216,106	238,063	523,858
Calcium cyanamide	97,725	68,231	96,195	82,218
Calcium nitrate	44,331	55,743	39,466	67,794
Nitrogen materials, n. s. p. f.	23,830	26,023	22,067	17,104
Potassium nitrate, crude	20	3,367	[1] 12,738	15,941
Potassium-sodium nitrate, mixtures, crude	20,409	8,655	16,460	12,516
Sodium nitrate	618,018	737,324	675,329	568,873
Exports:				
Industrial chemicals:				
Anhydrous ammonia	10,202	5,907	15,431	15,119
Ammonium nitrate	3,336	5,049	5,709	6,013
Fertilizer materials:				
Ammonium nitrate	94,169	1,255	[1] 3,833	2,172
Ammonium sulfate	819,285	134,100	121,587	39,440
Nitrogenous chemical materials, n. e. s.	41,363	63,768	48,109	46,485
Sodium nitrate	32,862	43,669	9,441	24,209

[1] Revised figure.

TECHNOLOGY

Continuous ammoniation of superphosphates and fertilizer mixtures gives promise of obtaining a higher degree of ammoniation than achieved previously. A continuous ammoniator was demonstrated on September 15 by the Tennessee Valley Authority.[13]

Many operating problems encountered in a high-pressure process necessitated equipment modification.[14] A description of the TVA ammonia plant showed that, through design improvement, this plant operated 8½ years without a shutdown for repairs.[15]

A new method of purifying synthesis gas for the production of ammonia by washing with liquid nitrogen was reported.[16]

New nitrogenous fertilizers introduced during 1953 included a solution of sodium and ammonium nitrates and a urea-formaldehyde compound.[17]

Several technical articles on the chemical behavior of nitrogen and its compounds were published.[18]

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13 Chemical and Engineering News, vol. 31, No. 30, July 27, 1953, p. 3042.
National Fertilizer Association, Process Progress: Vol. 2, Nos. 1–12, January–December 1953.

14 Slack, A. V., and others, Operating Problems in Ammonia Synthesis: Chem. Eng. Prog., vol. 49, No. 8, August 1953, pp. 393–403.

15 Farrar, G. L., Ammonia-Plant Advice: Oil and Gas Jour., vol. 51, No. 32, Dec. 15, 1952, pp. 82–83.

16 Chemical Engineering, vol. 60, No. 7, July 1953, pp. 133–134.

17 Chemical and Engineering News, vol. 31, No. 38, Sept. 21, 1953, pp. 3858–3859.
Chemical Engineering, vol. 60, No. 10, October 1953, p. 370.
Science News Letter, vol. 63, No. 14, Oct. 3, 1953, p. 217.

18 Adams, R. M., and Comings, E. W., Experimental Reaction Rates in the Synthesis of Ammonia: Chem. Eng. Prog., vol. 49, No. 7, July 1953, pp. 359–366.
Bridger, G. L., and Sinner, R. D., Adsorption of Ammonia on Fuller's Earth and Gas-Absorbent Carbon: Ind. Eng. Chem., vol. 45, No. 3, March 1953, pp. 581–589.
Burnett, J. A., and others, Stabilization of Ammonia Synthesis Catalyst: Ind. Eng. Chem., vol. 45, No. 8, August 1953, pp. 1678–1682.
Richter, G. N., and others, Viscosity of Nitrogen Dioxide in the Liquid Phase: Ind. Eng. Chem., vol. 45, No. 9, September 1953, pp. 2117–2119.
Selleck, F. T., and others, Volumetric and Phase Behavior of Mixtures of Nitric Oxide and Nitrogen Dioxide: Ind. Eng. Chem., vol. 45, No. 4, April 1953, pp. 814–819.

TABLE 4.—Sodium nitrate and potassium-sodium nitrate imported for consumption in the United States, 1944–48 (average) and 1949–53, by countries

[U. S. Department of Commerce]

	1944–48 (average)		1949		1950		1951		1952		1953	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Sodium nitrate:												
Canada	48	$2, 720	8	$416	8	$1, 137	84	$4, 622	50	$4, 138	1	$45
Chile	673, 924	16, 753, 842	675, 535	26, 005, 637	617, 999	22, 387, 123	737, 188	27, 015, 854	675, 279	27, 626, 811	568, 872	23. 268, 068
France							33	3, 213				
Germany					11	1, 330	5	576				
Poland							14	968				
Total	673, 972	16, 756, 562	675, 543	26, 006, 053	618, 018	22, 389, 590	737, 324	27. 025, 233	675, 329	27, 630, 949	568, 873	23, 268, 113
Potassium-sodium nitrate, mixtures:												
Canada							3	148				
Chile	3, 261	97, 963	6, 802	310, 343	20, 409	882, 582	8, 652	389, 749	16, 460	830, 693	12, 516	626, 149
Total	3, 261	97, 963	6, 802	310, 343	20, 409	882, 582	8, 655	389, 897	16, 460	830, 693	12, 516	626, 149

Development of ammonium nitrate manufacturing methods and operation of the ammonium nitrate plant of the Mississippi Chemical Corp. at Yazoo City, Miss., were described in an article published in 1953.[19]

According to an article, use of urea as a fertilizer was increasing; and it appeared that, as cheaper urea becomes available, it will compete with ammonium nitrate. Development of the Pechiney process contributed largely to reducing the cost.[20]

A new ammonium-ammonium carbonate leaching process was applied to a zinc carbonate ore.[21] Sherritt Gordon Mines, Ltd., began constructing an ammonia-leaching plant for treating nickel-copper-cobalt sulfide concentrates.[22]

WORLD REVIEW

According to the annual report of Aikman (London), Ltd., production and consumption again increased in 1953–54 compared with 1952–53. Details of world production and consumption are shown in tables 5 and 6.

TABLE 5.—World production and consumption of fertilizer nitrogen compounds, fiscal years ended June 30, 1952–54, by principal countries, in metric tons of contained nitrogen

[United Nations Food and Agriculture Organization]

Country	Production			Consumption		
	1951–52	1952–53 [1]	1953–54 [2]	1951–52	1952–53 [1]	1953–54 [2]
Austria	94,095	92,660	94,000	28,680	22,285	28,000
Belgium	217,210	176,000	180,000	81,500	83,500	85,000
Canada	163,000	164,000	168,000	40,000	40,000	40,000
Chile [3]	239,431	245,000	250,000	13,310	16,600	17,000
Czechoslovakia	30,300	30,300	30,300	40,000	40,000	40,000
Denmark				70,688	70,800	72,000
Egypt	17,050	20,150	27,900	105,625	111,030	117,900
France	293,000	288,000	305,000	250,100	271,000	298,000
Germany:						
Federal Republic	538,047	580,000	600,000	386,439	400,000	420,000
Soviet Zone	205,000	213,000	213,000	191,000	196,000	200,000
Greece				30,080	28,500	34,000
India	23,134	66,219	70,000	50,892	105,234	110,000
Italy	184,297	213,000	284,000	161,346	175,000	190,000
Japan	456,000	508,000	525,000	392,000	400,000	400,000
Korea, South				49,325	126,725	126,725
Netherlands	230,000	243,000	255,000	156,000	160,000	165,000
Norway	166,736	164,900	181,900	33,397	36,500	37,000
Peru (Guana)	33,205	29,547	30,000	37,377	35,547	36,000
Poland	65,000	65,000	65,000	75,000	75,000	75,000
Portugal [3] [4]	8,693	8,693	8,693	27,498	27,500	27,500
Spain	26,000	43,000	43,000	111,300	116,400	117,000
Sweden	17,535	21,345	22,000	62,494	68,795	68,000
Taiwan (Formosa)	13,849	14,320	14,320	76,215	80,000	80,000
United Kingdom	290,642	308,000	305,000	185,722	215,000	225,000
United States [4]	1,096,000	1,252,000	1,452,000	1,293,000	1,506,000	1,660,000
World total [5]	4,462,385	4,808,620	5,205,056	4,234,294	4,702,798	5,012,539

[1] Preliminary.
[2] Forecast.
[3] Calendar years 1952, 1953, and 1954.
[4] Figures for consumption include overseas territories.
[5] Exclusive of U. S. S. R.; includes quantities for minor producing and consuming countries not listed above.

[19] Shearon, W. H., Ammonium Nitrate: Ind. Eng. Chem., vol. 45, No. 3, March 1953, pp. 496–504.
[20] Chemical Week, vol. 72, No. 16, Apr. 18, 1953, pp. 70, 72, 74.
[21] Engineering and Mining Journal, vol. 154, No. 9, September 1953, pp. 84–90.
[22] Mining Engineering, vol. 5, No. 6, June 1953, pp. 576–581.

TABLE 6.—Revised estimates of world production and consumption of nitrogen, in thousand metric tons [1]

Year	Estimated production		Estimated consumption	
	For agriculture	For industry	In agriculture	In industry
1949-50	3,891	670	3,525	670
1950-51	4,035	770	3,985	770
1951-52	4,435	810	4,360	810
1952-53	4,905	910	4,885	910
1953-54	5,310	1,020	5,350	1,020

[1] Exclusive of U. S. S. R.

SOURCE: Aikman (London), Ltd., Annual Report on the Nitrogen Industry, Dec. 5, 1953; Half-Yearly Report on the Nitrogen Industry, June 1, 1954.

Australia.—The Electrolytic Zinc Co. of Australia, Ltd., was constructing a 50,000-ton-per-year ammonium sulfate plant at Risdon, Tasmania, with provision for future expansion. Hydrogen will be obtained from electrolysis of water.[23]

Austria.—Production of nitrogenous fertilizers by the Stickstoff Werke was 490,000 metric tons in 1953. Exports totaled 438,000 tons.[24]

Brazil.—Construction of an ammonia plant near the Cubatao oil refinery in São Paulo was begun late in 1953 by a French concern.[25]

Canada.—Sherritt Gordon Mines, Ltd., was building an ammonia plant at Fort Saskatchewan in connection with its new metal refinery. A portion of the ammonia and byproduct ammonium sulfate will be marketed.[26] Consolidated Mining & Smelting Co. of Canada, Ltd. announced expansion of ammonia facilities to meet the increased requirements of the company's fertilizer plants at Calgary and Trail, B. C. Surplus ammonia will be marketed.[27]

Chile.—Production of nitrates totaled 1,421,558 metric tons,

TABLE 7.—Exports of sodium nitrate and potassium nitrate from Chile, 1953, by countries of destination, in metric tons

Country of destination	Sodium nitrate	Potassium nitrate	Country of destination	Sodium nitrate	Potassium nitrate
Argentina	8,880	300	Jamaica	56	
Australia	3,736		Japan	1,483	
Belgium	15,068		Mexico	5,002	400
Bolivia	70	2	New Zealand	3,304	
Brazil	65,014	16,793	Panama	55	7
Colombia	280	810	Peru	6,016	1,541
Costa Rica	549	897	Portugal	14,643	
Denmark	15,936		Spain	174,296	5,000
Ecuador	700	300	Sweden	20,263	
Egypt	153,927		United Kingdom	13,138	2,529
El Salvador	1,977	593	United States	528,079	11,354
France	93,820		Uruguay	1,604	766
Germany	3,000		Venezuela	676	195
Guatemala	1,350	897			
Holland	12,290		Total	1,192,450	42,384
Italy	47,238				

SOURCE: Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 5, May 1954, p. 43.

[23] Chemical and Engineering News, vol. 31, No. 19, May 11, 1953, p. 2001.
[24] Chemical Week, vol. 74, No. 20, May 15, 1954, p. 34.
[25] Chemical Week, vol. 73, No. 21, Nov. 21, 1953, p. 22.
[26] Oil and Gas Journal, vol. 52, No. 30, Nov. 30, 1953, p. 44.
[27] Chemical and Engineering News, vol. 32, No. 17, Apr. 26, 1954, pp. 1664-1665.

slightly less than in 1952. Nitrate exports (table 7) decreased 6 percent compared with 1952. Two major problems faced the industry throughout the year—increased competition from synthetic plants and depletion of ore amenable to the Shanks process.[28] The largest producer was idle for nearly 2 months as a result of a strike during the later part of the year.

Colombia.—The Instituto de Fomento Industrial announced plans to build a nitrogen plant near the oil refinery at Barrancabermeja. It was reported that the plant would have a capacity of 50 tons of anhydrous ammonia per day. Plans to produce urea were also under consideration.[29]

Egypt.—Plans to expand the calcium ammonium nitrate plant of the Société Egyptienne d'Engrais et d'Industries Chemiques de Suez, operating since 1951 at a rated capacity of 200,000 tons per year, were contemplated during 1953. A new plant to produce ammonium nitrate was being considered in conjunction with the Aswan Dam electrification program.[30]

Finland.—The nitrogen plant at Oulu reached full production during 1953. This plant, with a rated annual capacity of 16,000 metric tons of nitrogen, was said to be able to supply about one-third of Finland's requirements.[31]

India.—The ammonium sulfate plant at Sindri was producing at near capacity at the end of 1953, and efforts were being made to increase production even more. Construction of plants to produce urea and ammonium nitrate were recommended by the Indian Fertilizer Mission.[32]

Italy.—Two new nitrogen fertilizer plants of the Montecatini Chemical Co., at Ferrara and Novara, began producing during 1953. These plants had a combined rated capacity of 400,000 tons per year of 20.5-percent nitrogen fertilizer and used methane as raw material. The Societa Industrie Chimiche Sintetiche was reported planning to build a synthetic ammonia plant at South Giovanni.[33]

Japan.—The nitrogen industry of Japan recovered from World War II and was capable of supplying all the domestic needs as well as exporting sizable quantities. Formosa and South Korea continued to be the major recipients of ammonium sulfate exported.[34]

Korea, Republic of.—Construction of new and rebuilding of damaged fertilizer plants received high priority in reconstruction plans. A 300,000-ton-per-year ammonium nitrate plant at Puk Pyong was proposed, but no definite action had been announced at the end of the year. Other projects under consideration included the repair of the plants of Puk Sam Chemical Co. and Oriental Chemical Co., to produce nitrogenous fertilizer materials.[35]

Netherlands.—Production of fertilizer nitrogen was estimated at 250,000 metric tons in 1953. The major portion was in the form of

[28] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 5, May 1954, pp. 42–44.
[29] Foreign Commerce Weekly, vol. 50, No. 16, Oct. 19, 1953, p. 20.
[30] Chemical and Engineering News, vol. 31, No. 32, Aug. 10, 1953, pp. 3262–3263.
Foreign Commerce Weekly, vol. 49, No. 15, Apr. 13, 1953, p. 23.
[31] Fertiliser and Feeding Stuffs Journal (London), vol. 39, No. 3, Feb. 4, 1953, p. 93.
Oil, Paint and Drug Reporter, vol. 163, No. 18, May 4, 1953, p. 48.
[32] Chemical Age (London), vol. 69, No. 1794, Nov. 28, 1953, p. 1125.
Chemical Week, vol. 73, No. 4, July 25, 1953, p. 70.
[33] Chemical Age (London), vol. 68, No. 1756, Mar. 7, 1953, p. 398.
Chemical Week, vol. 72, No. 13, Mar. 27, 1953, p. 32; vol. 73, No. 21, Nov. 21, 1953, p. 22.
[34] Fertilizer and Feeding Stuffs Journal (London), vol. 39, No. 7, Apr. 1, 1953, p. 254.
[35] Chemical Week, vol. 73, No. 16, Oct. 17, 1953, p. 32.

"Nitrolime," which is made by mixing finely ground limestone with a solution of ammonium nitrate. This product has a nitrogen content of 20.5 percent. Urea production was begun during 1952 to supply both the chemical and the fertilizer industries.[36]

Pakistan.—Completion of the new ammonium sulfate plant at Daudkhel, Punjab, was scheduled for 1956. The plant, being constructed under contract by Union Chemique Belge, S. A., will have a capacity of 50,000 tons per year. The Pakistan Industrial Development Corp. was considering an ammonium sulfate plant in the Mianwali district of Northwest Frontier Province.[37]

Philippines.—The Maria Cristina ammonium sulfate plant, operated by the National Power Corp., began operation during the year. Obtaining sulfur from domestic pyrite, the plant will produce 50,000 tons of ammonium sulfate per year.[38]

Portugal.—A new 6-year plan for economic development included further expansion of ammonium sulfate plants.[39]

Spain.—Sociedad Iberica del Nitrogeno was expanding its facilities at the LaFelquera and Oviedo plants to produce about 500 tons per day of ammonium sulfate.[40] A new sodium nitrate plant was planned by the Spanish Explosives Union Co. at Galdacano.[41]

Sweden.—Expansion of nitrogen facilities of the Superfosfat Fabriks was underway to permit increased production of ammonia, urea, and ammonium nitrate.[42]

Turkey.—It was reported that a nitrogen plant with a capacity over 100,000 metric tons of nitrogenous materials a year was being considered by the Turkish Government.[43]

Venezuela.—The Venezuela Development Corp. conducted economic studies on the feasibility of operating a nitrogen plant near the oil refinery operations. Conclusions were not announced.[44]

Yugoslavia.—Cyanamide was reported to be the major nitrogen fertilizer produced. Two plants, at Ruse and Durgi, had a combined capacity of 20,000 metric tons. New plants to produce ammonium nitrate and ammonium sulfate were being built.[45]

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36 Chemical Age (London), vol. 69, No. 1774, Aug. 8, 1953, p. 284.
Chemical Week, vol. 73, No. 16, Apr. 18, 1953, pp. 60–62.
Fertiliser, Feeding Stuffs and Farm Supplies Journal (London), vol. 39, No. 11, May 27, 1953, p. 395.
37 Foreign Commerce Weekly, vol. 49, No. 1, Jan. 5, 1953, p. 17.
Chemical Week, vol. 73, No. 19, Nov. 7, 1953, p. 22.
38 Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 2, August 1953, pp. 55–57.
39 Chemical and Engineering News, vol. 31, No. 23, June 8, 1953, p. 2421.
Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 5, November 1953, pp. 58–59.
40 Foreign Commerce Weekly, vol. 49, No. 13, Mar. 30, 1953, p. 19.
41 Chemical Age (London), vol. 70, No. 1800, Jan. 9, 1954, p. 184.
42 Chemical and Engineering News, vol. 32, No. 19, May 10, 1954, p. 1900.
43 Chemical Age (London), vol. 68, No. 1756, Mar. 7, 1953, p. 397.
44 Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 6, December 1953, p. 57
45 Fertiliser and Feeding Stuffs Journal (London), vol. 39, No. 19, Sept. 16, 1953, p. 395.
Chemical and Engineering News, vol. 31, No. 2, Jan. 12, 1953, p. 168.

Perlite

By Oliver S. North [1] and Annie L. Marks [2]

EACH successive year since expanded perlite first reached the market in commercial quantities in 1946 has been marked by a new record; 1953 was no exception—175,000 short tons was produced compared with 156,000 tons in 1952. Total sales reached 174,000 short tons or approximately 10,500,000 4-cubic-foot bags—an increase of 13 percent over the 1952 sales—valued at $8,895,000.

Although more perlite was expanded in 1953 than in any previous year the percentage increase was lower than in earlier years, indicating that the major market areas have been developed and that competition is becoming increasingly important to the industry.

Although some 90 percent of the output was used as aggregate in plaster and structural concrete, larger quantities of special grades of the material than in previous years were being used as loose-fill insulation, filter aid, molding sand in foundries, paint filler, for horticultural purposes and as a component in oil-well muds and concretes. A considerable quantity of the perlite used as plaster aggregate was mill-mixed with gypsum.

DOMESTIC PRODUCTION

Crude Perlite.—Nineteen firms and individuals with 21 mines in 7 States reported the output of crude perlite in 1953. Of these mines, 8 produced only for sale to other companies in crude form, 8 for use in their own expanding units only, and 5 both for their own furnaces and for sale to other expanders.

Of the 199,000 short tons of crude perlite used in the United States in 1953, 80 percent was produced in New Mexico and Nevada compared with 73 percent of the total in 1952. In 1953, 16 percent of the crude perlite used was mined in California and Colorado and the remaining 4 percent in Arizona, Oregon, and Utah. To avoid disclosing individual company operations, separate State totals are not published. Output of crude perlite in 1949–53 is shown in table 1.

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

TABLE 1.—Crude and expanded perlite produced and sold or used by producers in the United States, 1949–53

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
1949	71,500	27,300	$193,000	43,800	$317,000	58,100	52,200	$2,385,000
1950	110,694	59,802	411,205	41,734	237,957	88,892	86,962	4,741,383
1951	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	8,894,735

Expanded Perlite.—Production of expanded perlite in 1953 was reported from 79 plants in 30 States. Of these plants, 15 were in California, 6 in Texas, 5 each in Illinois, New York, and Pennsylvania, and 3 each in Florida, Iowa, Nevada, New Jersey, and Ohio. Separate figures cannot be published for Texas and New York because only combined statistics covering several States are available for certain multiple-plant operations. Output of expanded perlite in 1952–53 is shown in table 2.

TABLE 2.—Expanded perlite produced and sold by producers in the United States, 1952–53 by States

State	1952				1953			
	Produced (short tons	Sold			Produced (short tons)	Sold		
		Short tons	Value	Average value per ton		Short tons	Value	Average value per ton
California	28,663	28,419	$1,202,603	$42.32	35,403	35,342	$1,601,988	$45.33
Illinois	15,545	14,562	776,728	53.34	11,127	11,127	712,238	64.01
Ohio	9,975	9,881	667,561	67.56	10,344	10,015	675,207	67.42
Pennsylvania	15,690	15,441	938,690	60.79	13,158	13,109	810,965	61.86
Texas	11,780	11,691	627,917	53.71	(1)	(1)	(1)	(1)
Other Western States [2]	38,488	38,309	1,714,067	44.74	49,680	49,253	2,194,613	44.56
Other Eastern States [3]	35,814	36,260	2,070,165	57.09	55,522	55,615	2,899,724	52.14
Total	155,955	154,563	7,997,731	51.74	175,234	174,461	8,894,735	50.98

[1] Included under "Other Western States."
[2] Includes Arizona, Arkansas, Colorado, Iowa, Kansas, Louisiana, Minnesota, Missouri, Nebraska, Nevada, New Mexico, Oklahoma, Oregon, Texas (1953 only), and Utah.
[3] Includes Florida, Indiana, Maryland, Massachusetts, Michigan, New Jersey, New York, North Carolina, Tennessee, Virginia, and Wisconsin.

Perlite Mine and Plant Developments.—Great Lakes Carbon Corp. announced purchase of the perlite properties of Alexite Engineering Division, Alexander Film Co., Colorado Springs, Colo. The properties included mines near Rosita, Colo., a mill and expanding plant at Florence, Colo., and mining and processing machinery. The new owners were expected to continue operation of the mine and mill, utilizing existing equipment and personnel.[3] The former owner was one of the pioneers of the perlite industry.

[3] Pit and Quarry, Alexite Properties Sold to Perlite Division of Great Lakes Carbon Corp.: Vol. 45, No. 10, April 1953, p. 62.

Kaiser Gypsum Co., after 1 year of operation, relinquished its lease and option on the Maupin, Oreg., perlite deposit and plant owned by Dantore Division of Dant & Russell, Inc. The company will purchase future requirements of crude perlite rock from independent producers.[4]

An article described improvement of facilities at the No Agua, N. Mex., mine and Antonito, Colo., mill of F. E. Schundler & Co., Inc.[5]

Complete mining and milling practices of one of the newer producers of crude perlite—California Perlite Corp.—were described. The deposit being quarried is in the Lava Range, 6 miles north of Klondike, Calif., and the mill is in Klondike, a railroad station in the Mojave Desert 180 miles east of Los Angeles.[6]

Occurrence of an extensive perlite deposit in the Pinnacles National Monument, San Benito County, Calif., was reported. Since mining is not permitted within the boundary of the monument, it was expected that nearby areas open to development would attract attention.[7]

Perlite Industries, Inc., was reported to have begun operation of its new Terminal, Tex., plant in western Texas. The company produces plaster and concrete aggregate, as well as aggregate for use in oil-well cementing and for minimizing mud-circulation losses.[8]

Initial production of 1,500 bags daily was planned for the Jacksonville, Fla., perlite plant of Tennessee Products & Chemical Corp. The company market area is said to include Georgia and the Carolinas.[9]

An established producer of other types of lightweight aggregate (Western Mineral Products Co., Minneapolis, Minn.) was reported early in 1953 to have underway an expansion program that would enable it to manufacture perlite aggregate for plaster, plaster finish, float finish, and concrete.[10] Before the end of the year the company expanded a considerable quantity of perlite.

The California State Division of Mines released a list showing nine perlite-processing companies in the Los Angeles area, with the number and types of furnaces used by each, plant capacities, sources of crude perlite, and principal products. The industry in the Los Angeles area was reported to have a capacity of about 600 4-cubic-foot bags per hour.[11]

Perlite has been found in a number of localities in San Bernardino County, Calif., and large quantities of expansible material have been outlined.[12] Several individuals and firms have worked these deposits, and at least two producers are now in operation. However, total production in that county thus far has been relatively small.

[4] Pit and Quarry, Kaiser Closes Operations at Oregon Perlite Facilities: Vol. 46, No. 2, August 1953, p. 66.
[5] Pit and Quarry, Expansion and Improvement Mark Growth of Schundler Perlite Mining Operation: Vol. 45, No. 12, June 1953, pp. 99–100.
[6] Utley, H. F., California Perlite Processing Ore at New Plant in Mojave Desert: Pit and Quarry, vol. 46, No. 2, August 1953, pp. 81–82.
[7] California Mining Journal, State Division Reports Perlite in San Benito: Vol. 22, No. 11, July 1953, p. 10.
California Mineral Information Service, Discovery of Perlite in San Benito County: Vol. 6, No. 6, June 1, 1953, p. 6.
[8] Rock Products, Perlite-Processing Plant: Vol. 56, No. 3, March 1953, p. 65.
[9] Rock Products, Perlite-Processing Plant: Vol. 56, No. 12, December 1953, p. 85.
[10] Rock Products, Perlite-Plant Expansion: Vol. 56, No. 1, January 1953, p. 85.
[11] California Division of Mines, Mineral Information Service, Perlite-Processing Plants in the Los Angeles Area: Vol. 6, No. 7, July 1, 1953, p. 6.
[12] Wright, L. A., Stewart, R. M., Gay, T. E., Jr., and Hazenbush, G. C., Mines and Mineral Deposits of San Bernardino County, Calif.: California Jour. Mines and Geol., vol. 49, Nos. 1–2, January–April 1953, pp. 49–192.

CONSUMPTION AND USES

Crude Perlite.—Although small quantities may find application as common stone—for example, where practical, as aggregate in concrete or as road metal—in this chapter consumption statistics on crude perlite refer only to the material from which expanded perlite is 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.—The quantity and value of expanded perlite sold or used in 1952 and 1953 are shown in table 2; totals for earlier years appear in table 1.

For the first time the Bureau of Mines in 1953 asked producers of expanded perlite to estimate the approximate percentages of their outputs used for different purposes. Their excellent response has made possible compilation of the following estimated use breakdown for the United States: Plaster aggregate (premixed and job-mixed), 141,000 short tons; concrete aggregate (exclusive of oil-well concretes), 18,000 short tons; oil-well muds and concretes, 7,500 short tons; filter aid, 4,500 short tons; and other uses, 4,000 short 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. Because one company produces the bulk of the premixed perlite plaster, the Bureau of Mines cannot publish separately the quantity of perlite used in that product.

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 production of nearly all of the perlite used as a filter aid. Expanders throughout the country reported minor percentages used for loose-fill insulation, horticultural purposes (such as fertilizer conditioner and propagating medium), paint filler, oil absorbent, refractory brick, and roofing tile.

Other uses that were not specifically named but were covered in a miscellaneous classification 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 powder.

Although some processors still find it difficult to market the fine material unavoidably produced during furnacing, others reported adequate outlets for that fraction for such uses as filter additives trowel and brush finishes, fillers, abrasives, etc.

In the past, perlite processors have tried to produce a satisfactory all-purpose aggregate, which in many instances has not been well adapted to some specific uses. In 1953 processors gave more thought to the production of expanded perlite for specialized applications.

PRICES

The mill value of crude perlite (crushed and sized) sold by producers averaged $7.59 per short ton in 1953 compared with $6.46 in 1952, while the average book value of crude material processed by the companies by which it was mined was $6.40 per short ton compared with $4.36 in 1952. The average value for all milled crude perlite sold or used in the United States in 1953 was $7.24 per short ton compared with $6.08 in 1952.

As reported in the November 1953 issue of the California Division of Mines publication, Mineral Information Service, the cost of crude perlite rock, crushed and graded, delivered in the Los Angeles area, was $12.80 to $14.75 per short ton for concrete-aggregate grades and $11.80 to $13.75 for plaster-aggregate grades. Napa County crude delivered in the San Francisco-Oakland area was quoted at $10.50 to $14.00 per short ton, depending on specifications met by the material. These quoted prices have remained unchanged during the past two years.

The average value of expanded material in bags at the plant was $50.98 per short ton in 1953 compared with $51.74 in 1952 and $54.39 in 1951.

TECHNOLOGY

As in each of the past few years, patents were granted covering a number of furnaces and related equipment either designed specifically for or adaptable to the production of expanded perlite.

The Stein patent describes a widely used horizontal rotary unit composed of an outer mild-steel tube fitted with riding rings and two inner tubes of a heat-resistant alloy. The graded raw material is fed into the preheating chamber between the two inner shells and moved by lifters to the opposite end of the kiln, where a gas burner flame blows it into the inner expansion chamber.[13]

Another patent describes the vertical stationary furnace at present used in several plants. The inventor claims that perlite expanded in this kiln is composed of particles with sealed surfaces, a desirable quality.[14]

Supplementing an earlier perlite-furnace patent granted to the same inventor, a patent issued in 1953 described an apparatus for bagging perlite and a method for reducing acidity in the expanded material.[15]

Other patents describing furnaces suitable for processing perlite were issued to Harshberger on a vertical, top-fed kiln featuring an inner spiral structure referred to as a "clinker chaser;" [16] to Dube on an inclined rotary, countercurrent flow, unit designed to accomplish mechanical separation of the different size fractions;[17] and to Burwell on a horizontal kiln specifically designed to "cellulate" [18] and expand particles of glassy volcanic rock of rhyolitic composition.

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[13] Stein, H. A., Furnace for Producing Physical and Chemical Changes in Granular Materials: U. S. Patent 2,633,346, Mar. 31, 1953.

[14] Bradford, J. H. (one-half assigned to Combined Metals Reduction Co., Salt Lake City), Processing Furnace for Discrete Solids: U. S. Patent 2,639,132, May 19, 1953.

[15] Howle, E. O., Jackson, R. W., and Foster, N. M. (secondary patentees, assignors to Howle), Apparatus for Treating and Bagging Perlite and the Like: U. S. Patent 2,659,521, Nov. 17, 1953.

[16] Harshberger, N. P., Apparatus for Processing Fusible Materials: U. S. Patent 2,630,310, Mar. 3, 1953.

[17] Dube, J. B., Method for Producing Lightweight Aggregates: U. S. Patent 2,639,269, May 19, 1953. Apparatus for Producing Lightweight Aggregates: U. S. Patent 2,642,273, June 16, 1953.

[18] Burwell, A. L. (assigned to Oklahoma Research Institute), Method of Converting Volcanic Ash to Cellular Particle: U. S. Patent 2,637,702, May 5, 1953.

Several patents relating to perlite products were granted. One series of four patents describes, in considerable detail, the compositions and methods of manufacture of prefabricated board units from various combinations of uncoated or asphalt-coated perlite granules, fibrous organic or inorganic materials, and thermoplastic or bituminous binders. The inventors claim important economy and service advantages for their products. The units are said to be lightweight, relatively strong, resistant to moisture penetration, and possessing excellent and lasting insulating properties.[19]

A major United States building-products manufacturer patented a method for producing coated, agglomerated, expanded perlite granules suitable for loose-fill insulation. Hot perlite direct from the kiln and still in aerial suspension is sprayed with an adhesive such as asphalt or petroleum wax. The material is then subjected to turbulence and cooling, causing granules to adhere into agglomerated masses. The product is said to resist settling and compaction, moisture penetration, dusting, and flow escape through cracks.[20]

Another patent describes the use of different mineral aggregates, including perlite, in manufacturing an insulating material. The perlite may be added to a solution of sodium silicate, ethyl silicate, and aluminum powder. Chemical reaction causes the solution to dehydrate and expand into a foamed product, which either may be applied directly to surfaces or formed into blocks.[21]

The development and principles of operation of a new screening mechanism, utilizing accurately controlled gyratory motion in horizontal and vertical planes, were discussed. The device is used in a number of perlite mills for separating crushed crude perlite into desired size fractions.[22]

The thermal conductivities of 17 refractory, insulating, alumina-cement concretes were determined over a wide temperature range. Perlite and other lightweight aggregates were used. Published tables and charts show the thermal conductivities of all specimens, as indicated by the series of tests.[23]

The trade press described construction of a perlite-concrete roof deck cast on metal lath and covered with built-up bituminous roofing. The 3-inch-thick perlite-concrete layer weighed less than 10 pounds per square foot and had a desirable low coefficient of heat transfer.[24]

An article described the manufacture and use of precast panel walls in small-house construction. The panels received an interior face of poured, steel-float-finished perlite concrete. An interior face of this type can be painted or papered without the necessity of first having been plastered.[25]

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19 Miscall, J., and Rahr, C. E. (assigned to Great Lakes Carbon Corp., New York, N. Y.), Building Board of Fiber- and Asphalt-Coated Perlite: U. S. Patent 2,626,864, Jan. 27, 1953. Building Board: U. S. Patent 2,634,207, Apr. 7, 1953. Building Board: U. S. Patent 2,634,208, Apr. 7, 1953.
Miscall, J. (assigned to Great Lakes Carbon Corp., New York, N. Y.), Asphalt Building Board: U. S. Patent 2,626,872, Jan. 27, 1953.

20 Powell, E. R. (assigned to Johns-Manville Corp., New York, N. Y.), Expanded Perlite Insulation and Method of Manufacture: U. S. Patent 2,625,512, Jan. 13, 1953.

21 Andersen, G. W., and Diehl, J. M. (assigned to Bjorksten Research Laboratories, Inc., Chicago), Improved Silicaceous Insulating Material: U. S. Patent 2,664,405, Dec. 29, 1953.

22 Brant, D. G., The Principles and Applications of a Revolutionary Screening Device: Bull. Am. Ceram. Soc., vol. 32, No. 8, August 1953, pp. 267–271.

23 Hansen, W. C., and Livovich, A. F., Thermal Conductivity of Refractory Insulating Concrete: Jour. Am. Ceram. Soc., vol. 36, No. 11, November 1953, pp. 356–362.

24 Engineering News-Record, Perlite-Concrete Roof Cast on Metal Lath: Vol. 150, No. 21, May 21, 1953, p. 45.

25 Engineering News-Record, Precast Panel Walls for Small Houses: Vol. 150, No. 17, April 23, 1953, pp. 46–47.

A report described a perlite-expanding plant and discussed a number of economic factors and business conditions confronting a typical independent perlite processor. The author of the article reports marketing baghouse dust at a premium price for such uses as a base in certain paints, filter aid, and white-coat plasterwork. He also points out the marked physical difference between baghouse dust particles and the regular product. The latter are essentially cellular and porous but with sealed air pockets, while the dust consists largely of tiny splinters. This characteristic should be considered in the search for uses of this material, which is a waste product in some plants.[26]

The Perlite Institute began a labeling and certification program for perlite plaster aggregate. Under this program participating manufacturers are licensed to use a copyrighted seal on bags to guarantee that the material conforms to the applicable American Society for Testing Materials specification. To insure continued adherence to that quality standard, all producers are to be checked by unannounced visits of laboratory agents, who will procure samples for analysis.[27]

A technical paper reviewed the occurrences in western United States of the alkali-reactive rocks and minerals that, when used as aggregate, produce a concrete that may deteriorate owing to interaction of certain components of the aggregates with the oxides of sodium and potassium released by hydration of portland cement. Perlite and other volcanic and siliceous minerals and rocks are said to be alkali-reactive.[28]

Japanese investigators studied the firing results obtained from the addition of alkali-bearing bonding agents to fire-clay brick. One of the alkali-bearing materials used was perlite. It was found that products with a 5-percent addition of perlite, when fired to cone 8, sintered almost the same as brick without such admixture fired to cone 13.[29]

WORLD REVIEW

Increasing interest recently has been evinced in the perlite occurrences of other countries. A part of this attention has been directed by residents of the United States—principally in the Eastern States—toward locating a dependable foreign source of supply of good quality material that can be obtained via water transportation at a lower cost than via rail from the Western States. Although studies of this possibility have been made by several firms, little if any crude perlite has as yet been imported into the United States.

Local interest has been shown in a number of countries in the possibility of starting mining and processing activities. Although world production data are not available, to date Canada probably ranks second to the United States in the production and use of expanded perlite. Although Canada has perlite deposits in its western Provinces,[30] it has been found economical for plants in eastern Canada to

[26] Johnson, S. W., Improvements in Effluent Treatment at Texas Panacalite Company at Irving, Tex.: Mines Mag., vol. 43, No. 1, January 1953, pp. 37–38, 48.

[27] Rock Products, Perlite Certification Program Launched: Vol. 56, No. 7, July 1953, p. 48.

[28] Holland, W. Y., and Cook, R. H., Alkali Reactivity of Natural Aggregates in Western United States: Min. Eng., vol. 5, No. 10, October 1953, pp. 991–997.

[29] Wakabayashi, A., Hirano, H., and Tajima, F., [Addition of Alkali-Bearing Bonding Agents to Fire-Clay Brick. III. Addition of Shimoda White Clay and Perlite]: Taikabutsu-Kogyo, vol. 1, No. 1, 1949, pp. 25–27, abs. in Chem. Abs., vol. 47, No. 13, July 10, 1953, col. 6625, item f.

[30] Western Miner (Vancouver, Canada), Perlite Deposit: Vol. 26, No. 2, February 1953, p. 59.
Western Miner and Oil Review (Vancouver, Canada), The Discovery Post (Perlite): Vol. 26, No. 8, August 1953, p. 78.

purchase crude perlite from mining companies in the United States. At least four expanding plants are said to be in operation in Canada,[31] at Montreal, Toronto, Caledonia, and Calgary.

Considerable development work has been done on perlite deposits in Sardinia, an island in the Mediterranean Sea. According to reports, the rock is crushed to specifications in a plant near the mine and moved to the port of Cagliari, whence at present it is sent to company processing facilities in Milan, Italy. However, the firm plans to ship crude perlite to other European countries and, if economic and transportation factors prove favorable, to the United States.[32]

In 1951 an English company was reported to be stripping overburden in preparation for perlite-mining operations in the Tardree Hill area of County Antrim, Northern Ireland. At the time it was hoped that the operation would prove to be an important development in the economy of Northern Ireland by supplying the British market and earning dollars through exports to the United States.[33] More recently, insulating bricks and slabs made from perlite mined in Northern Ireland were said to be under development in England.[34] A perlite plant is reported to be in operation at Carlisle, Cumberland County, England.

Large quantities of perlite were reported to have been identified in New Zealand, particularly in Rotorua, North Island.[35]

Within the last few years articles have described perlite occurrences in Hungary,[36] French Morocco,[37] and Mexico.[38] It also is known to occur in Japan,[39] Greece, Iceland, France,[40] Australia,[41] and Alaska.[42] Perlite-processing plants reportedly are in operation in Mexico City, Mexico; Havana, Cuba; and Sydney, Australia.

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31 Johnson, S. W., Perlite (Review of 1953): Eng. and Min. Jour., vol. 155, No. 2, February 1954, pp. 106–107.

32 Pit and Quarry, Library Hunt Locates Major Source of Italian Perlite Deposits: Vol. 46, No. 2, August 1953, pp. 94, 96, 100.

33 Bureau of Mines, Mineral Trade Notes: Vol. 33, No. 5, November 1951, p. 31.

34 Mining Journal (London), Perlite and Its Uses: Vol. 241, No. 6164, Oct. 9, 1953, p. 412.

35 Refractories Journal (London), World in Brief News (Perlite): December 1953, p. 548.
Iron and Coal Trades Review (London), News in Brief (Perlite): Vol. 167, No. 4469, Dec. 4, 1953, p. 1316.

36 Liffa, A., [Perlite Occurrences of Tokaj Mountain]: Magyar Allami Foldt. Intezet, Evi Jelentese (Budapest, Hungary), 1951 (pub. 1953) (French summary), pp. 31–48.

37 Termier, H., and Termier, G., [The Evolution of Rocks in the Tichka Massif (Moroccan High Atlas)]: Compt. rend., (Paris, France), vol. 223, No. 16, 1946, pp. 580–582.

38 Garcia, R. L., [Deposits of Perlite in the State of Hidalgo]: Univ. nacl. Mexico, Anales inst. geol. (Mexico City, Mexico), vol. 10, 1951, pp. 97–105.

39 Kozu, S., Thermal Studies of Obsidian, Pitchstone, and Perlite from Japan: Sci. Repts., Tohoku Imp. Univ. (Sendai, Japan), Series 3, No. 3, 1929, pp. 225–238.

40 La Croix, A., [Volcanic Glasses of the Central Massif]: Compt. rend., (Paris, France), vol. 163, No. 12, 1916, pp. 406–411.

41 South African Mining and Engineering Journal (Johannesburg, Transvaal), Perlite: Vol. 64, part 2, No. 3185, Feb. 27, 1954, p. 934.

42 Wahrhaftig, C., and Eckhardt, R. A., Perlite Deposit Near Healy, Alaska: Geol. Survey Open-File Rept. 169, 1952, 6 pp.
Eckhardt, R. A., Wahrhaftig, C., and Moxham, R. M., Perlite Deposit Near Polychrome Pass, Alaska: Geol. Survey Open-File Rept. 170, 1952, 6 pp.

Phosphate Rock

By E. Robert Ruhlman[1] and Gertrude E. Tucker[2]

DURING 1953 the phosphate-rock industry was characterized by increased production and sales. Exports of phosphate rock increased 47 percent in 1953 over 1952. The world production of phosphate rock was approximately 25 million metric tons, the same as in the previous year.

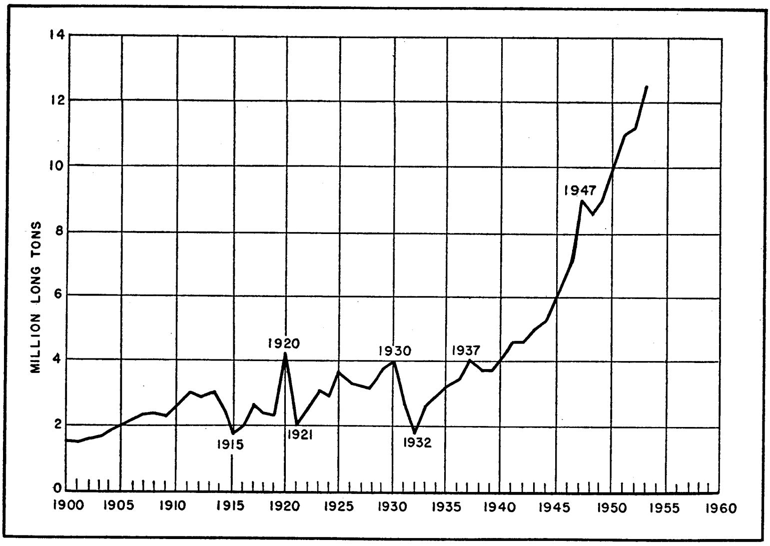

FIGURE 1.—Marketed production of domestic phosphate rock, 1900–53.

DOMESTIC PRODUCTION

Domestic mine production of phosphate-rock ore exceeded 40 million long tons in 1953. Marketable production rose 4 percent; Florida continued to be the largest producer, followed by Tennessee. A 17-percent increase was registered in the Western States marketable production.

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

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TABLE 1.—Salient statistics of the phosphate-rock industry in the United States, 1952–53

	1952				1953			
	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	[1] 32,800,000	(2)	(2)	(2)	40,139,000	5,102,000	(2)	(2)
Marketable production [3]	[4] 12,064,892	[4] 3,870,333	[5] $72,458,982	$6.01	12,503,830	3,987,412	[5] $76,632,480	$6.13
Sold or used by producers:								
Florida:								
Land pebble	8,624,186	2,901,008	50,483,421	5.85	9,009,220	3,029,215	54,498,217	6.05
Soft rock	75,853	15,358	433,203	5.71	75,910	15,565	470,062	6.19
Hard rock	81,086	28,575	625,175	7.71	81,725	28,800	643,993	7.88
Total Florida	8,781,125	2,944,941	51,541,799	5.87	9,166,855	3,073,580	55,612,272	6.07
Tennessee	1,452,508	386,039	10,874,760	7.49	1,622,170	428,687	12,251,117	7.55
Western States:								
Idaho, Utah (1952)	620,551	172,532	2,163,608	3.49				
Idaho					1,070,773	280,758	4,090,599	3.82
Utah					(6)	(6)	(6)	(6)
Montana	332,299	95,793	2,620,764	7.89				
Wyoming	137,675	44,114	919,987	6.68				
Montana, Wyoming (1953)					658,125	191,825	4,643,087	7.06
Total Western States	1,090,525	312,439	5,704,359	5.23	1,728,898	472,583	8,733,686	5.05
Total United States	11,324,158	3,643,419	68,120,918	6.02	12,517,923	3,974,850	76,597,075	6.12
Imports	[4] 110,197	(2)	[4,7] 2,332,444	[4,7] 21.17	101,171	(2)	[7] 2,545,081	[7] 25.16
Exports [8]	1,401,949	(2)	8,878,393	6.33	2,061,329	(2)	13,254,906	6.43
Apparent consumption [9]	[4] 10,032,406	(2)			10,557,765	(2)		
Stocks in producers' hands Dec. 31: [8]								
Florida	[4] 1,438,000	[4] 475,000	(2)	(2)	1,602,000	534,000	(2)	(2)
Tennessee [10]	[4] 531,000	[4] 146,000	(2)	(2)	428,000	116,000	(2)	(2)
Western States	[4] 569,000	[4] 152,000	(2)	(2)	494,000	135,000	(2)	(2)
Total stocks	[4] 2,538,000	[4] 773,000	(2)	(2)	2,524,000	785,000	(2)	(2)

1 Estimated figure.
2 Data not available.
3 See table 2 for kind of material produced.
4 Revised figure.
5 Derived from reported value of "sold or used."
6 Included with Montana and Wyoming.
7 Market value (price) at port of shipment and time of exportation to the United States.
8 As reported to the Bureau of Mines by domestic producers.
9 Quantity sold or used by producers plus imports minus exports.
10 Includes a small quantity of washer-grade ore (matrix).

Development of the Armour Fertilizer Works mine and plant facilities near Bartow, Fla., was begun near the end of 1953.[3]

The Coronet Phosphate Co., one of the large land-pebble producers, was purchased by the Smith-Douglass Co., Inc., of Norfolk, Va. Operation of the mine and plants will continue under the Coronet Division.[4]

The new triple-superphosphate plant of Davison Chemical Corp. at Ridgewood, Fla., rated at 200,000 tons per year, is scheduled for completion early in 1954. This company is reclaiming its mined-out land.[5]

3 Chemical Week, vol. 56, No. 2, February 1953, p. 64.
4 Mining World, vol. 15, No. 11, October 1953, p. 107.
5 Oil, Paint and Drug Reporter, vol. 163, No. 5, Feb. 2, 1953, p. 3.

TABLE 2.—Marketable production of phosphate rock in the United States, 1944–48 (average) and 1949–53, by States, in long tons

Year	Florida [1]	Tennessee [2]	Western States [3]	United States
1944–48 (average)	5,229,480	1,395,946	628,120	7,253,546
1949	6,695,407	1,403,469	778,598	8,877,474
1950	8,597,227	1,472,017	1,044,915	11,114,159
1951	8,211,820	1,424,516	1,138,696	10,775,032
1952	9,205,138	1,444,737	[4] 1,415,017	[4] 12,064,892
1953	9,331,002	1,518,912	1,653,916	12,503,830

[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, white rock in 1953, and a small quantity of apatite from Virginia in 1944–47.
[3] Mine production of ore (rock), plus a quantity of washer and drier production.
[4] Revised figure.

The Independent Chemical Co. received permission to operate a phosphate rock mine within the city of Bartow. The agreement with the city stipulates that the land will be leveled upon completion of mining.[6]

The International Minerals & Chemical Corp. was conducting a test-drilling program in cooperation with the Atomic Energy Commission, attempting to determine the relationship between uranium and phosphate rock in the land-pebble district.[7] A new dragline with a 26-cubic-yard bucket was being assembled for use in the Noralyn mine and will be the largest in the phosphate industry.[8] As a result of declining shipments, International Minerals & Chemical Corp. decreased mine production.[9] The new International Minerals & Chemical Corp. chemical plant at Bonnie, Fla., began operation about midyear. Products will be dicalcium phosphate, triple superphosphate, and byproduct uranium.[10]

The F. S. Royster Guano Co. announced plans to resume mining land-pebble phosphate to supply raw material for a 70,000-ton-per-year triple-superphosphate plant to be built near Mulberry, Fla.[11]

The 30,000-kw. electric furnace of the Shea Chemical Corp. began operating early in the year.[12]

The Virginia-Carolina Chemical Corp. reported plans to construct a chemical plant at Fernald, Ohio, to manufacture phosphoric acid and sodium phosphates.[13]

Several expansion programs were underway in the Western field. Monsanto Chemical Co. announced plans to erect a second electric elemental phosphorus furnace at Soda Springs, Idaho.[14] San Fran-

[6] Mining World, vol. 15, No. 8, July 1953, p. 103.
[7] Mining World, vol. 15, No. 9, August 1953, p. 102.
[8] Pit & Quarry, vol. 46, No. 6, December 1953, p. 65.
[9] Mining World, vol. 15, No. 12, November 1953, p. 106.
[10] Mining World, vol. 15, No. 8, July 1953, p. 104.
[11] Chemical Engineering, vol. 60, No. 5, May 1953, p. 114.
[12] Chemical and Engineering News, vol. 31, No. 4, Jan. 26, 1953, p. 339.
[13] Chemical Week, vol. 73, No. 4, July 25, 1953, p. 18.
[14] Oil, Paint and Drug Reporter, vol. 164, No. 7, Aug. 17, 1953, p. 5.

cisco Chemical Co., in addition to increasing its present underground operations at Montpelier, Idaho, and open-pit mining at Leefe, Wyo., was developing an underground mine near Randolph, Utah.[15] The J. R. Simplot Co. started production from an open-pit at Rex Peak, Utah, to supply part of the needs of the new 90,000-ton-per-year triple-superphosphate plant at Pocatello, Idaho. In addition, Simplot continued to operate the 200,000-ton-per-year ordinary superphosphate plant.[16] The Anaconda Copper Mining Co. began open-pit mining near its present underground workings.[17] The Central Farmers Fertilizer Co. was developing an underground and an open-pit mine near Georgetown, Idaho.[18]

Williams Phosphate Co. began production in Madison County late in 1953. About 250 tons daily will be mined for direct application.[19]

CONSUMPTION AND USES

The apparent consumption of phosphate rock again set a new record, rising more than 5 percent above 1952 and 119 percent above 1943. Data on phosphate rock sold or used by producers are shown in tables 4 through 9. Phosphate rock sold or used, by uses (table 9), has been revised to give more detail than was available in previous years. To avoid duplication only the quantity of raw phosphate

TABLE 3.—Apparent consumption [1] of phosphate rock in the United States, 1944–48 (average) and 1949–53, in long tons

Year	Long tons	Year	Long tons
1944–48 (average)	6, 373, 392	1951	9, 511, 545
1949	7, 735, 005	1952	[2] 10, 032, 406
1950	8, 580, 925	1953	10, 557, 765

[1] Quantity sold or used by producers plus imports minus exports.
[2] Revised figure.

TABLE 4.—Phosphate rock sold or used by producers in the United States, 1944–48 (average) and 1949–53

Year	Long tons	Value at mines		Year	Long tons	Value at mines	
		Total	Average			Total	Average
1944–48 (average)	7, 147, 976	$34, 598, 352	$4. 84	1951	11, 095, 204	$66, 158, 078	$5. 96
1949	8, 986, 933	51, 415, 027	5. 72	1952	11, 324, 158	68, 120, 918	6. 02
1950	10, 253, 552	59, 027, 848	5. 76	1953	12, 517, 923	76, 597, 075	6. 12

[15] Western Industry, vol. 18, No. 5, May 1953, p. 132.
[16] Rock Products, vol. 56, No. 10, October 1953, p. 97.
Western Industry, vol. 18, No. 4, April 1953, p. 115.
[17] Mining World, vol. 15, No. 10, September 1953, p. 101.
[18] Mining Congress Journal, vol. 39, No. 1, January 1953, p. 68.
[19] Mining and Iudustrial News, vol. 21, No. 1, November 1953, p. 14.

rock used to manufacture the listed products is shown. For example, the figure listed for the phosphate rock sold or used in manufacturing triple superphosphate in 1953 (1,154,537 long tons) does not include the phosphate rock sold or used to make the phosphoric acid subsequently employed in manufacturing triple superphosphate. Production, shipments, and stocks of superphosphates are shown in table 10.

TABLE 5.—Florida phosphate rock sold or used by producers, 1944–48 (average) and 1949–53, by kinds

Year	Hard rock			Soft rock [1]		
	Long tons	Value at mines		Long tons	Value at mines	
		Total	Average		Total	Average
1944–48 (average)	62, 880	$462, 811	$7. 36	77, 365	$312, 131	$4. 03
1949	23, 804	173, 211	7. 28	77, 088	344, 787	4. 47
1950	71, 319	538, 601	7. 55	81, 542	408, 595	5. 01
1951	75, 615	582, 247	7. 70	92, 183	495, 243	5. 37
1952	81, 086	625, 175	7. 71	75, 853	433, 203	5. 71
1953	81, 725	643, 993	7. 88	75, 910	470, 062	6. 19

Year	Land pebble			Total		
	Long tons	Value at mines		Long tons	Value at mines	
		Total	Average		Total	Average
1944–48 (average)	5, 063, 319	$23, 525, 806	$4. 65	5, 203, 564	$24, 300, 748	$4. 67
1949	6, 715, 097	37, 339, 985	5. 56	6, 815, 989	37, 857, 983	5. 55
1950	7, 933, 009	44, 430, 646	5. 60	8, 085, 870	45, 377, 842	5. 61
1951	8, 329, 033	49, 185, 072	5. 91	8, 496, 831	50, 262, 562	5. 92
1952	8, 624, 186	50, 483, 421	5. 85	8, 781, 125	51, 541, 799	5. 87
1953	9, 009, 220	54, 498, 217	6. 05	9, 166, 855	55, 612, 272	6. 07

[1] Includes material from waste-pond operations.

TABLE 6.—Tennessee phosphate rock [1] sold or used by producers, 1944–48 (average) and 1949–53

Year	Long tons	Value at mines		Year	Long tons	Value at mines	
		Total	Average			Total	Average
1944–48 (average)	1, 340, 227	$7, 012, 573	$5. 23	1951	1, 419, 892	$10, 604, 638	$7. 47
1949	1, 344, 470	9, 067, 589	6. 74	1952	1, 452, 508	10, 874, 760	7. 49
1950	1, 384, 473	10, 028, 404	7. 24	1953	1, 622, 170	12, 251, 117	7. 55

[1] Includes small quantity of Tennessee blue rock in 1944–47, white rock in 1952–53, and Virginia apatite in 1944–47 and 1949.

TABLE 7.—Western States phosphate rock sold or used by producers, 1944–48 (average) and 1949–53

Year	Idaho [1]			Montana [2]		
	Long tons	Value at mines		Long tons	Value at mines	
		Total	Average		Total	Average
1944–48 (average)	365,596	$1,852,621	$5.07	200,430	$1,235,291	$6.16
1949	471,305	1,915,125	4.06	355,169	2,574,330	7.25
1950	573,044	2,125,065	3.71	210,165	1,496,537	7.12
1951	695,026	1,750,974	2.52	304,507	2,353,381	7.73
1952	620,551	2,163,608	3.49	332,299	2,620,764	7.89
1953	1,070,773	4,090,599	3.82	658,125	4,643,087	7.06

Year	Wyoming			Total		
	Long tons	Value at mines		Long tons	Value at mines	
		Total	Average		Total	Average
1944–48 (average) [3]	38,158	$197,119	$5.17	604,184	$3,285,031	$5.44
1949	(1)	(1)	(1)	826,474	4,489,455	5.43
1950	(1)	(1)	(1)	783,209	3,621,602	4.62
1951	178,948	1,186,523	6.63	1,178,481	5,290,878	4.49
1952	137,675	919,987	6.68	1,090,525	5,704,359	5.23
1953	(2)	(2)	(2)	1,728,898	8,733,686	5.05

[1] Idaho includes Utah in 1946–48 and 1950–52 and Wyoming in 1949–50.
[2] Montana includes Utah and Wyoming in 1953.
[3] Includes Wyoming data for 1947–48 only.

TABLE 8.—Phosphate rock sold or used by producers in the United States, 1952–53, 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
1952								
Below 60	189,761	2	1,058,848	73	450,738	41	1,699,347	15
60 to 66	336	(2)	228,150	16	77,917	7	306,403	3
68 basis, 66 minimum	685,928	8	83,283	6	191,525	18	960,736	9
70 minimum	928,174	11	81,640	5	370,345	34	1,380,159	12
72 minimum	1,521,811	17					1,521,811	13
75 basis, 74 minimum	4,157,456	47	587	(2)			4,158,043	37
77 basis, 76 minimum	1,297,659	15					1,297,659	11
Total	8,781,125	100	1,452,508	100	1,090,525	100	11,324,158	100
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

[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, 1952–53, 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
1952								
Domestic:								
Superphosphates	5,953,922	68	249,902	17	291,097	27	6,494,921	57
Phosphates, phosphoric acid, phosphorus, ferrophosphorus	620,127	7	925,941	64	478,138	44	2,024,206	18
Direct application to soil	866,329	10	237,786	16	101,878	9	1,205,993	11
Fertilizer filler	363	(1)	15,374	1	----------	------	15,737	(1)
Stock and poultry feed	157,286	2	21,680	2	220	(1)	179,186	2
Undistributed [2]	341	(1)	1,825	(1)	----------	------	2,166	(1)
Exports [3]	1,182,757	13	----------	------	219,192	20	1,401,949	12
Total	8,781,125	100	1,452,508	100	1,090,525	100	11,324,158	100
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	[4] 732,984	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	(4)	(4)	13,157	1	----------	------	13,157	} 1
Other fertilizers [5]	----------	------	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 [2]	----------	------	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 [3]	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

[1] Less than 0.5 percent.
[2] Includes phosphate rock used in pig-iron blast furnaces, parting compounds, research, defluorinated phosphate rock, refractories, and other applications.
[3] As reported to the Bureau of Mines by domestic producers.
[4] Direct application to soil includes fertilizer filler.
[5] Includes phosphate rock used in calcium metaphosphate, fused tricalcium phosphate, Rhenania type phosphate, and other applications.

TABLE 10.—Production, shipments, and stocks of superphosphates,[1] 1944–48 (average) and 1949–53, in short tons

[Bureau of the Census]

	1944–48 (average)	1949	1950	1951	1952	1953
Normal and enriched superphosphates:						
Production	1,458,880	1,663,663	1,673,289	1,708,825	1,765,000	1,678,459
Shipments	800,930	872,132	911,718	883,849	874,846	850,970
Stocks in manufacturers' hands Dec. 31	155,601	[2] 209,451	190,122	196,349	[2] 235,950	236,313
Concentrated superphosphates:						
Production	153,621	246,827	309,084	322,420	388,055	457,235
Shipments	148,329	223,639	323,516	313,323	375,112	433,097
Stocks in manufacturers' hands Dec. 31	23,091	46,940	24,863	29,860	39,200	51,304

[1] 100 percent available phosphoric acid.
[2] Stock adjustment. Reported as beginning stocks for following year.

STOCKS

Producers' stocks on hand at the end of 1953 were about 1 percent less than in 1952 (table 1). The stock figures do not include quantities of matrix reported by Florida and Tennessee producers, except as noted.

PRICES

Prices for phosphate rock were decontrolled by Amendment 40 to General Overriding Regulation 9, issued by the Office of Price Stabilization, effective February 13, 1953. This was the first fertilizer material released from Government price control. Price changes as quoted by the Oil, Paint and Drug Reporter are shown in table 11. Prices for Western States phosphate rock are not quoted in the trade journals. Price quotations of elemental phosphorus and some phosphate compounds are published in the Oil, Paint and Drug Reporter.

TABLE 11.—Prices per long ton of Florida and Tennessee unground, washed, and dried phosphate rock, in bulk, f. o. b. cars at mine, in 1953, by grades

[Oil, Paint, and Drug Reporter of dates listed]

Grades (percent)[1]	Jan. 5, 1953	Mar. 9, 1953	July 27, 1953	Dec. 28, 1953
Florida land pebble:				
70/68 B. P. L.	\$4.35–\$4.40	\$4.88	\$4.69	\$4.69
72/70 B. P. L.	5.00	5.48	5.69	5.69
75/74 B. P. L.	6.00	6.48	6.69	6.69
78/76 B. P. L.	7.00	7.48	7.48	[2] 7.69
Tennessee brown rock:				
27–26 P_2O_5	6.45	(3)	(3)	(3)
30–29 P_2O_5	6.45	(3)	(3)	(3)

[1] B. P. L. signifies bone phosphate of lime, $Ca_3(PO_4)_2$.
[2] Change effective Oct. 19, 1953.
[3] Not quoted.

FOREIGN TRADE [20]

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.

TABLE 12.—Phosphate rock and phosphatic fertilizers imported for consumption in the United States, 1952–53

[U. S. Department of Commerce]

Fertilizer	1952		1953	
	Long tons	Value	Long tons	Value
Phosphates, crude, not elsewhere specified	[1] 110,197	[1] \$2,332,444	101,171	\$2,545,081
Superphosphates (acid phosphate):				
Normal (standard), not over 25 percent P_2O_5 content	[1] 5,887	[1] 189,276	3,060	100,800
Concentrated (treble), over 25 percent P_2O_5 content	[1] 2,327	[1] 148,647	1,885	114,331
Ammoniated	12	445	296	41,485
Total superphosphates	[1] 8,226	[1] 338,368	5,241	256,616
Ammonium phosphates, used as fertilizer	[1] 119,007	[1] 8,719,537	148,658	11,419,915
Bone dust, or animal carbon and bone ash, fit only for fertilizer	42,127	2,673,007	15,614	790,674
Guano	58	5,641	61	5,391
Slag, basic, ground or unground			79	2,138
Precipitated bone, fertilizer grade	[1] 22,515	[1] 1,885,799	4,483	249,186

[1] Revised figure.

[20] 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.—Eight percent less crude phosphate rock was imported into the United States than in 1952. Curaçao continued to supply the major part of the crude phosphate imported (85 percent); smaller quantities came from the French Pacific Islands (10 percent) and Mexico (5 percent). Imports of superphosphates decreased 36 percent from 1952, coming predominantly from Canada, with smaller quantities from Belgium-Luxembourg, The Netherlands, Italy, and the United Kingdom. Fertilizer-grade ammonium phosphate imports in 1953 exceeded those of 1952 by 25 percent and originated mostly in Canada. Other phosphatic fertilizer materials were imported from several European countries, Peru, and Egypt. The imports from Canada were largely fertilizers processed from United States phosphate rock.

TABLE 13.—Phosphate rock exported from the United States, 1952–53, by grades and countries of destination

[U. S. Department of Commerce]

Grade and country	1952		1953	
	Long tons	Value	Long tons	Value
Florida:				
High-grade hard rock:				
Bahamas			10	$200
Brazil	984	$14, 000	8, 744	187, 054
Canada	529	7, 468	155	3, 694
Colombia			1, 000	14, 880
Costa Rica			90	1, 135
Ecuador			446	22, 000
Mexico			64	2, 190
Surinam	4	106		
Taiwan	11, 745	108, 630	10, 086	91, 391
Venezuela			97	6, 710
Total high-grade hard rock	13, 262	130, 204	20, 692	329, 254
Land pebble:				
Belgium-Luxembourg	21, 780	184, 401	70, 005	593, 148
Brazil	7, 038	74, 067	18, 684	210, 527
Canada	173, 778	1, 576, 820	214, 824	1, 723, 257
Colombia	500	7, 520	1, 267	18, 933
Costa Rica			89	1, 270
Cuba	16, 562	112, 122	16, 013	105, 942
Denmark			10, 014	86, 621
El Salvador	1, 200	6, 152		
Germany, West	152, 956	1, 174, 077	192, 114	1, 458, 074
Italy	84, 904	819, 012	162, 905	1, 574, 308
Japan	[1] 430, 106	[1] 3, 007, 895	528, 965	3, 713, 388
Liberia			4	244
Mexico	35, 401	229, 179	49, 477	339, 059
Netherlands	42, 294	340, 828	311, 600	2, 831, 910
Sweden	49, 041	465, 726	45, 658	432, 002
Taiwan	41, 769	365, 286	35, 329	311, 528
Thailand	89	1, 205		
Union of South Africa	8, 306	78, 907		
United Kingdom	109, 560	887, 948	88, 957	750, 241
Venezuela	446	9, 788	532	11, 991
Yugoslavia			38, 115	276, 342
Total land pebble	[1] 1, 175, 730	[1] 9, 340, 933	1, 784, 552	14, 438, 785
Other phosphate rock: [2]				
Canada	228, 878	2, 836, 200	294, 742	3, 586, 378
Cuba	204	3, 688	410	7, 085
El Salvador	1, 072	14, 112	389	5, 949
Guatemala			13	293
Italy	45	835		
Mexico	53	865		
Union of South Africa	6, 399	76, 836		
Total other phosphate rock	236, 651	2, 932, 536	295, 554	3, 599, 705
Grand total	[1] 1, 425, 643	[1] 12, 403, 673	2, 100, 798	18, 367, 744

[1] Revised figure.
[2] Includes colloidal matrix, sintered matrix, soft phosphate rock, and Tennessee, Idaho, and Montana rock.

TABLE 14.—"Other phosphate material"[1] exported from the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Year	Long tons	Value	Year	Long tons	Value
1944–48 (average)	1,085	$152,854	1951	2,316	$372,685
1949	3,225	224,375	1952	[2] 1,144	[2] 187,605
1950	1,350	247,880	1953	8,477	178,168

[1] Class includes animal carbon, apatite, basic slag, bone-ash dust, bone meal, char dust, defluorinated phosphate rock, duplex basic phosphate, permanente thermosphos (granular), and tricalcium phosphate (fused).
[2] Revised figure.

TABLE 15.—Superphosphates (acid phosphates) exported from the United States, 1952–53, by countries of destination

[U. S. Department of Commerce]

Country	1952		1953	
	Long tons	Value	Long tons	Value
Brazil	12,693	$478,517	427	$15,424
Canada	[1] 168,260	3,827,072	181,838	4,285,104
Chile	15	1,489	15	1,525
Colombia	268	9,895	286	16,615
Costa Rica	809	46,800	1,339	80,450
Dominican Republic	2,073	98,692	268	13,658
Ecuador	750	39,440	842	53,941
El Salvador	89	3,155	22	1,688
Guatemala	45	1,575	112	4,958
Indochina			45	2,900
Italy	89	7,470		
Korea, Republic of	32,712	998,944	41,393	1,058,884
Mexico	1,548	106,926	3,879	242,002
Nicaragua	4	122	162	16,667
Peru	272	12,407	80	8,100
Philippines			879	32,633
Saudi Arabia	125	9,693	134	11,190
Thailand	893	28,530		
Venezuela	[1] 127	[1] 7,031	749	40,614
West Indies:				
British			38	1,188
Cuba	38,200	800,716	18,204	543,521
Haiti	8	817		
Other countries	24	1,558	26	1,346
Total	[1] 259,004	[1] 6,480,849	250,738	6,432,408

[1] Revised figure.

Exports.—Exports of all grades of phosphate rock increased 47 percent in 1953 over 1952. Taiwan and Brazil received 49 and 42 percent, respectively, of the hard-rock exports. Florida land-pebble exports went mainly to Japan (30 percent), The Netherlands (17 percent), Canada (12 percent), West Germany (11 percent), and Italy (9 percent). The exports of "other phosphate rock" to Canada represented material shipped for processing; a large part was imported back into the United States for use. Superphosphate exports from the United States were slightly less in 1953 than in 1952. The major recipients were Canada, South Korea, and Cuba.

TECHNOLOGY

The Minerals and Metals Advisory Board of the National Academy of Sciences studies the phosphate-slime problem in the Florida land-pebble field, and on March 16, 1953, its Phosphate Panel met at Lakeland, Fla.[21] The recommendations resulting from this meeting were as follows:

(1) Exploratory investigations on the general pattern of those previously conducted on leached zone material, but covering only a limited number of typical samples of phosphatic matrix. These investigations should include:
(a) Sizing assay tests.
(b) Mineral distribution grain counts of suitable size fractions.
(2) Similar investigations of the chemical and mineral composition of suitable size fractions derived from several typical samples of slime effluent from commercial washers.

The importance of the slime problem and the relative quantities of material recovered and discarded at present are shown graphically in figure 2. Several articles on the characteristics of these slimes were published.[22]

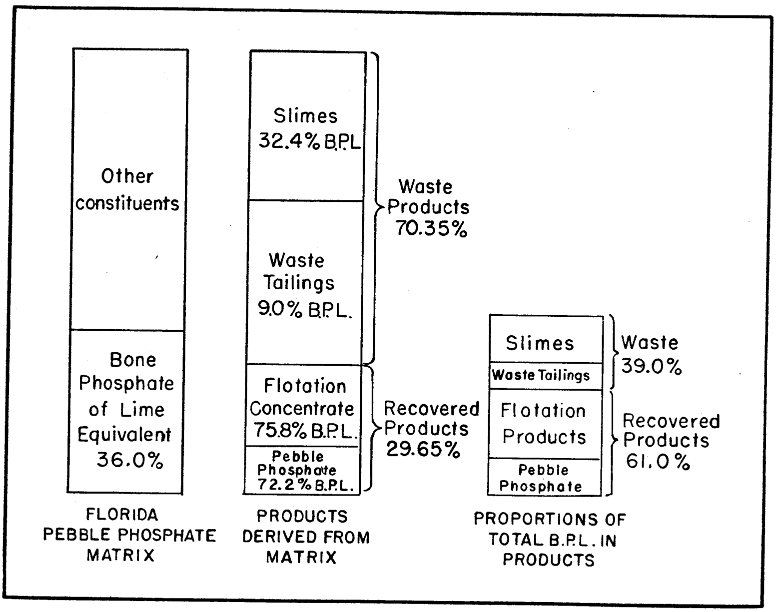

FIGURE 2.—Percentage distribution of products derived from land-pebble phosphate rock. (From National Academy of Sciences Report NMAB–45–C.)

Utilization of the phosphate content and recovery of the uranium from the "leached zone" immediately overlying the land-pebble ore (matrix) in Florida were investigated during 1953. The Atomic Energy Commission, at a meeting of the Phosphatic Fertilizers

[21] Tyler, P. M., and Waggaman, W. H., Report on the Possible Utilization of Phosphate-Rock Slimes: Nat. Research Council, Div. of Engineering and Industrial Research, Minerals and Metals Advisory Board, Rept. 45C, June 1953, 144 pp.

[22] LaMer, V. K., and others, Colloidal Characteristics and Behavior of Some Florida Phosphate Slimes: Columbia University, Progress Rept. for July 1, 1952–Nov. 30, 1952, issued March 1953, 25 pp.; Progress Rept. for Dec. 1, 1952–June 30, 1953, issued July 30, 1953. 37 pp.

Industry Advisory Committee, stated that it hoped at least one commercial plant would be brought into operation during 1956 to utilize this material, now wasted. Laboratory and pilot-plant studies were being conducted to determine the feasibility of methods.[23] Studies of the chemical and mineral composition of the "leached-zone" material were in progress.[24]

Three papers dealing with phosphates, presented at the Short Course in Fertilizer Technology at the University of Maryland, College Park, Md., were published.[25]

Experience in pumping phosphate-rock ore from mine to plant was described.[26] Velocities depend on size of material and are kept as low as possible because of turbulence at higher velocities.

Process control in the Noralyn plant of International Minerals & Chemical Corp. is highly automatic.[27]

The relationship between agriculture and the fertilizer industry was shown in an article.[28] The growth of the phosphate industry in the United States from discovery of deposits in 1867 in South Carolina to development of the new concentrated products of the present time was discussed. Based on the present 1-billion-dollar value, it was estimated that by 1965 annual sales of fertilizers would total nearly 2 billion dollars.

The increasing importance of fertilizer, especially the higher analysis material, was pointed out during the year. It was predicted that agriculture will use increasing quantities of fertilizer to insure a fair return on investments.[29]

The history of the triple-superphosphate industry, manufacturing methods, and a description of the British plant at Immingham, England, were published. This plant of Fisons, Ltd., was designed with an annual capacity of 70,000 long tons of triple superphosphate, plus 50,000 tons of ordinary superphosphate and 75,000 tons of granulated products.[30]

Problems encountered in designing a wet-process phosphoric acid plant were discussed in an article. The methods of filtering, heating, and avoiding frothing were described.[31] The new phosphoric acid plant of The Farmer's Co., Ltd., Cambridge, England, was reported to use the Nordengren dihydrate process. Using this new process,

[23] U. S. Department of Commerce, NPA Press Release: Oct. 1, 1953, NPA-3043.
Chemical and Engineering News, vol. 31, No. 44, Nov. 2, 1953, p. 4540.

[24] Owens, J. P., Berman, R., and Altschuler, Z. S., The Occurrence of Millisite and Pseudowavellite in the Leached Zone at Homeland, Fla.: Geo. Survey Trace Elements Investigation 316, March 1953, 18 pp.
Nuclear Science Abstracts, vol. 7, No. 17, Sept. 15, 1953, p. 583.

[25] Jacob, K. D., Phosphate Resources and Processing Facilities; chap. in Jacob, K. D., Fertilizer Technology and Resources in the United States: Academic Press, Inc., N. Y., Agronomy, vol. 3, 1953, pp. 117-165.
Siems, H. B., Chemistry and Manufacture of Superphosphates and Phosphoric Acid; chap. in Jacob, K. D., Fertilizer Technology and Resources in the United States: Academic Press, Inc., N. Y., Agronomy vol. 3, 1953, pp. 167-203.
Walthall, J. H., Chemistry and Technology of New Phosphate Materials; chap. in Jacob, K. D., Fertilizer Technology and Resources in the United States: Academic Press, Inc., N. Y., Agronomy, vol. 3, 1953, pp. 205-255.

[26] Tillotson, I. S., Hydraulic Transportation of Solids: Min. Cong. Jour., vol. 139, No. 1, January 1953, pp. 41-44.

[27] Anderson, D., Instrument Control in Phosphate Processing: Rock Products, vol. 56, No. 12, December 1953, pp. 94-96.

[28] Sauchelli, V., A Close Partnership; Phosphate Fertilizer and Agriculture: Agricultural Chemicals, vol. 8, No. 8, August 1953, pp. 33-36, 115.

[29] Adams, J. R., Parker, F. W., and Jacob, K. D., Use of Plant Nutrients: Agricultural Chemicals, vol. 8, No. 1, January 1953, pp. 36-40, 125, 127.
Oil, Paint and Drug Reporter, vol. 163, No. 24, June 15, 1953, pp. 4, 64-67; No. 25, June 22, 1953, pp. 7, 52-53.

[30] Porter, J. J., and Frisken, J., The Manufacture of Triple Superphosphate: Fertilizer Society (London), Proc. 21, pres. Jan. 22, 1953, 38 pp.

[31] Nordengren, Sven, and Nordengren, Rolf, Starting Up a Phosphoric Acid Plant: Chem. Age, (London), vol. 69, No. 1793, November 1953, pp. 1063-1067.

Morocco phosphate is ground to 85 to 95 percent through 100-mesh and first mixed with weak phosphoric acid. Following this the slurry is reacted with 65 to 75 percent sulfuric acid for 8 to 10 hours, during which time the temperature is closely controlled. The acid is then filtered part as product and the remainder for mixing with raw rock.[32]

The elemental phosphorus industry in Montana was described in a booklet published during 1953.[33]

The phosphorus content of the land is maintained by applying huge quantities of phosphatic materials. Two manmade phenomena, soil erosion and sewage disposal, were estimated to waste several million tons of phosphate annually in the United States. Means of controlling this waste would conserve the phosphate mineral reserves and increase productivity of the land.[34]

The potentially dangerous silicon tetrafluoride gas is removed from the effluents of superphosphate manufacture in four steps, as follows: Gas cooling, gas wetting, gas storage, and gas absorption. Regulations vary as to type and quantity of the toxic gases permissible in exhaust gases.[35]

The techniques used in North Africa to separate phosphate from calcite were described at the French Metal Mines Congress.[36]

Interest in nitraphosphates continued during 1953.[37] According to one article:

> The use of nitric acid as a partial or complete replacement for sulfuric acid in phosphate acidulation is perhaps the most significant development in fertilizer technology.[38]

An all nitric nitraphosphate was developed by the Tennessee Valley Authority.[39]

Metallic phosphate coatings were being used as a protective coating on metal products. Various types of zinc, iron, and manganese phosphates can be applied either by immersion or spraying.[40]

New uses for metallic phosphates were described.[41] One of the most recent uses was to inhibit rust and remove scale formation in cooling-water systems. Phosphate inhibitors were especially successful in high-chloride water.[42] The United States Smelting, Refining & Mining Co. adopted this inhibitor in the plant at Bayard, N. Mex.[43]

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[32] Chemical and Engineering News, vol. 31, No. 43, Oct. 26, 1953, p. 4448.
Fertiliser and Feeding Stuffs Journal (London), Manufacture of Phosphoric Acid: Vol. 39, No. 21, Oct. 14, 1953, pp. 755–757.

[33] Johnson, M., Phosphorus Production in Montana: Montana State Univ., Missoula, Mont., Bureau of Business and Economic Research, Regional Study 4, June 1953, 32 pp.

[34] Hopkins, D. P., Phosphorus and Life: Fertiliser and Feeding Stuffs Jour. (London), vol. 39, No. 26, Dec. 23, 1953, pp. 969–971.

[35] Donald, R., Superphosphate Plant Effluents: Chem. Age (London), vol. 69, No. 1795, December 1953, pp. 1171–1172, 1176.

[36] Miche [Differential Flotation of the Calcite and of the Phosphate of Lime in Phosphate Ores of North Africa]: Pres. at Congress on Washing French Metallic Ores, Paris, France, Sept. 29–30 and Oct. 1, 1953, 6 pp. [Aspects of the Flotation of the Phosphate Ores of Northern Africa]: Pres. at Congress on Washing French Metallic Ores, Paris, France, Sept. 29–30 and Oct. 1, 1953, 22 pp.

[37] Canadian Chemical Processing, vol. 37, No. 10, September 1953, p. 112.
Fertiliser and Feeding Stuffs Journal (London), vol. 39, No. 22, Oct. 28, 1953, p. 818.

[38] Kapusta, E. C., Fertilizer Technology: Chem. and Eng. News, vol. 31, No. 1, Jan. 5, 1953, pp. 28–30.

[39] Fertiliser, Feeding Stuffs, and Farm Supplies Journal (London), vol. 39, No. 21, Oct. 14, 1953, pp. 749–750.

[40] Gray, A. G., Phosphate Coatings Benefit Metal Finishing and Working: Metal Progress, vol. 63, No. 4, April 1953, pp. 106–108.
Steel, Phosphate Coating: Vol. 133, No. 17, Oct. 26, 1953, pp. 158–159.

[41] Ryan, V. H., New Protective Chemicals: South African Min. and Eng. Jour., vol. 63, No. 3126, Jan. 10, 1953, p. 811.

[42] Parham, D. N., and Tod, C. W., Condensed Phosphates in the Treatment of Corrosive Waters: Chem. and Ind. (London), No. 26, June 27, 1953, pp. 628–631.

[43] Engineering and Mining Journal, vol. 154, No. 9, September 1953, p. 104.

Ferrophosphorus concrete was tested in nuclear shields. Densities ranging around 300 pounds per cubic foot were reported with compressive strengths of about 3,000 pounds per square inch.[44] The use of slag from an electric phosphorus furnace for making mineral wool was reported, but the results were not very satisfactory.[45]

Tricresyl phosphate was being added to gasoline as a scavenger agent and to help remove or immobilize objectionable products of combustion.

New methods for determining the phosphate content of various compounds were investigated.[46]

The increased demand for phosphatic feed supplements and the expansion of the domestic industry were described. Imports of feed-grade dicalcium phosphate continued to compete with domestic materials despite the 12½-percent ad valorem duty imposed during 1952. Imports from Curaçao are raw rock and are imported duty free.[47]

Laboratory experiments on fusion of langbeinite with phosphate rock gave encouraging results, and a pilot plant was built to continue studies on the resulting fertilizer product. The fused fertilizer from the pilot plant analyzed 13 percent K_2O, 13 percent P_2O_5, 11 percent magnesia, and 1.6 percent fluorine. Preliminary economic studies indicated that this process would be competitive with other fertilizer manufacturing processes.[48]

RESERVES

Phosphorus fertilizer resources in the United States were described in two chapters of Soil and Fertilizer Phosphorus.[49] Phosphate-rock reserves, minable under present conditions, are estimated to be 5.1 billion long tons, with an additional 49 billion tons available if improved technology is used. Table 16 shows details of the most recent survey reserve estimate by the Geological Survey.

New outcrops of the Phosphoria formation in southwestern Montana were reported by the Geological Survey. Beds 4 to 6 feet thick and containing about 31 percent P_2O_5 were estimated to contain 50 million tons.[50]

A description of the superficial phosphate deposit near Minas, Uruguay, was published.[51] Despite the high P_2O_5 content the high iron and alumina discourage its use for fertilizer.

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44 Harlow, H. G., and Matthews, P. R., The Use of Ferrophosphorus in Making High-Density Concrete: Nuclear Sci. Abs., vol. 7, No. 14, July 31, 1953, p. 4104.

45 Greaves-Walker, A. F., and Welch, A. P., Development of Mineral Wool From Florida Minerals: Eng. Progress, University of Florida, vol. 7, No. 2, 1953, Bull. Ser. 59, 28 pp.

46 Menkowich, A. M., Total Phosphates in Metal Cleaning Compositions: ASTM Bull. 194, December 1953, pp. 50–56.
Caldwell, J. E., and Fowler, L., The Potassium Permanganate Test as Applied to Tricresyl Phosphate: ASTM Bull. 194, December 1953, pp. 67–69.

47 Lowe, J. N., Consumption and Supply of Phosphatic Feed Supplement: Agricultural Chemicals, vol. 8, No. 8, August 1953, pp. 44–45.

48 Bridger, G. L., and Boylan, D. R., Production of Fertilizer From Phosphate Rock by Fusion With Magnesium and Potassium Sulfates: Ind. Eng. Chem., vol. 45, No. 3, March 1953, pp. 646-652.

49 Pierre, W. H., and Norman, A. G., Soil and Fertilizer Phosphorus: Agronomy, vol. 4, Academic Press, Inc., New York, N. Y., 1953, 492 pp.

50 Mining World, vol. 15, No. 10, September 1953, p. 103.

51 Eckel, E. B., and Milton, C., Reconnaissance of Superficial Phosphate Deposit Near Minas, Uruguay: Econ. Geol., vol. 48, No. 6, September-October 1953, pp. 437–446.

TABLE 16.—Production and resources of phosphate rock in the United States

[Million long tons]

Source and type	Production		Inferred reserves minable under present conditions		Additional inferred resources minable under changed conditions	
	Marketed product [1]	P_2O_5 content [2]	Marketable product	P_2O_5 content	Product	P_2O_5 content
Florida:						
Land pebble:						
In matrix	[3] 124.7	41.7	[4] 1,000	[4] 330	[4,5] 2,000	[4,5] 600
In leached zone					[4,6] 800	180
River pebble	[7] 1.3	.3			[2] 50	12
Hard rock	[9] 14.0	4.8	[8,10] 1,040	330	[8,10] 500	140
Soft rock	1.1	.2	(11)	(11)	(11)	(11)
Hawthorn formation					20,000	4,000
Total	141.1	47.0	2,040	660	23,350	4,932
South Carolina:						
Land rock	[12] 9.3	2.5			[8] 9	2.4
River rock	[12] 4.1	1.0			(13)	(13)
Total	13.4	3.5			9	2.4
Tennessee:						
Brown rock	[14] 31.1	9.0	[8] 85	15	(13)	(13)
Blue rock	[14] 1.3	.4			83	25
White rock	.02	.007			15	4
Phosphatic limestone					[1] 5,300	1,100
Total	[15] 33.3	[15] 10.0	85	15	5,398	1,129
Western field (Phosphoria formation)	6.8	1.9	[16] 3,000	870	[17] 20,000	5,800
Arkansas	.03	.01			[8] 20	5
Other States (Alabama, Kentucky, North Carolina, Pennsylvania)	.17	.05			(12)	(12)
Grand total	195.00	62.00	5,100	1,500	49,000	12,000

[1] Figures rounded from those compiled by Jacob (1953), supplemented by figures for 1949 from the Bureau of Mines Minerals Yearbook.
[2] Approximate.
[3] Includes some river pebble and soft rock.
[4] Preliminary figures based upon recent Geological Survey investigations.
[5] Includes about 1 billion tons in the northern part of the district, containing 27–30 percent P_2O_5. The remainder is in the southern part of the district.
[6] All in the northern part of the field; comprised of (1) 1.5 billion tons, in deposits more than 5 feet thick, 20 percent (300 million tons) which is minus-150-mesh in size and contains 15 to 30 percent P_2O_5 and a similar amount of Al_2O_3; (2) 2.5 billion tons in deposits more than 1 foot thick, 20 percent (500 million tons) of which is minus 150-mesh in size.
[7] Some river pebble is included with land pebble.
[8] Figures rounded off from estimates compiled by Mansfield, 1942b.
[9] Includes some soft rock.
[10] Includes soft rock.
[11] Included with hard rock.
[12] Some river rock included with land rock.
[13] Data not available.
[14] Virginia apatite and some blue rock included with Tennessee brown rock.
[15] This figure is higher than the sum of the individual items because separate data for the different types of Tennessee phosphate are not available for the years before 1905.
[16] Preliminary, incomplete estimates based upon recent investigations of the Geological Survey; about one-fourth is acid grade (>31 percent P_2O_5) and the remainder is furnace grade (>24 percent P_2O_5).
[17] Preliminary, incomplete estimates based upon recent investigations of the Geological Survey; rocks are of minable thickness, contains more than 24 percent P_2O_5, but lie below entry level.

SOURCE: McKelvey, V. E., and others, Domestic Phosphate Deposits: Geol. Survey Open-File Rept., Mar. 30, 1953.

WORLD REVIEW

NORTH AMERICA

Canada.—The new ammonium phosphate plant of the Consolidated Mining & Smelting Co. of Canada, Ltd., at Kimberley, B. C., began production October 14, 1953. Raw materials for the 190-ton-per-day plant will be obtained as follows: Phosphate rock from subsidiary company operations in Montana; ammonia from Alberta; and sulfuric acid from the smelter at Kimberley.[52]

SOUTH AMERICA

Brazil.—The apatite operations near São Paulo continued during 1953. Development of the phosphate-rock deposit at Olinda was begun. Lowering of the water table and stripping of the overburden were in progress, and production was scheduled for early 1954. Plans were not complete for the proposed 5,000-ton-per-day plant, and initial production was to be used for direct application. All operations were conducted by Fosforita Olinda S/A.

Other sources of phosphatic materials, both apatite and phosphate rock were reported in several States.[53]

Venezuela.—The phosphate-rock deposits reported in the 1952 chapter were discovered in 1947 by the North Venezuela Petroleum Co., and in 1948 the State of Falcon was declared a national reserve for exploration and exploitation of phosphate-rock resources. Work by a United States company resulted in estimates of 15 to 20 million metric tons. It was reported that the Curaçao Mining Co. will begin mining this deposit.[54]

AFRICA

Algeria.—Production of phosphate rock declined more than 14 percent in 1953 from 1952 and was the lowest since 1946. The decreased production resulted from United States competition, large European stocks of basic slag, and a shortage of foreign exchange by regular buyers. The export tax was suspended during the latter part of the year to aid the producers.

Compagnie des Phosphates de Constantine continued to be the major producer, supplying 80 percent of the 1953 production. The remainder of the production came from Compagnie Minière du M'Zafta.

The price of 68 percent B. P. L. phosphate rock, f. o. b. Algerian ports, $9.43 at the beginning of 1953, was $8.43 on April 1.[55]

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[52] Canadian Chemical Processing, vol. 37, No. 12, November 1953, p. 102.
Canadian Mining Journal, vol. 74, No. 8, August 1953, p. 83.
Chemical Age (London), vol. 69, No. 1777, Aug. 1, 1953, p. 226.
[53] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 2, August 1954, pp. 62–64.
Chemical Age (London), Fertilizers in Brazil: Vol. 70, No. 1803, Jan. 30, 1954, p. 315.
[54] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 5, May 1953, pp. 45–47.
U. S. Department of Commerce, Foreign Commerce Weekly: vol. 49, No. 1, Jan. 5, 1953, p. 17.
Fertiliser and Feeding Stuffs Journal (London), vol. 39, No. 13, June 24, 1953, p. 472.
Mining World, vol. 15, No. 7, June 1953, p. 67.
[55] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 2, August 1953, p. 55.
United States Embassy, Algiers, Algeria, State Dept. Dispatch 261, June 21, 1954, pp. 3–4.

TABLE 17.—World production of phosphate rock by countries,[1] 1944–48 (average) and 1949–53, in metric tons [2]

[Compiled by Helen L. Hunt]

Country [1]	1944–48 (average)	1949	1950	1951	1952	1953
North America:						
Canada	152	18	117	5	----------	----------
United States	7,408,888	9,019,957	11,292,541	10,947,971	12,258,534	12,704,516
West Indies: Netherlands Antilles (exports)	46,993	92,784	104,240	107,144	106,902	96,035
South America:						
Brazil (apatite)	6,272	4,553	13,850	(3)	17,959	(3)
Chile (apatite)	23,262	49,311	13,437	37,182	26,417	[4] 50,000
Europe:						
Austria	[4] 4,153	----------	----------	----------	----------	----------
Belgium	53,434	44,643	50,846	129,065	58,983	35,896
France	90,872	59,643	73,752	110,000	102,000	73,000
Germany, West	[4] 614	----------	----------	----------	----------	----------
Ireland	13,011	(3)	[4, 5] 29,000	[4, 5] 25,000	(3)	(3)
Italy	320	----------	----------	----------	----------	----------
Spain	19,989	23,093	24,080	22,830	23,474	21,862
Sweden (apatite)	78,368	1,604	2,044	9,013	21,422	(3)
U. S. S. R. (apatite) [4]	1,727,000	2,540,000	2,540,000	2,794,000	3,000,000	3,000,000
Asia:						
British Borneo (guano)	303	508	653	659	707	642
China [4]	23,000	20,000	20,000	20,000	20,000	30,000
Christmas Island (Indian Ocean) (exports)	50,890	255,236	320,423	338,693	354,762	284,689
India (apatite)	602	588	3,074	423	452	(3)
Indochina	5,430	----------	----------	----------	----------	----------
Indonesia	[4] 5,206	[4] 5,000	[4] 5,000	----------	----------	828
Israel	----------	----------	----------	[6] 297	17,200	23,092
Japan	15,842	684	258	143	----------	----------
Jordan (exports)	4,782	----------	----------	6,635	24,941	28,700
Korea	[4] 19,006	(3)	(3)	(3)	(3)	(3)
Philippines (guano)	----------	10,998	32,606	4,821	4,231	640
Africa:						
Algeria	518,171	648,202	684,657	776,575	702,587	602,753
Angola (guano)	[7] 200	(3)	1,033	943	----------	----------
British Somaliland (guano) (exports)	[8] 303	580	308	691	(3)	(3)
Egypt	341,967	350,480	397,207	499,976	522,214	484,176
French Morocco	2,413,932	3,692,958	3,872,241	4,716,800	3,953,100	4,156,000
French West Africa (aluminum phosphate)	983	5,675	11,909	24,500	43,150	52,400
Madagascar	----------	----------	----------	----------	1,305	1,556
Seychelles Islands (exports)	14,133	14,171	10,005	4,547	11,120	8,859
Southern Rhodesia	2	67	36	----------	----------	----------
South-West Africa (guano)	1,183	957	581	785	1,675	1,604
Tanganyika Territory	170	130	468	459	169	151
Tunisia	1,245,439	1,441,918	1,524,833	1,678,905	2,264,641	1,718,530
Uganda	4,626	----------	467	2,242	5,010	5,448
Union of South Africa	33,522	56,471	51,844	81,840	96,568	80,125
Oceania:						
Angaur Island	[9] 58,117	157,049	[4] 137,000	[9] 144,843	[9] 83,905	[4, 9] 112,524
Australia	4,671	11	1,653	8,056	5,623	(3)
Makatea Island (French Oceania) (exports)	216,772	265,082	270,300	227,858	213,555	250,511
Nauru Island (exports)	156,096	802,070	1,070,358	942,945	1,164,038	1,178,364
New Zealand	7,952	----------	----------	----------	----------	----------
Ocean Island (exports)	73,796	265,087	251,218	256,451	249,542	286,894
Total (estimate)	14,700,000	19,850,000	22,800,000	24,000,000	25,500,000	25,500,000

[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] Data not available; estimate by author of chapter included in total.
[4] Estimate.
[5] Year ended June 30 of year stated.
[6] Production started second half of December 1951.
[7] Average for 1947–48.
[8] Average for 1946–48.
[9] Exports.

TABLE 18.—Exports of phosphate rock from Algeria, 1951–53, by countries of destination, in metric tons [1] [2]

Country	1951	1952	1953
Belgium-Luxembourg	5,110	7,550	----------
Czechoslovakia	29,230	14,400	----------
France	191,325	115,819	105,420
Germany, West	166,801	120,561	62,800
Hungary	12,390	11,900	12,050
Ireland	64,298	51,072	34,200
Netherlands	62,777	31,675	----------
Poland	50,000	36,250	36,710
Portugal	24,270	38,435	22,500
Spain	4,500	69,025	171,500
United Kingdom	54,687	74,356	89,800
Yugoslavia	10,180	14,800	----------
Others	17,418	11,140	15,750
French overseas territories	2,400	4,800	10,640
Total	695,386	601,783	561,370

[1] Compiled by John E. McDaniel, Division of Foreign Activities, Bureau of Mines, from Customs Returns of Algeria.
[2] This table incorporates a number of revisions of data published in the previous Phosphate Rock chapter.

Exports of phosphate rock from Algeria (table 18) again decreased in 1953 and were 7 percent less than in 1952.

Egypt.—Production of phosphate rock in Egypt in 1953 was 7 percent less than in 1952.

Total exports from Egypt for 1950–52 are shown in table 19. Data for 1953 are not yet available.

TABLE 19.—Exports of phosphate rock from Egypt, 1950–52, by countries of destination, in metric tons [1] [2]

Country	1950	1951	1952
Belgium-Luxembourg	20,816	----------	----------
Ceylon	28,347	34,483	34,453
Finland	18,303	37,579	----------
Germany, West	----------	9,130	----------
Greece	----------	9,330	----------
India	47,270	12,395	----------
Italy	115,356	58,446	----------
Japan	227,766	182,643	----------
Netherlands	9,702	----------	----------
New Zealand	15,474	----------	----------
Sweden	5,500	342	----------
Union of South Africa	----------	16,614	61,232
Yugoslavia	10,360	10,003	----------
Others	1,001	4,220	327,121
Total	499,895	375,185	422,806

[1] Compiled by John E. McDaniel, Division of Foreign Activities, Bureau of Mines, from Customs Returns of Egypt.
[2] This table incorporates a number of revisions of data published in the previous Phosphate Rock chapter.

French Morocco.—The output of phosphate rock in 1953 increased 5 percent over 1952. The Khouribga mine, producing 75 percent B. P. L. (bone phosphate of lime, $Ca_3(Po_4)_2$) rock, and the Louis-Gentil mine, producing 70 percent B. P. L. rock, contributed 80 and 20 percent, respectively, of the production. Both of these mines remained under control of Office Cherifien des Phosphates, a Government agency.

Prices of phosphate rock were not available. The average reported value of exports was $11.90 per ton.[56]

The exports of phosphate rock from French Morocco for 1951–53 are shown in table 20. Total exports were 5 percent above the 1952 figure, with over 90 percent going to European markets.

TABLE 20.—Exports of phosphate rock from French Morocco, 1951–53, by countries of destination, in metric tons [1] [2]

Country	1951	1952	1953
South America:			
Brazil	22,023	31,300	13,900
Chile			14,300
Uruguay	4,962	6,500	6,450
Europe:			
Belgium-Luxembourg	285,954	201,901	181,630
Denmark	271,075	213,230	242,520
Finland	92,456	97,992	38,340
France	540,017	407,215	492,600
Germany	232,443	321,267	234,380
Hungary	11,831		
Ireland	29,472	35,230	54,180
Italy	536,371	477,999	534,610
Netherlands	300,831	313,386	81,470
Norway	38,813	51,170	52,670
Poland	176,764	96,058	120,940
Portugal	166,826	175,256	219,380
Spain	338,836	448,327	464,610
Sweden	315,512	236,691	228,720
Switzerland	35,432	16,180	17,470
United Kingdom	676,949	526,614	754,120
Africa: Union of South Africa	293,133	249,741	259,570
Others	47,119		87,450
Total	4,416,819	3,906,057	4,099,310

[1] Compiled by John E. McDaniel, Division of Foreign Activities, Bureau of Mines, from Customs Returns of French Morocco.
[2] This table incorporates a number of revisions of data published in the previous Phosphate Rock chapter.

Tunisia.—Production of phosphate rock decreased nearly 25 percent in 1953. The Gafsa mine was the largest producer, followed by

TABLE 21.—Exports of phosphate rock from Tunisia, 1952–53, by countries of destination, in metric tons [1] [2] [3]

Country	1952	1953	Country	1952	1953
North America: Canada	4,000		Europe—Continued		
South America:			Sweden	7,890	5,300
Brazil	31,500	70,030	Switzerland	950	1,050
Chile	15,475	5,500	Turkey	15,558	12,755
Uruguay	1,726	3,000	United Kingdom and Ireland	593,347	181,734
Europe:			Yugoslavia	7,750	13,004
Belgium	69,100	36,230	Africa:		
Czechoslovakia	27,700	56,680	Madagascar	2,000	500
Denmark	7,440	7,300	Union of South Africa	70,708	
Finland	59,295	29,700	Asia:		
France	344,173	440,418	Indochina	16,200	17,506
Germany	133,225	47,350	Japan	10,000	10,450
Greece	63,865	71,927	Oceania: New Zealand	18,034	17,902
Italy	408,747	477,100	Others	30	3,558
Netherlands	70,345	4,210			
Portugal	26,325				
Spain	170,191	89,118	Total	2,175,574	1,602,322

[1] Compiled by John E. McDaniel, Division of Foreign Activities, Bureau of Mines, from Customs Returns of Tunisia.
[2] This table incorporates a number of revisions of data published in the previous Phosphate Rock chapter.
[3] Includes hyperphosphate.

[56] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 5, May 1954, pp. 44–45.

the M'Dilla, Kalaa Djerda, and Ain Kerma mines. Ore dressing was becoming increasingly important in Tunisia, and a new beneficiation plant near Gafsa began operating during the year. This plant was reported to have a capacity of 700,000 metric tons of ore per year. The new triple-superphosphate plant at Sfax, rated at 100,000 tons annual output, operated at about one third of capacity during 1953.

Prices of crude rock, 65–68 percent B. P. L. ranged from $8.97–$8.57 per metric ton, exclusive of transaction and customs taxes.[57]

Exports of phosphate rock, including hyperphosphate from Tunisia (table 21), were 26 percent less in 1953 than in 1952. As in the previous year, the bulk of exports went to European countries.

Union of South Africa.—Development of deposits by Foskar, the Government-sponsored phosphate company, is well underway, and production was scheduled for mid-1954. The ore, consisting of apatite, vermiculite, limestone, magnetite, and serpentine, averages about 25 percent P_2O_5 and will be beneficiated to 35–37 percent P_2O_5. Mining will be by open pit, developing benches about 35 feet high. The flotation mill at Phalaborwa (Palabora) will have an initial capacity of 56,000 long tons of concentrate per year. It is planned eventually to increase the capacity to 450,000 tons per year. Development of this deposit includes construction of a power station, water works, and a village for the workers.[58]

Other African Countries.—A phosphate deposit near Thies, Senegal, was under development, and production was planned for 1954.[59] Sizeable reserves of phosphates were blocked out in the Dorowa deposits by Imperial Chemical Institute; but, because of location, immediate production was not contemplated.[60] Reported phosphate deposits in the Republic of Togo were being investigated by the Phosphate exchange of North Africa.[61] The Phosphate Exchange of North Africa also was exploring phosphate occurrences in the Lower Dahomey State, French West Africa.[62] Over 18 million metric tons of low-grade phosphate were reported by Minerals and Engrais in the Holle region of French Equatorial Africa. The Comptoir des Phosphates de l'Afrique du Nord conducted experimental beneficiation studies with samples from this region, attempting to develop an economic concentration process.[63]

ASIA

India.—The Development Council for Heavy Chemicals recommended formation of a national fertilizer association to encourage use of fertilizer.

The phosphatic nodules found in the Trichinopoly district were successfully used in manufacturing dicalcium phosphate and defluorinated phosphate.

[57] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 5, May 1954, pp. 45–47.
[58] South African Mining & Engineering Journal, vol. 63, No. 3129, Jan. 31, 1953, p. 893.
Preller, G. S., The Phalaborwa Phosphate Project, part I: South African Min. & Eng. Jour., vol. 64, No. 3140, Apr. 18, 1953, pp. 225–227; part II, vol. 64, No. 3141, Apr. 25, 1953, pp. 269–271.
[59] Mining Journal (London), vol. 241, No. 6159, Sept. 4, 1953, p. 266.
[60] U. S. Department of Commerce, Foreign Commerce Weekly: vol. 49, No. 23, June 8, 1953, p. 11.
Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 1, July 1953, p. 57.
[61] Mining World, vol. 15, No. 13, December 1953, p. 74.
[62] Mining World, vol. 15, No. 12, November 1953, p. 77.
[63] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 6, December 1953, p. 49.

Plans were announced for constructing a 240-ton-per-day superphosphate plant near the Sindri ammonium sulfate plant in the State of Bihar.[64]

Israel.[65]—It is reported that extensive exploration disclosed about 50 million long tons of phosphate rock in the Negev desert. Beneficiation was planned to upgrade the 28-percent-P_2O_5 rock. Although production by the Negev Phosphate Co., Ltd., increased in 1953, over 5,000 tons of phosphatic fertilizers was imported.

Production of superphosphate was 32,415 long tons in 1953, a 35-percent increase over 1952, averaging 14 percent available phosphoric acid.

According to trade agreements, Israel is to supply phosphate to Finland and Norway.

Jordan.—Transjordan Phosphate Mines, Ltd., contracted to export 36,000 tons of phosphate rock to Italy in 1954. According to Government sources, the exportation of phosphate rock is to be increased substantially during the next several years.[66] The port facilities at Agaba were being enlarged to handle increased shipments.

The Transjordan Phosphate Mines, Ltd., was reorganized during 1953 with considerable Government backing.

Philippines.—The guano, guano-phosphate, and phosphatic clay deposits on the island of Marinduque were estimated to contain over 4,500 cubic yards of guano. Descriptions of the Bathala Deposit, Bongoy deposit, and the Talamban Caves were published.[67]

OCEANIA

Australia.—Imports from Nauru and Ocean Islands continued to supply the major share of Australia's phosphate-rock requirements. Small quantities were produced in Australia but used mainly in blast-furnace operations. To expand the superphosphate industry additional sulfuric acid plants were under construction, with a total capacity of 400 tons of acid per day from pyrites.[68]

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[64] Chemical Age (London), vol. 69, No. 1777, Aug. 1, 1953, p. 233; No. 1784, Sept. 19, 1953, p. 615; No. 1793, Nov. 21, 1953, p. 1086.
Fertiliser and Feeding Stuffs Journal (London), vol. 39, No. 14, July 8, 1953, p. 493.
U. S. Department of Commerce, Foreign Commerce Weekly: Vol. 50, No. 1, July 6, 1953, p. 9.
[65] Chemical Age (London), vol. 69, No. 1795, Dec. 5, 1953, p. 1190.
Industrial and Engineering Chemistry, vol. 45, No. 8, August 1953, pp. 18A, 20A.
Rock Products, vol. 57, No. 2, February 1954, p. 116.
Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 3, September 1953, p. 71.
[66] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 5, May 1953, p. 45.
Engineering and Mining Journal, vol. 154, No. 9, September 1953, p. 194.
U. S. Embassy, Amman, Jordan, State Dept. Dispatch 223, Dec. 22, 1953, 1 p.
State Dept. Dispatch 432, June 30, 1954, pp. 18, 22.
[67] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 2, August 1953, pp. 49–50.
[68] Chemical Age (London), vol. 68, No. 1768, May 30, 1953, p. 833.
Chemical and Engineering News, vol. 31, No. 31, Aug. 3, 1953, p. 3198.
Chemical Engineering and Mining Review (Melbourne) vol. 46, No. 2, Nov. 10, 1953, p. 54.
Chemical Week, vol. 73, No. 26, Dec. 26, 1953, pp. 22, 24.
Fertiliser and Feeding Stuffs Journal, vol. 39, No. 3, Feb. 4, 1953, p. 101; No. 13, June 24, 1953, p. 472.

Christmas Island.—According to the British Phosphate Commission, phosphate rock from Christmas Island was of good quality, even though the iron and alumina content was slightly higher than that of the phosphate from Ocean and Nauru Islands.[69]

Total exports of phosphate rock from Christmas Island for 1950, 1951, and 1952 were 315,361, 333,343 and 349,158 long tons, respectively.[70]

Makatea Island.—The Compagnie des Phosphates d'Oceanie continued to produce phosphate rock, the major part of which was exported to Japan.[71]

Nauru Island.—Reserves of phosphate rock, as of mid-1953, were estimated at 90 million long tons, distributed over 4,116 acres, nearly all of the remaining surface. About 16 million tons have been mined up to this time.[72]

[69] Fertiliser and Feeding Stuffs Journal, vol. 39, No. 13, June 24, 1953, p. 469.
[70] Bureau of Mines, Mineral Trade Notes, Vol. 36, No. 3, March 1953, p. 37.
[71] Mining World, vol. 15, No. 7, June 1953, p. 82.
[72] Report to the General Assembly of the United Nations on the Administration of the Trust Territory of Nauru.

Platinum-Group Metals

By James E. Bell[1] and Kathleen M. McBreen[2]

FEATURES of the platinum-group metals in 1953 were record imports, revocation of Government controls on the use and price of platinum, and the appearance of Russian platinum on world markets for the first time in 6 years. Prices continued high. Total sales of platinum-group metals to domestic consumers were 17 percent greater in 1953 than in the preceding year. Total imports were 40 percent larger in 1953 than in 1952 and 6 percent above the previous record high established in 1951. National Production Authority Order M–54, adopted April 1, 1951, prohibiting the sale or purchase of platinum for investment or for jewelry or decorative uses, was revoked May 1, 1953. Ceiling Price Regulation 136 of the Office of Price Stabilization, adopted on April 26, 1952, setting a maximum price of $93 per ounce for platinum, also was revoked May 1, 1953.

TABLE 1.—Salient statistics of platinum-group metals in the United States, 1952–53, in troy ounces

	1952	1953
Production:		
Crude platinum from placers and byproduct platinum-group metals	[1] 34,409	[1] 26,072
Refinery production:		
New metal:		
Platinum	41,810	46,963
Palladium	6,746	6,347
Other	3,919	6,957
Total	52,475	60,267
Secondary metal:		
Platinum	28,628	29,547
Palladium	25,540	30,494
Other	4,433	4,816
Total	58,601	64,857
Consumption:		
Platinum	228,698	276,580
Palladium	204,578	231,525
Other	20,945	25,193
Total	454,221	533,298

	1952	1953
Stocks in hands of refiners, importers, and dealers, Dec. 31:		
Platinum	130,136	138,846
Palladium	116,786	110,211
Other	35,451	31,991
Total	282,373	281,048
Imports for consumption:		
Unrefined materials	[2] 35,353	50,071
Refined metals	[2] 417,465	585,453
Total	452,818	635,524
Exports:		
Ore and concentrates		30
Refined metals and alloys, including scrap	[2] 23,723	25,728
Manufactures (except jewelry)	(3)	(3)

[1] Includes Alaska.
[2] Revised figure.
[3] Beginning Jan. 1, 1952, quantity not recorded.

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

Refinery production of platinum (new and secondary combined) in the United States in 1953 was 9 percent above that in 1952, and imports of refined platinum were up 68 percent. Consumption of platinum in the United States, as measured by sales, increased 21 percent, and stocks of refiners and dealers rose 7 percent. The chemical industry was the principal outlet, increasing to 58 percent of the total sales in 1953 from 55 percent in the preceding year. The Government purchased platinum for stockpiling.

Refinery production of palladium in the United States was 14 percent greater in 1953 than in 1952, and imports of refined palladium rose 13 percent. Consumption of palladium in the United States as measured by sales was 13 percent greater, and stocks of refiners and dealers were down 6 percent. The electrical industry again provided the greatest market, taking 66 percent of the total sold in 1953 compared with 54 percent in 1952.

Refinery production of iridium, rhodium, and ruthenium in the United States in 1953 was, respectively, 36, 39, and 87 percent above the 1952 rates, while that of osmium declined 7 percent. Imports of refined iridium dropped 65 percent in 1953, and imports of osmium declined slightly; imports of refined rhodium and ruthenium were up 99 and 27 percent, respectively. Stocks of the 4 metals together held by refiners and dealers declined 10 percent.

Construction of a $2.2 million plant at Newark, N. J., for producing a platinum-containing catalyst for upgrading and synthesizing aromatics from petroleum was announced by Baker & Co., Inc. The catalyst is the result of joint research by Sinclair Refining Laboratories, Inc. (a subsidiary of the Sinclair Oil Corp.), and Baker & Co. The plant was expected to be completed early in 1954.

An exhibit commemorating the 150th anniversary of the discovery of palladium in 1803 was held late in 1953 in Philadelphia, Pa. Excerpts from one report on the exhibit are quoted below.[3]

How the precious metal platinum, originally scorned as being less valuable than silver, and its five precious sister-metals are serving the needs and comforts of the American people is the theme of a comprehensive exhibit which opened here Tuesday evening (November 17) at the Franklin Institute.

* * * * *

Occasion for the event is the 150th anniversary this year of the announcement of the discovery of palladium, one of the platinum metals, by the British scientist, Dr. William Hyde Wollaston. This was the first of a rapid series of discoveries by Wollaston and his partner, Smithson Tennant. Between 1803 and 1805, they discovered three other platinum metals—iridium, rhodium and osmium—and Wollaston devised his classic method of powder metallurgy which he used to produce more than a ton of platinum ingots. The sixth metal in the platinum group is ruthenium.

The exhibit depicts, in dioramas, the history of the platinum metals and their diverse uses in such fields as medicine, dentistry, transportation, communication, clothing, food, and jewelry. Some of the modern uses shown are in the manufacture of glass fiber, rayon, high-octane gasoline, spark plugs, chemical fertilizers, pharmaceutical products, electrical contacts for the millions of relays required in the telephone system, and chemical catalysts.

* * * * *

Platinum was known to Colombian Indians before America was discovered by the Europeans. In the 17th century it was brought to the attention of Spanish colonists who scornfully called it "platina," and valued it lower than silver, because they were unable to separate and use the metal profitably, the exhibit shows.

[3] American Metal Market, vol. 60, No. 222, Nov. 18, 1953, pp. 1, 7.

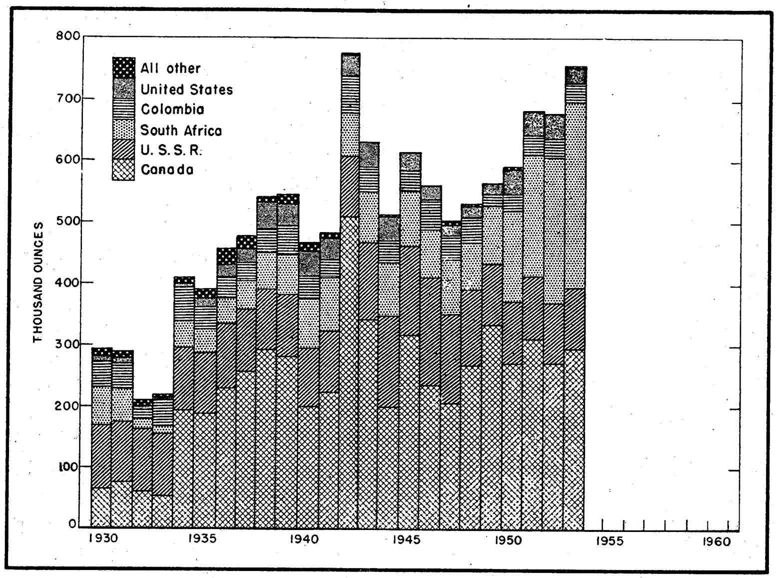

FIGURE 1.—World production of platinum-group metals, 1930–53.

GOVERNMENT REGULATIONS

National Production Authority Order M–54, which prohibited the sale or purchase of platinum for investment or for jewelry or decorative uses, was adopted April 1, 1951, and revoked on May 1, 1953. However, by regulations established under the Defense Materials System, announced by NPA on March 23, 1953, orders for military or atomic energy uses had priority ratings and took precedence over unrated orders.

Ceiling Price Regulation 136 of the Office of Price Stabilization, which set a maximum price of $93 per ounce for platinum, was adopted April 26, 1952, and revoked February 13, 1953. General Ceiling Price Regulation 30, concerning ceiling prices for various commodities including platinum-group metals, also was revoked May 1, 1953.

Export quotas on platinum metal as established by the Advisory Committee on Export Policy, limiting exports of platinum, were discontinued on December 10, 1953. Restrictions remained, however, on exportation of certain items manufactured from platinum-group metals and on exportation to the Soviet Bloc of all items containing these metals.

PRODUCTION OF CRUDE PLATINUM

Mine returns and refinery reports indicate a domestic recovery of 26,100 troy ounces of platinum-group metals in 1953 compared with 34,400 ounces in 1952. This metal includes crude platinum mined at placer-platinum deposits in the Goodnews Bay district in southwestern Alaska, byproduct crude platinum recovered from gold placer mining in California, and platinum-group metals contained in small quantities in some gold ores and copper ores and recovered as a byproduct in smelting and refining operations. No production of byproduct crude platinum was reported in Montana or Oregon in 1953.

Purchases.—United States buyers reported the purchase in 1953 of 59,400 ounces of crude platinum from Alaska, California, Colombia, Union of South Africa, and British Columbia (Canada). The corresponding quantity in 1952 was 53,700 ounces.

RECOVERY OF REFINED PLATINUM-GROUP METALS

New Metals Recovered.—Reports from refiners indicate a domestic recovery of 60,300 ounces of new platinum-group metals in 1953 compared with 52,500 ounces in 1952. Of the total new metals refined in 1953, 86 percent was recovered from crude platinum, both domestic and foreign, and 14 percent as a byproduct of gold ores and copper ores; the corresponding figures for 1952 were 82 and 18 percent.

Secondary Metals Recovered.—The domestic recovery of platinum-group metals in 1953 from the refining of scrap, sweeps, etc., was 64,900 ounces as against 58,600 ounces in 1952. Substantial quantities of wornout catalysts, spinnerets, laboratory ware and equipment, and other items are returned to refiners for refining or reworking. The platinum-group metals recovered from this source (or their

TABLE 2.—New platinum-group metals recovered by refiners in the United States, 1944–48 (average) 1949–51, and 1952–53, by sources, in troy ounces

	Platinum	Palladium	Iridium	Osmium	Rhodium	Ruthenium	Total
1944–48 (average)	94, 993	10, 407	3, 160	510	2, 020	865	111, 955
1949	42, 228	6, 008	2, 131	980	208	371	51, 926
1950	56, 757	11, 819	2, 351	1, 295	433	474	73, 129
1951	36, 007	6, 520	4, 417	1, 716	2, 879	1, 522	53, 061
1952							
From domestic—							
Crude platinum	18, 809	134	2, 005	559	292	51	21, 850
Gold and copper refining	1, 969	4, 196	9		14	1	6, 189
Total	20, 778	4, 330	2, 014	559	306	52	28, 039
From foreign—							
Crude platinum; Nickel and copper refining	21, 032	2, 416	412	320	91	165	24, 436
Total	41, 810	6, 746	2, 426	879	397	217	52, 475
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

equivalent in refined metals) are returned to the consumers. The platinum-group metals so recovered are not considered secondary production and are not included in the figures for secondary production.

TABLE 3.—Secondary platinum-group metals recovered in the United States, 1944–48 (average) and 1949–53, in troy ounces

	Platinum	Palladium	Iridium	Others	Total
1944–48 (average)	59, 597	29, 284	1, 616	3, 332	93, 829
1949	41, 734	37, 209	1, 101	3, 403	83, 447
1950	33, 894	21, 167	1, 064	1, 988	58, 113
1951	22, 470	27, 999	1, 014	1, 875	53, 358
1952	28, 628	25, 540	1, 030	3, 403	58, 601
1953	29, 547	30, 494	853	3, 963	64, 857

CONSUMPTION AND USES

Formerly better known as materials used chiefly for jewelry and luxury wares, today the platinum-group metals find their greatest application in the chemical and electrical industries. In recent years consumption of these metals in the United States has been 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 have excellent mechanical properties. 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.[4] The recently developed use of platinum as a catalyst for producing high-octane gasoline from low-grade and natural gasoline continued to expand, with a total of 71 units reported as operating or contracted for in the United States and abroad at the close of 1953.[5] 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 fila-

[4] Baker & Co., Inc., Platinum Metals Catalysts: Newark, N. J., 1953, 8 pp.
[5] Oil and Gas Journal, vol. 52, No. 33, Dec. 21, 1953, p. 346.

ments of minute diameter. Platinum alloys are employed also for handling molten glass in manufacturing 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. Large quantities of palladium are used for electrical contacts in relays, particularly for telephone service. Platinum, both pure and hardened with iridium or ruthenium, is used for contacts in voltage regulators, thermostats, relays, and contacts in high-tension magnetos. Spark plugs equipped with platinum-alloy electrodes have long life and resistance to fouling. Platinum and palladium alloys are employed in numerous delicate electrical and laboratory instruments and in electronic tubes. The military importance of platinum lies in its use in spark plugs and in high-duty electrical contacts for magnetos in motorized equipment and as a catalyst in many chemical production processes.

In the jewelry and decorative arts platinum hardened with iridium or ruthenium is recognized as the ideal metal, particularly for gem-set jewelry. Palladium alloyed with ruthenium is gaining in acceptance for jewelry, particularly in Europe. Both platinum and palladium are beaten into leaf for signs, book bindings, and other decorative uses. Because of their strength, workability, and resistance to tarnish, platinum and palladium alloys are used extensively for dentistry in cast and wrought forms and as pins and anchorages. Platinum and palladium are used in special photographic printing papers.

Ruthenium alloys are used for the tips of fountain pens and for long-life phonograph needles. Rhodium electroplate provides a brilliant finish for jewelry and a surface of high reflectivity for reflectors. Techniques have been developed recently for heavy electroplating of rhodium with controlled thickness on most common metals, permitting manufacturers to utilize the resistance to wear and to corrosion of pure rhodium on many production items.[6]

Sales of the platinum-group metals to consumers in the United States totaled 533,298 troy ounces in 1953 compared with 454,221 ounces in 1952, a 17-percent rise.

Sales of platinum to domestic consumers were 276,580 ounces in 1953 and represented 52 percent of the total sales of platinum-group metals; corresponding figures for 1952 were 228,698 ounces and 50 percent. The chemical industry was the largest user in 1953, taking 58 percent of the total platinum sales, followed by the electrical industry, with 25 percent. Sales for jewelry were permitted after revocation of Order M–54 May 1, 1953; but the quantities sold during the remainder of the year were below expectations, representing only 11 percent of total platinum sales. Sales of platinum for dental and medical and miscellaneous uses were, respectively, 5 and 1 percent of the total.

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[6] Materials and Methods, vol. 37, No. 3, March 1953, pp. 85–87.

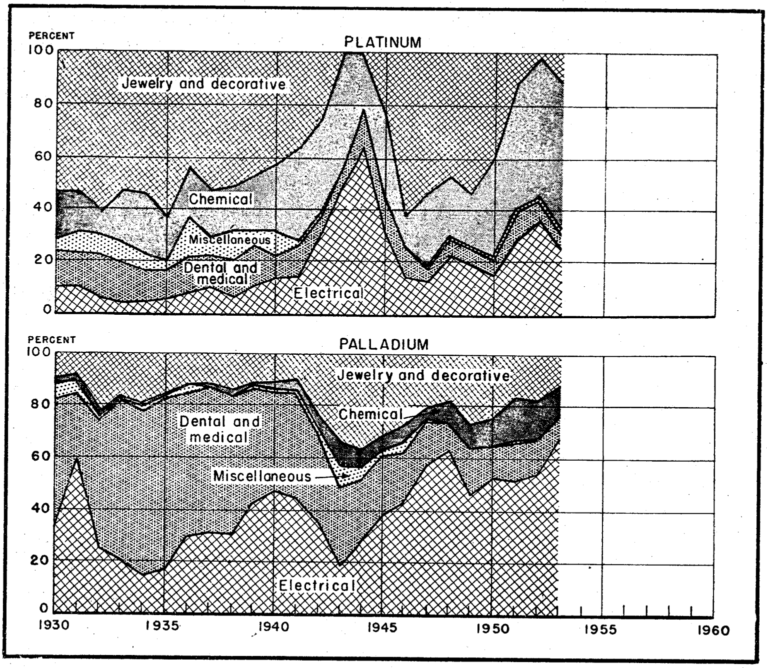

FIGURE 2.—Sales of platinum and palladium to various consuming industries in the United States, 1930–53, as percent of total.

TABLE 4.—Platinum-group metals sold to consuming industries in the United States in 1952–53, in troy ounces

Industry	Platinum	Palladium	Iridium, osmium, rhodium, and ruthenium	Total
1952				
Chemical	124, 938	25, 403	8, 621	158, 962
Electrical	82, 496	110, 883	4, 473	197, 852
Dental and medical	17, 080	30, 473	228	47, 781
Jewelry and decorative	1, 607	37, 081	4, 028	42, 716
Miscellaneous and undistributed	2, 577	738	3, 595	6, 910
Total	228, 698	204, 578	20, 945	454, 221
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

Sales of palladium to domestic consumers in 1953 were 231,525 ounces, or 43 percent of the total sales of platinum-group metals; corresponding figures for 1952 were 204,578 ounces and 45 percent. The distribution of consumption by uses was: Chemical 11 percent, electrical 66, dental and medical 11, jewelry and decorative 12, and miscellaneous less than 1.

Sales of iridium, osmium, rhodium, and ruthenium together in 1953 were 25,193 ounces, equal to 5 percent of total sales of platinum-group metals; corresponding figures for 1952 were 20,945 ounces and 5 percent. By quantity, sales of each of the 4 metals in 1953 were: Iridium 4,321 ounces, osmium 1,407, rhodium 12,701 and ruthenium 6,764.

STOCKS

Stocks of platinum-group metals in all forms in the hands of refiners, dealers, and importers declined 1,325 ounces to 281,048 ounces in 1953, a drop of less than 1 percent.

TABLE 5.—Stocks of platinum-group metals held by refiners, importers, and dealers in the United States, December 31, 1949–53, in troy ounces

Year	Platinum	Palladium	Iridium, osmium, rhodium, and ruthenium	Total
1949	138, 049	122, 408	35, 587	296, 044
1950	125, 234	107, 854	33, 474	266, 562
1951	138, 977	138, 099	36, 815	313, 891
1952	130, 136	116, 786	35, 451	282, 373
1953	138, 846	110, 211	31, 991	281, 048

PRICES

United States buyers reported purchases of domestic and foreign crude platinum in 1953 at prices ranging from $85.00 to $99.54 per ounce. This range in prices resulted chiefly from fluctuations in quotations for refined metals and variations in the iridium content of the crude platinum.

Except when it was raised to $95 in June and July, the quoted retail price of refined platinum remained at $93 per fine troy ounce during 1953. Palladium was quoted at $24 per ounce to May and $22–$24 thereafter. Iridium opened at $185–$200 per ounce, fell to $175–$185 in January and to $170–$175 in June, then rose to $175–$180 in August. Osmium opened at $200 per ounce, but three successive drops placed it at $140–$150 after August. Rhodium remained unchanged at $125 per ounce during the entire year. Ruthenium held at $90–$93 to late in June, but three successive drops placed it at $75–$80 after August.

FOREIGN TRADE[7]

Imports.—Imports of platinum-group metals into the United States in 1953 were at a new record high, totaling 40 percent more than in 1952 and 6 percent over the previous record set in 1951. The principal sources were Canada (220,857 ounces), Colombia (39,145 ounces), France (18,597 ounces), Netherlands (125,223 ounces), Soviet Union (31,256 ounces), and United Kingdom (179,891 ounces). Attention is called to footnote 4 of table 7 concerning imports of platinum from the Netherlands.

Imports of refined metals in 1953 totaled 585,453 troy ounces compared with 417,465 ounces in 1952, and imports of unrefined metals totaled 50,071 ounces compared with 35,353 ounces. Imports in 1953 of refined platinum, palladium, rhodium, and ruthenium rose 68, 13, 99, and 27 percent, respectively, but imports of iridium and osmium declined 65 and 2 percent, respectively.

TABLE 6.—Platinum-group metals imported for consumption in the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Year	Troy ounces	Value	Year	Troy ounces	Value
1944–48 (average)	347, 033	$12, 736, 972	1951	601, 423	$36, 307, 916
1949	218, 284	11, 855, 150	1952	452, 818	[1] 25, 533, 898
1950	427, 547	23, 220, 709	1953	635, 524	39, 436, 047

[1] Revised figure.

Exports.—Reflecting quotas established by the Advisory Committee on Export Policy, exports of refined platinum (including scrap) declined to 2,522 ounces in 1953 from 6,026 in 1952. Exports of other platinum-metals (including scrap) rose to 23,206 ounces in 1953 from 17,697 in 1952. Canada was the largest buyer of platinum, taking 1,036 ounces, followed by West Germany with 600. For the other platinum-group metals West Germany was the principal market, taking 13,019 ounces; and Canada was second with 6,433 ounces.

[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 7.—Platinum-group metals (unmanufactured) imported for consumption in the United States, 1952–53, by countries, in troy ounces [1]

[U. S. Department of Commerce]

Country	Unrefined materials [2]				Refined metals						Total
	Ores and concentrates of platinum metals	Platinum grain and nuggets (including crude, dust, and residues)	Platinum sponge and scrap	Osmiridium	Platinum	Palladium	Iridium	Osmium	Rhodium	Ruthenium	
1952											
Canada	41	78	1,672	41	113,925	101,443	3,700		5,165	347	226,412
Colombia		[3] 24,941	15								[3] 24,956
Ethiopia		1,303									1,303
France					1,273		187	25		150	1,635
Italy					300						300
Lebanon						3,922					3,922
Mexico	648	593	1,902		672						3,815
Netherlands			165		200	80,376					80,741
Norway		[3] 550			[3] 1,958	925	106		150	250	3,939
Switzerland					2,368						2,368
Union of South Africa				2,149	22,570	4,026	275	275	400	500	30,195
United Kingdom		68	209	602	59,633	9,810	450	294	436	1,341	72,843
Other countries		34	[3] 342		[3] 13						389
Total	689	[3] 27,567	[3] 4,305	2,792	202,912	200,502	4,718	594	6,151	2,588	452,818

1953											
Belgium-Luxembourg					497						497
Canada		409	367	60	106,986	103,594	400		8,386	655	220,857
Colombia		38,814	331								39,145
France					12,344	6,113	55		85		18,597
Germany, West			21				200				221
Italy					100	3,983					4,083
Lebanon		146									146
Netherlands					[4] 76,132	49,091					125,223
Norway	1,200	2,553			1,989	425	349		535	718	7,769
Switzerland		321			5,418		240				5,979
Union of South Africa				1,667							1,667
U. S. S. R.						31,256					31,256
United Kingdom		4,007		82	137,066	32,618	399	583	3,218	1,918	179,891
Other countries		12	76	5	100						193
Total	1,200	46,262	795	1,814	340,632	227,080	1,643	583	12,224	3,291	635,524

[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] American Metal Market, vol. 61, No. 67, Apr. 8, 1954, p. 1:

The importation of increased quantities of platinum into the United States from The Netherlands in the late months of 1953 appeared to have an explanation today in a report made by the Foreign Trade Division of the Bureau of the Census.

Since The Netherlands is not a platinum-producing country, importation of considerable quantities of the metals, with Holland given as the origin, was questioned several months ago.

The Foreign Trade Division, after some investigation work abroad, reports that the metal arrived in "crude impure lumps" in The Netherlands and was refined there. The origin of most of the material presumably was Russia.

TABLE 8.—Platinum-group metals (unmanufactured) imported for consumption in the United States, 1952–53 [1]

[U. S. Department of Commerce]

Material	1952		1953	
	Troy ounces	Value	Troy ounces	Value
Unrefined materials:[2]				
Ores and concentrates of platinum metals	689	$106,813	1,200	$30,000
Platinum grains and nuggets (including crude, dust, and residues)	[3] 27,567	[3] 2,104,555	46,262	3,443,958
Platinum sponge and scrap	[3] 4,305	[3] 386,172	795	70,211
Osmiridium	2,792	231,852	1,814	174,577
Total	[3] 35,353	[3] 2,829,392	50,071	3,718,746
Refined metals:				
Platinum	[3] 202,912	[3] 16,749,474	340,632	29,325,074
Palladium	200,502	4,169,556	227,080	4,548,460
Iridium	4,718	782,034	1,643	251,908
Osmium	594	137,698	583	67,126
Rhodium	6,151	688,067	12,224	1,314,571
Ruthenium	2,588	177,677	3,291	210,162
Total	[3] 417,465	[3] 22,704,506	585,453	35,717,301
Grand total	452,818	[3] 25,533,898	635,524	39,436,047

[1] On the basis of detailed information received by the Bureau of Mines from importers, certain items recorded by the U. S. Department of Commerce as "ores and concentrates" and "sponge and scrap" have been reclassified and included with other groups in this table.
[2] U. S. Department of Commerce categories are in terms of metal content. It is believed, however, that in many instances gross weights are actually reported.
[3] Revised figure.

TABLE 9.—Platinum-group metals exported from the United States, 1944–48 (average) and 1949–53 [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
1944–48 (average)	36	$2,440	11,546	$696,567	9,807	$428,078	5,233	$214,282
1949	165	1,985	18,150	1,379,976	22,628	745,349	20,702	452,824
1950	82	265	12,753	994,362	24,946	802,970	12,640	521,575
1951	732	117,500	8,760	834,985	52,088	1,355,514	17,348	932,085
1952			[2] 6,026	[2] 567,623	17,697	[2] 512,608	(3)	[2] 1,186,775
1953	30	580	2,522	237,853	23,206	591,439	(3)	1,555,046

[1] Quantities are gross weight.
[2] Revised figure.
[3] Beginning Jan. 1, 1952, quantity not recorded.

TABLE 10.—Platinum-group metals exported from the United States, 1952–53, 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, ruthenium, and osmium (metal and alloys, including scrap)		Platinum-group manufactures, except jewelry [2]
	Troy ounces	Value	Troy ounces	Value	Troy ounces	Value	Value
1952							
Austria			215	$20,000			
Brazil			186	20,825	480	$13,620	$5,519
Canada			[3] 1,385	[3] 141,173	983	[3] 52,419	[3] 862,813
Chile			45	5,128	16	390	2,442
Colombia			11	1,389	291	6,913	14,569
Cuba			34	3,323	266	6,783	3,395
France			1,378	120,595	374	19,810	3,663
Germany, West			1,561	145,150	11,578	299,130	10,347
Japan			160	14,880	24	1,580	400
Mexico			262	27,232	667	16,159	8,911
Spain			8	200	311	7,803	48,683
Switzerland					1,764	38,617	4,666
United Kingdom			639	57,741	139	22,281	8,872
Venezuela			46	2,703	208	5,543	7,592
Other countries			96	7,284	596	21,560	204,903
Total			[3] 6,026	[3] 567,623	17,697	[3] 512,608	[3] 1,186,775
1953							
Brazil			60	5,315	127	2,984	987
Canada			1,036	90,340	6,433	157,682	816,491
Chile			44	5,596	61	1,482	4,555
Colombia					386	9,093	25,223
Cuba			57	5,552	230	7,131	1,470
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
Japan					398	15,641	1,400
Mexico			176	18,754	464	10,881	12,712
Peru			57	5,236	67	2,350	6,763
Philippines			3	357	150	4,200	10,717
Spain					1,020	26,404	
Switzerland					321	7,054	856
United Kingdom	15	$290	249	22,481	95	14,313	598,162
Venezuela			96	9,490	313	7,211	4,129
Other countries	15	290	91	13,102	13	503	24,770
Total	30	580	2,522	237,853	23,206	591,439	1,555,046

[1] Quantities are in gross weight.
[2] Beginning Jan. 1, 1952, quantity not recorded.
[3] Revised figure.

WORLD REVIEW

Canada.—Nearly all of the output of platinum-group metals of Canada is obtained as a byproduct from nickel-copper ores mined in the Sudbury district in Ontario; a small quantity of crude platinum is recovered incidental to gold placer mining in British Columbia. According to the Dominion Bureau of Statistics, the total production in Canada in 1953 was 134,100 ounces of platinum and 161,600 of other platinum-group metals compared with 122,300 and 157,400 ounces, respectively, in 1952.

Deliveries of platinum-group metals by the International Nickel Co. of Canada, Ltd., were 270,600 ounces in 1953 compared with 287,100 ounces in 1952.

Favorable exploration results at a nickel-copper deposit containing significant quantities of platinum-group metals in the Kluane Lake district, Yukon Territory, discovered in 1952, were reported by the Hudson Bay Mining & Smelting Co., Ltd.[8]

Colombia.—The production of platinum-group metals in Colombia results from placer mining in the Choco district, mostly by dredging. The crude-platinum product for shipment averages about 85 percent platinum-group metals, principally platinum. The South American Gold & Platinum Co., which supplies most of the output, recovered 28,318 ounces of crude platinum in 1953 compared with 23,674 in 1952. Production figures for other sources were not available.

TABLE 11.—World production of platinum-group metals, 1944–48 (average) and 1949–53, in troy ounces [1]

[Compiled by Berenice B. Mitchell]

Country	1944–48 (average)	1949	1950	1951	1952	1953
Australia:						
Placer platinum	1	------	16	8	------	------
Placer osmiridium	100	39	48	33	51	59
Belgian Congo: Palladium from refineries	42	106	------	------	------	------
Canada:						
Platinum: Placer and from refining nickel-copper matte	[2] 140,700	153,784	124,571	153,483	122,317	134,108
Other platinum-group metals: From refining nickel-copper matte	[2] 175,569	182,233	148,741	164,905	157,407	161,550
Colombia: Placer platinum	38,872	20,797	26,445	[3] 32,000	[3] 33,700	28,977
Ethiopia: Placer platinum	708	373	641	266	100	566
Japan:						
Palladium from refineries	------	32	59	23	85	(4)
Platinum from refineries	299	68	151	245	484	997
New Guinea	------	4	------	5	2	6
New Zealand: Placer platinum	3	------	------	8	4	(4)
Papua: Placer platinum	------	------	(5)	[6] 2	5	------
Sierra Leone: Placer platinum	132	38	------	------	------	------
Union of South Africa:						
Platinum-group metals from platinum ores	22,630	30,470				
Concentrates (platinum-group metal content) from platinum ores	52,511	56,904	} 144,217	190,898	232,521	299,177
Osmiridium from gold ores	6,018	6,031	6,449	6,359	6,141	6,966
U. S. S. R.: Placer platinum and from refining nickel-copper ores (estimate)	150,000	100,000	100,000	100,000	100,000	100,000
United States: Placer platinum and from domestic gold and copper refining	27,113	24,807	37,855	36,951	34,409	26,072
Total (estimate)	620,000	575,000	600,000	675,000	675,000	750,000

[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 not included in the statistics for those years.
[3] Estimate.
[4] Data not available; estimate included in total.
[5] Less than 1 ounce.
[6] Year ended June 30 of year stated.

Union of South Africa.—Platinum-group metals are obtained in the Union of South Africa from two sources—as the principal product of underground mining operations on the Merensky reef (a horizon of the Bushveld igneous complex in the Transvaal) and as a byproduct of gold mining in the Rand district.

[8] Hudson Bay Mining & Smelting Co., Ltd., Annual Report to Stockholders: 1953.

All mining operations on the Merensky reef are carried on by Rustenburg Platinum Mines, Ltd., a coalition of several former producers. Recent expansions of mining and plant facilities of this company have resulted in a milling capacity approximating 1 million tons, annually. The potential annual output rate of platinum-group metals is around 400,000 ounces; copper and nickel are recovered as byproducts. A matte smelter for preliminary treatment of part of the increased output of matte has been under construction at Rustenburg in 1953. This plant, which is owned jointly by Johnson, Matthey & Co., Ltd., and Rustenburg Platinum Mines, Ltd., was expected to be ready for operation early in 1954.

During the past 15 years the output of osmiridium in the Rand has averaged around 6,000 ounces annually. The composition of the osmiridium is variable, but the metals contained range within the limits given below:

Metal:	*Range (percent)*
Osmium	44. 60–24. 13
Iridium	40. 55–21. 33
Ruthenium	16. 83– 8. 73
Platinum	18. 99– 3. 89
Gold	14. 94– . 05
Rhodium	1. 04– . 34

According to the Department of Mines the production of platinum-group metals in the Union of South Africa rose from 232,521 ounces in 1952 to 299,177 in 1953. The average analysis of 261,710 ounces of platinum-group metals exported from the Union in 1952 was reported as follows:[9] Platinum 66.27 percent, palladium 26.40, iridium 0.13, osmium and osmiridium 0.11, rhodium 2.39, ruthenium 1.34, and gold 3.36.

U. S. S. R.—The following views on the output of platinum-group metals in the Soviet Union were published in 1953:[10]

The production of platinum metals in Russia has been on the downgrade during the last four decades. Before the first world war, Russia was overwhelmingly the world's largest producer, averaging 208,000–224,000 f. oz. annually. During the inter-war period, 1922–1940, output averaged only about 122,000 f. oz. Since then the Urals production has declined steadily, and it is doubtful whether it exceeded 61,000 f. oz. by 1947. The increasing production of the Noril'sk mine in Eastern Siberia, however, has compensated for the decline of the Urals. Shimkin concludes that, as a result, total national output has varied little between 1941 and 1947, the probable range being from 124,000 f. oz. at the earlier to 144,000 f. oz. at the later date. However, at least 20 percent of the 1947 production consisted of the palladium characteristic of Noril'sk. This contrasts sharply with pre-war production, which was almost purely of platinum. The net effect of the downward trend in production, coupled with growing domestic requirements, will unquestionably be to reduce progressively Russia's importance as an exporter of platinum. On the other hand, Soviet platinum resources are almost certainly adequate to ensure self-sufficiently well beyond 1970.

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[9] Pretoria, Union of South Africa, Industrial Minerals Quarterly Report. Fourth Quarter 1953, p. 13.
[10] Mining Journal (London), vol. 241, No. 6158, Aug. 28, 1953, p. 244.

Potash

By E. Robert Ruhlman [1] and Gertrude E. Tucker [2]

DOMESTIC production of potash again reached a new high in 1953, and the total supply of potash (K_2O equivalent) available in the United States was nearly 2 million short tons. Large stock buildups, both domestic and foreign, caused some concern. Imports from Communist-dominated areas received considerable publicity.

TABLE 1.—Salient statistics of the potash industry in the United States, 1944–48 (average) and 1949–53

	1944–48 (average)	1949	1950	1951	1952	1953
Production of potassium salts (marketable)____short tons__	1,779,761	2,056,609	2,242,647	2,474,870	2,866,462	3,266,429
Approximate equivalent K_2O________short tons__	962,076	1,118,395	1,287,724	1,420,323	1,665,113	1,911,891
Sales of potassium salts by producers_______short tons__	1,783,189	2,062,789	2,221,920	2,451,913	2,757,252	2,965,986
Approximate equivalent K_2O________short tons__	962,648	1,120,653	1,276,164	1,408,408	1,598,354	1,731,607
Value at plant____________	$32,538,371	$35,105,799	$39,774,447	$44,788,880	$53,754,316	$59,620,083
Average per ton_________	$18.25	$17.02	$17.90	$18.27	$19.50	$20.10
Imports of potash materials short tons__	31,176	43,719	381,490	574,361	[1] 357,437	253,113
Approximate equivalent K_2O________short tons__	13,659	19,216	200,529	313,617	[1] 188,441	130,360
Value_____________________	$2,649,692	$2,358,557	$13,993,974	$18,543,112	[1] $12,714,434	$9,940,581
Exports of potash materials short tons__	124,572	126,757	117,137	124,211	101,200	88,208
Approximate equivalent K_2O [2]_______short tons__	67,988	69,558	65,047	68,654	56,281	49,109
Value_____________________	$7,586,353	$7,110,835	$5,534,176	$7,593,646	$4,836,659	$3,936,415
Apparent consumption of potassium salts [3] short tons__	1,689,793	1,979,751	2,486,273	2,902,063	[1] 3,013,489	3,130,891
Approximate equivalent K_2O________short tons__	908,319	1,070,311	1,411,646	1,653,371	[1] 1,730,514	1,812,858

[1] Revised figure.
[2] Estimate by Bureau of Mines.
[3] Quantity sold by producers, plus imports, minus exports.

PRODUCTION AND SALES

The upward trend in the production of domestic marketable potassium salts continued in 1953; it was 14 percent above the corresponding 1952 figure. Sales increased 8 percent above the previous year. The total value of sales was 11 percent more than in 1952.

Production of 60–62 percent muriate and sulfate of potash (including sulfate of potash-magnesia) increased 19 percent and 6 percent, respectively, in 1953 over 1952. Production of 48–50 percent muriate and manure salts decreased. The production of manure salts has

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

decreased from a high of 260,300 tons in 1948 to 4,600 tons in 1953. The output of high-analysis materials (60–62 percent K_2O minimum, including refined KCl and 93–96 percent KCl) was 90 percent of the total potassium salts produced in the United States.

California, New Mexico, and Utah continued to supply the major portion of the domestic production of potash. New Mexico supplied

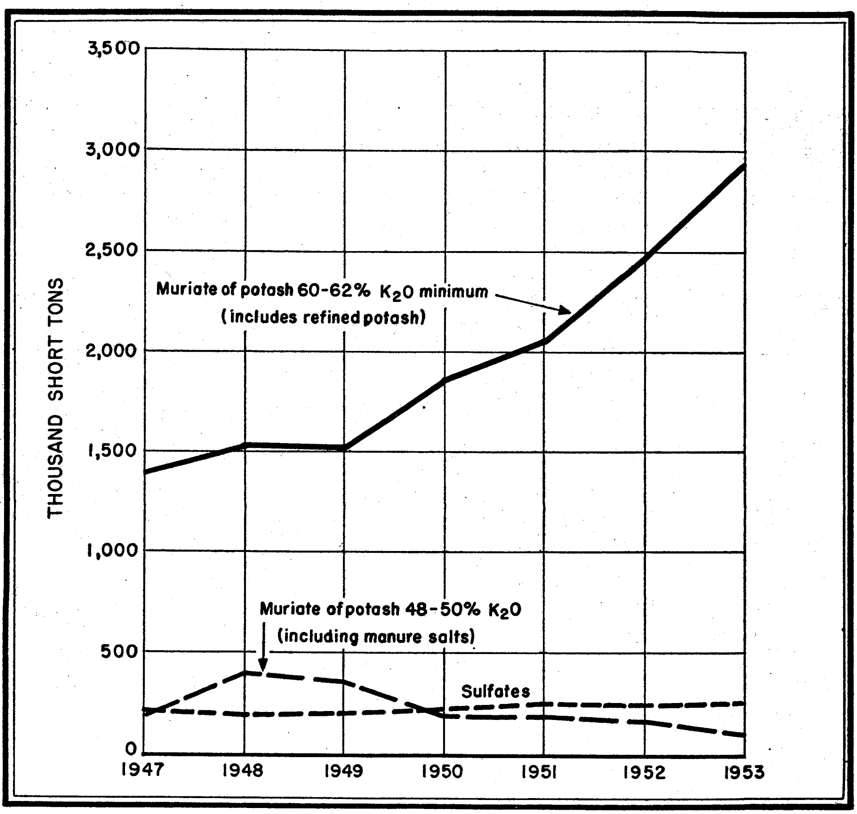

FIGURE 1.—Potassium salts produced in the United States 1947–53, by grades, in short tons.

90 percent of the domestic production. A small quantity continued to be produced in Maryland and Michigan.

TABLE 2.—Potassium salts produced in the United States, 1944–48 (average) and 1949–53, by grades, in short tons

Grade	1944–48 (average)	1949	1950	1951	1952	1953
Muriate of potash:						
60–62 percent K_2O minimum [1]	1, 284, 934	1, 513, 128	1, 846, 459	2, 047, 793	2, 468, 436	2, 926, 398
48–50 percent K_2O minimum	125, 056	172, 475	151, 547	155, 797	150, 959	81, 801
Manure salts	[2] 173, 235	177, 315	21, 532	19, 775	8, 409	4, 628
Sulfate of potash and sulfate of potash-magnesia	196, 536	193, 691	223, 109	251, 505	238, 658	253, 602
Total	1, 779, 761	2, 056, 609	2, 242, 647	2, 474, 870	2, 866, 462	3, 266, 429

[1] Includes refined potash, 1944–53, and some 93–96 percent KCl, 1946–53.
[2] Includes spillage of some higher grade salts in 1946.

TABLE 3.—Potassium salts produced, sold, and in producers' stocks in the United States, 1944–48 (average) and 1949–53

Year	Production			Sales				Producers' stocks, Dec. 31	
	Operators	Potassium salts (short tons)	Equivalent potash (K_2O) (short tons)	Operators	Potassium salts (short tons)	Equivalent potash (K_2O) (short tons)	Value f. o. b. plant	Potassium salts (short tons)	Equivalent potash (K_2O) (short tons)
1944–48 (average)	7	1,779,761	962,076	7	1,783,189	962,648	$32,538,371	57,599	25,585
1949	8	2,056,609	1,118,395	8	2,062,789	1,120,653	35,105,799	18,913	9,066
1950	7	2,242,647	1,287,724	7	2,221,920	1,276,164	39,774,447	39,640	20,620
1951	9	2,474,870	1,420,323	9	2,451,913	1,408,408	44,788,880	62,597	32,302
1952	10	2,866,462	1,665,113	10	2,757,252	1,598,354	53,754,316	[1] 170,608	[1] 98,244
1953	10	3,266,429	1,911,891	10	2,965,986	1,731,607	59,620,083	471,051	278,508

[1] Stock adjustment.

The potash-producing companies in the United States in 1953, by States, were as follows:

California:
American Potash & Chemical Corp., 3030 W. 6th St., Los Angeles 54, Calif. (plant at Trona, on Searles Lake, Calif.).
A. M. Blumer, 465 California St., San Francisco, Calif. (plant at Davenport, Calif.).

Maryland: North American Cement Corp., 41 East 42d St., New York 17, N. Y. (plant at Security, Md.).

Michigan: The Dow Chemical Co., Midland, Mich. (brine wells and plant near Midland, Mich.).

New Mexico (all mines and plants in New Mexico are near Carlsbad):
Duval Sulphur & Potash Co., 17th floor, Mellie Esperson Bldg., Houston 2, Tex.
International Minerals & Chemical Corp., 20 North Wacker Dr., Chicago, Ill.
Potash Company of America, Box 31, Carlsbad, N. Mex.
Southwest Potash Corp., Box 472, Carlsbad, N. Mex.
United States Potash Co., Inc., 30 Rockefeller Plaza, New York 20, N. Y

Utah: Bonneville, Ltd., 540 West 7th South, Salt Lake City 4, Utah (plant near Wendover, Utah).

Mine production of potash ores in New Mexico (over 9 million short tons, a new high) was 16 percent more than in 1952. The grade of ore produced was slightly higher in 1953—20.97 percent K_2O compared with 20.94 in 1952.

TABLE 4.—Production and sales of potassium salts in New Mexico, 1944–48 (average) and 1949–53, 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
1944–48 (average)	4,354,597	914,206	1,517,486	809,366	1,521,499	810,184	$26,919,294
1949	4,852,903	1,018,886	1,733,739	927,621	1,744,427	932,497	27,950,111
1950	5,802,004	1,198,021	1,904,565	1,086,996	1,878,094	1,072,772	31,944,365
1951	6,615,891	1,349,572	2,138,439	1,223,139	2,126,391	1,217,617	37,209,740
1952	7,852,732	1,644,034	2,530,596	1,468,029	2,439,042	1,411,125	46,385,452
1953	9,100,671	1,908,280	2,937,960	1,721,435	2,661,587	1,552,831	52,293,316

[1] Sylvite and langbeinite.

All 5 producing companies—Duval Sulphur & Potash Co., International Minerals & Chemical Corp., Potash Company of America, Southwest Potash Corp., and United States Potash Co., Inc.—mined sylvite (potassium chloride), and 1—International Minerals & Chemical Corp.—also mined langbeinite (potassium-magnesium sulfate). All 5 companies processed sylvinite, a mixture of halite and sylvite, to yield 60 percent or higher grade muriate. Potassium sulfate and potassium-magnesium sulfate were produced from langbeinite by the International Minerals & Chemical Corp. in its refinery near Carlsbad.

Expansion of potassium sulfate facilities at its Carlsbad plant by 35,000 tons per year was announced by International Minerals & Chemical Corp and scheduled for completion early in 1954.[3]

The Delhi Oil Co. was conducting an exploration program for potash near Moab, Utah. The salt beds in this area are reported to be over 3,500 feet below the surface.[4]

At the end of 1953 no decision had been announced by Freeport Sulphur Co. and the Farmers Union Service Corp. regarding development of potash deposits. Both companies completed diamond-drilling investigations during the year.

The Solvay Process Division of Allied Chemical & Dye Corp. announced plans for constructing a $2 million plant at Solvay, N. Y., to produce liquid, calcined, and hydrated potassium carbonate. The plant was scheduled for completion in 1954.[5]

CONSUMPTION AND USES

The apparent consumption of K_2O in 1953 (producers' sales plus imports minus exports) again was 5 percent more than during the previous year. The apparent consumption and sales of domestic producers, as reported to the Bureau of Mines, are shown in figure 2. The sales of domestic potash were 96 percent of apparent consumption compared with 92 percent in 1952 and 85 percent in 1951.

According to the American Potash Institute (press notice, March 18, 1954):

> Deliveries of potash in North America during 1953 amounted to 3,230,667 tons of salts containing an equivalent of 1,879,626 tons K_2O. This was an increase of 83,368 tons K_2O or 5% over 1952. Deliveries by the seven leading domestic producers were the highest ever achieved, 1,722,728 tons K_2O, an increase of 9% over last year. Imports were 156,898 tons K_2O, a 26% decrease under last year.
>
> Deliveries for agricultural purposes in the continental United States for 1953 were 1,663,242 tons K_2O, an increase of 70,662 tons over 1952. Canada received 72,501 tons K_2O, Cuba 4,509 tons, Puerto Rico 16,699 tons, and Hawaii 19,437 tons. Exports to other countries amounted to 1,742 tons K_2O
>
> In this country agricultural potash was delivered in 46 states and the District of Columbia. Illinois with over 204,000 tons K_2O was the leading state, followed in order by Ohio, Georgia, and Indiana, 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 95% of deliveries. The 60% muriate of potash continued to be by far the most popular material, comprising 90% of the total K_2O delivered for agricultural purposes. The 50% muriate of potash made up 3%, sulphate of potash and sulphate of potash-magnesia 7%, and manure salts an insignificant percentage of deliveries.

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[3] Chemical Engineering, vol. 60, No. 3, March 1953, p. 330; No. 4, April 1953, p. 148. The Mines Magazine, vol. 43, No. 1, January 1953, p. 44.
[4] The Mining Record (Denver), vol. 64, No. 48, Nov. 26, 1953, p. 3.
[5] Chemical Engineering, vol. 60, No. 7, July 1953, p. 145.

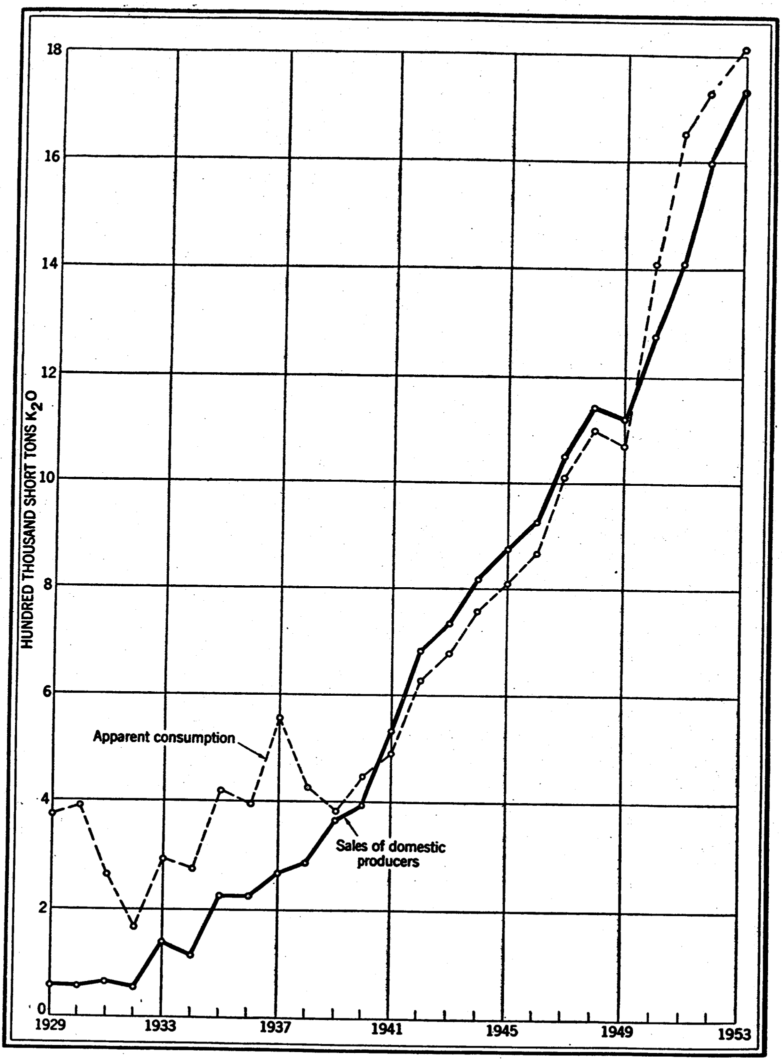

FIGURE 2.—Comparison of apparent domestic consumption of potash (K_2O) and sales of domestic producers of potash in the United States, 1929–53.

Deliveries for chemical purposes in 1953 were 152,869 tons of muriate of potash containing an equivalent of 96,156 tons K_2O and 10,544 tons of sulphate of potash containing 5,340 tons K_2O. The total chemical deliveries of 101,496 tons K_2O were 5% of all potash deliveries and 15,055 tons higher or 17% more than in 1952.

The deliveries of agricultural and chemical potash in North America from 1943 to 1953 are shown in figure 3, and the deliveries by States in 1953 are given in table 6.

In addition to the regular quarterly, semiannual, and annual releases, the American Potash Institute published a 17-year summary of statistics on the United States potash industry.[6]

[6] Turrentine, J. W., Some Statistics of the American Potash Industry: Am. Potash Inst., Mar. 30, 1953, 13 pp.

TABLE 5.—Apparent consumption[1] of potassium salts in the United States, 1944–48 (average) and 1949–53, in short tons

Year	Potassium salts	Approximate equivalent K_2O	Year	Potassium salts	Approximate equivalent K_2O
1944–48 (average)	1,689,793	908,319	1951	2,902,063	1,653,371
1949	1,979,751	1,070,311	1952 [2]	3,013,489	1,730,514
1950	2,486,273	1,411,646	1953	3,130,891	1,812,858

[1] Quantity sold by producers, plus imports, minus exports.
[2] Revised figures.

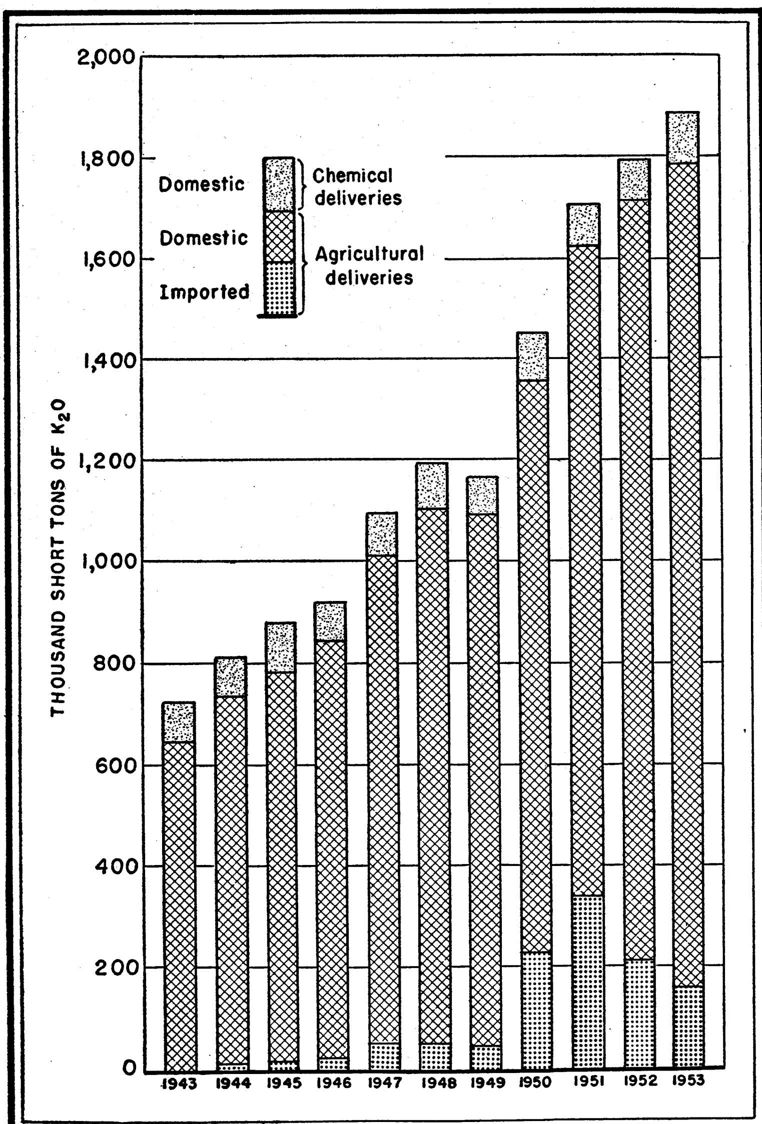

FIGURE 3.—Potash deliveries by use groups, in North America, 1943–53 (American Potash Institute).

TABLE 6.—Deliveries of potash salts in 1953, by States of destination, in short tons of K_2O

[American Potash Institute]

State	Agricultural potash	Chemical potash	State	Agricultural potash	Chemical potash
Alabama	51,625	72	Nebraska	2,278	----------
Arizona	435	----------	Nevada	----------	2,967
Arkansas	39,462	----------	New Hampshire	18	----------
California	13,293	4,771	New Jersey	37,153	1,918
Colorado	774	----------	New Mexico	56	----------
Connecticut	4,569	150	New York	30,290	65,494
Delaware	5,810	702	North Carolina	92,090	12
District of Columbia	235	----------	North Dakota	2,222	----------
Florida	98,868	3	Ohio	158,062	3,558
Georgia	121,299	120	Oklahoma	2,815	275
Idaho	367	----------	Oregon	3,042	223
Illinois	204,170	1,894	Pennsylvania	39,949	1,317
Indiana	116,244	571	Rhode Island	1,266	----------
Iowa	35,856	345	South Carolina	57,577	----------
Kansas	2,683	180	South Dakota	34	----------
Kentucky	35,806	101	Tennessee	58,140	----------
Louisiana	25,193	277	Texas	26,538	6,336
Maine	8,787	63	Utah	426	254
Maryland	69,110	777	Vermont	519	----------
Massachusetts	16,812	148	Virginia	97,200	138
Michigan	39,812	977	Washington	4,819	382
Minnesota	40,886	----------	West Virginia	1,105	5,487
Mississippi	27,526	----------	Wisconsin	50,973	50
Missouri	36,984	1,037			
Montana	64	----------	Total	1,663,242	100,599

STOCKS

Stocks reported by producers at the close of 1953 were 176 percent more than the 1952 figure and 7 times the 1951 figure. Outside storage by some producers was necessary to accommodate the large stocks.

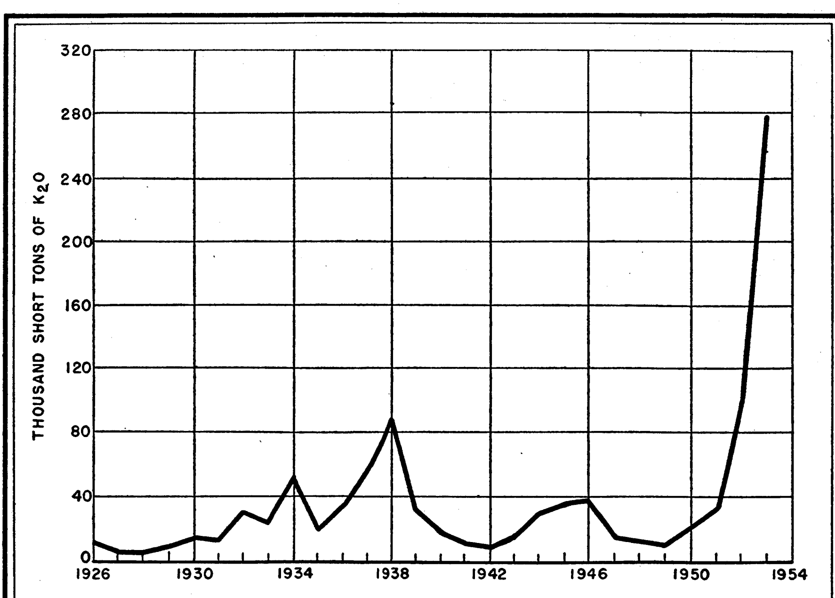

FIGURE 4.—Producers' stocks of potassium salts at end of year, 1926–53, in short tons of equivalent potash (K_2O).

Producers' stocks (K_2O equivalent) on hand at year end since 1926 are shown graphically in figure 4. The data for 1944–48 (average) and 1949–53 are included in table 3.

PRICES

Price controls for agricultural-grade potash were abolished by the Office of Price Stabilization early in March 1953. No industry-wide price changes resulted from this action.

The American Potash & Chemical Corp. issued its price schedule for agricultural-grade Trona potash for the 1953–54 season on April 7, 1953. A supplementary price schedule was issued on May 6 announcing changes in allowable discounts. The price for muriate of potash, 60 percent K_2O minimum, f. o. b. Trona, Calif., in bulk, in carlots of not less than 40 tons, was quoted at 53 cents per unit K_2O. The price for Trona sulfate of potash, f. o. b. Trona, Calif., 95–98 percent K_2SO_4, in bulk, in carlots of not less than 40 tons, was 88.5 cents per unit K_2O.

The list prices of both muriate and sulfate were subject to seasonal discounts. There were additional charges for shipments in bags.

Price schedules for New Mexico potash for agricultural purposes for 1953–54 were issued in April and May 1953 as shown in table 7.

TABLE 7.—Prices of agricultural potash quoted by producers, f. o. b. Carlsbad, N. Mex., for 1953–54 season [1]

Salt	Grade	Brand	Producer	(June 1–May 31) Price per unit K_2O
Muriate of potash	62–63 percent K_2O	Sunshine State	U. S. P.	$0.43
Do	60 percent K_2O minimum, standard.	Red Muriate	P. C. A.	.43
Do [2]	60 percent K_2O minimum	International	I. M. & C.	.43
Do	do	High-K	S. W. P. C.	.43
Do	do	Duval Muriate of Potash.	D. S. & P. C.	.43
Do	60 percent K_2O granular	Red Muriate	P. C. A.	.45
Do	59–61 percent K_2O granular	Sunshine State	U. S. P.	.435
Do [3]	50 percent K_2O minimum	International	I. M. & C.	.42
Manure salts	22 percent K_2O minimum	Red Muriate	P. C. A.	.21
Do	Run-of-mine 20 percent K_2O minimum.	Sunshine State	U. S. P.	.21
Do	Run-of-mine 22 percent K_2O minimum.	High-K	S. W. P. C.	.21
Sulfate of potash	49–51 percent K_2O minimum	International	I. M. & C.	.745
Sulfate of potash-magnesia	22 percent K_2O–18 percent MgO.	International Sulpo-mag.	do	[4] 16.00

[1] Bulk in carlots (minimum 40 tons). Subject to seasonal discounts.
[2] International Minerals & Chemical Corp. quoted muriate of potash, 60–61 percent K_2O, packed in 5-ply bags, 100 lb. each, at $30.25 per short ton, June 1–May 31.
[3] International Minerals & Chemical Corp. quoted granular muriate of potash, 50–51 percent K_2O, packed in 5-ply paper bags, 100 lb. each, at $25.70 per short ton, June 1–May 31.
[4] Per short ton.

FOREIGN TRADE [7]

Imports.—The imports of fertilizer and chemical potash materials again decreased in 1953 and were nearly 30 percent less than in 1952. The average value per ton of imports of fertilizer-grade potash materials at the port of origin was $30.77, approximately $1 more than the

[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 8.—Potash materials imported for consumption in the United States, 1952–53

[U. S. Department of Commerce]

Material	Approximate equivalent as potash (K_2O) (percent)	1952				1953			
		Short tons	Approximate equivalent as potash (K_2O)		Value	Short tons	Approximate equivalent as potash (K_2O)		Value
			Short tons	Percent of total			Short tons	Percent of total	
Used chiefly in fertilizers:									
Muriate (chloride)	56.4	[1]281,179	[1]158,585	[1]84.2	$7,538,286	175,545	99,007	76.0	$4,579,131
Potassium nitrate, crude	40.0	[1]12,738	[1]5,095	[1]2.7	[1]537,804	15,941	6,376	4.9	852,590
Potassium-sodium nitrate mixtures, crude	14.0	16,460	2,304	1.2	830,693	12,516	1,752	1.3	626,149
Potassium sulfate, crude	50.0	40,262	20,131	[1]10.7	1,493,534	37,993	18,997	14.6	1,388,286
Total fertilizer		[1]350,639	[1]186,115	98.8	[1]10,400,317	241,995	126,132	96.8	7,446,156
Used chiefly in chemical industries:									
Bicarbonate	46.0	65	30		16,026	11	5		3,080
Bitartrate:									
Argols	20.0	3,393	679		754,429	5,331	1,066		462,613
Cream of tartar	25.0	424	106		189,640	512	128		177,880
Carbonate	61.0	171	104		26,150	1,544	942		178,901
Caustic	80.0	74	59		32,333	179	143		65,830
Chlorate and perchlorate	36.0	741	267		245,650	101	36		26,182
Chromate and dichromate	40.0	1	(2)	1.2	234	1	(2)	3.2	432
Cyanide	70.0	909	636		735,390	1,404	983		1,033,185
Ferricyanide	42.0	178	75		129,883	287	121		192,239
Ferrocyanide	44.0	8	3		6,874	449	198		173,877
Nitrate	46.0	519	239		59,190	1,005	462		106,378
Permanganate	29.0	136	39		56,819	15	4		6,932
Rochelle salts	22.0	2	(2)		813	-------	-------		-------
All other	50.0	177	89		60,686	279	140		66,896
Total chemical		6,798	2,326	1.2	2,314,117	11,118	4,228	3.2	2,494,425
Grand total		[1]357,437	[1]188,441	100.0	12,714,434	253,113	130,360	100.0	9,940,581

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

1952 average. Details on imports by country of origin are given in table 9. The principal supplying countries were West Germany, East Germany, France, Spain, and Chile.

Imports of fertilizer-grade potash materials constituted 96 percent of total imports compared with 98 percent in 1952.

The average K_2O content of potash imports declined about 1 percent from the 1952 average. Muriate, the principal potash salt imported in 1953, came mainly from East Germany, West Germany, Spain, and France. The imports of potassium sulfate came mostly from West Germany and France. Potassium-sodium nitrate imports from Chile were 24 percent less than in 1952.

Imports of potash from Communist-dominated areas were discussed in considerable detail during 1953.[8] The Subcommittee on

[8] Engineering and Mining Journal, vol. 154, No. 5, May 1953, p. 160.
Oil, Paint and Drug Reporter, vol. 163, No. 14, Apr. 6, 1953, p. 3; No. 17, Apr. 27, 1953, pp. 3, 82; No. 24, June 15, 1953, pp. 3, 45; vol. 64, No. 7, Aug. 17, 1953, pp. 3, 78.
New York Times, vol. 102, No. 34,786, Apr. 21, 1953, p. C-3.
Rock Products, vol. 56, No. 8, August 1953, p. 70.

TABLE 9.—Potash materials imported for consumption in the United States, 1952–53, by countries, in short tons

[Figures in parentheses in column headings indicate, in percent, approximate equivalent as potash (K_2O)
[U. S. Department of Commerce]

Country	Bitartrate		Carbonate (61)	Caustic (hydroxide) (80)	Chlorate and perchlorate (36)	Cyanide (70)	Muriate (chloride) (56.4)	Potassium nitrate, crude (40)	Potassium sodium nitrate mixtures, crude (14)	Potassium sulfate, crude (50)	All other [1]	Total	
	Argols or wine lees (20)	Cream of tartar (25)										Short tons	Value
1952													
Algeria	1,983											1,983	$432,981
Belgium-Luxembourg						18	(2)				165	[3] 183	[3] 116,118
Brazil	17											17	3,939
Canada					3						(4)	3	3,226
Chile	112				39			11,354	16,460			27,965	1,307,295
Czechoslovakia						68						68	47,350
France	708	23	6			13	[3] 69,199			3,702	68	[3] 73,719	[3] 2,641,654
French Morocco	387											387	76,517
Germany:													
East							90,999			5,817	55	96,871	2,459,871
West			164			561	80,491	[3] 1,384		30,743	507	[3] 113,850	[3] 3,900,727
Hong Kong			1									1	559
India											(4)	(4)	42
Italy	21	225				51					1	298	139,939
Japan											25	25	9,706
Netherlands		(4)				12		(2)			200	[3] 212	[3] 114,593
Portugal	165	6										171	37,307
Spain		166					40,490					40,656	983,694
Sweden				74	16						28	118	39,046
Switzerland		1			683	9						693	236,255
United Kingdom		3				177					37	217	163,615
Total	3,393	424	171	74	741	909	[3] 281,179	[3] 12,738	16,460	40,262	1,086	[3] 357,437	[3] 12,714,434
1953													
Algeria	2,743											2,743	230,245
Belgium-Luxembourg				(4)		12				100	206	318	160,297
Canada				(4)	1		2	4				7	307
Chile					41				12,516			12,557	637,485
Czechoslovakia						62						62	41,494
France	1,605	1	11	11		77	37,726			10,843	72	50,346	1,742,271
French Morocco	21											21	17,033
Germany:													
East							49,018			3,857	6	52,881	1,440,230
West			1,533	20		689	45,048	15,937		23,193	1,049	87,469	3,631,648
Italy	469	283				4					6	762	157,059
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
Tunisia	284											284	16,762
United Kingdom				(4)		543	1,159				27	1,729	474,798
Total	5,331	512	1,544	179	101	1,404	175,545	15,941	12,516	37,993	2,047	253,113	9,940,581

[1] Approximate equivalent as potash (K_2O)—1952: 40 percent; 1953: 40 percent.
[2] Revised to none.
[3] Revised figure.
[4] Less than 1 ton.

Fertilizer and Farm Machinery of the Committee on Agriculture, United States House of Representatives, conducted hearings on this subject on April 20 and June 9, 1953. The report and conclusions of the subcommittee were published.[9]

[9] Committee on Agriculture, House of Representatives, Hearing Before the Subcommittee on Fertilizer and Farm Machinery, 83d Cong., 1st sess., Serial F, 1953, 108 pp.
Committee on Agriculture, House of Representatives, Subcommittee on Fertilizer and Farm Machinery, Imports of Potash—Report and Conclusions: 83d Cong., 1st sess., Committee print, 1953, 3 pp.

Exports.—Exports of potash materials again decreased in 1953 and were 13 percent less than in the previous year. About 98 percent of the exports went to countries in the Western Hemisphere. Canada, Cuba, and Mexico were the major recipients of the potash exports.

TABLE 10.—Potash materials exported from the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Year	Fertilizer		Chemical		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1944–48 (average)	103,736	$3,172,051	20,836	$4,414,302	124,572	$7,586,353
1949	111,156	3,818,006	15,601	3,292,829	126,757	7,110,835
1950	107,972	3,813,000	9,165	1,721,176	117,137	5,534,176
1951	109,139	4,023,434	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

TABLE 11.—Potash materials exported from the United States, 1952–53, by countries of destination

[U. S. Department of Commerce]

Country	Fertilizer				Chemical			
	1952		1953		1952		1953	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Argentina					364	$118,818	25	$25,000
Australia					12	7,080	11	9,067
Belgium-Luxembourg					67	14,616	35	10,261
Brazil	3,396	$196,707	668	$36,252	884	221,696	43	40,962
Canada	75,384	2,587,597	69,333	2,397,369	2,910	459,857	3,379	539,115
Chile					100	21,398	81	21,988
Colombia	50	1,410	150	4,860	218	58,946	218	54,729
Costa Rica	5	311			28	7,791	30	7,916
Cuba	11,232	343,809	9,063	299,732	292	84,779	145	38,340
Dominican Republic	675	27,424	25	1,619	4	1,041	5	1,339
Ecuador			33	1,107	15	4,485	18	5,156
El Salvador	100	3,641	150	4,513	19	6,696	18	6,058
France					161	64,795		
Germany, West					43	11,228		
Greece					8	4,293	(1)	138
Guatemala					94	24,247	75	18,142
Honduras	105	3,627			9	2,691	6	2,135
India					23	4,866	43	4,372
Italy					103	17,418	59	19,625
Japan					28	5,632		
Mexico	2,247	81,286	2,227	71,999	438	112,671	193	61,585
Netherlands					33	9,570		
New Zealand					12	2,252	1	542
Norway					13	4,129	3	814
Pakistan					33	21,673	7	6,308
Peru					36	11,674	20	8,355
Philippines	753	36,219	1,387	54,414	85	32,260	133	41,723
Portugal					33	13,512	9	3,664
Switzerland	330	16,221			12	3,618	5	2,550
Turkey					36	11,427		
Union of South Africa					121	37,658	35	27,547
United Kingdom					36	28,489	10	22,302
Uruguay					20	4,938	6	1,530
Venezuela	292	15,546	325	18,939	118	36,164	132	35,706
Other countries	109	6,891	51	3,142	114	43,562	51	25,500
Total	94,678	3,320,689	83,412	2,893,946	6,522	1,515,970	4,796	1,042,469

[1] Less than 1 ton.

TECHNOLOGY

Two papers dealing with potash, presented at the Short Course in Fertilizer Technology at the University of Maryland, College Park, Md., were published.[10] The paper by Reed gave an historical account of world potash production, a description of the potash minerals, and the potash resources of the United States and other countries. Harley described the operations of companies in New Mexico, California, Utah, and Michigan and discussed processes for obtaining potash from alunite, wyomingite, greensand, kelp, and other potash-bearing materials.

The high degree of mechanization in the Carlsbad potash mines was illustrated in an article describing the operations at the mine of Duval Sulphur & Potash Co. The methods of tramming, crushing, and hoisting the ore were described. The mechanical equipment for handling the ore at the bottom of the shaft is shown in figure 5. Similar arrangements are used at several other mines in this area.[11]

The refining processes used in the French potash field, based on the varying solubility of potassium chloride with temperature changes, were discussed. The average analysis is 25–35 percent KCl, 55–65 percent NaCl, and 10 percent insoluble. The principal insoluble impurities are clay, shale, and anhydrite. Little or no magnesium salts are present in the French potash.[12]

The St. Gobain process for manufacturing complete high-analysis fertilizers, a nitric acid process, has been in use in French plants for 11 years and produces complete fertilizers containing 11 to 20 percent K_2O.[13]

Vraic or seaweed is an important fertilizer on the Channel Islands. Here, the seaweed is collected throughout the whole year and spread over the fields. In addition to the plant-food content, seaweed provides trace elements and acts as a soil conditioner.[14]

The 124th national meeting of the American Chemical Society at Chicago on September 6 to 11 included a 3-day symposium on Fertilizer Technology and Soil Chemistry. One paper presented described the chemical principles involved in beneficiating and processing of potash ore.[15]

Potash was the subject of a daylong symposium at the annual meeting of the American Institute of Mining and Metallurgical Engineers, Los Angeles, Calif., February 16–19, 1953. The subjects included geology, mining, processing, and economics and were presented by industry representatives from New Mexico and California.

Refinery operations at the plant of the Duval Sulphur & Potash Co., begun late in 1951, were described. At this plant the sylvite

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[10] Reed, J. F., Potash Resources in the United States in Relation to World Supplies (chap. in Jacob, K. D., Fertilizer Technology and Resources in the United States): Academic Press, Inc., New York; Agronomy, vol. 3, 1953, pp. 257–286.
Harley, G. T., Production and Processing of Potassium Minerals (chap. in Jacob, K. D., Fertilizer Technology and Resources in the United States): Academic Press, Inc., New York; Agronomy, vol. 3, 1953, pp. 287–322.

[11] Link-Belt Co., Potash Mined in Big Way Near Carlsbad, N. Mex.: Link-Belt News, vol. 20, No. 9, November–December 1953, pp. 1–3.

[12] Chemical and Process Engineering (London), Potash Refining in France: Vol. 34, No. 4, April 1953, pp. 98–99, 102.

[13] General Industrial Corp., The St. Gobian Process: Farm Chem., vol. 116, No. 2, February 1953, pp. 31, 33, 35, 37.

[14] Jepson, S., Father Neptune's Compost: Farm Chem., vol. 116, No. 4, April 1953, pp. 41–42, 46.

[15] Turrentine, J. W., Chemistry as Applied in Potash Refining: Paper presented at Am. Chem. Soc. meeting, Chicago, Ill., Sept. 6–11, 1953.

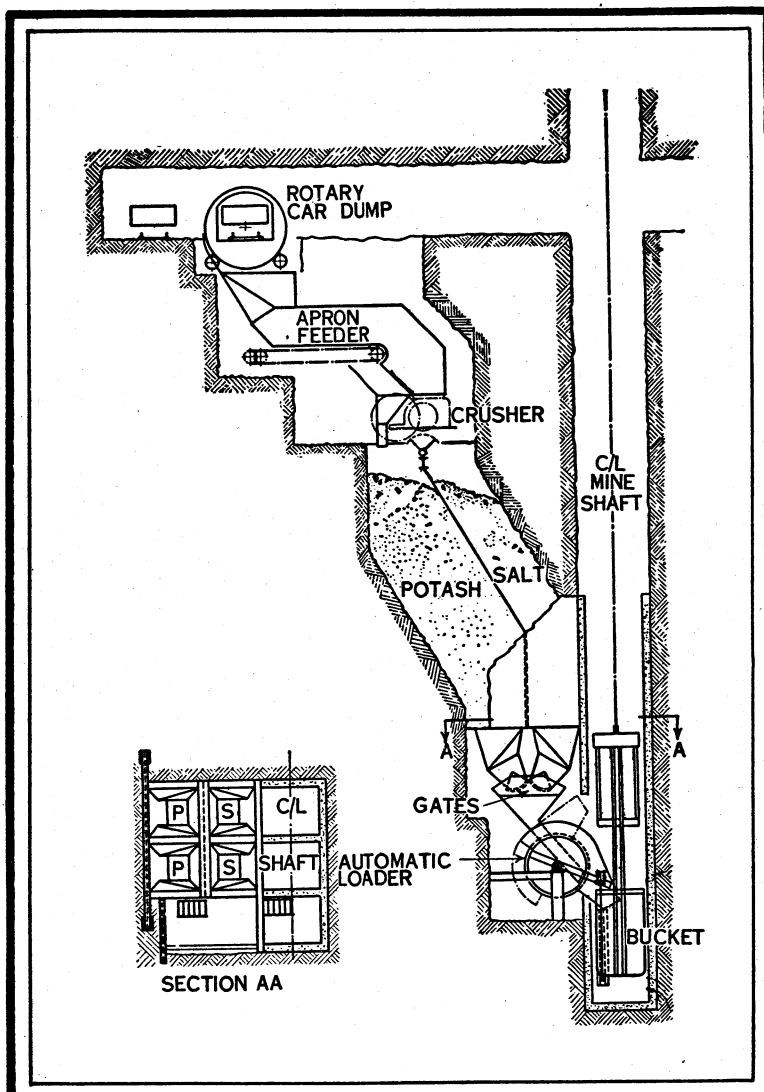

FIGURE 5.—Diagram of shaft-bottom mechanical handling equipment and storage pockets.
(Courtesy, Link-Belt Co.)

(KCl) is floated from the remainder of the ore (halite and clay) to produce a 60-percent K_2O muriate. Features include close temperature control and improved flotation reagents.[16]

Long-range soil improvement by utilization of rock dusts received increased attention during 1953. Rocks such as granite, basalt, greensands, and shales contain 3 to 10 percent K_2O and appreciable

[16] Atwood, G. E., and Bourne, D. J., Process Development and Practice of the Potash Division of the Duval Sulphur & Potash Co.: Trans. AIME, vol. 196, No. 11, Nov. 5, 1953, pp. 1099–1104.

quantities of numerous minor fertilizer elements. Experiments were conducted using various types of rock from many locations in the United States, and the results were tabulated.[17]

A leadless storage battery with caustic potash electrolytes was developed by the Alkaline Battery Corp. This battery, named the ABC Alkaline Battery, is made of iron, nickel, and caustic potash.[18]

Laboratory experiments on fusion of langbeinite with phosphate rock gave encouraging results, and a pilot plant was built to study further the resulting fertilizer product. The fused fertilizer from the pilot plant analyzed 13 percent K_2O, 13 percent P_2O_5, 11 percent magnesia, and 1.6 percent fluorine. Preliminary economic studies have indicated that this process might be competitive with other fertilizer manufacturing processes.

Polyhalite also was used, but results were not favorable.[19]

WORLD REVIEW

NORTH AMERICA

Canada.—Canada Southern Oils, Ltd., reported potash intersections during oil-well drilling in west central Saskatchewan at a depth of about 3,800 feet.[20]

Liberal Petroleums, Ltd., of Calgary, Alberta, announced discovery of a 25-foot potash bed in the Palo area 3,800 feet below the surface. This company has exploration permits for 100,000 acres.[21]

The Potash Company of America planned to continue prospecting in the Patience Lake area, east of Saskatoon, according to an agreement with the Saskatchewan Department of Mineral Resources that became effective November 1, 1953. The agreement stipulated that $220,000 be spent on exploration on 100,000 acres of land during a 3-year period and that the company begin sinking a shaft by May 1, 1956. Since the Potash Company of America began the exploration program early in 1952 the company has held 10 prospecting permits covering nearly 1,000,000 acres in the Saskatchewan, Watrous, Quill Lake, and Yorkton districts.[22]

Western Potash Corp., Ltd., reported that its shaft had reached a depth of 160 feet by the end of 1953. Considerable difficulty was encountered in penetrating the overburden. A 10-foot bed of quicksand was intersected 16 feet below the surface. Sinking was temporarily stopped at 160 feet to freeze the ground about 150 feet below this station, where the Ribstone Creek formation, some 40 feet thick, was known to have a high water content under pressure. A freezing method was ascertained to be the most economical means of sinking through this formation. In all, 36 holes were drilled, and a 50-ton-per-day ammonia plant was installed. Brine circulation was begun

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[17] Keller, W. D., Potash Agstones as Possible Aids to Soil Improvement: Pit & Quarry, vol. 45, No. 11, May 1953, pp. 90–93, 116.
Rodale, Robert, Rock Can Feed the Soil: Pit & Quarry, vol. 45, No. 7, January 1953, pp. 93–95, 98.
Rock Products, Rock Dust as Fertilizer: Vol. 56, No. 8, August 1953, p. 178.
[18] Chemical and Engineering News, vol. 31, No. 45, Nov. 9, 1953, p. 4682.
[19] Bridger, G. L., and Boylan, D. R. Production of Fertilizer From Phosphate Rock by Fusion With Magnesium and Potassium Sulfates: Ind. Eng. Chem., vol. 45, No. 3, March 1953, pp. 646–652.
[20] Rock Products, New Potash Discovery: vol. 56, No. 3, March 1953, p. 66.
[21] Commercial Fertilizer, vol. 86, No. 1, January 1953, p. 48.
[22] Canadian Mining Journal, vol. 2, No. 74, February 1953, pp. 67–68.
Chemical Age (London), Search for Potash: Vol. 69, No. 1787, Oct. 10, 1953, p. 762.
Mining World, vol. 15, No. 12, November 1953, p. 89.
Northern Miner, vol. 39, No. 26, Sept. 17, 1953, pp. 17, 21.
Western Miner and Oil Review, New Potash Development: Vol. 26, No. 12, December 1953, p. 82.

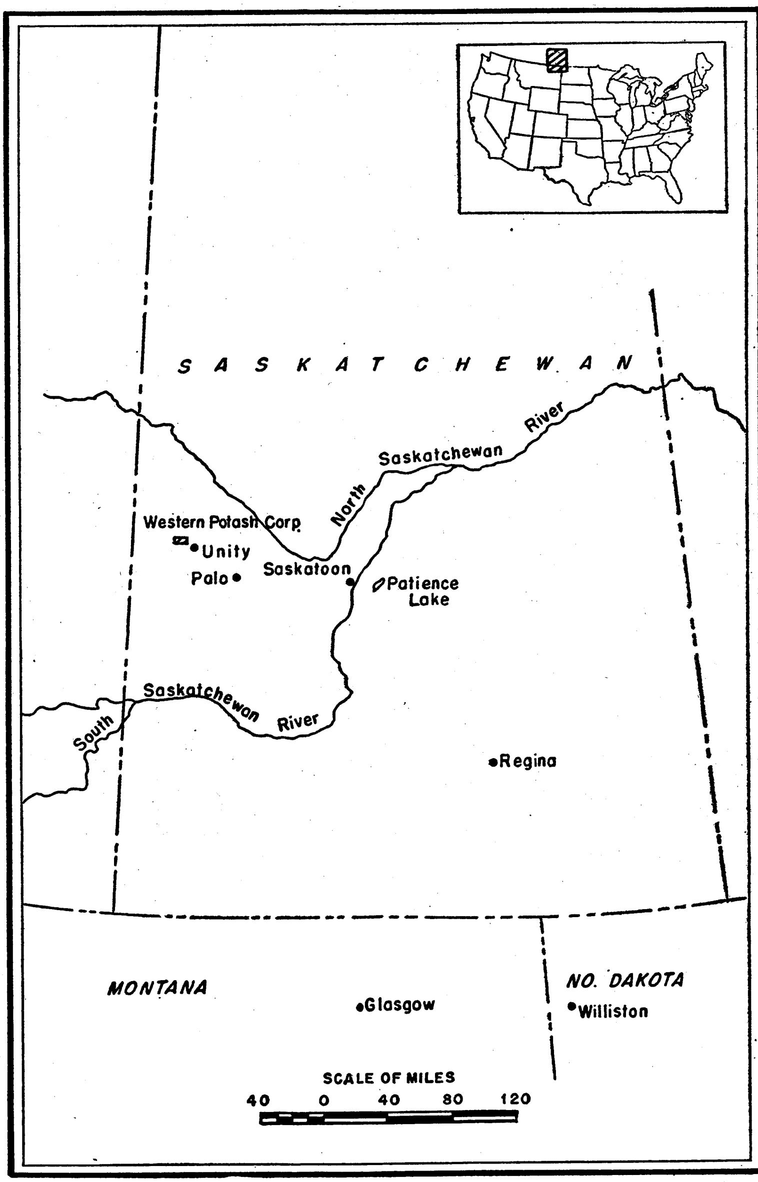

FIGURE 6.—Location of Canadian potash occurrences.

in October, and sinking was expected to resume early in 1954. The shaft is 12½ feet in diameter and lined with reinforced concrete. Western Potash held exploration permits covering nearly 340 square miles, and indicated reserves were estimated at more than 1 billion tons of minable ore.[23]

[23] Northern Miner, vol. 38, No. 45, Jan. 29, 1953, p. 25; No. 51, Mar. 12, 1953, p. 11; vol. 39, No. 14, June 25, 1953, p. 19.
Dawson, A. S., A Pioneering Potash Development: West. Miner and Oil Rev., vol. 26, No. 11, pp. 86–88.

TABLE 12.—World production of potassium salts and equivalent K_2O, by countries,[1] 1944–48 (average) and 1949–53, in metric tons [2]

[Compiled by Helen L. Hunt]

Country [1]	1944–48 (average) equivalent K_2O	1949		1950		1951		1952		1953	
		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	872,776	1,865,715	1,014,586	2,034,485	1,168,197	2,245,153	1,288,489	2,600,397	1,510,557	2,963,239	1,734,429
South America: Chile	[3] 1,407	5,020	1,422	(4)	1,442	(4)	(4)	(4)	(4)	(4)	(4)
Europe:											
France (Alsace)	500,456	5,285,649	798,510	5,859,342	902,264	5,518,800	987,600	6,238,000	1,055,000	5,850,000	1,030,800
Germany:											
East	} 1,229,321	{ (4)	1,098,000	(4)	1,251,000	(4)	1,639,000	(4)	1,803,000	(4)	[5] 1,900,000
West		7,290,000	748,800	8,927,219	1,094,286	10,847,520	1,323,913	12,585,300	1,553,700	[5] 12,075,000	[5] 1,520,000
Spain	189,539	918,156	151,542	1,013,333	161,619	1,058,884	172,870	1,215,636	181,086	1,052,376	181,356
Asia:											
India	2,235	6,456	3,048	5,589	2,743	5,296	2,642	8,519	4,267	(4)	(4)
Israel	[6] 42,253	----	----	----	----	----	----	----	----	5,164	3,098
Japan	[5] 51	3,544	213	3,396	203	3,897	[5] 230	2,614	157	(4)	(4)
Africa: Eritrea	----	420	203	555	264	----	----	----	----	----	----
Australia:											
New South Wales	47	436	33	406	30	456	34	319	24	----	----
Western Australia	494	32,782	1,471	919	84	----	----	----	----	----	----
Total (estimate)	2,966,000	----	4,000,000	----	4,800,000	----	5,700,000	----	6,400,000	----	6,700,000

[1] In addition to countries listed, China, Ethiopia, Italy, Korea, and U. S. S. R., are reported to produce potash salts, but statistics of production are not available; estimates by senior author of chapter included in totals.
[2] This table incorporates a number of revisions of data published in previous Potash chapters.
[3] Average for 1947–48.
[4] Data not available; estimate by author of chapter included in total.
[5] Estimate.
[6] Formerly Palestine.

SOUTH AMERICA

Brazil.—The Brazilian Department of Mineral Production investigated the potash deposits at Camisao, Bahia; Monteiro, Paraiba; and Pocos de Caldas, Minas Gerais. It was reported the deposits at Pocos de Caldas contain 20 million metric tons of ore assaying 10 to 14 percent K_2O.[24]

EUROPE

The International Potash Institute, formed in 1953 by the Société Commerciale des Potasses d'Alsace of France and Verkaufsgemeinschaft deutscher Kaliwerk G. M. B. H. of Germany, held its first meeting at Berne, Switzerland, July 21–22, 1953. The meeting was attended by agronomists and research workers from several European countries. The purpose of the institute was to "collect and disseminate published data on all problems relating to soils and fertilizers with particular reference to the potassium nutrition of crops." [25]

TABLE 13.—Exports of potash materials from France, 1950–52, by countries of destination in short tons [1] [2]

[Compiled by John E. McDaniel]

Country	1950	1951	1952
North America:			
Canada	27,240	21,911	20,975
Cuba	10,366	6,232	9,019
United States	55,506	74,219	70,363
South America:			
Argentina		380	147
Brazil	20,737	18,337	16,892
Colombia		11,822	3,142
Europe:			
Austria	18,432	18,632	14,323
Belgium-Luxembourg	168,595	105,769	185,555
Denmark	57,553	27,788	16,905
Finland		9,796	10,196
Italy	34,794	33,367	19,441
Netherlands	245,988	195,322	227,490
Norway	29,862	12,486	17,653
Sweden	49,522	21,677	26,731
Switzerland	30,889	29,883	27,570
United Kingdom	208,150	170,904	131,832
Yugoslavia	252	7,186	5,022
Asia:			
Ceylon	13,197	21,158	9,762
China	6,568	7,379	
India and Burma	2,675	7,203	
Japan	86,234	50,007	60,130
Philippines		3,178	
Africa: Algeria	21,939	25,224	16,359
Oceania: Australia and New Zealand	27,925	20,583	32,818
Other countries	70,606	67,283	59,201
Total	1,187,030	967,726	981,526

[1] Compiled from Customs Returns of France. Figures include salts, carbonate, chloride and nitrate of potash.
[2] This table incorporates a number of revisions of data published in the 1952 Potash chapter.

France.—Decreased sales resulted in production cutbacks and temporary suspension of the expansion program in the potash industry. Officials were hopeful that the program of the International Potash Institute would help bolster sales, especially in southeast Asia.[26]

[24] Chemical Age (London), Fertilisers in Brazil. vol. 70, No. 1803, Jan. 30, 1954, p. 315.
[25] Chemical and Engineering News, vol. 31, No. 29, June 29, 1953, p. 2698.
Fertiliser and Feeding Stuffs Journal (London), International Potash Institute, vol. 39, No. 16, Aug. 5, 1953, p. 587.
[26] Chemical Age (London), vol. 69, No. 1776, July 25, 1953, pp. 167–168.
Chemical and Engineering News, vol. 31, No. 29, June 29, 1953, p. 2698; No. 43, Oct. 26, 1953, p. 4437.

Seven plants operated during 1952 producing muriate of potash (60 percent K_2O and 50 percent K_2O), potash manure (40 percent K_2O), sylvinite (18 percent K_2O), and sulfate of potash (48 percent K_2O).[27]

The exports of potash materials from France were slightly higher in 1952 than in 1951. The data for 1953 are not yet available. European countries received 70 percent of the potash exports.

West Germany.—The West German potash industry continued its expansion program despite lower sales and increased stocks.

The Neuhof works in the Fulda district, idle since the 1920's, was being rehabilitated by Wintershall A. G. at an estimated cost of $2½ million. The Bergmannssegen-Hugo works continued to produce 4,000 tons per day, and the Herfa-Neurode plant was being expanded to the same capacity.[28] Underground flotation was reported at the Riedel mine of Burbach.[29]

Exports of potash materials from West Germany, by countries of destination, are shown in table 14. Total exports were 54 percent more than in 1952. European countries received 73 percent of the exports and Japan and the United States 14 and 4 percent, respectively.

TABLE 14.—Exports of potash materials from West Germany, 1951–53, by countries of destination, in short tons [1]

[Compiled by John E. McDaniel]

Country	1951	1952	1953
South America: Brazil	12,196	1,929	8,295
North America:			
Canada	7,220	6,425	21,643
Puerto Rico	----	11,657	1,654
United States	204,934	85,224	51,445
Europe:			
Austria	----	11,910	38,832
Belgium-Luxembourg	19,260	145,505	162,527
Denmark	57,022	150,733	218,357
Greece	13,240	----	----
Irish Free State	19,395	11,947	19,130
Italy	14,904	8,406	28,417
Netherlands	7,253	211,586	216,998
Portugal	1,819	2,204	----
Sweden	----	11,791	62,543
Switzerland	3,685	18,221	20,947
United Kingdom	114,091	126,588	259,961
Oceania: Australia and New Zealand	----	5,387	8,203
Asia:			
Ceylon	4,795	831	1,036
Formosa	19,324	----	----
India	5,998	685	2,174
Indonesia	1,651	----	2,016
Japan	94,392	54,758	200,862
Korea	----	7,167	----
Turkey	1,213	3,582	9,733
Africa: Union of South Africa and Northern and Southern Rhodesia	13,150	11,279	18,650
Other countries	18,724	27,277	53,496
Total	634,266	915,092	1,406,919

[1] Compiled from Customs Returns of West Germany. 1951 includes chloride and sulfate only. 1952 and 1953 include crude salts, chloride, sulfate, magnesium sulfate, and beet ash.

[27] Work cited in footnote 12.

[28] Chemical Age (London), vol. 68, No. 1751, Jan. 31, 1953, p. 217.
Chemical and Engineering News, vol. 31, No. 31, Aug. 3, 1953, pp. 3197–3198.
Chemical week, vol. 73, No. 19, Nov. 7, 1953, p. 22.

[29] Chemical and Engineering News, vol. 32, No. 5, Feb. 1, 1954, pp. 403–404.

East Germany.—According to reports, production increased but export quotas were not met because of lack of sufficient transportation. All sales were controlled by a Government-controlled agency.[30]

Spain.—The following four companies produced about the same quantity in 1953 as in 1952: Union Española de Explosives, S. A.; Minas de Potasa de Suria, S. A.; Potasas Abericas, S. A.; and Explotaciones Potasicas, S. A.

The deposits near Pamplona in the Province of Navarra contain an extimated reserve of 40 million tons of K_2O equivalent. It was planned to sink shafts at Astrain and Esparza de Galar and to achieve annual production capacity for each shaft of 680,000 tons of ore.[31]

Exports of potash materials from Spain were 13 percent less in 1952 than in 1951 (table 15). Data for 1953 are not yet available. European countries received 61 percent of Spain's potash materials in 1952.

TABLE 15.—Exports of potash materials from Spain, 1950–52, by countries of destination in short tons [1] [2]

[Compiled by John E. McDaniel]

Country	1950	1951	1952
North America: United States	32,419	88,274	43,497
Europe:			
Belgium-Luxembourg	48,715	48,064	54,456
Ireland	5,500	5,368	5,557
Italy		14,946	10,367
Netherlands	5,907	4,189	10,086
Norway	11,473	13,297	9,190
Portugal	8,859	10,979	8,736
Sweden	4,409		
United Kingdom	63,262	39,222	46,878
Asia:			
China		5,115	10,023
Japan	20,139	43,216	21,253
Korea			5,376
Other countries	5,574	2,954	13,149
Total	206,257	275,624	238,568

[1] Compiled from Customs Returns of Spain.
[2] This table incorporates a number of revisions of data published in previous Potash chapters.

AFRICA

French Equatorial Africa.—Petroleum drilling in the Gabon coastal area disclosed an occurrence of potash.[32]

ASIA

Israel.—Production of potash from the Dead Sea was resumed in 1953 by The Dead Sea Works, Ltd. Prior to 1948 this plant at the southern end of the Dead Sea, with a rated annual capacity of about 60,000 metric tons, was operated by Palestine Potash, Ltd. It was planned to produce 100,000 tons in 1954 and 300,000 tons per year by 1958. The first shipment was consigned to the United Kingdom.[33]

[30] Work cited in footnote 29.
[31] Fertiliser and Feeding Stuffs Journal (London), Potash Mining in Spain, vol. 39, No. 22, Oct. 28, 1953, p. 811.
[32] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 6, December 1953, p. 49.
[33] Chemical Age, (London), vol. 70, No. 1800, Jan. 9, 1954, p. 164.
Industrial and Engineering Chemistry, vol. 45, No. 8, August 1953, pp. 18A, 20A.
Rock Products, vol. 57. No. 2, February 1954, p. 116.

Korea.—Alunite production resumed during 1952 in the Republic of Korea with 1,180 metric tons reported. Data on 1953 are not yet available.

OCEANIA

Australia.—The plant of the State Alunite Works of Western Australia at Lake Campion remained closed during 1953. Disposal of the plant was proposed since a new plant would be required if production were resumed. A total of about 10,000 tons of crude potash was produced at this plant from 1944–50.[34]

[34] Fertiliser and Feeding Stuffs Journal (London), vol. 39, No. 3, Feb. 4, 1953, p. 101.

Pumice and Pumicite

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

UNTIL 10 years ago the use of pumice and pumicite (volcanic ash) in the United States was limited largely to abrasives, with smaller quantities used for concrete aggregates, acoustic plaster, and for a number of minor purposes. Beginning in 1944, when the domestic production of pumice and pumicite was 89,000 short tons, its use began to increase rapidly and by 1951 had reached 750,000 short tons; concrete aggregates composed 96 percent of that year's total. Inclusion of low-price volcanic cinder and scoria production, principally for ballast uses, in the 1953 chapter increased the domestic output figure to 1,348,000 short tons; however, the average value per ton has decreased from $3.80 a short ton in 1952 to $1.87 in 1953.

DOMESTIC PRODUCTION

Fifteen States and the Territory of Hawaii reported production of pumice and pumicite during 1953; 73 operating units were canvassed by the Bureau of Mines. Owing to the inclusion of volcanic cinder and scoria used for ballast, production figures showed an increase of 126 percent over 1952, but because of the comparatively lower value per ton of cinder and scoria the increase in the total value was only 11 percent during the same period.

New Mexico was the largest pumice-producing State in 1953, with 12 operating units reporting, followed in order by California with 30, Arizona with 3, and Idaho with 4. Only opencut mining methods were reported.

Whittaker, Clark & Daniels, Inc., has sold its pumice operations near Grants, N. Mex., that was operated by its subsidiary, Pumice Corp. of America, to the U. S. Gypsum Corp.[3]

Ownership and operation of the Pumice Aggregate Sales Corp. and the Cochiti Pumice Co. in Sandoval County, N. Mex., has been acquired by Dooley Bros. Pumice, Inc.[4]

CONSUMPTION AND USES

The physical structure of pumice and pumicite makes it an excellent insulating material against heat and sound, and its composition makes it virtually fireproof. Its weight—usually less than half that of the heavy aggregates—makes it especially useful as a lightweight aggregate.

During 1953 concrete aggregates and admixtures used 53 percent of the pumice and pumicite output; abrasive uses 2 percent; acoustic plaster 1 percent; and other uses 44 percent. Other uses included 561,000 short tons of volcanic cinder and scoria (42 percent of the

[1] Commodity-industry analyst.
[2] Statistical clerk.
[3] Rock Products, vol. 56, No. 7, July 1953, p. 47.
[4] Pit and Quarry, vol. 46, No. 2, August 1953, p. 63.

total) valued at approximately 50 cents a ton, that was used for railroad ballast, road material, or similar purposes. The use of pumice and pumicite in 1953 for concrete aggregates and admixtures increased 29 percent in tonnage and 8 percent in value over the preceding year.

Competition with other lightweight aggregates, and the freight charges to more distant points, have tended to restrict the use of pumice and pumicite for lightweight concrete to the market areas relatively near its production source. On the eastern seaboard imported pumice has found a market at several points in competition with domestic pumice and other lightweight materials.

TABLE 1.—Pumice and pumicite sold or used by producers in the United States, 1944–48 (average) and 1949–53

Year	Short tons	Value	Year	Short tons	Value
1944–48 (average)	323,190	$1,572,937	1951 [1]	749,942	$2,752,907
1949	716,742	2,369,082	1952	597,044	2,266,981
1950	719,356	2,661,052	1953 [2]	1,348,136	2,526,040

[1] Includes Alaska.
[2] Includes 612,000 short tons of volcanic cinders valued at $430,000.

TABLE 2.—Pumice and pumicite sold or used by producers in the United States, 1951–53, by States

State	1951		1952		1953	
	Short tons	Value	Short tons	Value	Short tons	Value
California	264,411	$1,228,569	129,780	$793,716	433,105	$647,910
Idaho	83,528	133,192	88,085	141,253	85,224	159,833
New Mexico	245,564	884,311	217,482	755,139	528,649	759,840
Oregon	47,026	137,136	59,578	201,809	73,080	173,822
Utah	9,422	11,478	(1)	(1)	(1)	(1)
Washington	5,105	10,832	3,604	8,089	(1)	(1)
Wyoming	1,867	9,141	2,851	10,918	648	1,898
Other States [2]	93,019	338,248	95,664	356,057	227,430	782,737
Total	749,942	2,752,907	597,044	2,266,981	[3] 1,348,136	[3] 2,526,040

[1] Included with "Other States" to avoid disclosure of individual company operations.
[2] Includes State indicated by footnote 1 and Alaska (1951), Arizona, Colorado, Hawaii (1953), Kansas, Montana (1951 and 1953), Nebraska, Nevada, Oklahoma, and Texas.
[3] Includes volcanic cinders from California, Hawaii, Nevada, and New Mexico amounting to 612,000 short tons valued at $430,000.

TABLE 3.—Pumice and pumicite sold or used by producers in the United States, 1951–53, by uses

Use	1951		1952		1953	
	Short tons	Value	Short tons	Value	Short tons	Value
Abrasive:						
Cleansing and scouring compounds and hand soaps	8,205	$124,314	17,308	$177,609	19,816	$140,900
Other abrasive uses	4,485	318,013	5,121	248,977	3,172	83,673
Acoustic plaster	3,761	112,518	3,934	100,097	7,506	171,336
Concrete admixture and concrete aggregate	720,170	1,988,204	553,899	1,525,331	713,931	1,649,993
Other uses [1]	13,321	209,858	16,782	214,967	603,711	480,138
Total	749,942	2,752,907	597,044	2,266,981	[2] 1,348,136	[2] 2,526,040

[1] Insecticide, insulation, brick manufacture, filtration, railroad ballast, roads (surfacing and ice control), absorbents, soil conditioner, and miscellaneous uses.
[2] Includes 612,000 short tons of volcanic cinders valued at $430,000.

The tonnage used for abrasive purposes trended upward slightly in 1953. Other minor uses of pumice and pumicite include insecticides, insulation, filtration, brick manufacture, and soil conditioning.

STOCKS

As production and sales of pumice and pumicite are usually closely comparable, stocks of material on hand are relatively constant and small and are not canvassed by the Bureau of Mines.

PRICES

As reported in the Oil, Paint and Drug Reporter, the quotations on domestic and imported pumice remained at nearly the same levels as the previous year and were as follows: Domestic, common, ground, coarse to fine, in bags, ton lots, 3⅝ to 4¼ cents a pound; smaller lots, 3⅞ to 4½ cents a pound. Italian, silk-screen, coarse, bags, ton lots, 6½ cents a pound; fine, bags, ton lots, 4 cents a pound; sun-dried, coarse, bags, ton lots, 2½ to 4 cents a pound; fine, bags, ton lots, 2½ to 4 cents a pound. Pumice in barrels is ½ cent a pound higher. The E&MJ Metal and Mineral Markets quoted per pound, f. o. b. New York or Chicago, in barrels, powdered, 3 to 5 cents; lump, 6 to 8 cents.

The value of pumice and pumicite at the mine in 1953 for the 73 operating units 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 1953

	Short tons	Value	Average value
Crude	598,586	$803,837	$1.34
Prepared	749,550	1,722,203	2.30
Total	1,348,136	2,526,040	1.87

[1] Includes 612,000 short tons of volcanic cinders valued at $430,000.

Average domestic values per ton at the mine for the preceding 4 years were 1952, $3.80; 1951, $3.67; 1950, $3.70; 1949, $3.31.

FOREIGN TRADE [5]

Imports of crude or unmanufactured pumice into the United States during 1953 totaled 32,712 short tons valued at $166,079 ($5.08 a ton). Wholly or partly manufactured pumice imports were 943 short tons valued at $19,975 ($21.18 a ton). Other types of pumice not otherwise specified valued at $5,415 also were imported. The larger part of the crude pumice came from Greece, while Italy supplied the manufactured pumice except for a very small quantity from Japan.

The duty on imported pumice was: Unmanufactured valued at $15 or less a short ton, $1 a ton; valued at over $15 a short ton, ⅛ cent a pound; manufactured pumice, ½ cent a pound, manufactured articles made of pumice, 17½ percent ad valorem.

[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 5.—Pumice and pumicite[1] imported for consumption in the United States, 1952–53, 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							
	1952		1953		1952		1953		1952		1953	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Greece	14,370	$57,927	24,907	$90,591								
Italy	6,926	63,719	7,311	65,395	690	$13,659	494	$10,093	478	$9,792	943	$19,966
Japan											(2)	9
Total	21,296	121,646	32,218	155,986	690	13,659	494	10,093	478	9,792	943	19,975

[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, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Class	1944–48 (average)		1949		1950		1951		1952		1953	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Crude or unmanufactured	[1] 4,366	[1] $43,728	8,843	$79,804	19,268	$125,726	15,752	$182,737	21,986	$135,305	32,712	$166,079
Wholly or partly manufactured	512	12,242	756	19,121	982	18,356	750	18,041	478	9,792	943	19,975
Manufactures, n. s. p. f.		53		694		953		2,591		6,301		5,415
Total		[1] 56,023		99,619		145,035		203,369		151,398		191,469

[1] Includes revised figure.

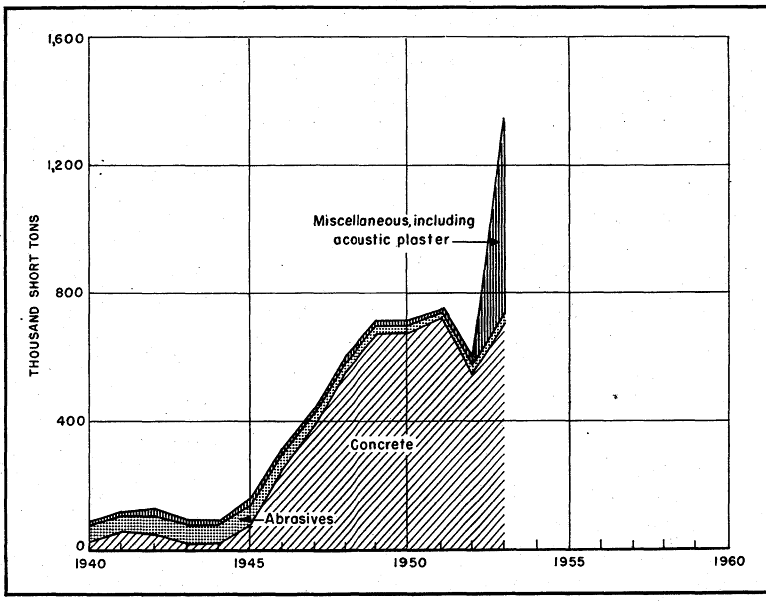

FIGURE 1.—Trends by uses, 1940–53.

TECHNOLOGY

Pumice concrete has been precast into beams and road-deck sections for highway bridges, the weight being about one-half that of similar members made of sand-and-gravel reinforced concrete. Ease of erection was given as one of its advantages.[6]

In the manufacture of refractory insulating concrete, pumice was used as an aggregate with satisfactory results.[7]

A comprehensive article on alkali reactivity in concretes, published in 1953, mentions pumice as one of the reactive rocks.[8]

The Oregon Engineering Experiment Station has reported on properties of the pumicites occurring in that area.[9]

The use of pumice in lightweight concrete aggregates has been studied by the Housing and Home Finance Agency and a technical paper issued.[10]

In a suit involving the legal meaning of the term "pumicite" a court has held that "pumicite" means "pumice." The legal reference is Davis v. Basalt Rock Co., 250 Pacific (2d) 254.[11]

WORLD REVIEW

The United States continues to be the largest pumice-producing country, followed in order by Italy, France, Greece and New Zealand.

[6] Engineering News Record, Bridge Built of Precast Pumice Concrete, vol. 150, No. 15, Apr. 9, 1953, p. 26.
[7] Hansen, W. C., and Livovich, A. F., Thermal Conductivity of Refractory Insulating Concrete, Jour. Am. Ceram. Soc., vol. 36, No. 11, November 1953, pp. 356–362.
[8] Holland, William Y., and Clark, Roger H., Alkali Reactivity of Natural Aggregates in Western United States: Min. Eng., vol. 5, No. 10, October 1953, pp. 991–997.
[9] Heath, C. O., Jr., and Brandenberg, N. R., Pozzolanic Properties of Several Oregon Pumicites: Oregon Eng. Exp. Sta., Oregon State College, September 1953, 35 pp.
[10] Housing and Home Finance Agency, Design Data for Some Reinforced Lightweight Aggregate Concretes: Housing Research Paper 26, October 1953, 19 pp.
[11] Pit and Quarry, vol. 46, No. 4, October 1953, p. 135.

TABLE 7.—World production of pumice, by countries,[1] 1948–53, in metric tons [2]

[Compiled by Helen L. Hunt]

Country [1]	1948	1949	1950	1951	1952	1953
Egypt	800	450	360	[3] 400	400	690
France:						
Pumice	22,500	14,800	14,200	16,000	12,130	202,000
Pozzolana	30,000	43,900	66,400	103,700	170,800	
Greece [4]	37,000	47,000	53,000	65,000	30,965	[3] 30,000
Italy:						
Pumice	24,131	49,077	71,247	79,884	[3] 125,000	[3] 125,000
Pumicite	7,370	27,800	32,350	44,000		
Pozzolana	610,100	676,482	844,650	[3] 800,000	[3] 800,000	[3] 800,000
New Zealand	6,973	13,335	9,872	8,915	9,766	2,045
Spain	212	984	422	1,115	664	555
United States (sold or used by producers)	551,335	650,214	652,585	680,332	541,626	[5] 1,223,002
Total (estimate)[1]	1,400,000	1,600,000	1,800,000	1,900,000	1,800,000	2,500,000

[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] Estimate.
[4] These figures include the following tonnages of Santorini earth: 1948, 30,000 tons; 1949, 35,000 tons; 1950, 38,000 tons; 1951, 45,000 tons; 1952, 18,528 tons; 1953, 20,000 (estimate).
[5] Includes 508,476 tons of volcanic cinder and scoria, used for railroad ballast or similar purposes, not previously included in this chapter.

Recently developed pumice deposits on the island of Martinique, French West Indies, may become a source of lightweight building material for local use and possibly for exportation.[12]

The existence of abundant quantities of pumice (volcanic glass) suitable for certain commercial uses, in the Lower Rhine district of West Germany has been reported.[13]

The production of pozzolana in Italy and France from materials of volcanic origin similar to pumice and pumicite has been included with the pumice and pumicite output of those countries. This increase, added to the expanded United States output, raised the world total output of pumice and related materials to over 2 million tons in 1953.

[12] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 5, May 1953, p. 47.
[13] Journal, American Ceramic Society, vol. 36, No. 9, September 1953, p. 167.

Quartz Crystal (Electronic Grade)

By Waldemar F. Dietrich[1] and Gertrude E. Tucker[2]

THIS CHAPTER is confined to electronic-grade or piezoelectric quartz crystal, which became an important strategic material during World War II when quartz-crystal oscillators were adopted by the United States Army Signal Corps for frequency control in mobile communication units. Other uses for quartz crystal are for optical applications (for example, prisms, wedges, and lenses), gems, and fusing stock.

The consumption of raw quartz crystal and the production of piezoelectric units decreased substantially in 1953 from the post-World War II peak of 1952 owing to declining production of military components. Brazil continued to supply the major portion of the optical- and electronic-grade quartz crystal, as well as nearly all of the fusing-grade crystal, for United States consumption. Domestic production was negligible.

Quartz crystal was in adequate supply for domestic requirements in 1953. On February 13, 1953, the Office of Price Stabilization, in General Overriding Regulation 9, decontrolled quartz-crystal prices and those of about 150 other metals and minerals.

PRODUCTION AND CONSUMPTION

Quartz-crystal cutters in the United States reported a 21-percent decline in the consumption of raw quartz for producing finished piezoelectric units (table 2). The raw quartz crystal is purchased from importers, usually in lots comprised of crystals in weight groups such as: 50–100 grams; 100–200 grams; 200–300 grams; 300–500 grams; and several higher weight groups. Larger quantities of 100–200 gram crystals are used than of the other groups.

In 1953, 7,217,700 piezoelectric units was produced, a 17-percent increase over 1952. A greater number of blanks, and in turn a greater number of units, was obtained per pound of raw quartz crystal. The average number of finished crystal units produced per pound of quartz was 18.1 in 1953, 12.3 in 1952, and 11.7 in 1951. The 1953 figure is lower than the peak of 20.3 units per pound in 1949 but is equivalent to the highest rate obtained during World War II.

Quartz-crystal consumers (cutters) and producers of quartz piezoelectric units were distributed in 19 States and the Territory of Hawaii, as shown in table 1. About 40 percent of the consumption of raw

[1] Chief, Ceramic and Fertilizer Materials Branch.
[2] Statistical assistant.

quartz crystal was in Pennsylvania, although the largest number of companies was in California. The majority of the 43 consumers also produced finished piezoelectric units, and some supplied blanks to many piezoelectric unit producers who do not produce blanks.

TABLE 1.—Consumption of electronic-grade quartz and production of piezoelectric units in the United States in 1953, by States

State	Consumption of electronic-grade quartz		Production of piezoelectric units [1]	
	Number of consumers	Pounds consumed	Number of producers	Number of units produced
California	9	40,400	10	919,500
Connecticut and Massachusetts	3	3,400	3	74,400
Florida, Georgia, and North Carolina	3	12,800	3	254,000
Hawaii	1	1,000	1	11,000
Illinois	3	19,800	3	365,900
Iowa, Missouri, Nebraska, and Oklahoma	3	[2] 18,100	6	583,800
Kansas	3	(3)	4	1,060,200
New Jersey	4	36,300	4	496,400
New York	4	14,200	5	339,500
Pennsylvania	5	155,800	6	2,748,300
Virginia	1	6,700	1	31,500
Other States [4]	4	[5] 90,700	6	333,200
Total	43	399,200	52	7,217,700

[1] For radio oscillators, telephone resonators, and filter plates.
[2] Includes consumption of electronic-grade quartz in Iowa and Nebraska only. No consumption of quartz was recorded for Missouri and Oklahoma.
[3] Included under "Other States" to avoid disclosure of individual company operations.
[4] Includes Maryland, Ohio, Texas, and a quantity unspecified by State.
[5] In addition to "Other States," includes consumption of electronic-grade quartz in Kansas.

PRICES

There were no changes in the Brazilian Government "Tabela" of the minimum allowable declared value of electronic-grade quartz crystal exports from Brazil in 1953 compared with 1952. The Tabela was published in the Minerals Yearbook, 1952 chapter. In 1953 actual declared values at Rio de Janeiro, Brazil, of the exports to the United States were about the same as the Tabela prices. The average for 1953 was $2.00 per pound compared with $2.75 in 1952 owing to an increased proportion of smaller crystals and lower qualities. Resale prices in the United States were negotiated between buyer and importer and bore no fixed relation either to the Tabela price schedule or to the actual declared value. Not only do the Brazilian quality classes differ from United States practice, but American inspection techniques are more efficient than Brazilian methods in detecting twinning and other flaws, principally because of the use of direct, instead of alternating, current illumination of the oil inspection bath.

Re-sorting of crystal receipts by importers therefore usually results in two or more lots of more uniform quality than the original lot. The best crystals may bring prices up to three times the Tabela schedule; others may have to be sold at a loss. For example, selected 201–300 gram, class 1 (more than 60-percent usability) crystals in 1953 sold for about $12.00 per pound in the United States compared with the Tabela schedule of $4.50 per pound, and selected 301–500 gram, class 1 crystals brought about $17.00 per pound versus the Tabela schedule of \$7.50. Crystals in the weight group of 201–300 grams imported as Brazilian class 3 (minimum usability 30 percent for crystals weighing over 200 grams) were sold in the United States for \$2.00 to \$3.00 per pound versus the Tabela value of \$1.25, and 301–500 gram, class 3 crystals that have a Tabela value of \$1.88 per pound sold for \$2.50 to \$3.50. Highly selected stock for optical uses, in sizes from 1,000–5,000 grams, sold for \$60.00–\$90.00 per pound.

FOREIGN TRADE[3]

In 1953, 1,119,198 pounds of electronic- and optical-grade quartz crystal was imported from Brazil, Argentina, France, Madagascar, and Switzerland, in order of importance (table 2). Brazil supplied 98 percent of the United States imports.

Exports of raw quartz crystal in 1953 were valued at \$4,658.

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, 1944–48 (average) and 1949–53

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
1944–48 (average)	1,030,880	\$5,124,380	\$4.97	640,020	10,575,780	16.5
1949	306,800	1,460,200	4.76	46,200	937,100	20.3
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] 1,119,198	[2] 2,240,154	2.00	399,200	7,217,700	18.1

[1] Figures for 1944–48 (average) and 1949–52 derived from 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

The effects of physical loading of the surface of two types of piezoelectric-quartz oscillator plates were investigated experimentally. Loading with Wood's metal increased the crystal unit *Q* severalfold and greatly improved activity-frequency characteristics over a temperature range from minus 60° to plus 90° C.[4]

Experiments at Antioch College on the hydrothermal synthesis of quartz crystals showed that in basic solutions silica glass dissolves directly to form silicate ions and that the rate of silicate-ion formation and deposition of quartz on a suspended seed plate increases with increasing pH, that is, under conditions favoring increasing concentrations of silicate ions.[5]

[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] Sogn, L. T., and Simpson, P. A., Loading of Quartz Oscillator Plates: Nat. Bureau of Standards Jour. Research, vol. 49, No. 5, November 1952, pp. 325–330.
[5] Corwin, J. F., Herzog, A. H., Owen, G. E., Yalman, R. G., and Swinnerton, A. C., The Mechanism of the Hydrothermal Transformation of Silica Glass to Quartz Under Isothermal Conditions: Jour. Am. Chem. Soc., vol. 75, No. 16, Aug. 20, 1953, pp. 3933–3934.

Large single quartz crystals weighing over 1 pound, free from twinning, and suitable for piezoelectric purposes were grown at the Bell Telephone Laboratories in less than 60 days by the temperature-difference method, at 12,000- to 15,000-p. s. i. pressure and a temperature of about 400° C. Autoclaves up to 4 inches in inside diameter and 48 inches in length were used for growing the quartz crystal on a seed plate suspended above the quartz nutrient.[6]

Early in the year Brush Laboratories Co. (formerly Brush Development Co.) completed installing expanded pilot-plant facilities for producing synthetic quartz crystal. The standard process required 2 *M*-Na_2CO_3, a temperature of about 350° C., and 5,000 p. s. i. pressure. Pressures down to 1,500 p. s. i. were successful but yielded about half the standard growth rate or 0.3 mm. per day measured normal to the minor rhombohedral face.[7]

The methods and equipment of hydrothermal synthesis were described, including the determination of the solubility of quartz in superheated steam at high pressures.[8]

Experiments by Brown and Thomas showed that synthetic quartz crystals do not darken when exposed to X-ray irradiation, as do natural quartz crystals. The darkening in natural quartz is associated with the presence of impurities and only when impurities are added directly or the quartz growth is not conducted under the best conditions does the synthetic quartz show darkening.[9]

Fused quartz produced either from pure silica sand or quartz crystals has a wide range of uses in the chemical, metallurgical, and electrical industries because of (1) resistance to high temperatures, (2) resistance to thermal shock, (3) resistance to corrosion, (4) low coefficient of thermal expansion, and (5) high electrical insulating value. The properties of fused quartz and its applications were discussed in detail.[10]

Patents were issued on a method for synthesizing single crystals of quartz and a quartz crystal lapping apparatus.[11]

WORLD REVIEW

Brazil.—Exports of piezoelectric-quartz crystal in 1953 totaled 1,137,500 pounds valued at 47,634,000 cruzeiros ($2,592,242), of which the United States received 95 percent and the United Kingdom 3 percent (time lag in transit accounts for a difference in the figures for United States imports and Brazilian exports). The remainder was shipped mainly to France, Germany, Japan, and Sweden. A total of

[6] Buehler, E., Growing Quartz Crystals: Bell Labs. Record, vol. 31, No. 7, July 1953, pp. 241–246.
Walker, A. C., Hydrothermal Synthesis of Quartz Crystals: Jour. Am. Ceram. Soc., vol. 36, No. 8, August 1953, pp. 250–256.

[7] Hale, D. R., Charbonnet, W. H., and Jost, J. M., Growth of Quartz Crystals at Low Pressures: Unpub. papers pres. at the 7th Ann. Frequency-Control Rev. of Tech. Progress, Asbury Park, N. J., May 19, 1953.

[8] Morey, G. W., Hydrothermal Synthesis: Jour. Am. Ceram. Soc., vol. 36, No. 9, September 1953, pp. 279–285.

[9] Brown, C. S., and Thomas, L. A., Response of Synthetic Quartz to X-Ray Irradiation: Nature, vol. 169, No. 4288, Jan. 5, 1952, pp. 35–36.

[10] Gialanella, Joseph, Fused Quartz: Chem. Eng., vol. 60, No. 4, April 1953, pp. 302, 304–305.
Wright, F. E., Fused Quartz—a Versatile Industrial Material: Materials and Methods, vol. 37, No. 2, February 1953, pp. 98–100.

[11] Friedman, I. I., and Tuttle, O. F., Method of Synthesizing Large Single Crystals of Quartz: U. S. Patent 2,638,408, May 12, 1953.
Wolfskill, J. M., Piezoelectric Crystal Lapping Apparatus: U. S. Patent 2,634,558, Apr. 14, 1953.

809,100 pounds of lasca valued at 1,818,000 cruzeiros ($98,936) also was exported.[12]

Lasca is fragments of crystals recovered from the rejects of electronic-grade crystal production. Most of the lasca is specially selected for chemical purity for use as fusing quartz. No production data were available.

Madagascar.—Production of quartz crystal totaled 41,887 pounds in 1953 and consisted of 24,251 pounds of clear (electronic-grade) and 17,636 pounds of opaque. Exports of electronic- and optical-grade quartz totaled 30,864 pounds, of which 28,659 pounds was shipped to France and 2,205 pounds to the United States.[13]

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[12] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 3, September 1954, pp. 68–69.
[13] State Department Dispatch 216, American Embassy, Tananarive, Madagascar, May 13, 1954, p. 1. Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 6, June 1954, p. 57.

Salt

By Joseph C. Arundale[1] and Annie L. Marks[2]

OUTPUT of salt in the United States reached an alltime high of over 20.8 million tons in 1953, exceeding the previous record of about 20.2 million tons in 1951. Output of evaporated salt and salt in brine increased, but production of rock salt decreased slightly. The largest increases were in Texas and Louisiana and in the Michigan and Ohio area.

TABLE 1.—Salient statistics of the salt industry in the United States,[1] 1944–48 (average) and 1949–53

	1944–48 (average)	1949	1950	1951	1952	1953
Sold or used by producers:						
Dry salt:						
Evaporated (manufactured) short tons	3, 249, 345	3, 284, 361	3, 329, 288	3, 654, 808	3, 641, 885	3, 702. 305
Rock salt do	3, 593, 437	3, 444, 341	3, 927, 267	4, 662, 194	4, 567, 531	4, 478, 655
Total do	6, 842, 782	6, 728, 702	7, 256, 555	8, 317, 002	8, 209, 416	8, 180, 960
Value	$40, 489, 725	$45, 956, 223	$51, 795, 728	$58, 425, 022	$59, 757, 322	$65, 407, 021
Average per ton	$5. 92	$6. 83	$7. 14	$7. 02	$7. 28	$7. 99
In brine:						
Short tons	8, 897, 344	8, 843, 513	9, 373, 254	11, 890, 129	11, 335, 798	12, 608, 043
Value	$7, 323, 466	$7, 670, 015	$8, 115, 615	$11, 309, 978	$11, 252, 767	$12, 869, 646
Total salt:						
Short tons	15, 740, 126	15, 572, 215	16, 629, 809	20, 207, 131	19, 545, 214	20, 789, 003
Value[2]	$47, 813, 191	$53, 626, 238	$59, 911, 343	$69, 735, 000	$71, 010, 089	$78, 276, 667
Imports for consumption:						
Short tons	4, 378	6, 309	7, 869	4, 329	7, 056	137. 308
Value	$39, 764	$60, 605	$58, 819	$46, 831	[3] $44, 230	$473, 472
Exports:						
Short tons	256, 941	359, 776	190. 377	439, 114	349, 971	249, 521
Value	$2, 977, 149	$3, 353, 115	$1, 776, 062	$3, 501, 904	$3, 458, 363	$2, 327, 656
Apparent consumption[4]: short tons	15, 487, 563	15, 218, 748	16, 447, 301	19, 772, 346	19, 202, 299	20, 676, 790

[1] Includes Hawaii (1952–53 only) and Puerto Rico.
[2] Values are f. o. b. mine or refinery and do not include cost of cooperage or containers.
[3] Revised figure.
[4] Quantity sold or used by producers, plus imports, minus exports.

DOMESTIC PRODUCTION

The record tonnage of salt produced domestically reflected the high level of industrial activity.

Michigan retained its leading position as a salt producer, with New York in second place but well behind. Louisiana jumped to third place from fifth in the previous year. Ohio dropped to fourth place, with Texas a close fifth. Production increased in all these States except New York, which decreased for the second consecutive year.

Salt was produced at 85 facilities in the United States. Of these, 9 had a production of over 1 million short tons each, with a com-

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[2] Statistical clerk.

bined output of over half of the United States total. Three plants produced between 500,000 and 1 million tons, 30 from 100,000 to 500,000, and the remainder less than 100,000 each. Twenty-six plants produced less than 10,000 tons each.

It was reported that International Salt Co. purchased all rights to mine salt beneath the Wayne County, Mich., airport. The company was expected to begin exploratory drilling. Mining probably would be at least 1,000 feet below the airport surface.[3]

Three firms in the United States produced sodium metal, using salt as a raw material.

TABLE 2.—Salt sold or used by producers in the United States, 1951–53, by States

State	1951			1952			1953		
	Quantity		Value	Quantity		Value	Quantity		Value
	Short tons	Percent of total		Short tons	Percent of total		Short tons	Percent of total	
California	1,275,574	6	$5,261,780	1,148,693	6	$4,880,392	1,123,365	5	$6,263,059
Kansas	900,917	5	6,639,343	911,744	5	6,850,027	905,227	4	7,480,556
Louisiana	2,737,149	14	7,662,179	2,553,448	13	7,807,693	3,061,234	15	9,189,526
Michigan	5,137,639	25	21,221,330	4,778,347	24	21,446,382	5,127,387	25	22,171,988
New Mexico	(1)	------	(1)	(1)	------	(1)	62,087	(2)	216,364
New York	3,518,715	17	16,552,890	3,417,443	17	16,746,462	3,322,659	16	17,351,111
Ohio	3,112,472	15	5,848,478	2,827,455	14	5,991,626	3,040,237	15	7,484,795
Puerto Rico	10,566	(2)	119,338	12,676	(2)	122,158	13,692	(2)	131,490
Texas	2,401,063	12	4,000,100	2,640,209	14	4,402,032	2,845,190	14	5,010,624
Utah	131,444	1	570,379	136,125	1	522,721	154,088	1	772,035
West Virginia	379,299	2	1,314,818	392,519	2	1,438,490	419,907	2	1,490,592
Other States [3]	602,293	3	544,365	726,555	4	802,106	713,930	3	714,527
Total	20,207,131	100	69,735,000	19,545,214	100	71,010,089	20,789,003	100	78,276,667

[1] Included with "Other States" to avoid disclosure of individual company operations.
[2] Less than 1 percent.
[3] Includes Alabama (1952–53), Hawaii (1952–53), Nevada, New Mexico (1951–52), Oklahoma, and Virginia.

TABLE 3.—Salt sold or used by producers in the United States,[1] 1952–53, by method of recovery

Method of recovery	1952		1953	
	Short tons	Value	Short tons	Value
Evaporated:				
Bulk:				
Oven pans or grainers	441,534	$8,303,464	432,126	$8,722,732
Vacuum pans	1,946,911	20,099,173	2,028,283	23,746,727
Solar	974,985	3,370,097	948,882	4,556,171
Pressed blocks	278,455	3,862,723	293,014	4,603,864
Rock:				
Bulk	4,499,709	23,285,272	4,416,408	22,924,006
Pressed blocks	67,822	836,593	62,247	853,521
Salt in brine (sold or used as such)	11,335,798	11,252,767	12,608,043	12,869,646
Total	19,545,214	71,010,089	20,789,003	78,276,667

[1] Includes production in Hawaii and Puerto Rico.

[3] Mining World, vol. 15, No. 9, August 1953, p. 101.

TABLE 4.—Evaporated salt sold or used by producers in the United States, 1951–1953, by States

State	1951		1952		1953	
	Short tons	Value	Short tons	Value	Short tons	Value
Kansas	360, 785	$4, 659, 036	358, 887	$4, 775, 741	370, 569	$5, 285, 805
Louisiana	119, 368	1, 170, 304	111, 713	1, 134, 991	121, 410	1, 580, 290
Michigan	818, 845	11, 081, 126	847, 873	11, 260, 605	820, 660	11, 912, 341
New York	502, 216	6, 419, 061	508, 317	6, 674, 698	532, 924	7, 832, 362
Ohio	479, 246	3, 908, 141	461, 289	4, 189, 883	498, 438	5, 175, 816
Puerto Rico	10, 566	119, 338	12, 676	122, 158	13, 692	131, 490
Texas	87, 644	1, 137, 376	97, 663	1, 259, 164	111, 851	1, 910, 250
Other States [1]	1, 276, 138	6, 341, 088	1, 243, 467	6, 218, 217	1, 232, 761	7, 801, 140
Total	3, 654, 808	34, 835, 470	3, 641, 885	35, 635, 457	3, 702, 305	41, 629, 494

[1] Includes California, Hawaii (1952–53), Nevada, New Mexico, Oklahoma, Utah, and West Virginia.

TABLE 5.—Rock salt sold by producers in the United States, 1944–48 (average) and 1949–53

Year	Short tons	Value	Year	Short tons	Value
1944–48 (average)	3, 593, 437	$14, 291, 574	1951	4, 662, 194	$23, 589, 552
1949	3, 441, 341	16, 232, 479	1952	4, 567, 531	24, 121, 865
1950	3, 927, 267	19, 435, 431	1953	4, 478, 655	23, 777, 527

TABLE 6.—Pressed-salt blocks sold by original producers of the salt in the United States, 1944–48 (average) and 1949–53

Year	From evaporated salt		From rock salt		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1944–48 (average)	270, 014	$2, 772, 328	77, 786	$700, 193	347, 800	$3, 472, 521
1949	268, 838	3, 270, 664	62, 749	602, 855	331, 587	3, 873, 519
1950	265, 835	3, 465, 935	63, 081	704, 600	328, 916	4, 170, 535
1951	284, 261	3, 936, 356	70, 597	787, 943	354, 858	4, 724, 299
1952	278, 455	3, 862, 723	67, 822	836, 593	346, 277	4, 699, 316
1953	293, 014	4, 603, 864	62, 247	853, 521	355, 261	5, 457, 385

CONSUMPTION AND USES

Probably no other mineral material has a more imposing number of uses than salt. It has literally thousands of direct and indirect applications in a wide range of products and services.

Apparent consumption of salt increased more than 1.2 million tons over the previous year. The chemical industry is the predominant direct consumer of salt; its largest single use is in manufacturing soda ash, which in turn has a multitude of uses. A near-record output of soda ash and a record tonnage of chlorine explained the greater consumption of salt. Tonnage of chlorine doubled in the previous 5 years.

TABLE 7.—Salt sold or used by producers in the United States, 1952–53, by classes and uses, in thousand short tons

Use	1952				1953			
	Evaporated	Rock	Brine	Total	Evaporated	Rock	Brine	Total
Chlorine, bleaches, chlorates, etc	527	907	3,817	5,251	590	1,018	4,457	6,065
Soda ash	(1)	(1)	7,195	[1] 7,195	(1)		7,846	[1] 7,846
Dyes and organic chemicals	43	67		110	47	55		102
Soap (precipitant)	30	11		41	38	10		48
Other chemicals	118	603	(1)	[1] 721	130	515	(1)	[1] 645
Textile processing	23	104	(1)	[1] 127	28	104	(1)	[1] 132
Hides and leather	88	140	(1)	[1] 228	103	156	(1)	[1] 259
Meat packing	344	420		764	345	409		754
Fish curing	20	11		31	18	10		28
Butter, cheese, and other dairy products	66	6		72	71	6		77
Canning and preserving	152	60		212	163	53		216
Other food processing	244	14		258	251	9		260
Refrigeration	76	143	(1)	[1] 219	79	156		235
Livestock, agriculture, and general farm use [2]	777	305		1,082	732	298		1,030
Highways, railroads and other dust and ice control	17	800		817	20	721		741
Table and other household use	468	78		546	453	68		521
Water treatment	282	338	(1)	[1] 620	294	338	(1)	[1] 632
Metallurgy	35	71		106	44	80		124
Undistributed [3]	332	489	324	1,145	296	473	305	1,074
Total	3,642	4,567	11,336	19,545	3,702	4,479	12,608	20,789

[1] Data included with "Undistributed" to avoid disclosure of individual company operations.
[2] Livestock salt is about 93 percent of the total.
[3] Comprises miscellaneous uses and uses for which data may not be shown separately (see footnote 1); also includes some exports and consumption in Territories and possessions.

PRICES

According to Oil, Paint and Drug Reporter, prices of salt at the beginning of 1953 were as follows: Rock salt, paper bags, carlots, works, 63 cents per 100 pounds; less than carlots, $1.09 per 100 pounds; table salt, vacuum, common fine, bags, works, carlots, 77 cents per 100 pounds; less than carlots, $1.12½ per 100 pounds. These prices changed in April to read as follows: Rock salt, paper bags, carlots, works, 98 cents per 100 pounds; table salt, vacuum, common fine, bags, works, carlots, $1.12 per 100 pounds.

Sodium metal was quoted in E&MJ Metal and Mineral Markets throughout the year at 16½ cents per pound in drums, carlots; less than carlots, 17 cents.

FOREIGN TRADE [4]

Because of the abundance of salt, imports are only a small fraction of United States requirements. As in the past, the bulk of the imports originated in Canada and in the West Indies. The sharp increase in shipments from the Bahamas came from a new operation.

Exports of salt decreased, largely because of the cessation of shipments to Japan and Korea. These countries found sources of salt in other areas.

[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 8.—Distribution (shipments) of evaporated and rock salt in the United States, 1952–53, by States of destination, in short tons

Destination	1952		1953	
	Evaporated	Rock	Evaporated	Rock
Alabama	16, 782	92, 770	21, 750	92, 024
Arizona	17, 100	6, 914	17, 312	9, 676
Arkansas	11, 880	52, 590	13, 328	58, 991
California	472, 253	64, 556	466, 991	96, 581
Colorado	48, 642	51, 889	51, 080	30, 593
Connecticut	13, 407	26, 215	14, 363	19, 830
Delaware	4, 632	6, 265	6, 220	7, 600
District of Columbia	5, 479	2, 653	5, 566	1, 780
Florida	11, 252	37, 546	12, 387	39, 466
Georgia	24, 102	52, 512	26, 728	57, 899
Idaho	21, 259	2, 034	20, 192	2, 065
Illinois	231, 910	292, 447	228, 677	286, 376
Indiana	114, 792	80, 279	112, 196	87, 337
Iowa	119, 310	104, 324	123, 392	111, 614
Kansas	56, 875	208, 034	57, 889	209, 734
Kentucky	31, 363	104, 528	32, 565	132, 178
Louisiana	19, 020	130, 320	19, 803	133, 564
Maine	13, 989	85, 721	11, 808	80, 520
Maryland	42, 287	76, 087	43, 474	79, 131
Massachusetts	51, 801	111, 774	54, 584	91, 928
Michigan	126, 421	201, 969	128, 820	185, 364
Minnesota	119, 072	81, 540	118, 924	80, 804
Mississippi	9, 414	27, 462	11, 141	28, 385
Missouri	76, 134	76, 381	74, 397	71, 961
Montana	24, 914	2, 041	21, 505	2, 359
Nebraska	65, 828	66, 315	64, 430	65, 777
Nevada	6, 666	113, 736	6, 074	100, 752
New Hampshire	4, 691	86, 727	5, 019	74, 753
New Jersey	109, 072	143, 625	111, 886	125, 786
New Mexico	11, 944	38, 244	12, 067	58, 297
New York	196, 908	762, 237	195, 735	762, 257
North Carolina	55, 465	88, 708	58, 062	95, 483
North Dakota	11, 471	4, 366	13, 346	4, 862
Ohio	200, 682	282, 421	212, 309	263, 670
Oklahoma	32, 209	24, 370	33, 397	27, 215
Oregon	142, 140	288	186, 582	258
Pennsylvania	137, 456	133, 414	140, 615	132, 042
Rhode Island	9, 625	12, 205	9, 174	12, 444
South Carolina	13, 807	22, 676	14, 442	22, 413
South Dakota	23, 988	16, 707	25, 442	14, 965
Tennessee	36, 562	69, 895	36, 600	78, 734
Texas	91, 824	[1] 235, 668	102, 744	175, 215
Utah	27, 812	(2)	45, 102	(2)
Vermont	6, 198	32, 228	6, 264	32, 717
Virginia	68, 212	82, 237	77, 199	82, 184
Washington	241, 311	2, 093	236, 995	624
West Virginia	158, 804	105, 542	175, 190	88, 433
Wisconsin	144, 581	56, 170	147, 695	60, 966
Wyoming	11, 592	3, 198	11, 304	2, 653
Other [3]	148, 947	[1] 205, 610	79, 540	198, 395
Total	3, 641, 885	4, 567, 531	3, 702, 305	4, 478, 655

[1] Revised figure.
[2] Included with "Other" to avoid disclosure of individual company operations.
[3] Includes shipments to Territories and possessions of the United States, exports, and some shipments to unspecified destinations.

TABLE 9.—Salt imported for consumption in the United States, 1952–53, by countries

[U. S. Department of Commerce]

Country	1952		1953	
	Short tons	Value	Short tons	Value
Bahamas	3, 640	[1] $10, 436	133, 263	$439, 713
Canada	2, 466	29, 045	2, 123	24, 882
Cuba	85	840		
Jamaica	859	3, 835	1, 011	3, 612
Mexico	6	59	911	5, 195
Netherlands			(2)	68
Taiwan			(2)	2
United Kingdom	(2)	15		
Total	7, 056	[1] 44, 230	137, 308	473, 472

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

TABLE 10.—Salt imported for consumption in the United States, 1944–48 (average) and 1949–53, 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
1944–48 (average)	766	$14, 208	3, 177	$24, 004	435	$1, 551
1949	2, 851	40, 308	3, 458	20, 297		
1950	3, 395	43, 567	4, 474	15, 252		
1951	2, 991	37, 245	1, 338	9, 586		
1952	2, 488	29, 538	4, 568	[1] 14, 692		
1953	2, 550	26, 428	134, 758	447, 044		

[1] Revised figure.

TABLE 11.—Salt exported from the United States, 1952–53, by countries

[U. S. Department of Commerce]

Country	1952		1953	
	Short tons	Value	Short tons	Value
North America:				
Bermuda	19	$1, 544	10	$587
Canada	208, 668	1, 840, 879	228, 746	1, 667, 114
Central America:				
Canal Zone	781	30, 439	734	43, 737
Costa Rica	195	4, 438	155	6, 498
Guatemala	1, 774	40, 334	88	3, 486
Honduras	439	12, 451	225	6, 763
Nicaragua	343	9, 192	307	7, 695
Panama	167	4, 733	104	2, 620
Mexico	6, 067	173, 001	5, 175	175, 169
West Indies:				
British:				
Jamaica	9	344	28	1, 198
Other British	2	834	2	673
Cuba	8, 764	213, 752	9, 495	248, 590
Dominican Republic	175	14, 367	229	21, 020
Haiti	15	1, 319	8	625
Netherlands Antilles	400	23, 511	314	26, 091
Other North America	115	3, 329	196	7, 547
South America:				
Ecuador	10	1, 239	81	5, 483
Other South America	25	3, 364	22	4, 726
Europe	3	1, 404	(1)	1, 109
Asia:				
Japan	82, 108	522, 865	13	2, 102
Korea	35, 683	476, 447		
Philippines	3, 872	51, 476	3, 369	77, 034
Saudi Arabia	144	9, 020	36	5, 517
Other Asia	25	2, 074	11	2, 376
Africa	21	2, 284	11	1, 040
Oceania:				
French Pacific Islands	113	4, 750	114	5, 804
New Zealand	11	360		
Western Pacific Islands	23	8, 613	48	3, 052
Total	349, 971	3, 458, 363	249, 521	2, 327, 656

[1] Less than 1 ton.

TABLE 12.—Salt shipped to possessions and other areas administered by the United States,[1] 1951–53

[U. S. Department of Commerce]

Territory	1951		1952		1953	
	Short tons	Value	Short tons	Value	Short tons	Value
American Samoa	3	$120	7	$1, 822	3	$138
Guam	147	9, 001	92	6, 678	68	6, 099
Puerto Rico	7, 108	458, 207	8, 378	555, 474	8, 827	618, 488
Virgin Islands	40	4, 177	69	6, 645	82	6, 813
Total	7, 298	471, 505	8, 546	570, 619	8, 980	631, 538

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

A patent was issued for a method of making a saturated sodium chloride brine from salt contaminated with impurities, including calcium and magnesium salts. The method includes leaching a body of salt with a solution of calcium hydroxide in water. When the solution is saturated with sodium chloride it is removed from contact with the salt, and an agent is introduced into the solution to precipitate the impurities.[5]

Morton Salt Co. announced plans for a new research and development organization to expand research in the field of salt products and processes and to engage in chemical process development. The new organization will have laboratory facilities and a chemical engineering staff in the Chicago area. Pilot-plant phases of the program probably will be conducted in part at some of the company's 9 operating plants in the United States or 4 plants of the Canadian Salt Co., Ltd., in which Morton recently acquired an interest.[6]

WORLD REVIEW

Australia.—It was reported that a local company was planning a project expected to cost $560,000 to extract salt from the sea near Point Paterson near Port Augusta in South Australia.[7]

Bahamas, British West Indies.—Since 1950 production of sea salt has risen steadily at the operations of West India Chemicals, Ltd., at Inagua; the operations are owned by three Americans. The company is reported to have signed new contracts with two Pacific coast chemical companies for the purchase of 200,000 tons of salt to be delivered over a 2-year period. In the early part of 1953 this firm opened extensive salt beds in the Lake Windsor area in the center of Inagua Island. The new beds cover an area much larger than the original company holdings. The first harvest from the new salt pans began in late August 1953 and added greatly to the total output for 1953.

According to local press reports, the company also plans to market salt from Turks Island in the United States.[8]

5 Hirsch, Alfred (assigned to Diamond Alkali Co.), Method of Making Purified Brine: U. S. Patent 2,624,654, Jan. 6, 1953.
6 Oil, Paint and Drug Reporter, vol. 163, No. 19, May 11, 1953, p. 4.
7 Chemical and Engineering News, vol. 31, No. 36, Sept. 7, 1953, p. 3666.
8 Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 5, May 1954, p. 52.

TABLE 13.—World production of salt by countries,[1] 1944–48 (average) and 1949–1953, in metric tons [2]

[Compiled by Helen L. Hunt]

Country [1]	1944–48 (average)	1949	1950	1951	1952	1953
North America:						
Canada	613,773	681,278	779,132	874,120	882,874	864,756
Costa Rica	6,596	8,200	8,400	5,445	2,268	3,891
Guatemala	10,024	11,962	11,502	12,061	11,974	15,183
Honduras	1,253	11,503	4,397	4,650	4,800	[3] 10,400
Mexico	133,508	124,700	147,000	165,100	172,500	(4)
Nicaragua	6,996	[3] 10,230	11,172	12,289	13,216	13,971
Panama	5,636	3,408	5,000	7,480	[3] 11,500	4,331
Salvador	18,342	[3] 16,000	[3] 16,000	[3] 27,200	[3] 18,000	34,700
United States:						
Rock salt	3,259,894	3,124,637	3,562,738	4,229,449	4,143,573	4,044,565
Other salt	11,019,234	11,002,165	11,523,492	14,102,056	13,587,217	14,814,803
West Indies:						
British:						
Bahamas	52,065	60,960	60,960	51,800	81,300	150,000
Turks and Caicos Islands	25,038	61,765	60,960	21,337	16,663	(4)
Cuba	52,380	59,874	59,266	50,267	56,004	51,013
Dominican Republic:						
Rock salt	15,454	2,412	2,304	2,270	2,603	3,795
Other salt		8,140	13,740	8,092	16,744	13,666
Haiti	[3] 8,000	[3] 8,000	(4)	(4)	30,400	30,400
Netherlands Antilles	2,318	370	3,000	(4)	2,649	(4)
South America:						
Argentina	[3] 412,800	703,421	468,800	806,618	932,749	452,482
Brazil	586,029	805,632	794,181	1,244,444	780,618	759,801
Chile:						
Rock salt	48,688	35,079	46,709	48,927	[3] 50,000	[3] 50,000
Other salt	[3] 29,500	4,450	942	348		
Colombia:						
Rock salt	121,765	102,160	106,918	110,085	167,628	148,630
Other salt		23,932	35,045	28,066	38,201	47,362
Ecuador	29,155	15,291	19,031	32,717	40,418	[3] 24,000
Peru	57,747	55,968	66,501	68,494	79,613	76,984
Venezuela	52,827	71,926	56,439	38,920	116,050	72,586
Europe:						
Austria:						
Rock salt	2,071	719	1,085	692	1,144	1,224
Other salt	209,002	304,792	327,426	362,294	334,076	331,563
Bulgaria [3]	64,330	(4)	(4)	(4)	(4)	(4)
Czechoslovakia [3]	7,700	(4)	(4)	(4)	(4)	(4)
France:						
Rock salt and salt from springs	1,468,069	1,772,067	2,059,123	2,327,581	1,953,454	[3] 2,000,000
Other salt	463,049	742,721	604,550	343,900	656,000	[3] 600,000
Germany, West:						
Rock salt	2,031,423	1,624,423	2,285,699	2,562,000	2,426,001	3,195,973
Brine salt		250,118	276,488	281,505	277,285	372,763
Greece	63,842	86,776	102,329	82,434	87,525	(4)
Italy:						
Rock salt and brine salt	409,729	804,435	746,153	1,112,851	749,526	1,298,216
Other salt	844,200	471,913	572,824	398,120	649,457	1,001,784
Malta	2,320	1,807	1,827	3,841	1,523	3,722
Netherlands	177,789	334,360	409,580	485,380	414,811	456,917
Poland	[3] 450,000	836,253	[3] 1,000,000	[3] 1,000,000	[3] 1,000,000	[3] 1,000,000
Portugal:						
Rock salt	63	41	42	39	45	49
Other salt (exports)	25,980	16,903	30,765	29,374	22,953	3,016
Rumania	278,152	(4)	(4)	(4)	(4)	(4)
Spain:						
Rock salt	258,377	288,896	308,228	367,809	375,257	393,808
Other salt	557,515	546,886	901,575	893,297	655,001	992,297
Switzerland	95,882	[3] 100,000	94,000	114,000	109,300	102,400
U. S. S. R.[3]	5,000,000	5,000,000	5,000,000	5,500,000	6,000,000	6,200,000
United Kingdom:						
Great Britain:						
Rock salt	27,458	41,658	41,658	54,867	45,722	[3] 50,000
Other salt	3,400,811	3,761,417	4,257,250	4,693,135	3,958,532	[3] 4,000,000
Northern Ireland	12,595	13,000	13,000	13,251	11,177	[3] 10,000
Yugoslavia	87,340	[3] 108,900	131,000	95,646	148,378	123,418

TABLE 13.—World production of salt by countries,[1] 1944–48 (average) and 1949–1953, in metric tons [2]—Continued

Country [1]	1944–48 (average)	1949	1950	1951	1952	1953
Asia:						
Aden	187,746	308,302	259,972	309,186	292,355	240,423
Afghanistan	[3] [5] 35,400	[3] 6,000	35,000	24,737	23,700	([4])
Burma	40,550	31,692	21,457	64,285	59,316	63,420
Ceylon	43,249	28,780	66,093	36,990	49,215	59,847
China [3]	2,334,000	2,000,000	3,000,000	3,000,000	3,500,000	4,000,000
Cyprus	4,877	----------	4,133	11,198	----------	1,992
India:						
Rock salt	147,463	4,299	5,130	5,530	6,088	3,212,998 (Rock salt and Other salt combined)
Other salt	1,992,412	2,017,831	2,657,852	2,773,244	2,865,430	
Indochina	80,000	113,600	75,722	93,908	[3] 144,000	107,000
Indonesia	202,690	320,000	375,000	480,592	323,000	266,000
Iran	[3] 6,200	[3] 100,000	[3] 100,000	76,252	[3] 200,000	[3] 220,000
Iraq	12,912	8,989	11,861	16,503	19,298	([4])
Israel	[6] 17,537	6,500	8,000	9,850	12,534	20,993
Japan	300,504	395,676	418,144	430,405	433,200	460,800
Jordan	([6])	([4])	([4])	2,712	7,377	([4])
Korea, Republic of	[3] 102,230	188,812	174,884	84,556	203,865	192,686
Lebanon	[3] 5,810	[3] 2,500	[3] 6,500	[3] 7,000	3,500	4,000
Pakistan:						
Rock salt [7]	[8] 177,675	177,709	147,169	140,429	130,328	146,833
Other salt [7]	[8] 201,190	138,600	192,687	229,976	170,895	151,745
Philippines	[3] 20,500	52,276	56,283	52,280	16,770	47,794
Portuguese India	[9] 13,325	18,132	17,608	31,577	21,380	15,972
Syria	15,870	21,619	19,167	3,999	16,015	19,485
Taiwan (Formosa)	204,492	253,948	175,063	274,766	311,711	171,450
Thailand (Siam) [3]	127,425	150,000	200,000	250,000	250,000	250,000
Turkey:						
Rock salt	257,583 (Rock salt and Other salt combined)	17,920	20,330	21,584	34,000	[3] 27,000
Other salt		298,425	284,912	249,970	302,000	[3] 358,500
Yemen	----------	----------	----------	----------	----------	100,000
Africa:						
Algeria	63,239	101,676	75,656	97,281	82,343	60,000
Anglo-Egyptian Sudan	38,930	43,029	40,754	46,215	53,311	([4])
Angola	48,413	41,286	40,473	49,228	57,510	57,809
Belgian Congo	1,004	813	550	583	620	810
Canary Islands	12,999	5,283	6,072	15,729	15,241	([4])
Cape Verde Islands	12,533	19,301	19,769	24,106	18,090	([4])
Egypt	[9] 285,876	349,878	539,016	687,038	498,393	380,000
Eritrea	37,132	85,760	53,922	[3] 60,000	[3] 40,000	[3] 40,000
Ethiopia: Rock salt	[3] 10,000	[3] 10,000	[3] 10,000	[3] 10,000	[3] 10,000	14,706
French Equatorial Africa [3]	([4])	1,800	3,600	3,900	4,300	4,100
French Morocco:						
Rock salt	39,171 (Rock salt and Other salt combined)	6,633	17,509	45,971 (Rock salt and Other salt combined)	40,000	40,794
Other salt		36,630	46,012			
French Somaliland	50,131	60,000	80,000	55,200	64,400	60,965
French West Africa [3]	52,600	50,000	66,000	66,000	50,000	36,000
Italian Somaliland [3]	560	3,000	1,500	2,000	5,000	4,500
Kenya	15,210	18,820	18,722	19,084	17,019	20,886
Libya:						
Cyrenaica	348	[3] 500	----------	[3] 2,500	----------	----------
Tripolitania	2,270	[3] 6,000	9,000	12,000	12,000	11,000
Mauritius	3,499	5,200	2,606	3,400	2,200	2,400
Mozambique	7,502	11,004	9,942	[3] 8,700	10,505	([4])
South West Africa:						
Rock salt	3,373	2,468	3,915	4,706	6,887	4,696
Other salt	9,985	13,730	12,903	39,880	33,258	36,525
Spanish Morocco [3]	254	254	254	254	254	254
Tanganyika	11,092	14,970	12,473	15,858	19,255	17,889
Tunisia	85,440	98,085	98,771	146,507	93,500	139,412
Uganda	4,939	7,400	7,413	7,869	4,108	7,638
Union of South Africa	[10] 142,546	162,936	106,396	149,795	140,574	127,559
Australia	204,767	[3] 248,932	269,253	[3] 304,815	281,446	314,976
Total (estimate) [1]	40,000,000	43,000,000	48,000,000	54,000,000	53,000,000	56,000,000

[1] In addition to the countries listed, salt is produced in Albania, Bolivia, Gold Coast, Hungary, Leeward Islands, 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] Average for 1945–48.
[6] Jordan included in Israel.
[7] Year ended March 31 of year following that stated.
[8] Average for 1947–48.
[9] Exports.
[10] Year ended June 30 of year stated.

Canada.—All of Canada's salt output comes from underground salt beds; nearly 90 percent is produced by the evaporation of brine obtained from these beds. The only rock-salt mine operated in Canada at present is at Malogash, Nova Scotia. However, Canadian Rock Salt Co., Ltd., was preparing to mine salt from a bed 1,100 feet below the surface at Ojibway near Windsor, Ontario. That Province is the chief producer of salt in Canada, followed by Nova Scotia, Saskatchewan, Alberta, and Manitoba.[9]

Drillers were reported to have found brine at Riverbrook, Newfoundland. The brine is said to have a high salt content and may have commercial value. Further drilling is in progress to check the extent of these resources.[10]

Dominican Republic.—Early in 1953 it was reported that most of the construction work and installation of machinery were completed at the Government-owned salt operations. An electric plant was yet to be completed to provide the power for the operations. The Government Agricultural and Industrial Credit Bank, which took over operation of the salt deposits late in 1950, is said to have been negotiating with a German company for purchase of a crane for the Port of Barahona. This is expected to increase the attractiveness of Dominican salt to foreign buyers by reducing the loading time for ships.[11]

India.—Expansion under a system of licensing eliminated shortages of salt in India and contributed to self-sufficiency of salt since 1950. Output in 1953 exceeded 3 million metric tons. With a stock exceeding 1 million tons at the beginning of 1953, the supply position was adequate to meet domestic demand and permit some export. Shortages in the nonproducing areas, arising from the defects of the distributive system, appear to have been brought under control. Self-sufficiency in production and improvement in movement of stocks marked the close of the preliminary stage in the development of the Indian salt industry. Problems of the next stage are improvement in quality and reduction in prices.

The largest importer of Indian salt in 1953 was Japan; Nepal and East Pakistan also imported sizable tonnages.

It was suggested that it would be desirable to change the licensing policy and aim at merger of the present small units into larger works of more economic size to improve efficiency and quality and to lower costs.

In the fall of 1953 core-drilling operations were in progress to determine the magnitude of India's only known rock-salt deposit in Mandi, Himachal Prodesh.

Per capita consumption of salt in India is 14 to 18 pounds compared with the world average of about 40 pounds, 100 pounds in United Kingdom, and over 200 pounds in the United States.[12]

Indonesia.—The Government monopoly over the production and sale of salt was extended to cover the entire country, effective April 1, 1953, by decree of the Minister of Finance, canceling the exemption to the monopoly regulations given to areas in Central Java from the time of the Renville Agreement. Approximately 10 percent

[9] Collings, R. K., Salt in Canada, 1953 (Preliminary): Canada Dept. of Mines and Technical Surveys, Ottawa, 3 pp.
[10] Foreign Commerce Weekly, vol. 49, No. 5, Feb. 2, 1953, p. 15.
[11] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 1, January 1953, pp. 40–41.
[12] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 2. February 1954, pp. 68–73.

of the annual production of about 300,000 metric tons has come from the northern coast of Central Java. The Government decision to wipe out this free production area was taken "in the public interest" to guarantee a uniform high quality of output and to eliminate the necessity for maintaining smuggling patrols between the "free" and "monopoly" areas.[13]

Japan.—Aside from China, Japan is the largest producer and consumer of salt in the Far East. Japan produces only about one-quarter of its salt requirements. In 1953, output was 460,800 metric tons, and domestic needs were estimated at about 1.8 million tons. Traditionally, Japan's principal supplier has been China. Although imports of salt from China in 1952 were very small, economic pressure is increasing in Japan for resumption of this trade. Meanwhile Japan has attempted to develop assured supplies of salt in southeast Asia.

Kenya.—A new salt plant was installed at the Magadi soda plant.[14]

Portugal.—By an order of the Ministry of Economy, December 12, 1953, salt producers are required to report their production by October 31 of each year to the Gramios da Lavoura (Farmers Guild).

Decree 38909 (September 12, 1952), gave to the Regulating Commission of Chemical and Pharmaceutical Products the responsibility for regulating production of and trade in salt. It also provided for representation of salt producers, wholesalers, and exporters on the commission and added a tax on salt production to the list of sources from which the commission would derive its revenue. The decree fixed the tax at 3 escudos a ton.[15]

Turkey.—Salt was produced by the Turkish salt monopoly, which is under the control of the Ministry of Customs and Monopolies. About 52 separate installations for salt recovery are in operation; some of them produce 2,000 to 3,000 metric tons of salt a year. The two major installations are the Camalti Salt Recovery Works near Izmir, which recovers salt from sea water, and the Yansan works, which harvests crystallized salts from a dry lake, Tuz Golu, near Kochisar.

Turkey's local need for salt was about 260,000 to 300,000 tons a year. Camalti output was about 154,000 tons, or 7,000 tons less than in 1951; Yavsan's production was estimated at about 70,000 tons. It is understood that the Monopoly authority extended only to the extraction of salt, whereas private firms can carry out refining, blocking, and any other finishing processes.[16]

United Kingdom.—Effective December 17, 1953, salt could be imported from any country without a separate import license, according to the Board of Trade.[17]

Yemen.—The Salif salt project was opened formally April 21, 1953. The operations were begun 8 months before, and the first 6 months' yield was shipped. It took 3 weeks to load the salt cargo of 10,500 tons, the first to be shipped from that port in recent years. The salt was shipped to Japan, where it was to be sold at 28 shillings per ton f. o. b. Salif.

[13] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 2, February 1954, p. 73.
[14] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 5, May 1954, p. 55.
[15] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 2, February 1954, p. 75.
[16] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 5, November 1953, pp. 72–73.
[17] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 2, February 1954, p. 75.

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An old site formerly mined by the Turks, the Salif salt dome has about 6 feet of topsoil and is easily mined. A narrow-gage railway was built to transport the salt from the mine to the crusher at the seashore. Here conveyor belts carry the salt into the crusher. The crushed salt is then loaded on barges, four of which were on hand at the time of the formal opening of the operations. These barges lighter the product to the waiting vessel—usually standing about 1 mile out to sea. Each barge is fitted with two 1-ton buckets that, with the help of the ship's crane, lift the salt aboard the vessel and store it in the appropriate hold.

Daily production in the spring of 1953 was estimated to be about 800 tons, or about 20,000 to 25,000 tons per month.[18]

[18] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 5, November 1953, p. 76.

Sand and Gravel

By L. M. Otis [1] and Dorothy T. Shupp [2]

DURING 1953 the large-tonnage uses for sand and gravel (building, paving, and railroad ballast) continued their upward trend. The year's production of most industrial sands, except for molding and engine sand, increased substantially as compared with 1952.

Except for a very slight decline in 1949, both the tonnage and value of sand and gravel produced annually have increased steadily since 1944. The great increase in sand and gravel consumption during this period was in building and paving uses. Industrial sands contributed only 1 percent of the total tonnage expansion since 1944.

A significant trend in the industry is the consistent increase since 1947 of the sand and gravel output in tons per man-shift. From a figure of 34.4 tons in 1947 this output has increased yearly to a high of 47.2 tons in 1953.

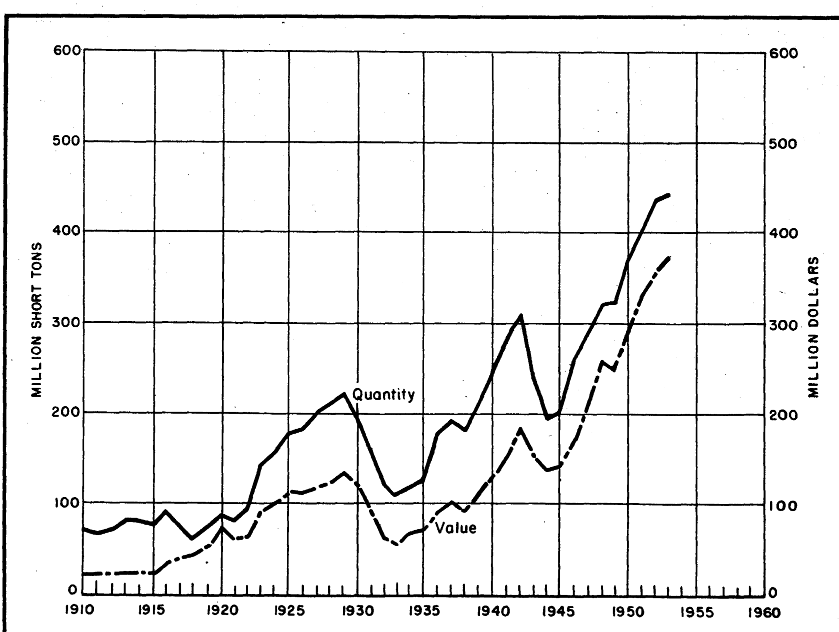

FIGURE 1.—Production of sand and gravel in the United States, 1910–53.

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

TABLE 1.—Sand and gravel sold or used by producers in the United States,[1] 1952–53, by class of operations and uses

	1952			1953			Percent of change in—	
	Short tons	Value		Short tons	Value		Tonnage	Average value
		Total	Average		Total	Average		
COMMERCIAL OPERATIONS								
Sand:[2]								
Glass	5,227,927	$13,918,171	$2.66	6,192,389	$17,491,358	$2.82	+18	+6
Molding	8,253,167	16,252,433	1.97	7,895,391	15,731,809	1.99	−4	+1
Building	73,660,508	63,670,537	.86	77,759,220	68,936,290	.89	+6	+3
Paving	43,666,274	36,746,584	.84	44,242,228	38,441,892	.87	+1	+4
Grinding and polishing[3]	1,229,794	2,920,088	2.37	1,492,348	3,375,362	2.26	+21	−5
Fire or furnace	413,789	819,908	1.98	501,304	894,949	1.79	+21	−10
Engine	1,900,621	1,939,025	1.02	1,680,459	1,811,383	1.08	−12	+6
Filter	288,207	606,501	2.10	384,619	839,450	2.18	+33	+4
Railroad ballast	828,750	404,669	.49	1,179,797	554,680	.47	+42	−4
Other	4,037,053	4,063,914	1.01	4,095,864	4,993,388	1.22	+1	+21
Total commercial sand	139,506,090	141,341,830	1.01	145,423,619	153,070,561	1.05	+4	+4
Gravel:[4]								
Building	64,263,744	68,212,707	1.06	64,557,406	70,826,198	1.10	------	+4
Paving	81,652,021	74,166,945	.91	80,689,807	74,926,696	.93	−1	+2
Railroad ballast	10,669,141	6,487,822	.61	10,505,285	6,504,889	.62	−2	+2
Other	5,637,498	4,930,002	.87	7,410,234	6,554,541	.88	+31	+1
Total commercial gravel	162,222,404	153,797,476	.95	163,162,732	158,812,324	.97	+1	+2
Total commercial sand and gravel	301,728,494	295,139,306	.98	308,586,351	311,882,885	1.01	+2	+3
GOVERNMENT-AND-CONTRACTOR OPERATIONS[5]								
Sand:								
Building	1,183,968	1,140,413	.96	1,077,951	1,196,638	1.11	−9	+16
Paving	15,402,448	6,229,943	.40	13,924,647	5,926,093	.43	−10	+8
Total Government and-contractor sand	16,586,416	7,370,356	.44	15,002,598	7,122,731	.47	−10	+7
Gravel:								
Building	3,561,751	2,857,283	.80	9,044,500	5,936,889	.66	+154	−17
Paving	113,634,572	48,017,270	.42	107,455,776	49,575,255	.46	−5	+10
Total Government-and-contractor gravel	117,196,323	50,874,553	.43	116,500,276	55,512,144	.48	−1	+12
Total Government-and-contractor sand and gravel	133,782,739	58,244,909	.44	131,502,874	62,634,875	.48	−2	+9
ALL OPERATIONS								
Sand	156,092,506	148,712,186	.95	160,426,217	160,193,292	1.00	+3	+5
Gravel	279,418,727	204,672,029	.73	279,663,008	214,324,468	.77	------	+5
Grand total	435,511,233	353,384,215	.81	440,089,225	374,517,760	.85	+1	+5

[1] Includes Alaska, American Samoa, Hawaii, Panama Canal Zone, and Puerto Rico.
[2] Includes sand produced by railroads for their own use—1952: 460,114 tons valued at $127,972; 1953: 338,772 tons, $73,422.
[3] Includes blast sand as follows—1952: 557,305 tons valued at $2,016,747; 1953: 651,149 tons, $2,156,691.
[4] Includes gravel produced by railroads for their own use—1952: 6,546,919 tons valued at $3,046,067; 1953: 5,553,079 tons, $2,476,789.
[5] Approximate figures for States, counties, municipalities, and other Government agencies directly or under lease.

DOMESTIC PRODUCTION

In 1953, for the fourth successive year, the output of sand and gravel established a new high record—440,089,000 tons valued at $374,518,000, an increase of 1 percent in quantity and 6 percent in value over 1952.

California retained its position as the leading producing State with almost double the output of Michigan, which came second, followed by Ohio, Wisconsin, New York, Illinois, Minnesota, and Texas, in that order.

Tables 3 and 4 show production by States and uses in 1953.

TABLE 2.—Sand and gravel sold or used by producers in the United States,[1] 1944–48 (average) and 1949–53

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)
1944–48 (average)	92,905	77,191	157,368	101,760	250,273	178,951
1949	117,036	105,489	202,068	142,954	319,104	248,443
1950	138,900	126,311	231,555	168,729	370,455	295,040
1951	149,590	145,148	251,044	188,566	400,634	333,714
1952	156,092	148,712	279,419	204,672	435,511	353,384
1953	160,426	160,193	279,663	214,325	440,089	374,518

[1] Includes Alaska, American Samoa, Hawaii, Panama Canal Zone, and Puerto Rico.

TABLE 3.—Sand and gravel sold or used by producers in the United States in 1953, by States

State	Short tons	Value	State	Short tons	Value
Alabama	3,710,707	$3,002,683	Nevada	2,266,064	$2,088,948
Alaska	7,689,278	5,079,681	New Hampshire	2,249,001	506,156
American Samoa	1,320	425	New Jersey	7,361,935	10,835,948
Arizona	3,446,821	2,680,470	New Mexico	1,416,380	1,238,979
Arkansas	4,903,835	4,955,383	New York	22,530,891	23,493,857
California	58,429,528	53,224,203	North Carolina	6,910,982	4,992,991
Colorado	12,438,600	8,609,151	North Dakota	6,173,737	2,164,685
Connecticut	3,025,840	2,347,750	Ohio	24,032,388	27,076,276
Delaware	520,817	399,685	Oklahoma	4,701,366	3,969,585
Florida	3,731,432	3,199,368	Oregon	8,763,078	8,629,632
Georgia	2,051,058	1,900,987	Panama Canal Zone	85,914	95,500
Hawaii	110,558	156,853	Pennsylvania	14,715,383	20,692,391
Idaho	3,776,180	2,841,440	Puerto Rico	226,586	250,202
Illinois	21,521,806	20,540,549	Rhode Island	898,393	775,700
Indiana	11,203,059	9,500,914	South Carolina	2,975,608	2,564,484
Iowa	10,385,322	6,400,827	South Dakota	5,402,378	2,827,726
Kansas	8,728,291	5,668,308	Tennessee	5,231,329	5,629,687
Kentucky	3,052,155	2,899,932	Texas	15,101,226	12,845,561
Louisiana	4,538,387	5,162,248	Utah	4,627,808	3,179,690
Maine	8,071,937	2,608,386	Vermont	1,113,607	690,073
Maryland	7,379,511	8,919,088	Virginia	5,276,350	5,160,564
Massachusetts	7,308,190	5,930,894	Washington	11,182,835	9,317,793
Michigan	30,459,663	23,170,802	West Virginia	3,162,776	6,070,847
Minnesota	19,774,411	7,304,351	Wisconsin	23,656,086	16,173,302
Mississippi	2,653,646	2,173,871	Wyoming	3,149,376	2,001,197
Missouri	5,792,058	5,233,999			
Montana	6,203,480	2,993,575	Total	440,089,225	374,517,760
Nebraska	5,969,858	4,340,163			

TABLE 4.—Sand and gravel sold or used by producers in the United States in 1953, 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	-	-	(1)	(1)	808,533	$619,224	-	-
Alaska	-	-	-	-	93,227	217,425	112,781	$218,224
American Samoa	-	-	-	-	-	-	690	175
Arizona	-	-	-	-	634,890	669,124	-	-
Arkansas	(1)	(1)	(1)	(1)	751,745	405,955	-	-
California	(1)	(1)	33,700	$84,686	12,676,258	11,362,921	326,775	225,379
Colorado	-	-	-	-	1,011,000	998,844	12,555	11,958
Connecticut	-	-	-	-	824,572	705,856	-	-
Delaware	-	-	-	-	82,484	50,675	-	-
Florida	-	-	-	-	2,735,832	2,268,803	-	-
Georgia	(1)	(1)	(1)	(1)	1,037,669	667,371	-	-
Hawaii	-	-	-	-	(1)	(1)	-	-
Idaho	-	-	-	-	179,710	226,410	70,385	80,945
Illinois	1,257,364	$2,879,382	1,020,423	2,343,187	4,428,688	3,274,134	-	-
Indiana	-	-	499,290	672,166	1,745,960	1,476,207	-	-
Iowa	-	-	(1)	(1)	1,553,823	1,300,260	-	-
Kansas	-	-	2,600	2,210	3,007,738	2,210,986	22,558	9,886
Kentucky	-	-	(1)	(1)	900,843	907,573	250	600
Louisiana	(1)	(1)	17,111	15,210	711,479	656,402	-	-
Maine	-	-	-	-	41,490	21,512	68	250
Maryland	(1)	(1)	-	-	1,769,587	2,043,842	-	-
Massachusetts	-	-	(1)	(1)	2,008,038	1,635,055	11,710	27,701
Michigan	(1)	(1)	1,959,807	1,968,065	3,655,863	2,610,498	-	-
Minnesota	6,254	13,865	(1)	(1)	1,963,605	1,551,800	369	159
Mississippi	-	-	-	-	400,663	257,283	129,370	90,322
Missouri	451,495	1,025,812	75,907	158,402	1,423,137	969,748	-	-
Montana	-	-	-	-	191,254	353,026	5,966	15,359
Nebraska	-	-	20,476	27,857	923,944	661,949	-	-
Nevada	(1)	(1)	79,876	191,897	161,059	237,672	-	-
New Hampshire	-	-	-	-	(1)	(1)	-	-
New Jersey	845,893	2,073,653	1,460,431	3,706,154	1,685,347	1,319,946	-	-
New Mexico	-	-	1,620	2,400	360,681	288,749	-	-
New York	-	-	292,915	835,498	6,050,568	6,535,419	56,887	30,588
North Carolina	-	-	-	-	1,187,343	776,605	50,000	25,000
North Dakota	-	-	-	-	208,898	214,710	-	-
Ohio	(1)	(1)	578,740	1,721,459	5,424,421	5,430,285	20,036	15,500
Oklahoma	(1)	(1)	13,117	27,341	1,214,575	904,767	-	-
Oregon	-	-	-	-	854,585	909,250	197,310	344,690
Panama Canal Zone	-	-	-	-	-	-	14,910	16,900
Pennsylvania	(1)	(1)	431,693	1,024,096	4,059,909	4,829,005	26,484	59,757
Puerto Rico	(1)	(1)	-	-	17,440	18,487	1,108	2,439
Rhode Island	-	-	(1)	(1)	157,975	139,937	-	-
South Carolina	-	-	-	-	1,015,864	568,816	-	-
South Dakota	-	-	-	-	374,314	307,498	-	-
Tennessee	(1)	(1)	386,657	852,117	1,006,132	1,235,398	-	-
Texas	(1)	(1)	8,812	10,804	3,029,186	2,358,453	112	320
Utah	-	-	(1)	(1)	425,997	333,022	6,592	3,316
Vermont	-	-	433	453	55,187	32,568	-	-
Virginia	(1)	(1)	(1)	(1)	943,661	828,068	-	-
Washington	9,300	70,000	(1)	(1)	1,337,385	1,183,895	11,035	17,170
West Virginia	1,152,776	3,357,367	(1)	(1)	447,163	632,302	-	-
Wisconsin	-	-	(1)	(1)	1,984,787	1,486,557	-	-
Wyoming	-	-	-	-	55,476	60,912	-	-
Undistributed [1]	2,469,307	8,071,279	1,011,783	2,087,807	139,235	181,086	-	-
Total	6,192,389	17,491,358	7,895,391	15,731,809	77,759,220	68,936,290	1,077,951	1,196,638

[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 1953, 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	441,915	$305,369	149,678	$88,654	(1)	(1)		
Alaska	(1)	(1)	7,763	12,425				
American Samoa			630	250				
Arizona	55,593	61,545	19,826	12,906				
Arkansas	308,649	226,618	197,500	144,325			(1)	(1)
California	6,383,638	5,578,210	1,656,012	746,253	126,945	$400,888		
Colorado	(1)	(1)	506,947	166,339	(1)	(1)		
Connecticut	476,004	391,690	576,700	149,506				
Delaware	(1)	(1)						
Florida	513,229	339,792	13,000	2,500	36,806	75,612	1,000	$2,000
Georgia	438,629	285,469	1,350	750	59,084	180,047		
Hawaii								
Idaho	32,825	42,640	132,885	66,430				
Illinois	3,230,802	2,318,874	138,769	73,787	135,557	528,476	(1)	(1)
Indiana	2,096,126	1,628,489	131,322	78,803			(1)	(1)
Iowa	743,108	555,386	464,613	87,273	(1)	(1)		
Kansas	1,691,021	1,210,994	587,093	284,690	(1)	(1)		
Kentucky	411,416	332,233						
Louisiana	546,449	516,965	158,540	63,400				
Maine	(1)	(1)	300,219	95,080				
Maryland	1,346,905	1,670,471	27,000	8,600				
Massachusetts	778,576	643,658	56,464	63,687			1,000	750
Michigan	3,150,812	2,537,940	526,827	72,546	(1)	(1)		
Minnesota	843,976	767,532	184,167	47,193				
Mississippi	176,815	148,966	156,199	116,349				
Missouri	721,879	588,869	10,246	11,754	(1)	(1)	15,908	29,800
Montana	37,385	37,354	312,321	44,200				
Nebraska	747,397	533,948	3,991	829				
Nevada			21,160	5,598	(1)	(1)		
New Hampshire	(1)	(1)	301,813	31,289				
New Jersey	1,181,939	1,067,014	2,159	899	59,310	206,555	16,742	28,859
New Mexico	1,800	1,667	3,731	8,292	1,012	1,110		
New York	5,120,423	5,193,269	199,768	41,054				
North Carolina	618,619	320,865	2,356,774	810,434				
North Dakota	24,074	22,374	29,160	2,160				
Ohio	3,363,159	3,153,238	405	300	(1)	(1)	69,139	164,594
Oklahoma	675,444	517,808	378,297	70,608	(1)	(1)		
Oregon	177,480	203,931						
Panama Canal Zone			14,910	16,900				
Pennsylvania	2,111,500	2,895,286			(1)	(1)	63,746	223,146
Puerto Rico	33,700	32,205	1,218	712				
Rhode Island	119,745	82,146	49,011	24,112				
South Carolina	312,099	142,327	49,829	14,432	(1)	(1)		
South Dakota	97,304	73,261	66,874	43,628				
Tennessee	526,666	540,227	568,522	424,362	(1)	(1)	(1)	(1)
Texas	1,344,594	1,054,917	385,627	48,520	132,980	477,855		
Utah	250,852	201,159	106	207	(1)	(1)	(1)	(1)
Vermont	56,513	40,423	140,000	48,750	43,213	43,213		
Virginia	914,104	493,615	68,981	45,534	(1)	(1)	(1)	(1)
Washington	440,420	230,155	446,310	417,790	(1)	(1)		
West Virginia	326,012	329,677			(1)	(1)	(1)	(1)
Wisconsin	1,164,428	948,319	2,504,979	1,405,743	(1)	(1)		
Wyoming	7,518	8,133	14,951	26,240				
Undistributed [1]	200,686	166,864			897,441	1,461,606	333,769	445,800
Total	44,242,228	38,441,892	13,924,647	5,926,093	1,492,348	3,375,362	501,304	894,949

[1] Figures that may not be shown separately are combined as "Undistributed."
[2] Includes 651,149 tons of blast sand valued at $2,156,691.

TABLE 4.—Sand and gravel sold or used by producers in the United States in 1953, 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	(1)	(1)			21,983	$4,502	(1)	(1)
Alaska							(1)	(1)
American Samoa								
Arizona	578	$578					(1)	(1)
Arkansas	(1)	(1)			(1)	(1)	(1)	(1)
California	84,407	92,385	(1)	(1)	(1)	(1)	290,284	$332,223
Colorado	(1)	(1)					30,795	36,381
Connecticut	1,375	550	(1)	(1)			13,460	8,962
Delaware	(1)	(1)					4,293	4,293
Florida	3,903	3,997	6,832	$9,032	(1)	(1)	71,807	55,927
Georgia	27,077	13,911	(1)	(1)	27,008	14,854	156,893	174,718
Hawaii								
Idaho	9,280	3,535			18,275	6,765	18,275	6,770
Illinois	108,497	100,621	14,458	74,347	(1)	(1)	575,314	1,204,733
Indiana	72,087	43,019			(1)	(1)	34,283	10,320
Iowa	24,488	33,192	(1)	(1)	24,601	11,309	82,216	62,174
Kansas	97,331	82,176	(1)	(1)	216,872	120,657	111,375	92,961
Kentucky	67,628	60,030			(1)	(1)		
Louisiana	4,503	2,484			(1)	(1)	120,205	106,769
Maine	(1)	(1)			31	23	(1)	(1)
Maryland	(1)	(1)					2,273	2,273
Massachusetts			(1)	(1)			29,930	22,650
Michigan	55,845	39,183			(1)	(1)	196,904	97,108
Minnesota	(1)	(1)	(1)	(1)	28,893	8,297	63,288	37,306
Mississippi	(1)	(1)						
Missouri	12,503	11,249	7,768	12,677	(1)	(1)	103,514	254,560
Montana							26,878	4,864
Nebraska	106,648	69,286	(1)	(1)	(1)	(1)	39,500	15,625
Nevada							(1)	(1)
New Hampshire			(1)	(1)			(1)	(1)
New Jersey	12,230	8,101	92,277	137,603			382,257	389,521
New Mexico								
New York	(1)	(1)	62,789	61,118	(1)	(1)	174,866	102,855
North Carolina	59,451	53,760	(1)	(1)	(1)	(1)	37,500	37,500
North Dakota	240	41					686	214
Ohio	81,856	133,450	37,321	39,590	23,677	19,927	324,644	455,953
Oklahoma	26,717	20,782					81,192	105,907
Oregon	5,075	5,250			(1)	(1)	(1)	(1)
Panama Canal Zone								
Pennsylvania	220,136	440,007	(1)	(1)			205,944	454,209
Puerto Rico								
Rhode Island							(1)	(1)
South Carolina	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
South Dakota					(1)	(1)	180	151
Tennessee	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Texas	50,326	31,905	(1)	(1)			120,741	59,772
Utah	(1)	(1)	(1)	(1)			107,588	81,278
Vermont	2,205	2,905					7	7
Virginia	(1)	(1)					79,129	94,826
Washington	11,000	4,475					33,685	26,870
West Virginia	152,887	288,179					105,838	274,379
Wisconsin	(1)	(1)			56,873	32,282	262,459	109,405
Wyoming	(1)	(1)						
Undistributed [1]	382,186	266,332	163,174	505,083	761,584	336,064	207,661	269,924
Total	1,680,459	1,811,383	384,619	839,450	1,179,797	554,680	4,095,864	4,993,388

[1] Figures that may not be shown separately are combined as "Undistributed."
[3] Includes 49,467 tons of engine sand valued at $29,514, produced by railroads for their own use.
[4] Includes 114,650 tons of ballast sand valued at $11,970, produced by railroads for their own use.
[5] Includes 174,655 tons of sand valued at $31,938, used by railroads for fills and similar purposes.

TABLE 4.—Sand and gravel sold or used by producers in the United States in 1953, 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	808,041	$788,641			679,606	$640,723	164,906	$68,393
Alaska	128,163	237,812	1,000,469	$758,479	309,970	758,715	5,728,587	2,691,626
American Samoa								
Arizona	554,141	650,280			877,861	698,317	1,244,600	542,542
Arkansas	64,404	67,694			707,351	823,496	2,328,389	2,512,283
California	13,255,772	13,698,631	5,452,315	3,105,707	9,328,175	9,501,357	7,144,736	4,544,443
Colorado	1,290,665	1,467,774	370,560	190,600	574,289	404,721	8,535,068	5,214,584
Connecticut	482,642	557,497			438,890	414,461	106,726	36,358
Delaware	38,922	64,017			45,047	64,589		
Florida	279,553	343,008			(1)	(1)		
Georgia	(1)	(1)			(1)	(1)	3,375	500
Hawaii							(1)	(1)
Idaho	282,170	328,215	176,865	201,945	294,210	315,680	2,521,160	1,552,315
Illinois	3,724,300	2,908,330	29,450	13,085	4,867,033	3,526,256	618,652	351,088
Indiana	1,735,956	1,667,002			3,583,081	2,974,015	412,430	203,008
Iowa	820,812	1,221,910	91,000	16,000	2,840,845	1,749,101	3,403,078	803,431
Kansas	136,140	115,345	132,720	7,665	1,341,702	1,038,158	1,307,679	419,133
Kentucky	711,353	876,756	35,000	35,000	335,644	338,336	215,369	58,061
Louisiana	1,284,839	1,672,031			1,286,425	1,639,916	74,250	8,250
Maine	99,046	70,907	7,755	1,264	477,577	278,809	6,985,330	2,016,548
Maryland	1,549,821	2,412,652			1,687,725	2,430,437	744,387	148,171
Massachusetts	1,959,185	2,178,423	11,585	23,723	901,757	661,218	729,060	71,776
Michigan	3,815,209	3,795,671			10,253,572	8,210,413	5,723,474	2,549,494
Minnesota	1,215,413	1,735,049			2,214,272	1,517,922	11,937,820	1,071,302
Mississippi	373,792	355,699			830,561	758,792	297,954	253,838
Missouri	845,309	765,213	9,315	948	538,245	441,612	839,880	450,846
Montana	203,578	273,869	19,308	31,799	61,769	68,062	4,686,303	1,856,247
Nebraska	938,932	710,947	770	516	2,734,073	2,078,800	417,295	224,697
Nevada	148,345	222,001			1,269	2,610	1,711,319	968,983
New Hampshire	(1)	(1)			(1)	(1)	(1)	(1)
New Jersey	1,003,602	1,168,799			563,157	660,588	28,690	14,345
New Mexico	467,463	389,910			102,693	124,392	390,599	361,917
New York	3,463,115	4,767,410	94,326	15,119	3,721,360	3,980,578	2,714,316	1,602,545
North Carolina	687,513	1,014,282			1,212,271	1,311,639	365,124	378,427
North Dakota	502,065	811,288	46,175	2,181	1,060,855	634,367	4,044,739	341,972
Ohio	3,734,072	3,981,481			7,045,828	7,839,975	338,595	220,968
Oklahoma	126,143	115,223			303,703	403,409	1,635,565	1,260,296
Oregon	1,296,495	1,417,322	516,675	807,655	2,456,180	2,394,889	2,860,358	2,243,185
Panama Canal Zone			28,047	30,850			28,047	30,850
Pennsylvania	3,917,298	4,835,198			2,304,527	3,075,064	274,455	21,592
Puerto Rico	59,117	79,225	3,757	8,585	(1)	(1)	1,928	2,019
Rhode Island	(1)	(1)			165,075	170,713	174,626	168,428
South Carolina	(1)	(1)			(1)	(1)		
South Dakota	61,373	80,175	750	203	1,826,987	1,199,671	2,873,776	1,049,774
Tennessee	967,755	1,261,537	84,500	32,500	645,573	608,906	680,302	223,354
Texas	3,957,972	4,458,818	278	480	2,496,541	2,817,227	2,848,246	369,319
Utah	601,711	481,335	5,775	3,465	882,739	585,549	2,103,311	1,408,518
Vermont	19,306	27,080			166,570	203,079	613,757	280,925
Virginia	1,490,271	1,718,954			1,259,916	1,537,286	286,251	167,904
Washington	2,157,435	1,793,445	927,105	649,120	1,169,295	1,093,783	3,844,655	3,395,445
West Virginia	410,808	528,674			195,502	253,274	156,000	99,000
Wisconsin	1,995,251	1,588,501			4,661,254	3,359,064	9,011,683	5,494,726
Wyoming	73,688	93,157			360,943	243,358	2,546,495	1,548,696
Undistributed [1]	818,450	1,029,010			877,889	1,093,369	1,752,431	273,155
Total	64,557,406	70,826,198	9,044,500	5,936,889	80,689,807	74,926,696	107,455,776	49,575,255

[1] Figures that may not be shown separately are combined as "Undistributed."
[6] Includes 693,835 tons building gravel valued at $374,593, produced by railroads for their own use.

TABLE 4.—Sand and gravel sold or used by producers in the United States in 1953, 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	410,022	$229,992	77,306	$78,103	3,396,123	$2,845,636	314,584	$157,047
Alaska	(1)	(1)			839,678	1,398,927	6,849,600	3,680,754
American Samoa							1,320	425
Arizona	2,226	2,226	(1)	(1)	2,182,395	2,125,022	1,264,426	555,448
Arkansas	277,324	220,587	(1)	(1)	2,377,946	2,298,775	2,525,889	2,656,608
California	268,768	194,877	849,831	946,303	43,849,690	44,602,421	14,579,838	8,621,782
Colorado	(1)	(1)	82,199	90,498	3,013,470	3,025,670	9,425,130	5,583,481
Connecticut	(1)	(1)	42,553	13,242	2,342,414	2,161,886	683,426	185,864
Delaware			187,458	112,474	520,817	399,685		
Florida	(1)	(1)			3,718,432	3,196,868	13,000	2,500
Georgia					2,046,333	1,899,737	4,725	1,250
Hawaii					(1)	(1)	(1)	(1)
Idaho	33,215	2,945	6,925	6,845	874,885	939,805	2,901,295	1,901,635
Illinois	962,335	531,440	326,466	211,717	20,734,935	20,102,589	786,871	437,960
Indiana	523,815	438,916	75,231	54,514	10,659,307	9,219,103	543,752	281,811
Iowa	126,974	62,200	70,549	135,940	6,426,631	5,494,123	3,958,691	906,704
Kansas	20,164	6,356	30,190	25,245	6,678,241	4,946,934	2,050,050	721,374
Kentucky	328,508	250,580	(1)	(1)	2,801,536	2,806,271	250,619	93,661
Louisiana	32,447	27,471	(1)	(1)	4,305,597	5,090,598	232,790	71,650
Maine	97,376	52,328	8,468	4,308	778,565	495,244	7,293,372	2,113,142
Maryland			(1)	(1)	6,608,124	8,762,317	771,387	156,771
Massachusetts	(1)	(1)	661,812	304,476	6,499,371	5,744,007	808,819	186,887
Michigan	506,727	349,729	96,456	65,699	24,209,362	20,548,762	6,250,301	2,622,040
Minnesota	1,101,877	448,575	181,387	64,808	7,652,055	6,185,697	12,122,356	1,118,654
Mississippi	184,558	97,725	(1)	(1)	2,070,123	1,713,362	583,523	460,509
Missouri	165,390	103,710	40,625	39,547	4,932,617	4,770,451	859,441	463,548
Montana	390,073	194,302	268,645	114,493	1,179,582	1,045,970	5,023,898	1,947,605
Nebraska	(1)	(1)	7,447	4,725	5,547,802	4,114,121	422,056	226,042
Nevada			(1)	(1)	533,585	1,114,367	1,732,479	974,581
New Hampshire			26,364	19,908	(1)	(1)	(1)	(1)
New Jersey	(1)	(1)	(1)	(1)	7,331,086	10,820,704	30,849	15,244
New Mexico	63,156	43,042	23,625	17,500	1,022,050	868,770	394,330	370,209
New York	3,710	3,351	501,196	283,853	19,465,594	21,804,551	3,065,297	1,689,306
North Carolina	275,444	227,569	(1)	(1)	4,139,084	3,779,130	2,771,898	1,213,861
North Dakota	208,076	124,682	48,769	10,696	2,053,663	1,818,372	4,120,074	346,313
Ohio	870,489	629,880	1,812,458	2,183,274	23,673,352	26,839,508	359,036	236,768
Oklahoma			(1)	(1)	2,687,504	2,638,681	2,013,862	1,330,904
Oregon	211,705	196,145	154,500	88,430	5,188,735	5,234,102	3,574,343	3,395,530
Panama Canal Zone							85,914	95,500
Pennsylvania	57,956	31,850	80,191	135,670	14,414,444	20,611,042	300,939	81,349
Puerto Rico			1,080	1,400	218,575	236,447	8,011	13,755
Rhode Island			103,029	23,204	674,756	583,160	223,637	192,540
South Carolina	(1)	(1)	5,680	8,000	2,925,779	2,550,052	49,982	14,432
South Dakota	84,820	60,365	(1)	(1)	2,460,978	1,734,121	2,941,400	1,093,605
Tennessee	(1)	(1)	(1)	(1)	3,898,005	4,949,471	1,333,324	680,216
Texas	436,465	393,898	79,971	97,902	11,866,963	12,426,922	3,234,263	418,639
Utah	201,633	18,514	(1)	(1)	2,512,024	1,764,184	2,115,784	1,415,506
Vermont	16,416	10,670			359,850	360,398	753,757	329,675
Virginia	(1)	(1)			4,921,118	4,947,126	355,232	213,438
Washington	337,320	177,090	454,130	241,070	5,953,730	4,838,268	5,229,105	4,479,525
West Virginia	(1)	(1)	(1)	(1)	3,006,776	5,971,847	156,000	99,000
Wisconsin	1,249,717	531,152	142,697	65,929	12,139,424	9,272,833	11,516,662	6,900,469
Wyoming	(1)	(1)	(1)	(1)	587,930	426,261	2,561,446	1,574,936
Undistributed [1]	1,056,579	842,722	962,996	1,104,768	305,315	358,587	2,054,244	304,422
Total	10,505,285	6,504,889	7,410,234	6,554,541	308,586,351	311,882,885	131,502,874	62,634,875

[1] Figures that may not be shown separately are combined as "Undistributed."
[7] Includes 4,194,493 tons of ballast gravel valued at $1,877,473, produced by railroads for their own use.
[8] Includes 664,751 tons of gravel valued at $224,723, used by railroads for fills and similar purposes.

Government-and-Contractor Production.—Sand and gravel produced by, or directly for, Government agencies in 1953 is shown in tables 5 and 6. Figure 2 shows graphically the relative proportion of this Government production compared with commercial production. Noncommercial production constituted 30 percent of total output compared with 31 percent in 1952 and 29 percent in 1951. The 1953 value of noncommercial production was 17 percent of total output, 1 percent more than in the previous year.

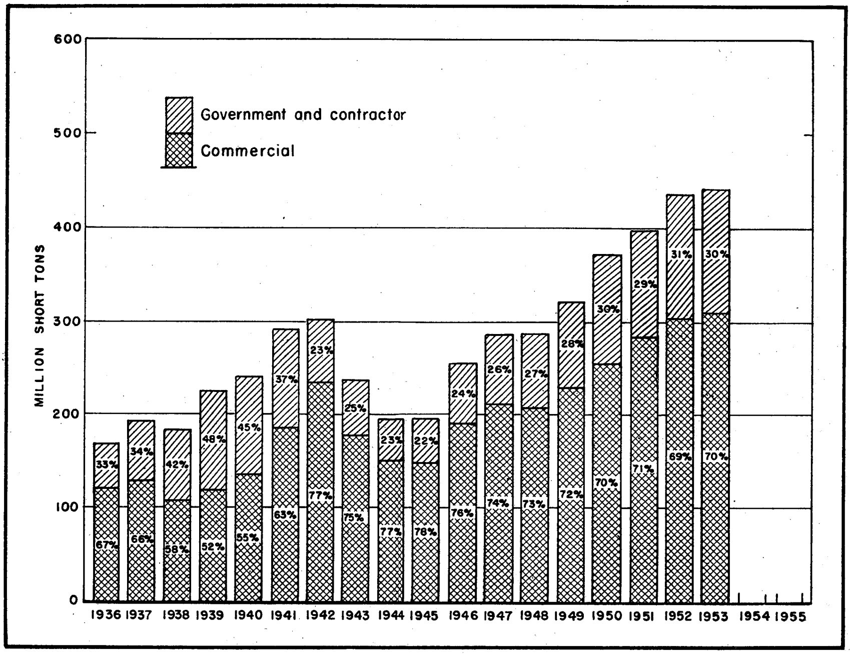

FIGURE 2.—Sand and gravel sold or used in the United States by producers, 1936–53.

TABLE 5.—Sand and gravel sold or used by Government-and-contractor producers in the United States,[1] 1944–48 (average) and 1949–53, 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)
1944–48 (average)	1,170	549	5,672	2,165	3,051	1,843	52,194	22,193	62,087	26,750
1949	1,604	959	7,424	2,820	3,133	2,235	75,738	31,093	87,899	37,107
1950	2,759	1,675	11,159	4,286	5,216	4,510	93,765	43,245	112,899	53,716
1951	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

[1] Includes Alaska, American Samoa, Hawaii, Panama Canal Zone, and Puerto Rico.

States reported 54 percent of the noncommercial total in 1953, counties 30 percent, Federal agencies 14, and municipalities 2 percent. Contractors furnished 65 percent of all noncommercial production. The balance was produced by Government construction and maintenance crews.

TABLE 6.—Sand and gravel sold or used by Government-and-contractor producers in the United States,[1] 1944–48 (average) and 1949–53, by type of producer

Type of producer	1944–48 (average)		1949		1950	
	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	35,210	$0.33	43,586	$0.31	48,742	$0.33
Contractors	26,877	.57	44,313	.53	64,157	.59
Total	62,087	.43	87,899	.42	112,899	.48
States	29,542	.47	44,354	.44	61,798	.50
Counties	24,554	.31	33,822	.31	37,841	.30
Municipalities	1,448	.39	2,131	.40	2,109	.54
Federal agencies	6,543	.72	7,592	.82	11,151	.89
Total	62,087	.43	87,899	.42	112,899	.48

Type of producer	1951		1952		1953	
	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	41,637	$0.36	46,901	$0.35	46,250	$0.38
Contractors	73,178	.53	86,882	.48	85,253	.53
Total	114,815	.47	133,783	.44	131,503	.48
States	60,387	.43	68,928	.44	71,199	.49
Counties	34,249	.37	39,107	.37	39,954	.38
Municipalities	2,159	.47	2,068	.52	2,720	.46
Federal agencies	18,020	.77	23,680	.53	17,630	.64
Total	114,815	.47	133,783	.44	131,503	.48

[1] Includes Alaska, American Samoa, Hawaii, Panama Canal Zone, and Puerto Rico.

Degree of Preparation.—Seventy-six percent of the total sand and gravel used in 1953 was washed, screened, or otherwise prepared. The balance was a bank-run product used chiefly as a base for secondary roads. Of the latter use 70 percent was supplied by Government-and-contractor operations. Table 7 shows the relationship of prepared to unprepared production for 1952–53.

Size of Plants.—The average annual plant output for commercial operating units (except railroads) in 1953 dropped to 116,000 tons compared with 118,000 tons in 1952. Ninety-six new plants, each producing less than 25,000 tons annually, increased the number of operations in this size range to 920, which accounted for only 3 percent of total production. Ten new plants in the 800,000- to 1,000,000-ton yearly range increased the total plants in this category to 17 and produced almost 5 percent of total 1953 output. Table 8 gives details of the number of plants in various size groups and comparison of 1953 with the previous year.

TABLE 7.—Sand and gravel sold or used by producers in the United States,[1] 1952–53, by class of operation and degree of preparation

	1952			1953		
	Quantity		Average value per ton	Quantity		Average value per ton
	Short tons	Percent		Short tons	Percent	
Commercial operations:						
Prepared	272,225,449	90	$1.03	277,193,735	90	$1.04
Unprepared	29,503,045	10	.53	31,392,616	10	.75
Total	301,728,494	100	.98	308,586,351	100	1.01
Government-and-contractor operations:						
Prepared	47,158,666	35	.84	58,365,305	44	.74
Unprepared	86,624,073	65	.21	73,137,569	56	.27
Total	133,782,739	100	.44	131,502,874	100	.48
Grand total	435,511,233		.81	440,089,225		.85

[1] Includes Alaska, American Samoa, Hawaii, Panama Canal Zone, and Puerto Rico.

TABLE 8.—Comparison of number and production of commercial sand and gravel plants in the United States, 1952–53, by size group [1]

Size group, in short tons annual production	1952				1953			
	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	824	32.9	8,356	2.8	920	35.3	9,048	3.0
25,000 to less than 50,000	429	17.1	15,644	5.3	440	16.9	15,884	5.3
50,000 to less than 100,000	438	17.5	31,188	10.6	461	17.7	32,754	10.8
100,000 to less than 200,000	405	16.2	56,760	19.3	373	14.3	53,531	17.7
200,000 to less than 300,000	179	7.1	43,562	14.8	166	6.4	40,844	13.5
300,000 to less than 400,000	82	3.3	27,656	9.4	89	3.4	30,844	10.2
400,000 to less than 500,000	40	1.6	17,799	6.0	48	1.9	21,320	7.0
500,000 to less than 600,000	29	1.2	15,594	5.3	32	1.2	17,368	5.7
600,000 to less than 700,000	24	1.0	15,668	5.3	18	.7	11,693	3.9
700,000 to less than 800,000	17	.7	12,652	4.3	14	.5	10,658	3.5
800,000 to less than 900,000	5	.2	4,233	1.4	13	.5	10,905	3.6
900,000 to less than 1,000,000	2	.1	1,921	.7	4	.2	3,814	1.3
1,000,000 and over	27	1.1	43,688	14.8	27	1.0	44,032	14.5
Total	2,501	100.0	294,721	100.0	2,605	100.0	302,695	100.0

[1] Excludes operations by or for States, counties, municipalities, and Federal Government agencies as follows—1952: 806 operations with an output of 134,788,739 tons of sand and gravel; 1953: 1,035 operations, 131,502,874 tons. Excludes operations by or for railroads as follows—1952: 176 operations with an output of 7,007,033 tons of sand and gravel; 1953: 110 operations, 5,891,851 tons. Includes Alaska, Hawaii, and Puerto Rico.

[2] Includes a few companies operating more than 1 plant but not submitting separate returns for individual plants.

Methods of Transportation.—Of the total sand and gravel sold or used in 1953, 73 percent was hauled by truck, about the same as in the previous year. Details of all reported methods of transportation for 1951–53 are shown in table 9.

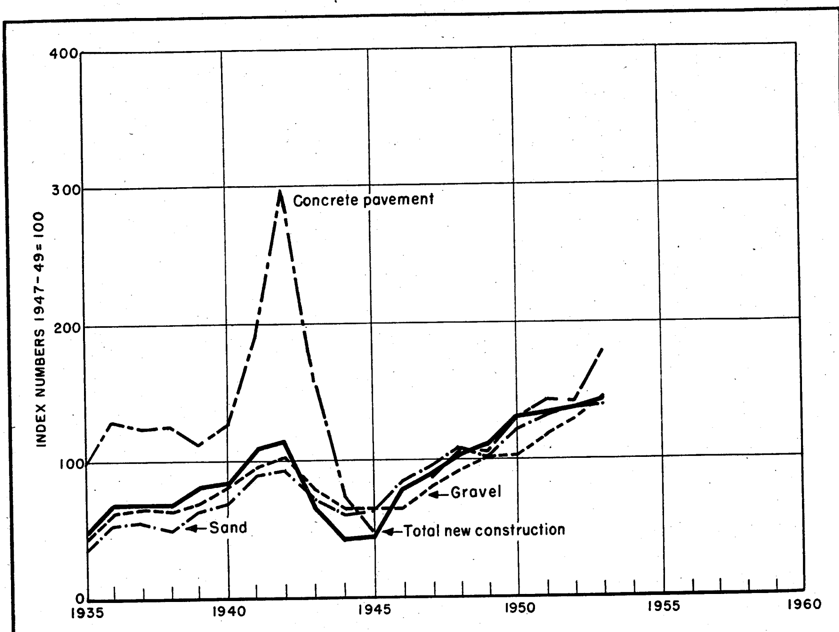

FIGURE 3.—Quantity of sand and gravel produced compared with value of total new construction, adjusted to 1947–49 prices, and total square yards of concrete pavements contracted for in the United States, 1935–53. Data on construction from Statistical Abstracts of the United States and on pavements from Survey of Current Business.

TABLE 9.—Sand and gravel sold or used in the United States,[1] 1951–53, by method of transportation

	1951		1952		1953	
	Thousand short tons	Percent of total	Thousand short tons	Percent of total	Thousand short tons	Percent of total
Commercial:						
Truck	166,992	41	187,267	43	189,733	43
Rail	80,062	20	83,381	19	74,612	17
Waterway	23,617	6	25,891	6	27,416	6
Unspecified	15,148	4	5,189	1	16,825	4
Total commercial	285,819	71	301,728	69	308,586	70
Government-and-contractor: Truck[2]	114,815	29	133,783	31	131,503	30
Grand total	400,634	100	435,511	100	440,089	100

[1] Includes Alaska, American Samoa, Hawaii, Panama Canal Zone, and Puerto Rico.
[2] Entire output of Government-and-contractor operations assumed to be moved by truck.

Employment and Productivity.—The number of men employed in the commercial sand and gravel industry in the United States during 1953 totaled almost 27,000, compared with 28,000 men in 1952. The average number of days worked per man was 240 and the average number of hours per man per day 8.6. Output rose to 47.2 tons per man-shift from 45.7 in 1952, 43.9 in 1951, and 41 in 1950. The greatest average production per hour was reported from New York, followed in order by the Illinois-Indiana and Michigan-Wisconsin areas. Table 10 presents further details of employment and productivity in the commercial sand and gravel industry, by regions.

TABLE 10.—Employment in the commercial sand and gravel industry and average output per man in the United States, 1944–48 (average) and 1949–53, by regions [1]

	Employment					Production (short tons)			Percent of commercial industry represented
	Average number of men	Time employed				Commercial sand and gravel	Average per man		
		Average number of days	Total man shifts	Man-hours			Per shift	Per hour	
				Average man per day	Total				
1944–48 (average)	19, 169	239	4, 585, 714	8. 8	40, 162, 203	155, 434, 986	33. 9	3. 9	82. 5
1949	22, 964	232	5, 336, 711	8. 7	46, 286, 039	199, 655, 709	37. 4	4. 3	86. 4
1950	24, 276	238	5, 771, 740	8. 7	50, 250, 732	236, 420, 288	41. 0	4. 7	91. 8
1951	24, 375	241	5, 883, 607	8. 7	51, 367, 929	258, 335, 982	43. 9	5. 0	90. 4
1952									
Maine, N. H., Vt., R. I., Mass., and Conn	957	214	204, 831	8. 7	1, 774, 548	9, 983, 365	48. 7	5. 6	93. 3
N. Y	1, 229	226	277, 241	8. 4	2, 318, 015	16, 703, 526	60. 2	7. 2	92. 1
Pa., N. J., and Del	2, 491	260	647, 499	8. 6	5, 563, 218	21, 140, 635	32. 6	3. 8	97. 2
W. Va., Va., and Md	1, 574	269	423, 251	8. 9	3, 774, 758	13, 556, 695	32. 0	3. 6	87. 0
S. C., Ga., Ala., Fla., and Miss	1, 163	264	306, 624	8. 9	2, 739, 062	12, 058, 060	39. 3	4. 4	96. 8
N. C., Ky., and Tenn	1, 155	251	289, 430	9. 3	2, 689, 182	10, 858, 391	37. 5	4. 0	98. 6
Ark., La., and Texas	2, 325	264	613, 288	9. 1	5, 571, 623	22, 206, 319	36. 2	4. 0	91. 6
Ohio	1, 917	240	460, 219	8. 6	3, 972, 552	19, 414, 708	42. 2	4. 9	95. 4
Ill. and Ind	2, 190	250	547, 243	8. 4	4, 620, 973	28, 352, 292	51. 8	6. 1	93. 7
Mich. and Wis	2, 646	212	561, 872	9. 0	5, 065, 519	32, 403, 272	57. 7	6. 4	91. 4
N. Dak., S. Dak., and Minn.	984	174	171, 192	9. 2	1, 574, 322	9, 536, 018	55. 7	6. 1	82. 2
Nebr. and Iowa	862	217	187, 047	9. 6	1, 794, 610	10, 019, 944	53. 6	5. 6	93. 5
Kans., Mo., and Okla	1, 375	240	329, 326	8. 7	2, 859, 281	14, 359, 030	43. 6	5. 0	96. 7
Wyo., Colo., N. Mex., Utah, and Ariz	640	209	133, 757	8. 4	1, 116, 901	5, 880, 755	44. 0	5. 3	91. 7
Calif. and Nev	2, 840	251	712, 490	8. 3	5, 935, 574	40, 955, 781	57. 5	6. 9	97. 4
Mont., Wash., Oreg., and Idaho	1, 349	201	271, 539	8. 1	2, 212, 373	12, 695, 494	46. 8	5. 7	82. 2
Alaska	58	131	7, 572	8. 4	63, 316	382, 446	50. 5	6. 0	49. 7
Total	25, 755	239	6, 144, 421	8. 7	53, 645, 827	280, 506, 731	45. 7	5. 2	93. 0
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 Tex	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

[1] Incomplete totals. Includes only those companies reporting employment figures and does not include plants operated by or directly for States, counties, municipalities, and Federal Government agencies.

CONSUMPTION

Construction Uses, Including Ballast.—Sand and gravel for building, paving, and railroad ballast constituted 93 percent of all 1953 output compared with 94 percent in 1952. The quantity consumed for these purposes was about the same as in 1952, but the value was 5 percent greater.

Industrial Sands.—The tonnages of industrial sands used in 1953 compared with 1952 were: Glass sand, 18 percent greater; grinding and polishing, 21 percent greater; and fire and furnace, 21 percent more. Molding sand and engine sand decreased 4 and 12 percent, respectively.

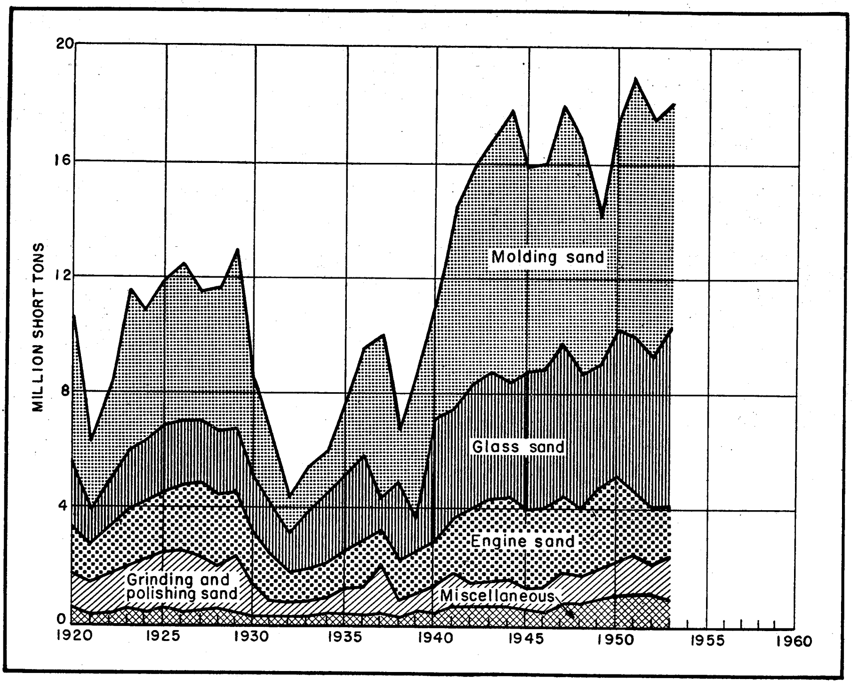

FIGURE 4.—Production of industrial sands in the United States, 1920–53.

Merchandising.—Several neighboring sand and gravel companies found it advantageous to handle their sales through a single selling organization. This arrangement is reported to have reduced selling costs, made it possible and economical to meet difficult specifications, resulted in profitable liquidation of surplus grades, and provided better service to the customers.[3]

[3] Brady, Charles E., Merchandise Production of Several Companies Through Sales Concern: Rock Products, vol. 56, No. 5, May 1953, pp. 88–90.

STOCKS

Stocks of sand and gravel are relatively small compared with output and substantially constant from year to year. For this reason the terms "production" and "sales" are employed interchangeably in this chapter.

PRICES

Commercial sand and gravel prices in 1953 compared with 1952 were mostly higher, except for industrial sand used for grinding and polishing, fire and furnace sand, and sand used for railroad ballast. The percentage of change for each individual class, together with their average per ton value at the source, is shown in table 1.

FOREIGN TRADE [4]

Table 11 shows domestic imports of sand and gravel for 1944–48 (average) and 1949–53 as reported by the United States Department of Commerce. Virtually all glass sand imported in 1953 came from Belgium. All other significant imports of sand and gravel came from Canada. Exports of sand and gravel totaled about 1 million tons, with a value of $3,280,000. The 3 principal destinations of sand exported from the United States were Canada, with 803,800 short tons at $3 per ton; Mexico, 133,700 short tons at $3.25; and Bermuda, which received 28,200 short tons valued at $5.86 per ton. Nearly all exports of gravel went to Canada in 1953.

TABLE 11.—Sand and gravel imported for consumption in the United States, 1944–48 (average) and 1949–53, 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
1944–48 (average)	5,948	$9,219	261,280	$207,311	99,813	$46,422	367,041	$262,952
1949	11,491	20,152	287,452	277,564	135,227	19,194	434,170	316,910
1950	9,191	25,481	290,025	266,065	146,079	29,011	445,295	320,557
1951	[3] 6,260	[3] 91,424	319,584	317,205	149,766	31,189	475,610	[3] 439,818
1952	[3] 4,016	[3] 23,998	300,182	344,674	104,332	13,771	[3] 408,530	[3] 382,443
1953	[3] 5,690	[3] 114,000	313,176	329,612	87,028	9,699	[3] 405,894	[3] 453,311

[1] Classification reads: "Sand containing 95 percent or more silicon and not more than 0.6 percent oxide of iron and suitable for manufacture of glass."
[2] Classification reads: 1944–47: "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; and 89 short tons valued at $106,478 in 1953 imported from West Germany and consisting of synthetically prepared silica and not actually glass sand.

TECHNOLOGY

The increase in zoning ordinances by city and parkway planning commissions is making it more difficult to conduct sand and gravel operations near cities. A dredging operation near Denver was able to get approval to remove over 4 million tons of material from 130

[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.

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acres in Clear Creek Valley with the understanding that the area would later be planted and landscaped to form a parklike, water-bordered community.[5]

An unusual method of conveying gravel to the washing plant from a wet-pit operation involves a moored floating receiving hopper discharging by mechanical feeder onto a belt conveyor. The shore end of the conveyor is made portable by mounting on a platform with flanged wheels, which travel on rails. The belt straddles a second conveyor feeding the washing plant. Thus both shore and floating end can be easily moved to accommodate the position of the shovel.[6]

Description of a recent dry-grinding installation outlined the use of gas-fired rotary driers discharging dry sand to a pebble mill in closed circuit with an air classifier. The finest of 3 sizes produced is 98 percent through 200-mesh.[7]

An example of modern engineering is a 265-t. p. h. gravel plant that operates with 1 man per 8-hour shift, assisted only by a maintenance man and dragline operator. The unit reclaims from a 60,000-ton stockpile, crushes screen oversize, and makes a variety of specification products. Two control panels are built into the plant, 1 centrally located at ground level and 1 on the first crusher-screen tower commanding a complete view of operations.[8]

A company in Indiana solved its problem of depleted reserves without moving the washing plant, by spanning a river with a 756-foot wire rope suspension bridge to support a 400-t. p. h. capacity belt conveyor.[9]

The California Division of Highways has embodied in some sand specifications a sand-equivalent test, emphasizing that any claylike material in sand is detrimental, whether for road bases, subbases, bituminous surfacing, or concrete aggregate. The allowable limits of deleterious material can be determined in a quick field test by engineers and inspectors. It consists of shaking a standard volume of sand to be tested in an emulsion, allowing a standard settling time, and then measuring the relative heights of the sand and clay suspensions. Remedies for excessive clay minerals include dilution with clean granular aggregate or eliminating the clays with scrubbers or attrition machines. In the latter cases loss of extremely fine sand sizes becomes a problem, solved frequently by the use of "liquid cyclones."[10]

A description of a 700-t. p. h. operation at the Folsom Dam on the American River in California outlines a flowsheet that includes gold recovery. A washed, minus-¼-inch product from the head end of the plant passes through jigs where the gold is collected.[11]

An idle Colorado gold dredge has been moved to a suburb of Denver, where the gold in the gravel is of much lower content than at the original site but where a satisfactory market exists for the washed sand and gravel. The sands go directly from the trommel

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[5] Utley, Harry F., Reactivated Gold Dredge "Gravel Gertie" Proves Worth: Pit and Quarry, vol. 45, No. 10, April 1953, pp. 65–67, 75.

[6] Lenhard, Walter B., Produce Many Sizes in Compact Plant: Rock Products, vol. 56, No. 1, January 1953.

[7] Utley, Harry F., New Sand-Grinding Facilities Double Output at California Plant: Pit and Quarry, vol. 45, No. 12, June 1953.

[8] Rock Products, vol. 57, No. 6, June 1953, pp. 86–87, 162, 164.

[9] Ahlswede, L. E., How American Aggregates Solved An Unusual Plant-Expansion Problem: Pit and Quarry, vol. 46, No. 2, August 1953.

[10] Lenhart, Walter B., Progress in the Sand and Gravel Industry: Rock Products, vol. 56, No. 1, January 1953, pp. 92, 93–95.

[11] Utley, Harry F., Aggregates for Folsom Dam Project Supplied by Eastern Concerns: Pit and Quarry, vol. 46, No. 4, October 1953, pp. 103–106.

to riffle boxes containing mercury, where the recoverable gold is caught as amalgam and removed every 3 or 4 weeks. The sand then goes to twin sand screws, where it joins the fines from crushed boulders removed at the trommel.[12]

Valuable byproducts of high specific gravity are recovered from sand and gravel operations in San Joaquin County, Calif. Gold, ilmenite, zircon, monazite, and magnetite are caught by passing a portion of the sand stream over shaking tables. The constituents of the bulk concentrate from the tables are then separated.[13]

In a dredging operation with an extremely variable feed, a rod mill has proved very helpful as auxiliary equipment to grind a portion of the pea-gravel fraction into sand sizes. This installation maintains the desired sand-gravel ratio. Any excess sand is shunted to a stockpile and forms a salable product.[14]

A river dredging operation removes soft and porous gravel, coal, wood, and clay from an otherwise good quality gravel by passing all plus-⅜-inch material to a barge-mounted, heavy-medium separation unit. At an effectual specific gravity of 2.50 about 38 percent of the feed is rejected. Magnetite forms the heavy medium and is recovered magnetically with a loss of about 1 pound per ton of gravel feed.[15]

A land-based sand and gravel plant uses heavy-medium separation to remove 6 to 7 percent of its feed as objectionable material, principally shale, but also iron oxide, clay balls, and lignite. The feed to the sink-float plant is minus-1¼-inch plus-⅜-inch. The heavy-medium makeup contains about 60 percent magnetite to 40 percent ferrosilicon, and loss of medium is approximately 6½ cents per ton of treated gravel.[16]

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[12] Work cited in footnote 5.
[13] Rock Products, Recovering High-Value Byproducts: Vol. 56, No. 11, November 1953, pp. 92, 96.
[14] Nordberg, Bror, Rod Mill Brings Sand Production Into Balance: Rock Products, vol. 56, No. 10, October 1953, pp. 101–104, 138, 140, 142.
[15] Price, W. L., Dravo Builds Floating Plant for Heavy-Media Separation of Gravel: Pit and Quarry, vol. 45, No. 10, April 1953.
[16] Avery, William M., H. M. S. Process Solves Substandard Material Problem for Gravel Firm: Pit & Quarry, vol. 46, No. 4, October 1953, pp. 87–91, 122.

Secondary Metals—Nonferrous

By Archie J. McDermid [1] [2]

EARLY IN 1953 most Government controls on production and use of materials were removed; price ceilings were also dropped. These controls had been established in the previous 2 years to provide adequate supplies of metals and other materials for military purposes and essential civilian needs, but by February 1953 supplies of most materials were considered adequate for most purposes. As a

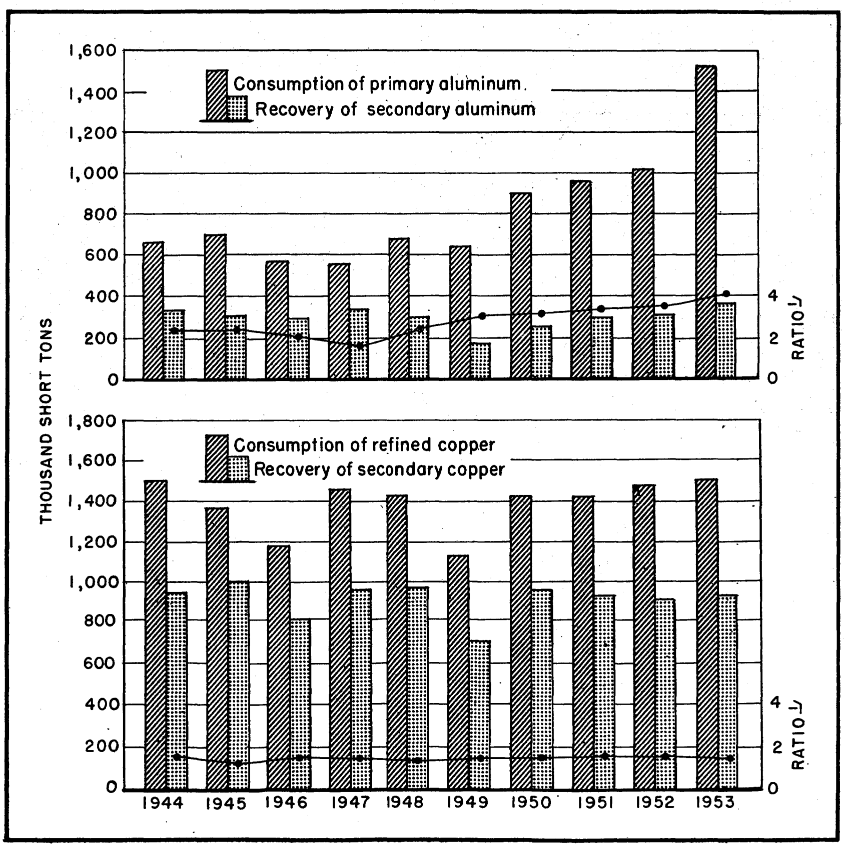

FIGURE 1.—Consumption of refined and recovery of secondary aluminum and copper, 1944–53.

[1] Ratio of refined metal consumption to secondary metal recovery.

[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.

result of restoration of a free market, the flow to consumers of copper and aluminum scrap, the supply of which had been inadequate and which had been kept off the market by owners in hope of higher prices, increased immediately. Receipts and consumption of these items by consumers were considerably higher in the first half of 1953 than in the latter half of 1952; then they slackened as demand weakened. Oversupply of lead and zinc, largely brought about by heavy imports of primary materials, depressed the price of both primary and secondary lead and zinc in 1952 and 1953 and weakened the market for scrap of these metals.

Secondary recovery of aluminum increased more than that of any other nonferrous metal in 1953, and that of copper was second. In 1953 consumption of primary aluminum was 4 times recovery of secondary aluminum, whereas consumption of refined copper was 1½ times recovery of secondary copper. Of the 8 metals listed in table 2, recovery from scrap of 5 rose and that of 3 declined. Figures 1 and 2 show the consumption of refined or primary metal, the recovery of secondary metal, and the ratio of the former to the latter of the 4 major nonferrous metals (those with secondary recovery in hundreds of thousands of tons) in the 10-year period 1944 through 1953.

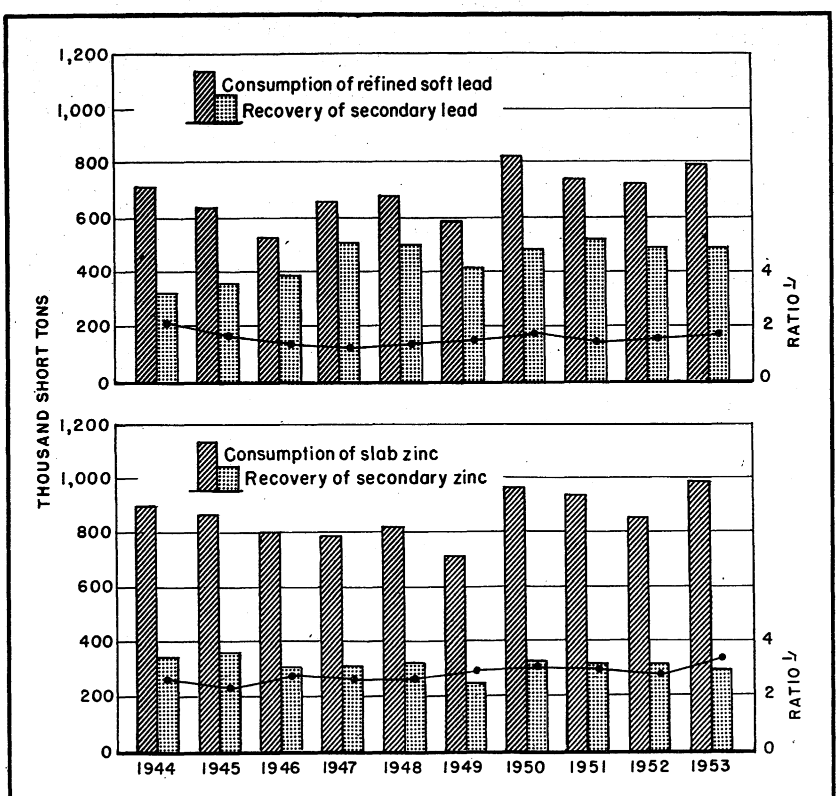

FIGURE 2.—Consumption of refined and recovery of secondary lead and zinc, 1944–53.

[1] Ratio of refined metal consumption to secondary metal recovery.

TABLE 1.—Salient statistics of nonferrous secondary metals recovered from scrap processed in continental United States, 1952–53

Metal	From new scrap		From old scrap		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1952						
Aluminum	233,258	$85,698,989	71,264	$26,182,394	304,522	$111,881,383
Antimony	3,471	3,055,868	19,618	17,271,688	23,089	20,327,556
Copper	488,562	236,464,008	414,635	200,683,340	903,197	437,147,348
Lead	59,463	19,147,086	411,831	132,609,582	471,294	151,756,668
Magnesium	4,240	2,077,600	7,237	3,546,130	11,477	5,623,730
Nickel	3,220	3,788,652	4,259	5,011,139	7,479	8,799,791
Tin	9,328	22,469,286	22,933	[1] 55,241,011	32,261	[1] 77,710,297
Zinc	235,758	78,271,656	74,665	24,788,780	310,423	103,060,436
Total	-----------	450,973,145	-----------	[1] 465,334,064	-----------	[1] 916,307,209
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

[1] Revised figure.

TABLE 2.—Secondary metals recovered as unalloyed metal, in alloys, and in chemical compounds in the United States, 1944–48 (average) and 1949–53, in short tons

Metal	1944-48 (average)	1949	1950	1951	1952	1953
Aluminum	306,744	180,762	243,666	292,608	304,522	368,566
Antimony	19,345	18,061	21,862	23,943	23,089	22,360
Copper	939,107	713,143	977,239	932,282	903,197	958,464
Lead	419,857	412,183	482,275	518,110	471,294	486,737
Magnesium	9,121	5,962	9,476	11,526	11,477	11,930
Nickel	7,489	5,680	8,795	8,602	7,479	8,352
Tin	31,114	24,901	35,481	34,434	32,261	30,914
Zinc	328,405	237,813	326,030	314,377	310,423	294,678

In the 10-year period the ratio of apparent consumption of primary aluminum to recovery of secondary aluminum exhibited a definitely rising trend, with increases in all years except 1946, 1947, and 1951. This trend is explained by the rapid rise in primary production, which largely increased the supply of primary metal. The demand for aluminum was strong enough to provide a good market for both scrap and refined metal, especially in the latter half of the 10-year period. The ratio graph for copper shows comparatively little change during the 10-year interval. The ratio of consumption of refined lead to recovery of secondary lead was lower in 1953 than in 1944, but the low point was in 1947 and from then on there was a moderate upward trend because of high imports of refined metal. The trend in the ratio of consumption of slab zinc to recovery of secondary zinc was upward for the 10-year period, was a little more pronounced than that for lead, and was also influenced by high imports of refined metal.

Considering the 4 metals with secondary recoveries less than 100,000 tons, the secondary recovery of antimony is related more to the recovery of lead than to consumption of primary antimony, as most of it is recovered from lead-alloy scrap. The case of tin is similar, as most secondary tin is recovered from lead and copper alloys. Consumption of primary magnesium has exhibited wide variation, declining from 133,000 tons in 1944 to 7,000 in 1947, then increasing to 50,000 in 1953, whereas secondary recovery of this metal has been between 5,000 and 15,000 tons per year for the 10-year period ended in 1953. Consumption of primary magnesium increased 321 percent in the 1949–53 period, and recovery of secondary magnesium rose 100 percent. Data on nickel are inconclusive because they do not include nickel in iron and steel.

Possibly and even probably the increases in consumption of primary metals in the 1949–53 period may be reflected in increased secondary recovery in a later period. The use of primary metal is recorded only once, whereas the same metal may be returned a number of times as scrap for reuse.

The Bureau of Mines at College Park, Md., conducts research to develop processes for recovering metal from nonferrous material discarded as valueless or to improve processes already in use for recovering metal from nonferrous scrap and from residues, both primary and secondary. Methods under investigation in 1953 included selective oxidation, in which a successful thermal balance was developed; centrifugation and filtration of molten zinc dross and various base-metal alloys; electrolytic recovery of zinc from galvanizers' residues; and vacuum distillation of primary tin residues, galvanizers' dross, and aluminum-silicon alloys.

Publications on this work included reports on centrifugation [3] and vacuum leaching.[4]

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 1 column if they used scrap items of more than 1 base; some smelters are listed as lead smelters, aluminum smelters, and copper smelters, because they consumed lead-, aluminum-, and copper-base scrap. In the same way some foundries have been counted as both aluminum and brass foundries. The tabulation of plants in some categories is subject to limitations. The large number of foundries and the small size of many of them make it impossible to obtain reports from all units. Also, a few large corporations operating two or more plants prefer to file consolidated reports, in which the number and location of plants are not given. As a rule, response by the larger plants is excellent, so that coverage of quantities of metals consumed is better than coverage according to the number of plants.

The reports from industry, on which data in this chapter are based, are received monthly from smelters, brass and aluminum rolling mills, wire mills, primary producers, and some foundries and manufacturers. All brass foundries, some manufacturers, and a number of the smaller aluminum foundries were canvassed on an annual basis.

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[3] Schellinger, A. K., and Spendlove, M. J., Centrifugal Separation of Liquid and Solid Phases From Some Binary Alloys: Bureau of Mines Rept. of Investigations 5007, 1953, 19 pp.

[4] Spendlove, M. J., and Caldwell, H. S., Jr., Vacuum Leaching of Aluminum From Al-Si Alloy: Bureau of Mines paper for pres. at Annual Meeting, AIME, Los Angeles, Calif., Feb. 16–20, 1953.

TABLE 3.—Number and classification of plants in the United States consuming nonferrous scrap metals, refined copper, and copper-alloy ingots in 1953

Kind of plant	Type of materials used				
	Aluminum	Copper	Lead and tin	Zinc	All nonferrous types
Primary plants	[1] 72	[2] 12	6	11	------------
Secondary smelters	[3] 165	[4] 102	270	130	------------
Distillers	------------	------------	------------	[5] 23	------------
Chemical plants	26	50	------------	20	------------
Brass mills	------------	63	------------	------------	------------
Wire mills	------------	[6] 13	------------	------------	------------
Foundries and miscellaneous manufacturers	[7] 1,025	[8] 1,536	30	[9] 61	[10] 281

1 Includes 15 aluminum-reduction plants and 57 rolling mills and extrusion plants having melting facilities, that consumed aluminum scrap or ingot.
2 Primary refineries that consumed copper-base scrap.
3 Includes 158 aluminum-alloy ingot makers and 7 military aluminum smelters.
4 Includes 79 secondary copper smelters and 23 smelters using copper material in other than copper alloys.
5 Includes 15 secondary plants and 8 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 1 plant.
7 Includes foundries using either aluminum scrap or ingot.
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 and reporting annually only.

Detailed information on primary metals may be found in the chapters devoted to those metals.

Definitions of terms used in this chapter follow:

Secondary metals are metals or alloys recovered from scrap and residues. The term "secondary" applies only to the source of the metal and has no relation to the type of product recovered as to quality, degree of purity, or physical characteristics.

Scrap 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 that 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 of old scrap are discarded trolley wire, battery plates, railroad-car boxes, fired-cartridge cases, automobile crankcases, used pipe, plumbing fixtures from building demolition, lithographers' plates, and obsolete military equipment (frequently unused).

New scrap consists of process or plant scrap generated in 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.

Home scrap or *runaround scrap* is process scrap consumed in the plant where generated. In this chapter consumption of new and old scrap only is tabulated, as no record is being kept of home scrap in nonferrous metal canvasses. Scrap generated in a machine shop and consumed in a foundry at the same plant location is considered home scrap, and its consumption is not tabulated. Consumption of scrap is always measured at the point where it loses its identity as scrap and becomes secondary metal.

Toll scrap is scrap treated for a toll or conversion charge and is reported by the plant at which the scrap is consumed, not by the plant owning the material.

Borings and turnings and other items of process scrap, when consumed outside the plant where generated, are new scrap, whether clean, rusty, or oily and whether generated recently or long before reclamation. Residues are new scrap if generated in processing scrap or refined metal. For example, flue dust from smelting brass scrap is new scrap. Zinc-chemical residues resulting from the consumption of zinc dust in manufacturing sodium hydrosulfite are also new scrap. On the other hand, residues generated in processing ore or concentrates are not scrap but "primary residue." Old mine tailings are primary residue because generated in processing ore. Aircraft plants melt zinc-die alloys and antimonial lead to make dies and remelt the dies to make new ones whenever necessary. The same material may be remelted several times during a year. In such 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.

Purchased scrap is a term used in nonferrous-scrap-metal questionnaires to cover all scrap that should be reported. It includes new scrap, old scrap, and toll scrap, all of which have passed through commercial transactions. It also includes scrap generated at one plant and transferred to another plant of the same company for processing, which usually involves transportation charges. The term also includes scrap reclaimed in shipyard repair work and from line operations at railroad foundries, although no definite financial transaction may have resulted.

Secondary metal products are those made from scrap with or without the addition of alloying ingredients, such as primary metal or scrap of other metals 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.

Consumed means "used," that is, smelted, melted, rolled, drawn, forged, or converted to ingots, billets, sheet, wire, castings, chemicals, etc.

The recovery tables that appear near the beginning of each of the sections on metals in this chapter are double. The figures on the left side represent the recoverable metal in the scrap processed. They are obtained by multiplying the reported gross weights of scrap consumed during the year by percentage recovery factors to obtain the metallic recovery (weight after melting loss), then multiplying the metallic recovery by composition percentages of the products to obtain the quantities of aluminum, copper, lead, zinc, etc., recoverable. The recoverable zinc from zinc die-cast scrap is part of the zinc from zinc-base scrap, as shown in the zinc-recovery table in the Secondary Zinc section of this chapter, the recoverable copper is credited to zinc-base scrap in the copper-recovery table, and the recoverable aluminum to the zinc-base scrap in the aluminum-recovery table.

Tonnages of metal recovered are listed on the right side of the recovery table, by products, as the companies report them to the Bureau of Mines. The totals so derived for each side of the table do not agree, because the actual weight of metal produced from melting or otherwise consuming scrap is seldom precisely the same as the calculated recoverable weight. As presented in the tables, however, the items have been adjusted to give the exact balance theoretically expected. The word "recovery" may therefore be applied to both sides of the table.

SECONDARY ALUMINUM

Recovery of secondary aluminum from purchased and toll-treated aluminum scrap processed in 1953 was calculated to be 369,000 short tons with a value [5] of $146,100,000, a 21-percent increase in quantity over the 305,000 tons valued at $111,881,000 recovered in 1952. Tonnage recovered reached a record high in 1953, exceeding that of 1947, the previous alltime record year, by 7 percent.

Of the total secondary aluminum recovered in 1953, 79 percent was from new scrap and 21 percent from old; 1952 recovery was 77 percent from new scrap and 23 percent from old. Aluminum recovered from smelting copper-base, zinc-base, and magnesium-base scrap, though small in relation to total aluminum recovery (1,400 tons in 1952 and 1,500 tons in 1953) increased about 8 percent.

TABLE 4.—Aluminum recovered from scrap processed in the United States, 1952–53, in short tons

Recoverable aluminum-alloy content of scrap processed			Aluminum recovered [1] from scrap processed		
Kind of scrap	1952	1953	Form of recovery	1952	1953
New scrap:			As metal	4,897	5,203
Aluminum-base [2]	232,833	288,994	Aluminum alloys	[3] 295,000	357,084
Copper-base	191	150	In brass and bronze	387	360
Zinc-base	88	203	In zinc-base alloys	898	1,149
Magnesium-base	146	279	In magnesium alloys	[3] 47	94
			In chemical compounds	3,293	4,676
Total	233,258	289,626	Grand total	304,522	368,566
Old scrap:					
Aluminum-base [4]	70,301	78,072			
Copper-base	123	138			
Zinc-base	318	245			
Magnesium-base	522	485			
Total	71,264	78,940			
Grand total	304,522	368,566			

[1] In accordance with common usage, the term "aluminum" covers aluminum alloys, and the figures include all constituents of the alloys recovered from aluminum-base scrap.
[2] Recoverable aluminum content of new aluminum-base scrap was 216,314 tons in 1952 and 270,393 tons in 1953.
[3] Revised figure.
[4] Recoverable aluminum content of old aluminum-base scrap was 65,139 tons in 1952 and 69,645 tons in 1953.

The record scrap consumption of 413,000 tons in 1953 resulted from the large quantities of scrap generated in the production of aluminum cast and wrought products, which also was at a record high. Alloy-sheet scrap processed in 1953 totaled 116,000 short tons, of which 106,000 tons was new scrap. Large quantities of borings and turnings

[5] These values are computed at 19.82 cents per pound in 1953 and 18.37 cents in 1952, the average prices received by primary producers for virgin pig aluminum in those years.

TABLE 5.—Stocks and consumption of new and old aluminum scrap in the United States in 1953, 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]						
2S and 3S sheet and clips	1,023	17,847	15,893	2,229	18,122	748
Castings and forgings	1,238	30,558	6,441	24,250	30,691	1,105
Alloy sheet	2,632	55,766	46,234	9,615	55,849	2,549
Borings and turnings	3,315	77,122	76,941		76,941	3,496
Grindings and sawings	446	1,158	1,392		1,392	212
Dross and skimmings	1,873	30,290	30,956		30,956	1,207
Foil and wire	380	5,330	1,076	4,359	5,435	275
Pots and pans	245	7,604		7,365	7,365	484
Aircraft	687	19,154		13,958	13,958	5,883
Pistons	212	3,002		3,023	3,023	191
Irony aluminum	689	10,071		10,124	10,124	636
Miscellaneous	1,034	23,070	12,345	10,078	22,423	1,681
Total	13,774	280,972	191,278	85,001	276,279	18,467
Primary producers and fabricators:						
2S and 3S sheet and clips	446	20,637	20,197	51	20,248	835
Castings and forgings	116	1,207	645	531	1,176	147
Alloy sheet	1,826	58,255	57,791	15	57,806	2,275
Borings and turnings	898	16,729	16,838		16,838	789
Dross and skimmings	35	266	278		278	23
Foil and wire	193	1,509	450	900	1,350	352
Pots and pans	7	166		173	173	
Aircraft	97	231		134	134	194
Miscellaneous	909	17,741	15,947	2,061	18,008	642
Total	4,527	116,741	112,146	3,865	116,011	5,257
Foundries and miscellaneous manufacturers:						
2S and 3S sheet and clips	109	2,564	2,301	24	2,325	348
Castings and forgings	108	4,661	3,190	1,103	4,293	476
Alloy sheet	8	2,424	1,995	156	2,151	281
Borings and turnings	350	4,082	4,071		4,071	361
Dross and skimmings	77	1,146	1,142		1,142	81
Foil and wire	6	18		4	4	20
Pots and pans	1	100		94	94	7
Aircraft	6	55		51	51	10
Pistons	7	194		158	158	43
Miscellaneous	70	876	137	543	680	266
Total	742	16,120	12,836	2,133	14,969	1,893
Chemicals plants:						
Borings and turnings	3	49	37		37	15
Dross and skimmings	1,161	5,317	5,141		5,141	1,337
Castings and forgings	14	601		611	611	4
Miscellaneous	59	251	283	2	285	25
Total	1,237	6,218	5,461	613	6,074	1,381
Grand total:						
2S and 3S sheet and clips	1,578	41,048	38,391	2,304	40,695	1,931
Castings and forgings	1,476	37,027	10,276	26,495	36,771	1,732
Alloy sheet	4,466	116,445	106,020	9,786	115,806	5,105
Borings and turnings	4,566	97,982	97,887		97,887	4,661
Grindings and sawings	446	1,158	1,392		1,392	212
Dross and skimmings	3,146	37,019	37,517		37,517	2,648
Foil and wire	579	6,857	1,526	5,263	6,789	647
Pots and pans	253	7,870		7,632	7,632	491
Aircraft	790	19,440		14,143	14,143	6,087
Pistons	219	3,196		3,181	3,181	234
Irony aluminum	689	10,071		10,124	10,124	636
Miscellaneous	2,072	41,938	28,712	12,684	41,396	2,614
Total	20,280	420,051	321,721	91,612	413,333	26,998

[1] Revised figures.
[2] Excludes secondary smelters owned by primary aluminum companies.

(classified as new scrap), resulting from machining operations on extruded shapes, castings, etc., were generated, and the secondary aluminum industry reported the use of 98,000 tons of this type of scrap in 1953, an increase of about 19 percent compared with the previous year. Aluminum drosses and skimmings (a low-recovery scrap item), totaling 38,000 tons, were used in 1953, principally for making deoxidizing ingot. Primary producers and fabricators raised their consumption of aluminum scrap 49 percent from 1952 to 116,000 tons in 1953 and secondary smelters 8 percent to 276,000. The largest part of the increased consumption by primary producers was in alloy sheet (19,000 tons). Secondary smelters used almost the same quantity of alloy sheet as the primary producers and over four times the quantity of borings and turnings. Foundries melted about the same quantity in 1953 as in 1952 (15,000 tons).

Following the removal of ceiling prices in February 1953, the monthly consumption of aluminum scrap increased through June, after which it declined, averaging 31,000 tons per month in the latter half of the year compared with 34,000 tons per month in the first half. Year-end stocks of aluminum-base scrap at consumers' plants increased 33 percent from 1952.

Unsegregated borings and turnings and irony aluminum scrap were suitable only for production of lower grades of ingot, and many secondary plants developed mechanized material flow for low-cost high production of these alloys. Among such developments were pneumatic transportation, overhead charging, use of conveyor belts, end-well charging of fine material, and bulldozer charging of irony aluminum. Irony aluminum was often melted in sweating furnaces with sloping hearths, from which the iron was removed by rake and the molten aluminum by draining.

TABLE 6.—Production of secondary aluminum and aluminum-alloy products in the United States, 1951–53, gross weight in short tons

Product	1951 [1]		1952	1953
	January-July	August-December		
Secondary aluminum ingot: [2]				
Silicon (Cu max., 1 percent)	10,930			
Silicon (Cu, 1 to 2.5 percent)	3,678			
Other copper (Si max., 2.5 percent) alloys	[3] 2,594			
Copper-silicon (each over 2.5 percent) alloys	62,177			
Aluminum-magnesium and aluminum-zinc alloys	3,292			
Pure aluminum (98.5 percent)	2,422	2,916	4,893	5,203
Aluminum-silicon (Cu max., 0.6 percent) alloys		5,048	15,372	21,647
Aluminum-silicon (Cu, 0.6 to 2 percent) alloys		3,028	7,092	8,012
No. 12 alloy and variations	9,263	6,534	20,665	17,963
Aluminum-copper (Si max., 1.5 percent) alloys		[3] 2,225	[3] 6,240	[3] 4,448
No. 319 alloy and variations		13,838	37,055	34,369
AXS 679 alloy and variations		13,226	61,839	74,646
Aluminum-silicon-copper-nickel alloys	7,433	3,062	15,474	17,316
Deoxidizing and other dissipative uses	24,708	15,801	43,398	43,682
Aluminum-base hardeners	3,399	2,253	6,485	8,387
Aluminum-magnesium alloys		331	1,019	675
Aluminum-zinc alloys		1,342	3,181	2,678
Miscellaneous	1,288	881	10,307	12,719
Total	131,184	70,485	233,020	251,745
Secondary aluminum recovered by primary producers and independent fabricators	77,377		73,392	111,106
Aluminum-alloy castings	15,394		7,811	12,907
Aluminum in chemicals	1,394		3,293	4,676

[1] Classification of ingot for reporting to the Bureau of Mines was changed Aug. 1, 1951.
[2] Gross weight, including copper, silicon, and other alloying elements at independent secondary smelters; total secondary aluminum and aluminum-alloy ingot contained 12,353 tons of primary aluminum in 1951, 20,509 tons in 1952, and 19,528 tons in 1953.
[3] Of the total, 1,438 tons was produced in 1951, 1,031 tons in 1952, and 883 tons in 1953 at Naval Air Stations and United States Air Force Bases.

Production of secondary aluminum ingot by nonintegrated secondary smelters in 1953 increased 8 percent from 1952 to 252,000 short tons. Alloy AXS 679 and variations led all other types of secondary-aluminum alloys produced, totaling 74,600 tons, a 21-percent increase from the previous year. This alloy was used extensively in the manufacture of aluminum-die castings. Production of deoxidizing grades of ingot was 43,700 tons in 1953, about the same as in 1952. Aluminum-silicon (Cu max., 0.6 percent) alloys increased 41 percent, and aluminum-base hardeners 29 percent above 1952. Slightly less than 2 percent of the metallic recovery was as pure (98.5 percent) aluminum. Ingot and shot produced by secondary smelters were used chiefly in aluminum foundries and for deoxidizing steel. Secondary aluminum smelters could make only small quantities of ingot suitable for wrought products because their chief source of raw material was casting alloy scrap which could not be processed to specifications required for wrought products because of the high silicon content. Scrap used by the primary producers was frequently diluted with primary aluminum, so that ingot produced could be used in wrought alloys.

An increase in exports reduced the domestic supply of aluminum scrap to processors late in 1953. Increased foreign smelting capacity made it possible for foreign smelters to buy scrap in the United States, process it abroad, and return the product for sale here. Prices offered for scrap for export in some instances exceeded the price that domestic smelters could pay and still sell their product in competition with primary aluminum.

Borings and turnings, largely generated in the finishing of castings, are not as suitable for export as other types because they are bulky in proportion to weight and subject to corrosion if exposed. They were therefore often in plentiful supply when other kinds were scarce because of the large quantities exported in late 1953.

TABLE 7.—Dealers' average monthly aluminum scrap buying prices and consumers' alloy-ingot prices at New York in 1953, in cents per pound

[Metal Statistics, 1954]

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
New aluminum clippings	10.50	11.25	12.95	12.43	12.07	13.36	14.00	13.00	13.00	12.00	13.00	13.33	12.57
Cast aluminum scrap	7.50	8.25	9.95	9.24	8.38	9.36	10.00	9.00	9.00	8.25	9.96	10.33	9.10
No. 12 aluminum-alloy ingot	19.50	20.90	22.97	22.70	22.36	22.74	22.57	22.12	21.74	20.27	20.40	20.17	21.54

SECONDARY ANTIMONY

Recovery of secondary antimony in 1953 totaled 22,400 short tons valued[6] at $16,100,000, a 3-percent decrease in quantity from the 23,100 tons valued at $20,300,000 reclaimed in 1952. Consumption of storage-battery plates totaled 372,000 tons (3 percent less than the quantity of plates smelted in 1952) and yielded 55 percent of all secondary antimony reclaimed.

[6] The values are computed at 35.90 cents per pound in 1953 and 44.02 cents in 1952, the average New York selling price for primary antimony in each year.

Antimony recovered from scrap in antimonial lead was obtained from other types of antimonial lead scrap, as well as storage-battery plates, and totaled 15,000 tons in 1953. This was 3 percent less than was recovered in 1952. Secondary and primary lead and copper remelters, smelters, and refiners recovered 91 percent of the antimony reclaimed in 1953 and manufacturers and foundries the remaining 9 percent.

TABLE 8.—Antimony recovered from scrap processed in the United States, 1952–53, in short tons

Recoverable antimony content of scrap processed			Antimony recovered from scrap processed		
Kind of scrap	1952	1953	Form of recovery	1952	1953
New scrap:			In antimonial lead [1]	15,462	14,941
Lead-base	3,471	3,356	In other lead alloys	7,445	7,277
Tin-base			In tin-base alloys	182	142
Total	3,471	3,356	Grand total	23,089	22,360
Old scrap:					
Lead-base	19,451	18,837			
Tin-base	167	167			
Total	19,618	19,004			
Grand total	23,089	22,360			

[1] Includes 1,615 tons of antimony recovered in antimonial lead from secondary sources at primary plants in 1952 and 1,747 tons in 1953.

Antimony added to lead and tin alloys in 1953 totaled 30,100 tons, consisting of 7,700 tons of primary antimony and virtually all of the 22,400 tons of antimony recovered from scrap. It was added in metallic form and as a component of lead and tin scrap. A small quantity of antimony oxide was used in making cable covering. All of the 14,300 tons of antimony used in nonmetal products was in unalloyed, oxide, or sulfide form, but not in the form of scrap.

Mandatory reporting on stocks and consumption of antimony remained in effect through June 30, 1953, all other Government controls over the metal having been removed in 1952.

Data on consumption of scrap from which antimony was recovered may be found in the tables on lead and tin scrap in the section of this chapter devoted to those metals. Products in which antimony was recovered are included in the lead- and tin-products table of this chapter under the heading Secondary Lead.

SECONDARY COPPER AND BRASS

Recovery of copper in unalloyed and alloyed form from all classes of nonferrous scrap metal in 1953 totaled 958,000 short tons valued [7] at $550,000,000, a 6-percent increase in quantity over the 903,000 tons valued at $437,000,000 recovered in 1952.

The event having greatest effect on use of copper and brass scrap in 1953 was the removal in February of price ceilings and other Government controls over industrial operations. The existence of price ceilings had induced a scarcity in the market; considerable scrap

[7] These values are computed at 28.7 cents per pound in 1953 and 24.2 cents in 1952, which were the average weighted prices for all grades of refined copper sold by producers in those years.

existed but was not available to consumers at ceiling prices. Removal of controls immediately increased the flow of copper scrap to users and accounts for the higher average monthly consumption, by the 3 major groups, of this raw material in the first half of 1953 (113,000 tons) compared with the monthly average for 1952 (95,000 tons).

TABLE 9.—Copper recovered from scrap processed in the United States, 1952–1953, in short tons

Recoverable copper content of scrap processed			Copper recovered from scrap processed		
Kind of scrap	1952	1953	Form of recovery	1952	1953
New scrap:			As unalloyed copper:		
Copper-base	477,853	522,502	At primary plants	122,376	189,585
Aluminum-base	10,442	6,303	At other plants	51,528	53,270
Nickel-base	261	246			
Lead-base			Total	173,904	242,855
Zinc-base	6	25			
			In brass and bronze	686,382	663,560
Total	488,562	529,076	In alloy iron and steel	2,290	2,769
			In aluminum alloys	24,606	27,232
Old scrap:			In other alloys	627	498
Copper-base	411,296	425,827	In chemical compounds	15,388	21,550
Aluminum-base	2,553	2,619			
Nickel-base	657	824	Total	729,293	715,609
Lead-base	31	21			
Tin-base	97	96	Grand total	903,197	958,464
Zinc-base	1	1			
Total	414,635	429,388			
Grand total	903,197	958,464			

Treatment of copper scrap by major consuming groups, consisting of primary producers, secondary smelters, and brass mills, reached 131,000 tons in April 1953, then declined to 87,000 tons in July and averaged 88,000 for the remainder of the year. The price of No. 1 copper wire scrap, of which the ceiling price was 19.25 cents, rose to about 26 cents in March and was about 23 cents at the end of the year. Prices for ingotmakers' alloy scrap were not above ceilings in 1953, except in February, March, and April, after controls were removed, and were slightly lower at the end of the year than at the beginning. Prices for brass-mill scrap rose several cents when ceilings were removed and although lower at the end of the year were still above the former ceilings.

TABLE 10.—Copper recovered as refined copper, in alloys and in other forms, from copper-base scrap processed in the United States, 1952–53, in short tons

	From new scrap		From old scrap		Total	
	1952	1953	1952	1953	1952	1953
By secondary copper smelters	53,871	60,047	229,876	215,160	283,747	275,207
By primary copper producers	87,715	112,489	41,547	85,209	129,262	197,698
By brass mills	316,037	327,607	48,570	34,146	364,607	361,753
By foundries and manufacturers	18,305	20,007	85,827	82,311	104,132	102,318
By chemical plants	1,925	2,352	[1] 5,476	9,001	[1] 7,401	11,353
Total	477,853	522,502	[1] 411,296	425,827	[1] 889,149	948,329

[1] Revised figure.

A strong export market for copper scrap helped to sustain the prices of such scrap in the later months of 1953. As the large exports created a domestic scarcity of scrap, some ingot-makers favored renewal of export limitations. Others, while favoring a free market, felt that some restraint should have been exercised by the United States Department of Commerce in granting licenses for export of scrap to Japan, where a dual copper price had been established. Copper used for export orders could be imported at 30 to 32 cents a pound, whereas Japanese fabricators were required to pay about 40 cents a pound for metal produced by Japanese refineries and used in fabrication for home use. Under this arrangement, Japanese smelters could afford to outbid domestic buyers in the United States market. Scrap-metal dealers were opposed to restrictions, except for reasons of national security, on scrap exports, which constitute an outlet for the dealers when the domestic market is dull.

In addition to increasing the flow of scrap to the market, removal of price ceilings affected the distribution of scrap used by the different major groups. The primary producers increased their consumption of scrap from 220,000 tons in 1952 to 328,000 in 1953, particularly by using twice as much No. 2 copper and 44 percent more low-grade and refinery brass scrap in the latter year. They did not increase their consumption of No. 1 copper scrap after removal of ceiling prices. The brass mills used 72,000 tons of this material—90 percent of it new—in 1953 compared with 49,000 in 1952. Brass-mill scrap, defined as process scrap from production of brass-mill or copper-wire products, was channeled to the brass mills while controls were in effect, but removal of price ceilings and other controls enabled the mills to obtain more of the high-grade unalloyed copper scrap in 1953 than they had under allocation. Melting of fired cartridge cases by the brass mills declined from 55,000 tons in 1952 to 38,000 in 1953, owing to lower return of this material from Korea.

The scrap used by brass mills is chiefly segregated, uncontaminated process scrap generated by fabricators in making articles from sheet, rod, and tubing sold to them by the mills. Furnaces in brass mills are used for remelting and generally are not designed for removal of impurities in the metals used. The operations of secondary copper smelters are largely remelting of scrap, but these plants use old scrap of lower grade than brass mills, and their reverberatory furnaces and cupolas will remove most impurities. For example, a moderate percentage of iron can be slagged off, and silica will take the carborundum out of grindings. Antimony is an impurity that cannot practicably be removed. It is tolerated up to 1 percent in brass used in railroad-car boxes. Automobile radiators are good scrap for smelters, being free of antimony; 45,000 tons were reported consumed in 1953. Aluminum is objectionable in copper scrap, except aluminum and manganese bronze. It prevents formation of the liquid slag needed in secondary smelter reverberatories. Primary copper smelters and refineries use the lowest grade scrap of any of the major groups of consumers. Impurities can be slagged off in the blast furnaces, burned out in the converters, or skimmed from the bath in the reverberatories of these plants. Refined copper is the chief product, other metals being recovered as byproducts—zinc, for example, as oxide from the flue dust and nickel from the sludge of the refining cells.

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TABLE 11.—Stocks and consumption of new and old copper scrap in the United States in 1953, gross weight in short tons

Class of consumer and type of scrap	Stocks, beginning of year	Receipts	Consumption			Stocks, end of year
			New scrap	Old scrap	Total	
Secondary smelters:						
No 1. wire and heavy copper	2,072	34,550	2,295	32,490	34,785	1,837
No. 2 wire, mixed heavy, and light copper	4,232	49,628	4,109	46,447	50,556	3,304
Composition or red brass	6,201	95,222	40,901	56,086	96,987	4,436
Railroad-car boxes	125	472		499	499	98
Yellow brass	6,240	68,364	11,814	56,929	68,743	5,861
Cartridge cases	235	1,432	56	1,443	1,499	168
Auto radiators (unsweated)	4,283	43,006		45,410	45,410	1,879
Bronze	3,103	30,650	4,930	26,483	31,413	2,340
Nickel silver	461	3,046	250	2,776	3,026	481
Low brass	229	2,695	2,350	298	2,648	276
Aluminum bronze	191	516	50	589	639	68
Low-grade scrap and residues	7,280	50,371	30,689	20,005	50,694	6,957
Total	34,652	379,952	97,444	289,455	386,899	27,705
Primary producers:						
No. 1 wire and heavy copper	980	24,944	18,892	6,604	25,496	428
No. 2 wire, mixed heavy, and light copper	2,039	93,749	59,796	33,852	93,648	2,140
Refinery brass	5,746	59,646	19,182	34,928	54,110	11,282
Low-grade scrap and residues	23,116	177,480	76,442	77,944	154,386	46,210
Total	31,881	355,819	174,312	153,328	327,640	60,060
Brass mills:						
No. 1 wire and heavy copper	2,380	71,550	65,066	6,886	71,952	1,978
No. 2 wire, mixed heavy, and light copper	504	38,750	37,715	1,106	38,821	433
Yellow brass	16,210	320,208	317,495	2	317,497	18,921
Cartridge cases	1,269	37,360		37,689	37,689	940
Bronze	235	2,706	2,505		2,505	436
Nickel silver	801	9,561	9,660	138	9,798	564
Low brass	585	21,020	20,443	37	20,480	1,125
Aluminum bronze	82	921	913		913	90
Total	22,066	502,076	453,797	45,858	499,655	24,487
Foundries, chemical plants, and other manufacturers:						
No. 1 wire and heavy copper	2,384	21,078	8,915	12,456	21,371	2,091
No. 2 wire, mixed heavy, and light copper	1,857	9,528	3,922	5,818	9,740	1,645
Composition or red brass	3,780	18,791	5,035	14,165	19,200	3,371
Railroad-car boxes	5,479	71,366		72,008	72,008	4,837
Yellow brass	1,849	13,480	4,563	8,612	13,175	2,154
Auto radiators (unsweated)	36	80		116	116	
Bronze	1,779	6,584	1,061	6,159	7,220	1,143
Nickel silver	19	130	21	121	142	7
Low brass	231	1,492	501	1,058	1,559	164
Aluminum bronze	301	564	381	372	753	112
Low-grade scrap and residues	391	27,989	1,603	24,808	26,411	1,969
Total	18,106	171,082	[1] 26,002	[1] 145,693	[1] 171,695	17,493
Grand total:						
No. 1 wire and heavy copper	7,816	152,122	95,168	58,436	153,604	6,334
No. 2 wire, mixed heavy, and light copper	8,632	191,655	105,542	87,223	192,765	7,522
Composition or red brass	9,981	114,013	45,936	70,251	116,187	7,807
Railroad-car boxes	5,604	71,838		72,507	72,507	4,935
Yellow brass	24,299	402,052	333,872	65,543	399,415	26,936
Cartridge cases	1,504	38,792	56	39,132	39,188	1,108
Auto radiators (unsweated)	4,319	43,086		45,526	45,526	1,879
Bronze	5,117	39,940	8,496	32,642	41,138	3,919
Nickel silver	1,281	12,737	9,931	3,035	12,966	1,052
Low brass	1,045	25,207	23,294	1,393	24,687	1,565
Aluminum bronze	574	2,001	1,344	961	2,305	270
Low-grade scrap and residues [2]	36,533	315,486	127,916	157,685	285,601	66,418
Total	106,705	1,408,929	[1] 751,555	[1] 634,334	[1] 1,385,889	129,745

[1] Of the totals shown, chemical plants reported the following: Unalloyed copper scrap, 872 tons of new and 4,066 tons of old; copper-base alloy scrap 1,538 tons of new and 24,400 tons of old.
[2] Includes refinery brass.

Consumption of scrap by brass mills was about the same as that of secondary smelters in 1950 and 1951, but the mills used 116,000 tons more than the smelters in 1952 and 113,000 more in 1953. Use of copper scrap by foundries declined 2 percent to 141,000 tons in 1953 and their reported consumption of brass ingot 5 percent to 256,000 tons. Stocks of scrap held by all consumers increased from 107,000 tons at the end of 1952 to 130,000 at the end of 1953.

TABLE 12.—Analysis and production of secondary copper and copper-alloy products in the United States, 1952–53

Item produced from scrap	Approximate analysis (percent)						Gross weight produced (short tons)	
	Cu	Sn	Pb	Zn	Ni	Al	1952	1953
Unalloyed copper products:								
Refined copper, electrolytic grade (99.9 Cu+Ag)	100						128,260	179,507
Refined copper (under 99.9 Cu+Ag)	99						14,503	31,433
Copper sheet, rod, tubing, etc.	99						23,522	23,370
Copper powder	98						3,851	6,816
Copper castings	98						3,768	1,729
Total							173,904	242,855
Brass and bronze ingots:								
Tin bronze	88	10		2			23,894	18,183
Leaded-tin bronze	88	6	1.5	4.5			23,023	21,152
Leaded red brass	85	5	5	5			106,760	98,686
Leaded semired brass	81	3	7	9			52,268	60,322
High-leaded-tin bronze	80	10	10				20,941	16,822
Do	84	6	8	2			13,500	17,207
Do	75	5	20				8,599	5,963
Leaded yellow brass	66	1	3	30			23,596	21,917
Manganese bronze	62			27		5	20,440	18,157
Aluminum bronze	89					10	5,629	5,115
Nickel silver	58	2	17	18	14		2,955	3,728
Do	65	4	3	5	22			
Low brass	80			20			2,201	3,084
Silicon bronze	92			4			4,212	4,835
Conductor bronze	94	2	2	2			669	548
Hardeners and special alloys	81						11,160	9,708
Total [1]							319,847	305,427
Brass-mill billets made by ingot-makers							7,702	6,632
Brass and bronze sheet, rod, tubing, etc.[2]							491,590	465,610
Brass and bronze castings [3]							119,112	111,824
Brass powder							926	1,160
Copper in chemical products (content)							15,388	21,550

[1] Gross weight of brass and bronze ingot. Includes 255,297 tons of copper, 10,994 tons of tin, 13,214 tons of lead, 39,847 tons of zinc, 408 tons of nickel, and 87 tons of aluminum in 1952 (revised figures); and 241,150 tons of copper, 10,076 tons of tin, 13,905 tons of lead, 39,780 tons of zinc, 441 tons of nickel, and 75 tons of aluminum in 1953.

[2] Gross weight of secondary brass and bronze in commercial shapes. Includes 350,700 tons of copper, 268 tons of tin, 5,680 tons of lead, 133,650 tons of zinc, 1,180 tons of nickel, and 112 tons of aluminum in 1952; and 339,067 tons of copper, 116 tons of tin, 5,254 tons of lead, 119,782 tons of zinc, 1,311 tons of nickel, and 80 tons of aluminum in 1953.

[3] Gross weight of secondary metal in brass and bronze castings. Includes 92,696 tons of copper, 5,212 tons of tin, 14,595 tons of lead, 6,484 tons of zinc, 58 tons of nickel, and 67 tons of aluminum in 1952; and 83,039 tons of copper, 5,221 tons of tin, 17,505 tons of lead, 5,919 tons of zinc, 60 tons of nickel, and 80 tons of aluminum in 1953.

The simplest way to measure the changes in activity of any single group of consumers of copper scrap is by their recovery of copper from scrap, as shown in table 10. The scrap consumed by some groups contains higher percentages of copper than that used by others, so the best way of comparing activities of one group with those of another is by means of their total secondary production (recovery) of all metals from copper scrap. Brass mills recovered 491,000 tons of all metals from copper scrap in 1953, of which 362,000 tons or two-thirds was copper. Secondary copper smelters recovered 329,000 tons, of which 275,000 tons or four-fifths was copper, and the foundries 134,000 tons, of which three-fourths was copper. Most of the scrap consumed by the mills and smelters was in alloy form, and the metal was recovered in alloy form by remelting. Primary producers raised their output of secondary copper from 122,000 tons in 1952 to 190,000 in 1953 and were the only major group to show an increase. The copper scrap, from which the secondary metal was made, was added to the primary raw material at various stages of the smelting and refining process, so that the primary copper was inseparable and indistinguishable from the secondary in the final products, which consisted of refined copper and copper sulfate. Secondary smelters lowered their output of refined copper from 31,000 tons to 23,000 in 1953, and their production of brass ingot decreased from 320,000 tons in 1952 to 305,000. Secondary copper recovered in chemicals totaled 22,000 tons in 1953 compared with 15,000 in 1952. Of the 22,000-ton total, chemical plants reclaimed 57 percent and smelters, primary and secondary, the remainder.

TABLE 13.—Consumption of copper and brass materials in the United States, 1952–53, by principal consuming groups, in short tons

Item consumed	Primary producers	Brass mills	Wire mills	Foundries and other manufacturers [1]	Secondary smelters
1952					
Copper scrap	220,455	516,811		143,158	400,439
Primary material	[2] 1,177,696				
Refined copper [3]		675,073	739,487	38,535	22,918
Brass ingot		12,546	262	292,817	
Slab zinc		[4] 138,463		[4] 7,529	[4] 8,616
Miscellaneous		887		408	18,408
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		14,162	838	289,083	
Slab zinc		162,741		6,467	8,974
Miscellaneous		546		335	18,424

[1] Excludes chemical plants. Represents approximate shipments from smelters to foundries.
[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.

Effective May 6, 1953, the National Production Authority issued Order M–11A providing for reservation, for defense purposes, of specified percentages of each plant's output of intermediate copper and brass shapes, brass-mill products, copper-wire-mill products, and brass-foundry products. The percentage specified for most products was 26, and the range was 15 to 55. Plants were required to accept controlled material orders up to specified percentages and until the beginning of lead time (time allowed for delivery) for any given month.

Public Law 221 of the 83d Congress, approved August 7, 1953, amended Public Law 869 of the 81st Congress extending the suspension of import duties on scrap metals, except lead or zinc scrap, until June 30, 1954.

Consumption of brass and bronze ingot reported by foundries in 1953 totaled 256,000 short tons compared with 269,000 in 1952 and 326,000 in 1951. In addition to the 256,000 tons reported consumed by the foundries, 15,000 tons was used by brass and wire mills. Thirteen hundred foundries reported consumption of ingot in 1953, an average of 197 tons each. Average consumption in 1952 and 1951 was 186 and 225 tons, respectively, with the same number of foundries (about 1,450) reporting in both years. Secondary copper smelters' shipments of brass ingot in 1953 were 304,000 tons, virtually all of which, except the 15,000 tons used by the mills, were shipped to the foundries. On this basis, and assuming stocks remained the same, coverage of the foundry consumption survey was 88 percent in quantity in 1953, 93 percent in 1952, and 91 percent in 1951.

About 3,000 foundries (including a small number of other manufacturers) were canvassed for consumption of brass ingot, refined copper, and scrap. Of these, about 1,300 reported appreciable use of brass ingot. The others used little or no ingot or failed to report. About 500 others reported consumption of refined copper and/or copper scrap, but no use of ingot.

In table 14 the ingot consumption has been classified under 9 general types, and by States, combined in 9 groups, according to Minerals Yearbook practice. As in 1952, the geographic division containing Ohio and Illinois consumed more than any other group—108,000 tons—and Ohio more than any other State—38,000 tons. The division using the next largest total—67,000 tons—was the Middle Atlantic, in which the New York metropolitan area lies. These 2 regions together consumed 69 percent of the total quantity used by foundries. Of the 305,000 tons of copper-alloy ingot produced in 1953, about 40 percent was made in the Chicago metropolitan area, 15 percent in the New York City area, and 5 percent in Ohio. Consumption of composition ingot—the largest item—was 139,000 tons or 54 percent of the total.

In table 15 consumption of the different types of ingot has been compared percentagewise for the 6 years in which the survey has been conducted.

TABLE 14.—Foundry consumption of brass ingot, in the United States in 1953, by geographic divisions and States, in short tons

Geographic division and State	Tin bronze	Leaded tin bronze	Leaded red brass	High-leaded tin bronze	Leaded yellow brass	Manganese bronze	Hardeners	Nickel silver	Low brass	Total	Number of respondents
New England:											
Connecticut	245	1,946	3,931	50	1,828	214	9		1,454	9,677	40
Maine	20	17	206	39	1	183	36		10	512	10
Massachusetts	877	2,697	5,167	527	333	880	12	124	207	10,824	80
New Hampshire	8	27	609	101	123	98	1	63	33	1,063	9
Rhode Island and Vermont	53	151	1,431	67	95	41	8		65	1,911	21
Total	1,203	4,838	11,344	784	2,380	1,416	66	187	1,769	23,987	160
Middle Atlantic:											
New Jersey	1,468	956	5,048	490	476	701	33	45	98	9,315	58
New York	2,410	3,610	11,156	816	2,059	2,214	218	251	554	23,288	131
Pennsylvania	3,080	2,380	16,298	3,887	1,137	4,768	1,386	334	1,229	34,499	143
Total	6,958	6,946	32,502	5,193	3,672	7,683	1,637	630	1,881	67,102	332
East North Central:											
Illinois	1,152	2,375	17,778	1,277	985	877	60	271	1,119	25,894	104
Indiana	258	336	7,987	1,068	77	189	142	23	51	10,131	49
Michigan	705	1,991	12,376	1,034	1,017	2,153	73	45	536	19,930	88
Ohio	2,813	5,372	18,874	8,005	764	1,172	291	350	554	38,195	122
Wisconsin	1,178	894	5,779	2,126	2,335	480	50	1,210	239	14,291	63
Total	6,106	10,968	62,794	13,510	5,178	4,871	616	1,899	2,499	108,441	446
West North Central:											
Iowa	7	31	1,827	62	42	89	3	13		2,074	16
Kansas	30	71	115		90	4			2	312	5
Minnesota	317	482	1,937	459	27	119	7		72	3,420	27
Missouri	125	198	2,383	265	1,042	102	45	98	295	4,553	30
Nebraska and South Dakota	80	3	234	12		26				355	6
Total	559	785	6,496	798	1,201	340	55	111	369	10,714	84
South Atlantic:											
Delaware	4	13	418	27	31	13			1	507	4
Florida	13		76			60			150	299	9
Georgia	4	475	136	3						618	10
Maryland and District of Columbia	48	241	464	86		85	8	97	75	1,104	12
North and South Carolina	22	42	23	381	163	18	1			650	11
Virginia	426	220	108	133	49	44	12		1	993	20
West Virginia	1	114	4,192	2	404	24				4,737	8
Total	518	1,105	5,417	632	647	244	21	97	227	8,908	74

East South Central:											
Alabama	40	430	4,197	154	863	616	8	13	171	6,492	7
Kentucky		46	361	105	4,283	12	22		3	4,832	6
Mississippi	3		3	2						8	3
Tennessee	64	151	644	694	65	31	2		43	1,694	10
Total	107	627	5,205	955	5,211	659	32	13	217	13,026	26
West South Central:											
Arkansas and Louisiana	47	12	50	21		23	2		2	157	4
Oklahoma	419	237	123	68	3		1		5	856	7
Texas	79	166	1,597	71	23	188	4	5	77	2,210	24
Total	545	415	1,770	160	26	211	7	5	84	3,223	35
Mountain:											
Arizona, Colorado, and New Mexico	124	36	262	21	4	4	1		10	462	11
Idaho, Montana, and Utah		1					4			5	5
Total	124	37	262	21	4	4	5		10	467	16
Pacific:											
California	572	721	13,292	1,706	1,677	702	42	61	379	19,152	104
Oregon	1	62	9	386		3			8	469	5
Washington	7	61	90	14		104	4		1	281	19
Total	580	844	13,391	2,106	1,677	809	46	61	388	19,902	128
Grand total	16,700	26,565	139,181	24,159	19,996	16,237	2,485	3,003	7,444	255,770	1,301

TABLE 15.—Foundry consumption of brass ingot in the United States, percent by type of ingot, 1948–53

(Percent of total)

Type of ingot	Tin bronze	Leaded tin bronze	Leaded red brass	High-leaded tin bronze	Leaded yellow brass	Manganese bronze	Hardeners	Nickel silver	Low brass	Total tons consumed
1948	5.7	17.4	54.8	7.5	6.3	4.2	1.1	1.1	1.9	225,298
1949	5.6	15.2	57.9	6.1	7.2	4.3	1.0	.7	2.0	162,188
1950	4.4	15.0	61.8	4.6	6.9	3.7	1.3	.6	1.7	273,433
1951	6.1	15.8	54.2	7.5	7.5	4.9	1.2	.6	2.2	325,786
1952	7.2	12.5	54.5	8.1	6.7	6.6	.8	1.3	2.3	268,651
1953	6.5	10.4	54.5	9.4	7.8	6.3	1.0	1.2	2.9	255,770

TABLE 16.—Brass and copper scrap imported into and exported from the United States, 1944–48 (average) and 1949–53, in short tons

[U. S. Department of Commerce]

	1944–48 (average)	1949	1950	1951	1952	1953
Imports for consumption:						
Brass scrap	42,085	23,486	37,537	6,523	10,321	9,679
Scrap copper	3,945	6,765	34,242	6,792	5,125	7,827
Exports:						
Brass scrap	2,277	13,963	9,054	4,857	6,261	33,613
Scrap copper	875	8,284	9,445	7,701	8,941	34,568

TABLE 17.—Dealers' average monthly buying prices for copper scrap and consumers' alloy-ingot prices at New York in 1953, in cents per pound

[Metal Statistics, 1954]

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
No. 1 heavy copper scrap	19.00	21.50	25.67	23.85	21.86	23.16	23.00	20.83	21.00	22.35	23.53	23.45	22.43
No. 1 composition scrap	17.75	18.37	19.00	18.24	17.00	17.00	17.00	15.10	15.00	16.00	16.99	17.32	17.06
No. 1 composition ingot	27.25	27.94	29.50	28.12	26.00	26.00	25.74	24.50	24.50	24.50	24.50	24.50	26.09

SECONDARY LEAD

In 1953 secondary lead recovered totaled 487,000 short tons valued [8] at $128 million compared with 471,000 tons valued at $152 million in 1952. For the eighth successive year, the output of secondary lead was greater than domestic mine production, which was 342,000 tons in 1953.

Secondary metal content of shipments of lead and tin products, as shown in table 19, totaled 496,000 tons in 1953 compared with 497,000 in 1952. Of the total in 1953, 88 percent was shipped by secondary smelters (which used chiefly scrap metal as raw material), 9 percent by primary plants (which used chiefly primary material), and the remainder by foundries and manufacturers. In addition to their use of scrap, secondary smelters consumed 121,000 tons of refined metal,

[8] Values are computed at 13.1 cents per pound for 1953 and 16.1 cents for 1952, the average weighted prices of all grades of refined lead sold by producers in those years.

including 97,100 tons of lead, 5,700 tons of antimonial lead, 11,400 tons of primary and detinners' brand tin, 5,900 tons of antimony, and 600 tons of miscellaneous metals. The secondary metal recovery in lead and tin products by the primary smelters and refiners totaled 42,700 tons and constituted 8 percent of their 1953 total production of refined and antimonial lead.

Secondary lead recovered in unalloyed form by primary and secondary smelters together totaled 127,000 tons, representing a 10-percent decrease from the 1952 total. Lead recovered in alloys, however, increased 29,000 tons to 360,000 tons. The recoverable lead in the lead and tin scrap consumed, as shown in table 18, totaled 450,000 tons. All of it emerged in lead and tin products. All the 36,600 tons of recoverable lead in the copper scrap consumed was recovered in copper products. The secondary lead content of shipments, as shown in table 19, is approximately the same as the lead recoverable from lead and tin scrap, as shown in table 18, although one relates to production and the other to shipments.

TABLE 18.—Lead recovered from scrap processed in the United States, 1952–53, in short tons

Recoverable lead content of scrap processed			Lead recovered from scrap processed		
Kind of scrap	1952	1953	Form of recovery	1952	1953
New scrap:			As metal:		
Lead-base	51,380	49,902	At primary plants	3,070	4,211
Copper-base	8,083	8,085	At other plants	137,032	122,363
Total	59,463	57,987	Total	140,102	126,574
Old scrap:					
Battery-lead plates	254,827	247,332	In antimonial lead [1]	222,951	236,555
All other lead-base	130,302	152,897	In other lead alloys	93,048	92,379
Copper-base	26,679	28,498	In copper-base alloys	14,479	30,826
Tin-base	23	23	In tin-base alloys	714	403
Total	411,831	428,750	Total	331,192	360,163
Grand total	471,294	486,737	Grand total	471,294	486,737

[1] Includes 35,145 tons of lead recovered in antimonial lead from secondary sources at primary plants in 1952 and 36,749 tons in 1953.

All consumers of lead scrap (primary refiners, secondary smelters, foundries, and other manufacturers) used 620,000 tons of lead scrap and residues in 1953, or 2 percent more than in 1952. Use of battery plates decreased about 3 percent and type-metal scrap 14 percent, but these decreases were more than offset by a 32-percent gain in the use of soft-lead scrap to 70,000 tons, a 31-percent increase in cable-lead scrap to 24,000 tons, and a 16-percent increase in the use of solder scrap to 17,000 tons. Battery plates consumed composed 60 percent of all scrap used in 1953 and totaled 372,000 tons, from which it was calculated (by application of recovery and composition percentage factors) that 247,000 tons of lead, 12,000 tons of antimony, and 800 tons of tin were recoverable. All of the antimony and tin and most of the lead were recovered in alloys. Some of the lead was recovered as refined lead. In the latter operation the antimony content of the scrap treated was removed as a high-antimony dross, which was added to other charges to make antimonial lead, solder, babbitt, or type metal. The greatest activity in the industry occurred in October; May showed the lowest consumption of scrap and consequent recovery of metal.

Although the National Production Authority revoked all lead consumption and stock controls in 1952, mandatory reporting of the quantities consumed or stocked was maintained through June 1953. In February 1953 price ceilings and most other emergency controls on industrial operations were removed. The price paid for battery-plate scrap varied with the price of refined lead, but when there was an oversupply of this scrap the smelting charge was raised, in effect reducing the price paid for the scrap.

Secondary smelters shipped to consumers 422,000 tons of percentage metals, that is, lead and tin products in pig, bar, or ingot form, of specified composition. They also reshipped 27,000 tons of these metals within the industry. The total shipments included 211,000 tons of antimonial lead, 107,000 tons of soft lead, 59,000 tons of solder, 37,000 tons of type metals, 15,000 tons of common babbitt, 18,000 tons of cable lead, 2,000 tons of tin babbitt, and 200 tons of remelt tin.

As in the case of zinc, heavy imports created an oversupply of lead in 1953, but the effect on lead was not as severe as on zinc. General imports of lead scrap totaled 5,000 tons (lead content) in 1953 compared with 12,000 tons in 1952. The price of common lead received by producers at New York decreased a little over 1 cent during 1953, whereas that of zinc declined about 3 cents. Scrap prices for both metals decreased in proportion to changes in prices of refined metal, but consumption of lead scrap increased 2 percent, and that of zinc scrap declined 2 percent.

TABLE 19.—Secondary metal content of shipments[1] of secondary lead and tin products in the United States in 1953, gross weight in short tons

Product	Lead	Tin	Antimony	Copper	Total
Refined pig lead	97,207				97,207
Remelt lead	29,167				29,167
Lead foil	200				200
Total	126,574				126,574
Refined pig tin		3,053			3,053
Remelt tin		145			145
Tin foil		3			3
Total		3,201			3,201
Lead and tin alloys:					
Antimonial lead	236,555	190	14,941	33	251,719
Common babbitt	22,794	2,119	3,035	53	28,001
Genuine babbitt	41	304	44	27	416
Other tin babbitts	362	430	98	25	915
Solder	38,082	8,536	501	7	47,126
Type metals	30,987	1,867	3,697	13	36,564
Miscellaneous lead-tin alloys	416	38	40		494
Total	329,237	13,484	22,356	158	365,235
Composition foil	100	82	4		186
Tin content of chemical products		554			554
Grand total	455,911	17,321	22,360	158	495,750

[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.

TABLE 20.—Shipments of secondary lead and tin products in the United States in 1953, by type of plant, gross weight in short tons

Plant	Lead	Tin	Antimony	Copper	Total
Secondary smelters	398,985	16,504	18,869	132	434,490
Primary producers	40,960	----------	1,747	----------	42,707
Manufacturers and foundries	15,966	817	1,744	26	18,553
Total	455,911	17,321	22,360	158	495,750

TABLE 21.—Stocks and consumption of new and old lead scrap in the United States in 1953, 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	5,981	67,100	----------	69,121	69,121	3,960
Hard lead	2,899	17,389	----------	16,664	16,664	3,624
Cable lead	583	23,610	----------	23,841	23,841	352
Battery-lead plates	20,682	374,900	----------	371,853	371,853	23,729
Mixed common babbitt	626	6,931	----------	7,131	7,131	426
Solder and tinny lead	387	16,316	----------	15,907	15,907	796
Type metals	796	19,479	----------	19,541	19,541	734
Dross and residues	22,310	79,999	77,310	----------	77,310	24,999
Total	54,264	605,724	77,310	524,058	601,368	58,620
Foundries and other manufacturers:						
Soft lead	388	1,065	45	1,114	1,159	294
Hard lead	43	984	31	842	873	154
Cable lead	13	192	----------	191	191	14
Battery-lead plates	88	47	----------	75	75	60
Mixed common babbitt	533	14,287	160	14,231	14,391	429
Solder and tinny lead	576	1,401	1,297	99	1,396	581
Type metals	2	45	----------	46	46	1
Dross and residues	119	479	475	----------	475	123
Total	1,762	18,500	2,008	16,598	18,606	1,656
Grand total:						
Soft lead	6,369	68,165	45	70,235	70,280	4,254
Hard lead	2,942	18,373	31	17,506	17,537	3,778
Cable lead	596	23,802	----------	24,032	24,032	366
Battery-lead plates	20,770	374,947	----------	371,928	371,928	23,789
Mixed common babbitt	1,159	21,218	160	21,362	21,522	855
Solder and tinny lead	963	17,717	1,297	16,006	17,303	1,377
Type metals	798	19,524	----------	19,587	19,587	735
Dross and residues	22,429	80,478	77,785	----------	77,785	25,122
Total	56,026	624,224	79,318	540,656	619,974	60,276

[1] Revised figures.

TABLE 22.—Dealers' monthly average buying prices for lead scrap and prices of refined lead at New York and battery-plate smelting charges in 1953

[American Metal Market]

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
CENTS PER POUND													
No. 1 heavy scrap lead	11.18	10.50	10.41	9.62	9.87	10.66	10.93	11.25	9.99	9.75	10.22	10.50	10.41
Refined lead	14.19	13.50	13.40	12.64	12.75	13.41	13.68	14.00	13.74	13.50	13.50	13.50	13.48
DOLLARS PER TON													
Battery-plate smelting charge	40	60	45	45	40	45	50	60	70	70	65	70	------

SECONDARY MAGNESIUM

Secondary magnesium recovered from purchased scrap in 1953 totaled 11,900 short tons valued[9] at $6,350,000, compared with 11,500 tons valued at $5,620,000 in 1952.

Consumption of purchased and toll-treated magnesium scrap rose from 10,000 tons in 1952 to 11,500 tons in 1953, representing an increase of 15 percent. Consumption of primary magnesium was 44,000 tons in 1952 and 50,000 tons in 1953, also representing an increase of 15 percent. In both years about one-sixth of the primary metal and scrap consumed was used for dissipative purposes from which no recovery of secondary magnesium could be expected.

TABLE 23.—Magnesium recovered from scrap processed in the United States, 1952–53, in short tons

Recoverable magnesium content of scrap processed			Magnesium recovered from scrap processed		
Kind of scrap	1952	1953	Form of recovery	1952	1953
New scrap:			Magnesium-alloy ingot[1] (gross weight)	6,411	6,710
Magnesium-base	2,529	3,945	Magnesium-alloy castings (gross weight)	716	436
Aluminum-base	1,711	1,947	Magnesium-alloy shapes	1	3
Total	4,240	5,892	In aluminum alloys	3,022	3,113
Old scrap:			In zinc and other alloys	40	4
Magnesium-base	6,519	5,393	Chemical and other dissipative uses	14	86
Aluminum-base	718	645	Cathodic protection	1,273	1,578
Total	7,237	6,038	Grand total	[2]11,477	11,930
Grand total	[2]11,477	11,930			

[1] Figures include secondary magnesium incorporated in primary magnesium ingot.
[2] Includes 926 tons of alloying ingredients.

Almost 8,300 tons of scrap was consumed in making magnesium-alloy ingot, 54 percent was used as a minor addition in primary alloy suitable for wrought products and castings, and the remaining 46 percent was used to make casting ingot which could be used for making castings only. The primary alloy was chiefly virgin magnesium, with small additions of scrap and alloying ingredients such as aluminum. The casting ingot made by secondary smelters totaled 5,000 tons and was largely made from scrap. The casting ingot made by the primary producers and foundries was chiefly primary magnesium, with small additions of scrap and alloying ingredients. Of the total purchased scrap consumed only 3 tons was reported used directly in wrought products, whereas 500 tons was reported used in castings. However, the ingot made from scrap was an intermediate product that was eventually used chiefly in wrought or cast products.

Magnesium-scrap-melting operations, like those of aluminum and copper, follow the general rule that casting-alloy scrap may be used in making casting alloys but cannot be used, without considerable dilution, in making wrought alloys. For this reason, the secondary magnesium smelters confine their operations to the production of casting alloys. The chief obstacle to using magnesium casting scrap

[9] Values calculated at 26.6 cents per pound in 1953 and 24.5 cents in 1952, the average prices paid for primary magnesium ingot (98.5 percent) f. o. b., Freeport, Tex., during the 2 years.

in wrought alloys is the different zinc and aluminum content of these two materials. The most commonly used magnesium casting alloys, whether in scrap or product form, contain 5.3 to 9.7 percent aluminum and 2.0 to 3.0 percent zinc, whereas the common wrought alloys contain 2.5 to 3.5 percent aluminum and less than 1 percent zinc. The addition of aluminum to magnesium alloys increases the strength but tends to reduce ductility. Zinc gives some resistance to corrosion and improves hot-working characteristics. It reduces grain size and so gives greater strength and good ductility. Two-thirds of the total quantity of magnesium alloys made in 1953 was casting alloys. The old cast scrap in 1953 consisted chiefly of wrecked and obsolete aircraft parts. The borings, grindings, and turnings were largely generated in machine-shop processing of castings and were therefore of casting-alloy composition. Seven-eighths of the scrap reported consumed in 1952 and 1953 was casting-alloy scrap. The use of heat-resistant magnesium alloys containing zirconium and rare earths increased in 1953. When returned to a secondary magnesium smelter as scrap they can be conveniently used only in making an alloy of the same composition as the scrap. This type of scrap and most other magnesium scrap that is unsuitable for magnesium alloys may, however, be used as a minor component in aluminum alloys. Wrought scrap is suitable for use in casting alloys but, being more conveniently used in wrought alloys, usually finds its way back to the rolling mills.

Most of the purchased wrought scrap consumed was process scrap generated by rolling mills and fabricators, and most of it was consumed in wrought alloys by mills with melting facilities or by the primary producer. Some foundries and fabricators make their own alloys from scrap, primary magnesium, and alloying ingredients, the last often in the form of hardeners or chemicals. Manganese, for example, may be added as manganese chloride. The Dow Chemical Co. was the sole domestic producer of primary magnesium in 1953. Some primary magnesium was sold in unalloyed form, but most of it was combined with other metals to make wrought or casting alloys. Six companies produced secondary magnesium ingot for sale to foundries. The wrought alloys were made in the form of billets and slabs for rolling, extrusion, and drawing.

Magnesium is melted (in ingot or scrap form) in steel melting pots and crucibles. The metal is always covered with flux to prevent it from catching fire. The fluxes consist chiefly of chlorides of potassium, calcium, and magnesium. Some contain manganese chloride, which provides the manganese needed in some alloys. Impurities combine with the flux and sink to the bottom of the pot as sludge or dross. Iron is only slightly soluble in magnesium and to a great extent drops out through mechanical settling in addition to combining with the flux. The sludge is removed at intervals or after all the molten magnesium has been ladled off. The larger shots and fragments of metal are salvaged from the cooled sludge, which consists of flux, impurities, and 5 to 15 percent magnesium; the remainder is usually discarded. Iron can be separated from molten magnesium by fluxing, but not aluminum, zinc, or copper, which remain alloyed with the magnesium. Magnesium can be separated from aluminum alloys by adding aluminum chloride or by blowing chlorine gas through the melt. Cast-steel pots for melting magnesium can be used for a comparatively long time because, unlike aluminum, magnesium does not attack iron. Wear results from oxidation of the outer surface from the heat applied for melting.

Very little fine material, including borings and grindings, is generated in processing wrought magnesium alloys. Borings and turnings from castings are an important raw material for smelters, but the fire hazard in using grindings makes their use impracticable, except in times of great metal scarcity. A convenient material for fighting magnesium fires around melting operations is the cover flux. Other fire-quenching materials that can be used are "G–1" powder (a manufactured extinguisher), graphite powder, and clean iron borings. Water should not be used, as steam formed by contact of water with burning magnesium reacts with the metal to form magnesium oxide and hydrogen, the latter adding to the conflagration and causing explosions.

The price of primary magnesium was advanced on March 9 from 24.5 cents a pound to 27 cents; it remained there for the balance of the year. The price of remelt ingot was quoted in American Metal Market at 31 cents throughout 1953.

TABLE 24.—Stocks and consumption of new and old magnesium scrap in the United States in 1953, gross weight in short tons

Scrap item	Stocks, beginning of year	Receipts	Consumption			Stocks, end of year
			New scrap	Old scrap	Total	
Cast scrap	1,136	7,886	1,464	6,587	8,051	971
Solid wrought scrap	155	1,823	1,517		1,517	461
Borings, turnings, drosses, etc.	154	2,154	1,987		1,987	321
Total	1,445	11,863	4,968	6,587	[1] 11,555	1,753

[1] Includes 534 tons consumed in making magnesium castings, 3 tons in wrought products, 635 tons in aluminum alloys, 4 tons in other alloys, 8,295 tons in magnesium-alloy ingot, 1,966 tons in cathodic protection, and 118 tons in miscellaneous dissipative uses.

SECONDARY NICKEL

The recovery of secondary nickel from nonferrous scrap totaled 8,400 short tons, valued [10] at $10,400,000 in 1953, an increase of 12 percent in quantity over the 7,500 tons, valued at $8,800,000, recovered in 1952. Secondary nickel recovered as nickel rose 261 percent to 1,000 tons and that added as nickel or in nonferrous scrap to iron and steel 34 percent to 1,500 tons following a 1,000-ton decrease in 1952. More was recovered in copper alloys than in any other form—3,000 tons in 1953 and 2,700 in 1952. This was 36 percent of the total secondary recovery in both years. In both 1952 and 1953 two-thirds of the total secondary nickel recovered was reclaimed from nickel scrap and one-fourth from copper (nickel-silver) scrap.

Nickel scrap consumed in 1953 totaled 8,000 tons compared with 7,400 tons in 1952. Of the 4 items listed in the nickel-scrap consumption table, use of 3 increased in 1953, whereas use of nickel residues, a low-grade item, declined. Of the 13,000 tons of nickel-silver scrap, a copper-base item, consumed in 1953, brass mills used

[10] The values are computed at 62.26 cents a pound in 1953 and 58.83 cents a pound in 1952, the average spot-delivery prices of Grade F nickel ingots and shot in 10,000-pound lots at New York.

9,800 tons, smelters 3,000 tons, and foundries 200 tons. From the total quantity of nickel scrap treated in 1953, 84 percent (6,700 tons) of nickel and copper, was recovered, as unalloyed nickel, mixed with primary metal, in alloy form, or in dissipative uses compared with 74 percent in 1952. The lower figure in 1952 was due to the greater proportion of low-grade scrap used in that year.

TABLE 25.—Nickel recovered from scrap processed in the United States, 1952–1953, in short tons

Recoverable nickel content of scrap processed			Nickel recovered from scrap processed		
Kind of scrap	1952	1953	Form of recovery	1952	1953
New scrap:			As metal	274	989
Nickel-base	941	1,046	In nickel-base alloys	1,067	1,184
Copper-base	1,458	1,702	In copper-base alloys	2,708	3,032
Aluminum-base	821	368	In aluminum-base alloys	1,141	542
			In lead-base alloys	24	26
Total	3,220	3,116	In cast iron and steel [1]	1,130	1,518
			In chemical compounds	1,135	1,061
Old scrap:					
Nickel-base	3,604	4,623	Grand total	7,479	8,352
Copper-base	362	472			
Aluminum-base	291	140			
Lead-base	2	1			
Total	4,259	5,236			
Grand total	7,479	8,352			

[1] Includes only nonferrous nickel scrap added to cast iron and steel.

TABLE 26.—Stocks and consumption of new and old nickel scrap in the United States in 1953, gross weight in short tons [1]

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	58	1,102	44	1,028	1,072	88
Monel metal	316	2,025	581	1,391	1,972	369
Nickel silver	[1] 461	[1] 3,046	[1] 250	[1] 2,776	[1] 3,026	[1] 481
Miscellaneous nickel alloys	20	358	45	308	353	25
Nickel residues	20	105	----------	88	88	37
Total	414	3,590	670	2,815	3,485	519
Foundries and plants of other manufacturers:						
Unalloyed nickel	97	847	391	332	723	221
Monel metal	466	873	98	1,010	1,108	231
Nickel silver	[1] 820	[1] 9,691	[1] 9,681	[1] 259	[1] 9,940	[1] 571
Miscellaneous nickel alloys	72	608	37	621	658	22
Nickel residues	313	1,956	523	1,550	2,073	196
Total	948	4,284	1,049	3,513	4,562	670
Grand total:						
Unalloyed nickel	155	1,949	435	1,360	1,795	309
Monel metal	782	2,898	679	2,401	3,080	600
Nickel silver	[1] 1,281	[1] 12,737	[1] 9,931	[1] 3,035	[1] 12,966	[1] 1,052
Miscellaneous nickel alloys	92	966	82	929	1,011	47
Nickel residues	333	2,061	523	1,638	2,161	233
Total	1,362	7,874	1,719	6,328	8,047	1,189

[1] Excluded from totals since it is copper-base scrap although containing considerable nickel. Stocks include home scrap.

The spot-delivery price of Grade F nickel ingots and shot was increased from 58.83 cents to 62.42 cents a pound on January 14, 1953, and remained 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, increased from 36 cents to 55 per pound when price ceilings were removed in February and those of Monel clippings from 29 to 33 cents. Nickel clippings were $1.00 a pound in April but declined to 65 cents by the year end. Monel clippings ended the year at 24 cents.

Imports of nickel scrap in 1951, 1952, and 1953 were 800, 500, and 900 tons, respectively.

SECONDARY TIN

Secondary tin recovered in 1953 totaled 30,900 short tons valued [11] at $59,200,000 compared with 32,300 tons valued at $77,700,000 in 1952.

The same quantity of tin—3,200 tons—was recovered as metal in 1953 as in 1952. The 1,400-ton decrease in total recovery was due chiefly to a 2,000-ton decline in tin recovered in brass and bronze, which was partly offset by a 400-ton rise in the secondary tin constituent of lead-base alloys produced in 1953.

Total consumption of tin scrap was 5,100 tons, a 23-percent decrease from the 6,600 tons consumed in 1952. In 1953 less than half the quantity of block-tin pipe was melted, and approximately half the quantity of tin scruff and dross was treated compared with the preceding year. Use of high-tin babbitt was about the same both years, but consumption of residues more than tripled in 1953. Only 119 tons of tin scrap was reported consumed by manufacturers and foundries in 1953; the remainder was used by smelters and refiners.

Of the 30,900 tons of secondary tin recoverable in 1953, 24,000 tons was in lead and copper scrap, and 26,000 was recovered (produced) in lead and copper alloys. The tin in the alloy scrap remained in alloy form and was recovered in alloys; in addition, some unalloyed tin scrap was added to alloys. Besides the tin consumed as scrap, over 50,000 tons of refined tin from foreign sources was consumed in 1953.

The recovery of metal from solder dross generated in canning operations is difficult because the dross is contaminated with chlorine from the flux used. The Bureau of Mines has had encouraging initial results in devising a method of treating this material.

In February, all end-use and price-control orders on tin, secondary tin, and tin residues were revoked. Mandatory reporting by consumers was discontinued after June 30.

The average price of scrap-tin pipe for the year, New York, was 78.85 cents per pound. During the first 3 months of the year the average remained at $1.00 per pound, but several decreases brought the August average price to 64 cents. In September the average rose to 66 cents a pound, where it remained the last 3 months of the year.

[11] Values computed at 95.77 cents per pound in 1953 and 120.44 cents for 1952, the average New York selling price for Straits tin in each year.

TABLE 27.—Tin recovered from scrap processed in the United States, 1952–53, in short tons

Recoverable tin content of scrap processed

Kind of scrap	1952	1953
New scrap:		
Tin plate	3,117	3,392
Tin-base	1,447	1,035
Lead-base	2,435	2,394
Copper-base	2,329	2,654
Total	9,328	9,475
Old scrap:		
Tin cans	185	80
Tin-base	3,855	2,889
Lead-base	6,822	7,279
Copper-base	12,071	11,191
Total	22,933	21,439
Grand total	32,261	30,914

Tin recovered from scrap processed

Form of recovery	1952	1953
As metal:		
At detinning plants	3,022	2,993
At other plants	185	208
Total	3,207	3,201
In solder	8,255	8,536
In tin babbitt	885	734
In chemical compounds	382	555
In lead-base alloys	3,916	4,296
In brass and bronze	15,616	13,592
Total	29,054	27,713
Grand total	32,261	30,914

TABLE 28.—Stocks and consumption of new and old tin scrap in the United States in 1953, 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	47	685	----------	702	702	30
Tin scruff and dross	418	1,189	1,119	----------	1,119	488
No. 1 pewter	22	81	----------	81	81	22
High-tin babbitt	322	2,222	----------	2,336	2,336	208
Residues	459	657	790	----------	790	326
Total	1,268	4,834	1,909	3,119	5,028	1,074
Foundries and other manufacturers:						
Block-tin pipe, scrap, and foil	2	26	5	23	28	----------
High-tin babbitt	18	73	4	87	91	----------
Residues	2	2	----------	----------	----------	4
Total	22	101	9	110	119	4
Grand total:						
Block-tin pipe, scrap, and foil	49	711	5	725	730	30
Tin scruff and dross	418	1,189	1,119	----------	1,119	488
No. 1 pewter	22	81	----------	81	81	22
High-tin babbitt	340	2,295	4	2,423	2,427	208
Residues	461	659	790	----------	790	330
Total	1,290	4,935	1,918	3,229	5,147	1,078

[1] Revised figures.

Secondary tin recovered by detinning plants, as metal and in chemical compounds, increased 4 percent in 1953. The total tin recovered was 3,600 short tons in 1953 compared with 3,400 in 1952. Tin-plate clippings and old cans were the source of 3,500 tons in 1953, of which 3,000 was reclaimed as metal and 500 in the form of tin compounds. During 1952 the usage of such material provided 3,300 tons, comprising 3,000 tons of metal and 300 in compounds. The treatment of other tin-bearing materials accounts for the remaining production of 100 tons in 1953 and in 1952.

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TABLE 29.—Tin recovered from scrap processed at detinning plants in the United States, 1952–53

	1952	1953
Scrap treated:		
Clean tinplate clippings____long tons__	439,321	526,226
Old tin-coated containers____do____	25,890	10,850
Total____do____	465,211	537,076
Tin recovered:		
From new tinplate clippings____short tons__	3,117	3,392
From old tin-coated containers____do____	185	80
Total____do____	3,302	3,472
Form of recovery:		
As metal____do____	2,952	2,966
In compounds____do____	350	506
Total____do____	[1] 3,302	[1] 3,472
Weight of tin compounds produced____do____	719	1,125
Average quantity of tin recovered per long ton of clean tinplate scrap used__pounds__	14.19	12.88
Average quantity of tin recovered per long ton of old tin-coated containers used__do____	14.31	14.81
Average delivered cost of clean tinplate scrap____per long ton__	$36.50	$28.81
Average delivered cost of old tin-coated containers____do____	$33.33	$32.53

[1] Recovery from tinplate clippings and old containers only. In addition, detinners recovered 76 tons of tin as metal and in compounds from tin-base scrap and residues in 1953, and 102 tons from these sources in 1952.

The tonnage of tinplate clippings treated in 1953 was the largest on record. The industry treated 526,000 long tons of tinplate clippings in 1953—20 percent more than in 1952 and 9 percent more than the previous peak of 481,000 tons used in 1951. The average cost of such clippings delivered at plants decreased from $36.50 a long ton in 1952 to $28.81 in 1953. The average quoted composite price of steel scrap declined from $41.79 per gross ton in 1952 to $39.52 in 1953. Steel scrap is one of the products of the detinning industry being sold to open-hearth plants. The demand for iron and steel scrap was at a high rate with domestic output of steel reaching an alltime high in 1953. Old cans processed decreased from 26,000 long tons in 1952 to only 11,000 in 1953. Tin recovered from tinplate clippings in 1953 was 3,400 short tons, 9 percent more than 1952, while that from old cans, 100 tons, decreased 57 percent.

The average quantity of tin recovered per long ton of tinplate scrap treated was 12.88 pounds in 1953 compared with 14.19 pounds in 1952. The lower recovery continued to reflect the treatment of a larger proportion of electrolytic tinplate carrying a thinner coating of tin than the hot-dipped product. The average quantity of tin recovered per long ton of old tin cans increased slightly from 14.31 pounds in 1952 to 14.81 pounds in 1953.

Imports of tinplate scrap were 38,000 long tons in 1953 against 43,000 tons in 1952. In 1953 exports of tinplate scrap were 5,000 tons (3,600 tons in 1952), the highest since 1939. Mexico was the destination of most of the tinplate scrap exported in 1953.

TABLE 30.—Tinplate scrap imported into the United States, by countries, 1952–1953, in long tons

[U. S. Department of Commerce]

Country	1952	1953
Australia	7,817	5,460
Canada	25,505	23,930
Cuba	1,337	1,243
French Morocco	1,953	3,373
New Zealand	384	284
Union of South Africa	4,239	1,935
All others	1,424	1,357
Total	42,659	37,582

SECONDARY ZINC

Secondary zinc recovered in 1953 from purchased scrap and residues totaled 295,000 short tons, with a value [12] of $67,800,000, representing a decrease in quantity of 5 percent from the 310,000 tons valued at $103,000,000 recovered in 1952. The 1953 total was the smallest since 1949, when 238,000 tons was reclaimed.

Of the 118,000 tons of recoverable zinc in new copper scrap consumed in 1953, 111,000 tons was in scrap used by brass mills; and of the 43,000 tons of recoverable zinc from old copper scrap, 27,000 was in scrap used by smelters. In addition to the zinc contained in scrap, brass mills consumed 163,000 tons of slab zinc for alloying purposes in 1953 and smelters 8,000. The recoverable zinc content of copper scrap consumed in 1953 declined 9 percent or to 161,000 tons and the secondary zinc recovered (produced) in brass and bronze products decreased 9 percent or to 169,000 tons, chiefly because of smaller use of copper-alloy scrap in copper-alloy products. The recoverable zinc content of zinc scrap consumed also declined in 1953; that of aluminum scrap and of magnesium scrap increased, but the last two were minor items. As indicated in the right side of table 31, the decrease in zinc recovered in brass and bronze was comparatively large. Most other items also decreased, but total recovery in chemical products, following a drop from 40,800 tons in 1951 to 31,200 in 1952, increased to 34,700 in 1953.

Total consumption of zinc scrap and residues decreased 2 percent to 190,000 tons in 1953. The chief decreases in items consumed were 6,000 tons in die castings and 4,000 in skimmings and ashes. Principal increases in items used were 5,000 tons in sal skimmings and 3,000 in chemical residues. Consumption of remaining items decreased, except for galvanizers' dross; about 400 tons more was treated in 1953 than in 1952.

The metallic die-cast scrap reported used was chiefly redistilled to make slab zinc, roasted to make zinc oxide, or remelted to make die castings or remelt die-cast slab. Most of the die-cast skimmings were remelted with coke and ammonium chloride flux to make remelt die-cast slab, which was used for the same products as the die-cast scrap.

[12] Values computed at 11.5 cents per pound for 1953 and 16.6 cents for 1952, the average weighted prices for all grades of refined zinc in those years.

TABLE 31.—Zinc recovered from scrap processed in the United States, 1952–53, in short tons

Recoverable zinc content of scrap processed			Zinc recovered [1] from scrap processed		
Kind of scrap	1952	1953	Form of recovery	1952	1953
New scrap:			As metal:		
Zinc-base	108,273	110,774	By distillation:		
Copper-base	126,625	117,611	Slab zinc	54,560	50,344
Aluminum-base	820	1,985	Zinc dust	22,292	22,185
Magnesium-base	40	73	By remelting	6,275	6,116
Total	235,758	230,443	Total	83,127	78,645
Old scrap:					
Zinc-base	24,997	19,622	In zinc-base alloys	9,875	8,535
Copper-base	49,312	42,888	In brass and bronze	184,935	168,951
Aluminum-base	226	1,604	In aluminum-base alloys	1,120	3,673
Magnesium-base	130	121	In magnesium-base alloys	161	194
			In chemical products:		
Total	74,665	64,235	Zinc oxide (lead-free)	8,914	11,430
			Zinc sulfate	3,871	4,566
Grand total	310,423	294,678	Zinc chloride	10,794	12,981
			Lithopone	6,922	5,008
			Miscellaneous	704	695
			Total	227,296	216,033
			Grand total	310,423	294,678

[1] Zinc content.

TABLE 32.—Production of secondary zinc and zinc-alloy products in the United States, 1944–48 (average) and 1949–53, gross weight in short tons

Products	1944–48 (average)	1949	1950	1951	1952	1953
Redistilled slab zinc	52,931	55,041	66,970	48,657	55,111	52,875
Zinc dust	26,293	21,243	27,507	29,754	25,113	25,297
Remelt spelter [1]	7,856	6,045	7,243	4,454	3,197	2,938
Remelt die-cast slab	7,091	8,266	12,647	5,596	7,098	5,695
Zinc-die and die-casting alloys	2,629	3,873	5,233	4,919	3,400	3,411
Galvanizing stock	705	406	354	198	203	107
Rolled zinc	2,528	2,775	3,589	3,474	2,948	3,132
Secondary zinc in chemical products	45,631	37,424	43,693	40,760	31,205	34,680

[1] Contains small tonnages of bars, anodes, etc.

The best zinc-base die-casting alloys consist of Special High-Grade zinc, with small additions of aluminum and magnesium and sometimes of copper. Die-casting alloys of various grades are also made from scrap die castings. They are not, usually as good as the alloys made from Special High-Grade zinc but are satisfactory for some purposes, and even the highest grade alloys can be made from scrap if the latter is of suitable quality. Obviously, castings made from scrap or remelt die-cast slab, which is made from scrap, are more likely to contain impurities than castings made from refined metal. The maximum allowable percentage of lead in die-casting alloys is usually specified as 0.007; if the percentage exceeds that, the occurrence of subsurface network corrosion is promoted. Copper gives strength and corrosion resistance to die-casting alloys, but if much over 1 percent is present, dimensional stability is lessened. Additions of manganese tend to increase the hardness and strength of zinc without affecting ductility. Lithium, in small proportions, increases the hardness of zinc and decreases its ductility. The effects of corrosion and dimensional change may not become evident for years.

TABLE 33.—Stocks and consumption of new and old zinc scrap in the United States in 1953, 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	144	2,064	2,000	----------	2,000	208
Sheet and strip	346	3,204	----------	2,986	2,986	564
Engravers' plates	125	1,240	----------	1,189	1,189	176
Skimmings and ashes	3,655	35,225	35,484	----------	35,484	3,396
Sal skimmings	477	1,722	1,960	----------	1,960	239
Die-cast skimmings	898	6,879	6,502	----------	6,502	1,275
Galvanizers' dross	4,840	55,919	53,187	----------	53,187	7,572
Die castings	2,647	18,239	----------	19,052	19,052	1,834
Rod and die scrap	219	569	----------	644	644	144
Flue dust	370	6,731	6,887	----------	6,887	214
Chemical residues	1,809	10,955	12,647	----------	12,647	117
Total	15,530	142,747	118,667	23,871	142,538	15,739
Chemical plants, foundries, and other manufacturers:						
Clippings	139	3,868	3,927	----------	3,927	80
Sheet and strip	15	36	----------	44	44	7
Engravers' plates	16	72	----------	87	87	1
Skimmings and ashes	1,990	7,107	8,110	----------	8,110	987
Sal skimmings	4,000	26,670	23,295	----------	23,295	7,375
Galvanizers' dross	----------	48	39	----------	39	9
Die castings	36	1,187	938	213	1,151	72
Rod and die scrap	12	50	----------	50	50	12
Flue dust	260	2,185	2,263	----------	2,263	182
Chemical residues	876	8,171	8,272	----------	8,272	775
Total	7,344	49,394	46,844	394	47,238	9,500
Grand total:						
Clippings	283	5,932	5,927	----------	5,927	288
Sheet and strip	361	3,240	----------	3,030	3,030	571
Engravers' plates	141	1,312	----------	1,276	1,276	177
Skimmings and ashes	5,645	42,332	43,594	----------	43,594	4,383
Sal skimmings	4,477	28,392	25,255	----------	25,255	7,614
Die-cast skimmings	898	6,879	6,502	----------	6,502	1,275
Galvanizers' dross	4,840	55,967	53,226	----------	53,226	7,581
Die castings	2,683	19,426	938	19,265	20,203	1,906
Rod and die scrap	231	619	----------	694	694	156
Flue dust	630	8,916	9,150	----------	9,150	396
Chemical residues	2,685	19,126	20,919	----------	20,919	892
Total	22,874	192,141	165,511	24,265	189,776	25,239

When metal is melted to make die-cast alloys or die castings, about 12 to 15 pounds of skimmings, with a zinc content of about 65 percent, is generated per ton of metal melted. This residue can be melted with flux and coke to recover the metal content, but the operation requires considerable skill.

Many die-casting plants are in districts or buildings where the fumes from melting and fluxing scrap and residues would not be allowable. This and the skill and experience needed in such operations have led some smelters to specialize in making remelt die-cast slab for sale to die casters. Although consumption of scrap die castings declined in 1953, use of slab zinc to make die castings rose 71,000 tons. Zinc skimmings, the other item to decrease notably in use in 1953, is used chiefly to make zinc oxide and redistilled slab.

Sal skimmings are generated in galvanizing and are used chiefly by chemical plants to make ammonium chloride and zinc-ammonium chloride fluxes, which are sold back to the galvanizers. Use of slab zinc in galvanizing rose in 1953, increasing the demand for fluxes. Considerable quantities of chemical residues—the only other zinc-scrap item considered in significantly increased amounts—were generated as a byproduct in the manufacture of sodium hydrosulfite and were used chiefly in making zinc chemicals, secondary production of which increased in 1953.

Although consumption of slab zinc in 1953 reached a record high, heavy imports of refined zinc, ore and concentrates caused an oversupply of slab zinc, which reduced the demand for zinc scrap.

TABLE 34.—Dealers' monthly average buying prices for zinc scrap at New York and prices of Prime Western zinc at East St. Louis in 1953, in cents per pound

[Metal Statistics, 1954]

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
New zinc clips	7.37	6.56	6.50	6.12	5.50	5.50	5.50	5.50	5.19	5.00	5.00	5.00	5.73
Old zinc	5.77	5.00	5.00	4.81	4.50	4.50	4.50	4.50	3.74	3.50	3.50	3.50	4.40
Prime Western zinc	12.60	11.48	11.03	11.00	11.00	11.00	11.00	11.00	10.18	10.00	10.00	10.00	10.86

Silver

By James E. Bell [1] and Kathleen M. McBreen [2]

WITH A DROP of 5 percent in 1953 compared with 1952, the United States mine production of recoverable silver declined for the third successive year. The 1953 output—37,571,000 fine ounces—was 64 percent above the wartime low in 1946 but 43 percent below the average for the 5 years 1936–40. The drop in 1953 was explained largely by lower prices for lead and zinc that closed or curtailed operations at some mines producing these metals with silver as a byproduct.

Idaho continued its rank as the leading silver-producing State, followed by Utah, Montana, and Arizona, an order unchanged since 1943. These 4 States furnished 86 percent of the domestic silver output in 1953. Nearly 61 percent of the Idaho production was recovered from dry ores mined principally for silver, but most of the rest from the 4 leading States was byproduct silver from ores mined chiefly for base metals. Approximately 98 percent of the total domestic silver output was recovered in smelting ores and concentrates.

TABLE 1.—Salient statistics of silver in the United States,[1] 1944–48 (average) and 1949–53

	1944–48 (average)	1949	1950	1951	1952	1953
Mine production, fine ounces	32, 066, 387	34, 674, 952	42, 459, 014	[2] 39, 764, 932	39, 452, 330	37, 570, 838
Ore (dry and siliceous) produced (short tons):						
Gold ore	2, 501, 879	3, 376, 139	3, 584, 360	2, 606, 202	2, 339, 160	2, 198, 688
Gold-silver ore	393, 425	412, 378	433. 461	368, 184	237, 211	81, 658
Silver ore	311, 735	476, 960	627, 349	492, 143	502, 208	555, 050
Percentage derived from—						
Dry and siliceous ores	24	24	33	32	31	29
Base-metal ores	76	76	67	68	69	71
Placers	(3)	(3)	(3)	(3)	(3)	(3)
Net consumption in industry and the arts—fine ounces	107, 437, 800	88, 000, 000	110, 000, 000	105, 000, 000	96, 500, 000	106, 000, 000
Imports	$49, 450, 835	$73, 535, 694	$110, 035, 107	$103, 468, 510	$67, 296, 379	$95, 103, 962
Exports	$59, 471, 147	$23, 281, 043	$6, 201, 874	$8, 590, 185	$4, 921, 285	$8, 426, 910
Monetary stocks (end of year)—fine ounces [4]		1, 978, 000, 000	1, 983, 000, 000	1, 965, 000, 000	1, 938, 000, 000	1, 926, 000, 000
Price, average, per fine ounce [5]	$0. 808+	$0. 905+	$0. 905+	$0. 905+	$0. 905+	$0. 905+
World production, fine ounces (estimated)	164, 840, 000	[2] 179, 200, 000	[2] 203, 000, 000	[2] 199, 100, 000	[2] 216, 800, 000	216, 400, 000

[1] Includes Alaska.
[2] Revised figure.
[3] Less than 0.5 percent.
[4] Owned by Treasury Department; privately held coinage not included.
[5] Treasury buying price for newly mined silver.

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

Outside of the United States the production of silver was 1 percent greater in 1953 than in the preceding year; drops of considerable size in some of the principal silver-producing countries were more than offset by gains in others. The world production of silver in recent years has remained well below the average prewar rate.

The United States Treasury buying price for silver mined domestically after July 1, 1946, continued unchanged at $0.9050505+ per fine troy ounce. The New York price for silver ranged narrowly from $0.8325 to $0.8525 per ounce during 1953, and the New York market continued to represent the basis for dealings in silver throughout most of the world. Transactions in the London and Bombay silver markets remained subject to Government controls. Demand by governments for silver for coinage was approximately 74,800,000 ounces in 1953 compared with 104,100,000 ounces in 1952. Continuing a trend that resumed in 1946, the net inflow of silver into the United States was maintained in 1953; however the excess of imports over exports was 39 percent greater in 1953 than in 1952.

Legislation proposed in 1953 included a bill providing for a return to a bimetal standard and a bill to repeal all silver purchase acts. The Congress took no action on either bill.

DOMESTIC PRODUCTION

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 that is explained largely by time lag. 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 49 years 1905–53 show a total excess of silver of 16,375,313 ounces (a difference of 0.63 percent).

There is no record of the silver production of the United States before 1834, but it is known to have been insignificant. Approximately 750,000 ounces of silver was recovered between 1834 and 1858, mostly from bullion produced in the Southern Appalachian and California gold districts. The advent of the United States as a major silver producer dates, however, from discovery of the Comstock lode in Nevada in 1859. Data, by 5-year periods, on the domestic silver production from 1834 to 1953 are presented in table 3.

TABLE 2.—Silver produced in the United States,[1] 1905–53, according to mine and mint returns, in fine ounces of recoverable metal

Year	Mine	Mint
1905–48	2,412,796,604	2,428,359,480
1949	34,674,952	34,944,554
1950	42,459,014	42,308,739
1951	[2] 39,764,932	39,907,257
1952	39,452,330	39,840,300
1953	37,570,838	37,735,500
Total, 1905–53	2,606,718,670	2,623,095,830

[1] Includes Alaska.
[2] Revised figure.

TABLE 3.—Mine production of silver in the United States by 5-year periods 1834–1953 [1]

Period	Quantity, fine ounces	Average annual production, fine ounces
1834–35	26,297	13,149
1836–40	92,835	18,567
1841–45	112,968	22,594
1846–50	193,500	38,700
1851–55	193,500	38,700
1856–60	309,400	61,880
1861–65	28,810,600	5,762,120
1866–70	49,113,200	9,822,640
1871–75	121,083,300	24,216,660
1876–80	157,680,500	31,536,100
1881–85	182,878,629	36,575,726
1886–90	231,045,135	46,209,027
1891–95	287,068,980	57,413,796
1896–1900	279,544,300	55,908,860
1901–05	278,798,400	55,759,680
1906–10	277,326,600	55,465,320
1911–15	338,337,073	67,667,415
1916–20	325,952,991	65,190,598
1921–25	314,007,876	62,801,575
1926–30	288,896,791	57,779,358
1931–35	158,006,438	31,601,288
1936–40	334,039,072	66,807,814
1941–45	227,789,929	45,557,986
1946–50	173,968,164	34,793,633
1951–53	116,788,100	38,929,367

[1] Merrill, Charles White, Economic Paper 8, Bureau of Mines (1930), Summarized Data of Silver Production. (Table 2 of this paper brought to date.)

MINE PRODUCTION

The domestic mine production of recoverable silver declined in 1953 for the third successive year. The drop in 1953 was general in all the principal silver-producing States except Montana; it was attributed in large part to lower prices for lead and zinc, which caused a decline in activity at many mines that produce these metals with silver as a byproduct. The rate of silver production in the United States is far below the prewar average.

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 recovered or recoverable silver shown by assays to be contained in ore, bullion, and other material produced.

Virtually all the silver produced in the United States is obtained from lode deposits, mainly from underground operations; in addition to those worked principally for the precious metals, they include those that yield ore valued chiefly for copper, lead, zinc, or other base metals but that contribute silver as a byproduct. Around 0.1 percent of the current domestic silver output 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.

TABLE 4.—Mine production of silver in the United States [1] in 1953, by months

	Fine ounces		Fine ounces
January	3,050,570	August	3,068,352
February	2,885,038	September	3,109,302
March	3,443,180	October	3,215,055
April	3,198,907	November	3,044,541
May	3,154,323	December	3,186,842
June	3,154,316		
July	3,060,412	Total	37,570,838

[1] Includes Alaska.

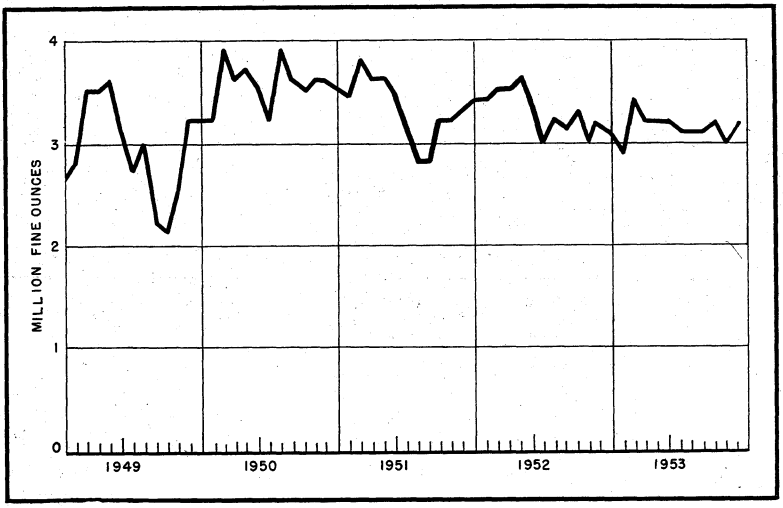

FIGURE 1.—Mine production of silver in the United States, 1949–53, by months, in terms of recoverable silver.

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 1953. 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 66 percent of the domestic silver output in 1953.

Of the 25 leading domestic silver-producing mines in 1953, only 5 depended exclusively on silver ore; ores with values chiefly in copper, lead, zinc, and gold supplied most of the silver production. The 8 leading mines (each producing over 1,000,000 ounces of silver in 1953) contributed 56 percent of the United States total output; the entire 25 leading mines contributed 81 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, 1944–48 (average) and 1949–53, by districts and regions that produced 200,000 fine ounces or more during any year (1949–53), in fine ounces

District or region	State	1944–48 (average)	1949	1950	1951	1952	1953
Coeur d'Alene Region	Idaho	8, 254, 787	9, 146, 146	15, 056, 131	13, 639, 808	13, 752, 081	13, 636, 680
Summit Valley (Butte)	Montana	4, 932, 137	5, 635, 101	6, 121, 264	5, 950, 647	5, 514, 330	6, 289, 415
West Mountain (Bingham)	Utah	3, 968, 235	4, 316, 378	4, 963, 586	4, 923, 249	5, 338, 291	5, 027, 419
Warren (Bisbee)	Arizona	1, 237, 910	1, 166, 210	1, 079, 311	1, 292, 719	1, 242, 935	1, 266, 153
Coso	California	637, 306	352, 482	600, 440	570, 595	(1)	(1)
Park City Region	Utah	1, 305, 903	1, 061, 902	952, 632	1, 131, 360	861, 563	802, 036
Upper San Miguel	Colorado	343, 819	579, 498	730, 860	621, 257	764, 478	717, 939
Pioneer (Superior)	Arizona	300, 746	401, 202	529, 186	581, 952	[2] 606, 563	627, 890
Big Bug	do	339, 928	581, 351	701, 973	636, 812	581, 699	591, 388
Red Cliff (Battle Mountain).	Colorado	178, 024	216, 580	669, 461	412, 788	348, 090	581, 100
Tintic	Utah	995, 312	914, 150	924, 722	944, 818	666, 345	562, 649
Warm Springs	Idaho	438, 274	468, 302	502, 973	560, 363	630, 886	561, 554
Ajo	Arizona	360, 928	471, 134	473, 020	437, 675	450, 303	435, 940
Copper Mountain (Morenci).	do	407, 510	606, 111	754, 591	612, 336	402, 593	369, 470
Southeastern	Missouri	92, 851	123, 413	236, 273	184, 424	517, 432	359, 781
Pioche	Nevada	461, 695	708, 216	608, 710	415, 622	425, 475	317, 628
Mineral Creek (Ray)	Arizona	33, 643	34, 514	130, 669	172, 765	214, 030	265, 857
Chelan County	Washington	101, 061	135, 662	137, 483	113, 155	[3] 241, 935	[3] 251, 205
Flint Creek	Montana	134, 646	15, 040	22, 528	82, 033	233, 799	[4] 225, 005
Rush Valley	Utah	(1)	(1)	95, 324	189, 110	179, 401	204, 793
California (Leadville)	Colorado	(1)	(1)	(1)	272, 352	[2] 322, 000	196, 239
Creede	do	384, 417	263, 867	345, 247	236, 652	174, 219	173, 966
Ash Peak	Arizona	74, 020	147, 958	227, 342	193, 419	136, 072	168, 163
Animas	Colorado	329, 967	539, 402	564, 321	415, 876	321, 308	99, 619
Central	New Mexico	(1)	(1)	(1)	236, 484	306, 236	78, 842
Verde (Jerome)	Arizona	451, 971	509, 828	456, 254	408, 891	233, 946	30, 553
Pima (Sierritas, Papago, Twin Buttes).	do	143, 554	252, 334	182, 540	145, 941	128, 847	26, 771
Grand Island	Colorado	5, 024	53, 188	58, 262	109, 206	274, 104	(1)
Ten Mile	do	116, 406	254, 294	68, 289	811	671	334
Comstock	Nevada	69, 014	233, 705	108, 944	3, 512	8	143
Resting Springs	California	(1)	(1)	(1)	(1)	(1)	2
Sand Springs	Nevada	32, 883	174, 718	200, 217	111, 529	----------	----------

[1] Figure withheld to avoid disclosure of individual company operations.
[2] Corrected figure.
[3] Chelan and Ferry Counties combined in 1952 and 1953 to avoid disclosure of individual company output.
[4] Combined with First Chance and Henderson districts in 1953 to avoid disclosure of individual company output.

TABLE 6.—Twenty-five leading silver producing mines in the United States in 1953, in order of output

Rank	Mine	District	State	Operator	Source of silver
1	Butte Hill Mines	Summit Valley (Butte)	Montana	Anaconda Copper Mining Co	Copper, lead-zinc ores.
2	Sunshine	Evolution	Idaho	Sunshine Mining Co	Silver 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	Polaris	Evolution	do	Sunshine Mining Co	Silver ore.
6	United States and Lark	West Mountain (Bingham)	Utah	U. S. Smelting, Refining & Mining Co	Gold-silver, lead, lead-zinc ores.
7	Copper Queen	Warren (Bisbee)	Arizona	Phelps Dodge Corp	Copper, lead-zinc ores.
8	Silver Summit	Evolution	Idaho	Polaris Mining Co	Silver ore.
9	Darwin group	Coso	California	Anaconda Copper Mining Co	Zinc-lead, lead ores.
10	St. Germaine, Purim, and Lincoln	Evolution	Idaho	Sunshine Mining Co	Silver ore.
11	Magma	Pioneer (Superior)	Arizona	Magma Copper Co	Copper ore.
12	Kelley Shaft	Summit Valley	Montana	Anaconda Copper Mining Co	Do.
13	Treasury Tunnel, etc	Upper San Miguel	Colorado	Idarado Mining Co	Copper-lead-zinc ore.
14	Iron King	Big Bug	Arizona	Shattuck Denn Mining Corp	Lead-zinc ore, zinc tailings.
15	Eagle Group	Red Cliff (Battle Mountain)	Colorado	New Jersey Zinc Co., Empire Zinc Div	Silver, zinc ores.
16	Galena	Placer Center	Idaho	American Smelting & Refining Co	Lead ore.
17	Triumph	Warm Springs	do	Triumph Mining Co	Lead-zinc ore.
18	Chief No. 1	Tintic	Utah	Chief Consolidated Mining Co	Silver, lead, lead-zinc ores.
19	Silver Syndicate	Evolution	Idaho	Sunshine Mining Co	Silver ore.
20	Page	Yreka	do	American Smelting & Refining Co	Lead-zinc ore.
21	New Cornelia	Ajo	Arizona	Phelps Dodge Corp	Copper ore, old tailings.
22	Park Galena-Mayflower	Blue Ledge	Utah	New Park Mining Co	Lead-zinc ore.
23	Morenci	Copper Mountain	Arizona	Phelps Dodge Corp	Copper ore.
24	Lucky Friday	Hunter	Idaho	Lucky Friday Silver-Lead Mines	Lead-zinc ore.
25	Pioche group	Pioche	Nevada	Combined Metals Reduction Co	Zinc-lead, manganese ores.

TABLE 7.—Mine production of recoverable silver in the United States, 1944–53, with production of maximum year, and cumulative production from earliest record to end of 1953, by States, in fine ounces

	Maximum production [1]		Production by years										Total production from earliest record to end of 1953
	Year	Quantity	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	
Western States and Alaska:													
Alaska	1916	1,379,171	13,362	9,983	41,793	66,150	67,341	36,056	52,638	[2] 31,023	32,986	35,387	20,113,726
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	326,564,159
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	115,659,347
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	750,184,348
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	612,740,270
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	794,546,010
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	598,728,687
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	70,655,568
Oregon	1941	276,158	20,243	10,461	6,927	30,379	13,596	12,195	13,565	6,218	4,037	12,259	5,317,561
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	10,556,168
Texas	1938	1,433,008	5,355	23,265	42,922	20,547	3,065	2,691	2,454	1,381	4,672	----------	33,303,173
Utah	1925	21,276,689	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	770,037,149
Washington	1902	721,450	321,608	281,444	264,453	293,736	375,831	357,853	363,656	334,948	315,645	321,202	15,192,744
Wyoming	1901	21,400	3	31	26	95	11	21	----------	2	----------	11	74,832
Total	--------	----------	34,200,636	28,823,331	22,765,937	35,592,183	37,880,673	34,449,927	42,109,386	[2] 39,449,640	38,780,045	37,053,117	4,123,673,742
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	5,791,107
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	157,892
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	603,186
North Carolina	1906	30,769	1,461	----------	----------	----------	----------	----------	----------	----------	----------	----------	357,223
Pennsylvania	1942	15,501	13,545	10,434	7,887	9,863	13,731	10,827	10,563	13,575	9,247	6,972	256,332
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	3,390,444
Vermont	1952	45,361	18,862	20,586	35,275	21,469	24,910	27,446	28,205	41,300	45,361	43,128	[3] 335,871
Virginia	1944	18,993	18,993	1,300	----------	----------	----------	----------	----------	----------	----------	1,169	80,558
Total	--------	----------	180,661	106,044	79,266	137,780	101,171	101,612	113,355	130,868	154,853	157,940	15,491,740
Grand total	--------	----------	34,473,540	29,024,197	22,914,604	35,823,563	38,096,031	34,674,952	42,459,014	[2] 39,764,932	39,452,330	37,570,838	4,144,956,589

[1] States east of the Mississippi figures are peaks since 1896, except New York and Pennsylvania, which are peaks since 1905. The Illinois figure is the peak since 1907. Alaska, California, Nevada, and Oregon are peaks since 1880.

[2] Revised figure.

[3] Includes a small quantity for New Hampshire.

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 1953 [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	441	0.451				
Arizona	2,252	.585	2,467	5.965	22,772	8.761
California	241,548	.144			107	19.047
Colorado	182,038	.078	48,616	1.417	22,619	21.184
Idaho	17,292	1.632	32	146.750	313,554	28.227
Montana	1,476	5.898	14,572	4.743	2,333	8.948
Nevada	155,993	.034	1,832	4.978	2,569	11.865
New Mexico	1,445	.036	124	22.863	371	1.863
Oregon	1,156	8.876				
South Dakota	1,479,735	.093				
Utah			14,015	3.825	190,725	3.756
Washington	115,312	1.649				
Wyoming						
Total	2,198,688	.196	81,658	2.731	555,050	18.557
States east of the Mississippi						
Total	2,198,688	.196	81,658	2.731	555,050	18.557

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			34	23.588		
Arizona	[2] 45,264,368	0.070	6,059	8.792	1	8.000
California	8,517	[3] 1.143	7,489	39.952		
Colorado	172	.686	29,066	4.701		
Idaho	66,299	.353	152,575	6.079	53,792	1.602
Montana	4,185,818	.499	6,949	6.129		
Nevada	[2] 7,758,567	[4] .036	11,376	8.280		
New Mexico	[5] 7,884,048	[6] .014	54,824	.056		
Oregon	59	1.220				
South Dakota			67	8.955		
Utah	29,941,541	.114	5,826	6.772		
Washington	1,186	.460	3,989	1.182		
Wyoming	2	5.500				
Total	95,110,577	.096	278,254	5.757	53,793	1.602
States east of the Mississippi	5,622,965	.020	168			
Total	100,733,542	.091	278,422	5.754	53,793	1.602

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 1953 [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	----------	----------	----------	----------	[7] 475	2.107
Arizona	7,619	0.526	421,479	2.156	[2] 45,727,017	.095
California	----------	----------	132,922	5.142	390,583	[3] 2.635
Colorado	187,106	.984	734,900	1.792	1,204,517	1.827
Idaho	75,664	.826	1,410,977	3.300	[8] 2,090,185	7.004
Montana	[9] 28,143	.003	1,862,057	2.395	[5] 6,101,348	1.096
Nevada	326	----------	96,739	2.849	8,027,402	[4] .087
New Mexico	135,869	.542	10,369	1.651	[3] 8,087,050	.025
Oregon	----------	----------	----------	----------	1,215	8.505
South Dakota	----------	----------	----------	----------	1,479,802	.094
Utah	20,143	.256	526,554	4.724	[10] 30,698,804	.219
Washington	(11)	(11)	[12] 1,585,923	[12] .079	1,706,410	.188
Wyoming	----------	----------	----------	----------	2	5.500
Total	454,870	.724	6,781,920	2.202	105,514,810	.351
States east of the Mississippi	2,712,592	----------	1,472,221	.026	[13] 9,807,946	[13] .015
Total	3,167,462	.104	8,254,141	1.814	115,322,756	.322

[1] Missouri excluded.
[2] Includes copper precipitates.
[3] Includes metal recovered from tungsten ore or tungsten tailings.
[4] Includes metal recovered from manganese ore.
[5] Includes copper precipitates and old slag.
[6] Includes 4,637 ounces of silver recovered from 4,353 tons of blister copper.
[7] Includes 34 tons of lead ore containing 802 ounces of silver produced in 1952 and shipped in 1953.
[8] Includes 75,664 tons of old zinc slag.
[9] Includes 28,089 tons of old zinc slag.
[10] Includes 20,143 tons of old zinc slag.
[11] Combined with lead-zinc ore to avoid disclosure of individual output.
[12] Includes zinc ore to avoid disclosure of individual output.
[13] Excludes magnetite-pyrite ore and gold and silver therefrom.

TABLE 9.—Mine production of silver in the United States,[1] 1944–48 (average) and 1949–53, by percent from sources and in total fine ounces

Year	Placers	Dry ore	Copper ore	Lead ore	Zinc ore	Zinc-lead, zinc-copper, lead-copper, and zinc-lead-copper ores	Total fine ounces
1944–48 (average)	0.2	23.6	26.7	7.6	2.0	39.9	32,066,387
1949	.2	23.5	20.0	7.8	1.5	47.0	34,674,952
1950	.2	32.8	19.6	5.1	1.0	41.3	42,459,014
1951	.2	31.9	20.8	4.2	1.8	41.1	39,764,932
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

[1] Includes Alaska.

TABLE 10.—Mine production of silver in the United States in 1953, 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	34,386	199	-------	802	-------	-------	-------	35,387
Arizona	19	215,537	3,169,762	53,269	8	4,008	908,826	4,351,429
California	7,225	36,715	[1] 9,733	299,204	-------	-------	683,495	[1] 1,036,372
Colorado	245	562,300	118	136,625	-------	184,173	1,316,856	2,200,317
Idaho	1,064	8,883,613	23,429	927,446	86,149	62,472	4,655,567	14,639,740
Illinois	-------	-------	-------	-------	-------	-------	2,338	2,338
Missouri	-------	-------	-------	[2] 359,781	(2)	-------	-------	359,781
Montana	42	98,696	2,088,054	42,591	-------	74	4,460,099	6,689,556
Nevada	2,412	44,906	[3] 280,009	94,197	-------	-------	275,562	[3] 697,086
New Mexico	2	3,578	[4] 107,833	3,095	-------	73,677	17,124	205,309
New York	-------	-------	-------	-------	-------	-------	35,398	35,398
Oregon	1,926	10,261	72	-------	-------	-------	-------	12,259
Pennsylvania	-------	-------	[5] 6,972	-------	-------	-------	-------	6,972
South Dakota	-------	138,042	-------	600	-------	-------	-------	138,642
Tennessee	-------	-------	68,935	-------	-------	-------	-------	68,935
Utah	1	769,987	3,423,889	39,452	-------	5,148	2,487,330	6,725,807
Vermont	-------	-------	43,128	-------	-------	-------	-------	43,128
Virginia	-------	-------	-------	-------	-------	-------	1,169	1,169
Washington	3	190,101	545	4,716	-------	(6)	[7] 125,837	321,202
Wyoming	-------	-------	11	-------	-------	-------	-------	11
Total	47,325	10,953,935	9,222,490	1,961,778	86,157	329,552	14,969,601	37,570,838

[1] Includes metal recovered from tungsten ore or tungsten tailings.
[2] A little silver recovered from lead-copper ore from 1 mine included with that from lead ore.
[3] Includes metal recovered from manganese ore.
[4] Includes 4,637 ounces of silver recovered from 4,353 tons of blister copper.
[5] From magnetite-pyrite ore.
[6] Combined with lead-zinc ore to avoid disclosure of individual output.
[7] Includes zinc ore to avoid disclosure of individual output.

TABLE 11.—Silver produced in the United States from ore and old tailings, in 1953, 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 (fine ounces)	Concentrates smelted and recoverable metal		Short tons	Fine ounces
				Concentrates (short tons)	Fine ounces		
Western States and Alaska:							
Alaska	[2] 475	[2] 440	69	32	121	35	811
Arizona	[3 4] 42,150,223	[3] 41,423,025	25	1,331,215	2,898,909	[4] 727,198	1,452,476
California	[5] 390,583	378,276	24,586	30,524	688,826	12,307	315,735
Colorado	1,204,517	1,175,899	18,407	125,671	1,677,110	28,618	504,555
Idaho	[6] 2,090,185	1,993,769	1,720	242,383	14,403,604	96,416	233,352
Montana	[7] 6,101,348	5,965,610	38	640,414	6,400,347	135,738	289,129
Nevada	[4 8] 8,027,402	7,917,546	2,177	291,390	504,348	109,856	188,149
New Mexico	[9] 8,087,050	7,961,301	107	249,436	159,756	125,749	45,444
Oregon	1,215	1,156	25	127	10,236	59	72
South Dakota	1,479,802	1,479,735	138,042	-------	-------	67	600
Utah	[10] 30,698,804	30,448,505	-------	977,962	5,896,071	250,299	829,735
Washington	1,706,410	1,650,035	42,741	91,110	242,585	56,375	35,873
Wyoming	2	-------	-------	-------	-------	2	11
Total	101,938,016	100,395,297	227,937	3,980,264	32,881,913	1,542,719	3,895,942
States east of the Mississippi	[11] 9,807,946	[11] 9,807,946	-------	631,686	157,940	-------	-------
Total	111,745,962	110,203,243	227,937	4,611,950	33,039,853	1,542,719	3,895,942

[1] Missouri excluded.
[2] Excludes ore reported in prior years that produced 124 ounces of silver shipped in 1953.
[3] Excludes 3,576,794 tons of ore leached from which no silver was recovered.
[4] Includes copper precipitates.
[5] Excludes tungsten ore.
[6] Includes 75,664 tons of old zinc slag.
[7] Includes 28,089 tons of old zinc slag.
[8] Excludes manganese ore.
[9] Includes copper precipitates and old slag.
[10] Includes 20,143 tons of old zinc slag.
[11] 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, 1944–48 (average) and 1949–53 [1]

Year	Bullion and precipitates recoverable (fine ounces)		Silver from all sources (percent)			
	Amalgamation	Cyanidation	Amalgamation	Cyanidation	Smelting [2]	Placers
1944–48 (average)	54,940	229,415	0.2	0.7	98.9	0.2
1949	119,443	555,859	.3	1.6	97.9	.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

[1] Includes Alaska. Illinois, Michigan, and Missouri excluded, 1944–46; Missouri excluded, 1947–53.
[2] Both crude ores and concentrates.

TABLE 13.—Silver produced at amalgamation and cyanidation mills in the United States in 1953, 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	69	-----	0.19	-----
Arizona	25	-----	(1)	-----
California	12,734	11,852	1.23	1.14
Colorado	8,715	9,692	.40	.44
Idaho	1,676	44	.01	(1)
Montana	38	-----	(1)	-----
Nevada	400	1,777	.06	.25
New Mexico	107	-----	.05	-----
Oregon	25	-----	.20	-----
South Dakota	74,608	63,434	53.81	45.75
Washington	2	42,739	(1)	13.31
Wyoming	-----	-----	-----	-----
Total	98,399	129,538	.26	.35
States east of the Mississippi	-----	-----	-----	-----
Grand total	98,399	129,538	.26	.34

[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.

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TABLE 14.—Silver refined in the United States, 1944–48 (average) and 1949–53, and approximate distribution by source (State), in 1953

[U. S. Bureau of the Mint]

State or Territory:	*Fine ounces*
1944–48 (average)	32, 726, 622
1949	34, 944, 554
1950	42, 308, 739
1951	39, 907, 257
1952	39, 840, 300
1953:	
Alaska	37, 000
Arizona	4, 370, 000
California	1, 050, 000
Colorado	2, 400, 000
Idaho	14, 500, 000
Illinois	2, 000
Missouri	200, 000
Montana	6, 600, 000
Nevada	730, 000
New Mexico	210, 000
New York	37, 300
Oregon	11, 000
Pennsylvania	7, 700
South Dakota	137, 000
Tennessee	62, 900
Texas	600
Utah	7, 000, 000
Vermont	44, 000
Washington	336, 000
Wyoming	(1)
Total	37, 735, 500

[1] Less than 1 fine ounce.

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 10 percent greater in 1953 than in the preceding year and was the largest since 1950. For over a decade, consumption of silver in the United States has exceeded any annual output ever achieved by domestic mines.

TABLE 15.—Silver produced in the United States, 1792–1953 [1]

Period	Fine ounces	Value [2]
1792–1847	309,500	$404,500
1848–73	146,218,600	193,631,500
1874–1953	4,038,141,730	3,060,205,414
Total	4,184,669,830	3,254,241,414

[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 1944 and thereafter at Government's average buying price for domestic product.

TABLE 16.—Net industrial [1] consumption of silver in the United States, 1944–48 (average) and 1949–53, in fine ounces

[U. S. Bureau of the Mint]

Year	Issued for industrial use	Returned from industrial use	Net industrial consumption
1944–48 (average)	148,029,914	40,592,114	107,437,800
1949	110,660,459	22,660,459	88,000,000
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

[1] Including the arts.

For many years the principal nonmonetary consumer of silver has been the silverware industry, mostly in the fabrication of sterling-silver tableware. Pure silver is too soft for most uses and is alloyed with 7.5 percent copper to form "sterling silver" of standard grade. Jewelry, insignia, and many novelties are also made of sterling silver.

Second in rank in the consumption of silver is the photographic industry, followed by the electroplating industry and the manufacture of silver-clad equipment for the chemical industry.

Of growing importance are 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 are widely used in joining pipes, making electrical connections, and forming mechanical assemblies. Silver alloyed with about 10 percent copper finds 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 are used for caustic, astringent, and antiseptic purposes in medicine. Silver has considerable use in dentistry as dental fillings and in surgery as suture wires and plates.

MONETARY STOCKS

Silver holdings of the United States Treasury decreased 12 million ounces in 1953 to 1,926 million ounces. These holdings do not include 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. Ratification of the Japanese Peace Treaty in April 1952 marked the start of the 5-year period during which lend-lease silver was to be returned to the United States Treasury, but no silver had been returned to the end of 1953.

Requirements of governments for silver for coinage fell from approximately 104,100,000 ounces in 1952 to 74,800,000 ounces in 1953. The United States used approximately 42,800,000 ounces of the total, Mexico 14,100,000, Cuba 5,200,000, Canada 3,900,000, Belgium 2,800,000, and others 6 million.

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 Cong.), 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+ cents per ounce; there has been no price change since.

The New York price of silver per troy ounce, 0.999 fine, opened in 1953 at $0.8325. Responding to brisk demand it reached $0.8525 in mid-January and remained at that figure for the balance of the year. The London price of silver per troy ounce, 0.999 fine, ranged in 1953 from 72 7/8 d. to 74 d., equivalent in United States currency to $0.8505 and $0.8636, respectively.

FOREIGN TRADE [3]

As has been the case since 1946, silver imports exceeded exports by a wide margin again in 1953. The excess of imports in 1953 was 39 percent greater than that of 1952, due mostly to substantially greater imports in 1953.

TABLE 17.—Value of silver imported into and exported from the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

	Imports	Exports	Excess of imports over exports [1]
1944–48 (average)	$49,450,835	$59,471,147	−$10,020,312
1949	73,535,694	23,281,043	50,254,651
1950	110,035,107	6,201,874	103,833,233
1951	103,468,510	8,590,185	94,878,325
1952	67,296,379	4,921,285	62,375,094
1953	95,103,962	8,426,910	86,677,052

[1] Excess of exports over imports indicated by minus sign.

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

TABLE 18.—Silver imported into the United States in 1953, by countries of origin

[U. S. Department of Commerce]

Country of origin	Ore and base bullion		Bullion, refined		United States coin (value)	Foreign coin (value)
	Troy ounces	Value	Troy ounces	Value		
Australia	1, 250, 163	$1, 064, 634				
Belgium-Luxembourg	707, 745	607, 728	123, 194	$104, 067		
Bolivia	4, 137, 034	3, 502, 470				
Brazil	5, 364	4, 592				
British West Africa, n. e. c	147	125				
Canada	8, 375, 002	7, 136, 194	12, 269, 692	10, 373, 933	$1, 574, 386	$5, 067
Chile	1, 143, 501	967, 928				
Colombia	14, 496	12, 368				
Cuba	167, 895	144, 590			1, 220, 100	22, 008, 000
Ecuador	76, 339	64, 358				
El Salvador	305, 101	256, 648				
France						450
Germany, West	11, 714	9, 945	192, 814	163, 806		
Guatemala	2, 159	1, 792				
Honduras	5, 516, 442	4, 692, 269	4, 366	3, 635	896, 313	
Iran	98	83				
Japan	665, 203	554, 527	1, 605, 078	1, 355, 041		
Lebanon	7, 218	6, 036				
Malta, Gozo, and Cyprus	13, 537	11, 913				
Mexico	6, 911, 876	5, 785, 980	19, 200, 840	16, 344, 337	39, 833	
Mozambique	7, 335	6, 372				
Netherlands	835, 663	710, 072	2, 212, 178	1, 881, 899		36
Nicaragua	443, 684	375, 763				
Nigeria	1, 043	880				
Northern Rhodesia	179, 794	154, 464				
Norway	790	673				
Panama	671	564				
Peru	5, 880, 501	4, 999, 361	7, 584, 670	6, 454, 656		176, 698
Philippines	349, 509	302, 270	2, 488	2, 115		745
Portugal	45, 109	38, 073				
Saudi Arabia	24, 118	20, 560				
Southern Rhodesia	5, 613	4, 880				
Surinam					700	
Switzerland			71, 650	60, 902		
Taiwan			19, 040	15, 993		
Turkey	63, 488	54, 111				
Union of South Africa	493, 934	421, 077				58
United Kingdom	39, 720	33, 757	438, 899	376, 237	8, 804	3, 364
Venezuela	3, 213	2, 724	100, 007	83, 006		
Total	37, 685, 219	31, 949, 781	43, 824, 916	37, 219, 627	3, 740, 136	22, 194, 418

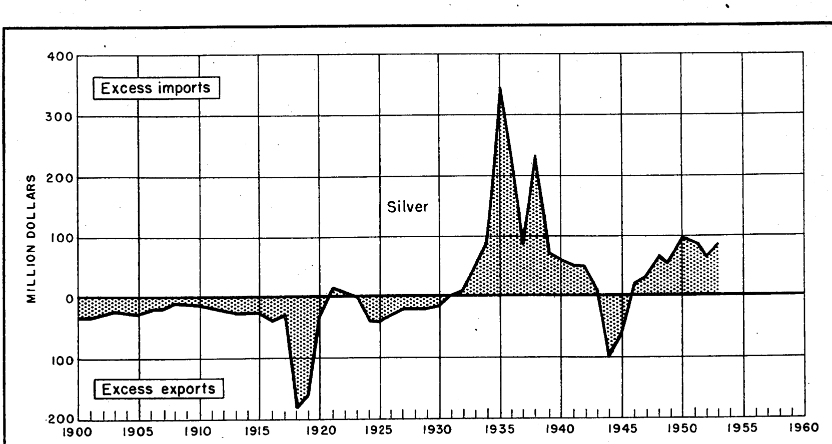

FIGURE 2.—Net imports or exports of silver, 1900–53.

TABLE 19.—Silver exported from the United States in 1953, by countries of destination

[U. S. Department of Commerce]

Country of destination	Bullion, refined		United States coin (value)	Foreign coin (value)
	Troy ounces	Value		
Bahamas			$9,000	
Brazil	38,536	$32,594		
Canada	273,567	229,280	17,900	$2,025,328
Canal Zone			12,000	
Colombia	139,163	119,426		
Cuba	12,100	10,711		5,150,000
Dominican Republic				75,000
El Salvador			150,000	
French West Indies			160	
Haiti			1,000	
Honduras				1,074
Liberia			110,000	
Netherlands	31,611	27,109		
Portugal	280	242		
Saudi Arabia			4,500	
Surinam	500	441		
Switzerland	2,485	2,142		
Union of South Africa	499,350	426,944		
United Kingdom	1,017	882		
Venezuela	24,164	21,177		
Total	1,022,773	870,948	304,560	7,251,402

WORLD REVIEW

The world production of silver in 1953 (216,400,000 ounces) was virtually the same as in the preceding year. Among the principal silver-producing countries, drops in output in the United States and Mexico were offset by gains in Canada, Peru, the Soviet Union, and Australia. The 1953 world output was about 20 percent below the average for the 5 prewar years 1936–40.

Silver probably was discovered later than gold or copper but was known and valued by mankind before the beginning of history. Ancient slag dumps in Asia Minor and on islands in the Aegean Sea attest that men had learned to mine and smelt lead-silver ores and separate silver from lead as early as the third millennium B. C. The most famous of the ancient silver districts was at Laurium, Greece, which was worked for several centuries in the first millennium B. C., with a total output estimated at over 250 million ounces. Silver was mined widely during the era of the Roman Empire, and most of the silver deposits now known in what was once the empire were known to the Romans. Silver mines were worked in some countries in Europe during the Middle Ages, but the output was relatively small.

An enormous increase in the world production rate of silver followed soon after America was discovered in 1492, when deposits of silver ores far larger and richer than those previously known in the Old World were opened by the early Conquistadors. Famous among the many bonanza silver districts found and developed in the 1500's are Potosí, Bolivia; Guanajuato, Mexico; and Pachuca, Mexico. Potosí, with a total production of over 1 billion ounces, was the greatest of all. Bolivia was the leading silver producer to 1700, and Mexico has held the lead during most years since that date. Canada became an important silver producer following discovery of the rich Cobalt district in Ontario in 1903.

Production of silver in the United States was small until the Comstock lode was discovered in Nevada in 1859. Development of this great deposit and a long series of others in the Western States subsequently placed the United States first in silver production from about 1871 to 1900. Since 1900 the United States has been second in silver output, exceeded by Mexico. Most of the predominantly 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 base metals or gold.

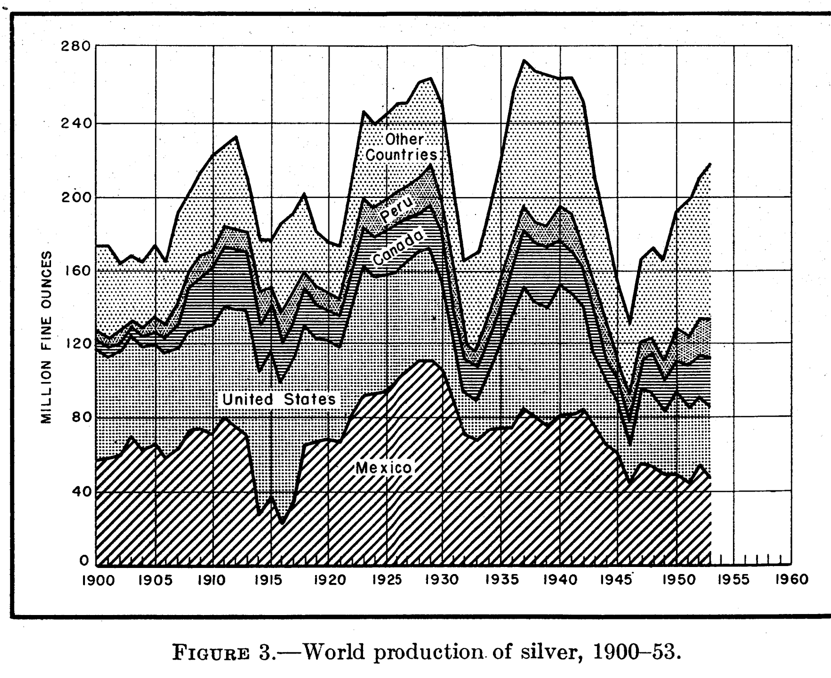

FIGURE 3.—World production of silver, 1900–53.

TABLE 20.—World production of silver, 1944–48 (average) and 1949–53, by countries [1], in fine ounces [2]

[Compiled by Pauline Roberts and Berenice B. Mitchell]

Country	1944–48 (average)	1949	1950	1951	1952	1953
North America:						
United States	32,723,180	34,944,554	42,308,739	39,907,257	39,840,300	37,735,500
Canada	14,406,266	17,641,493	23,221,431	23,125,825	25,222,227	28,330,251
Central America and West Indies:						
Costa Rica [3]	1,998	720	215	582	----------	----------
Cuba	121,910	[3] 157,411	[3] 221,779	[3] 172,318	[3] 163,211	[3] 167,895
Guatemala	----------	81,502	339,360	309,857	371,679	328,636
Honduras	2,877,205	3,431,614	3,514,556	3,182,254	3,703,975	4,783,969
Nicaragua	[4] 235,828	[3] 191,082	[3] 133,282	[3] 141,764	[3] 137,309	[3] 443,684
Panama	80	([5])	1,940	5,788	----------	----------
Salvador	[4] 264,851	280,309	462,973	352,102	368,448	353,169
Mexico	57,236,900	49,454,882	49,141,445	43,797,734	50,353,560	47,886,440
Total	107,868,000	106,184,000	119,346,000	110,996,000	120,161,000	120,030,000
South America:						
Argentina	[6] 2,236,460	1,249,421	1,150,000	1,253,879	962,948	895,474
Bolivia (exports)	6,675,227	6,655,204	6,558,751	7,137,465	7,073,163	6,140,792
Brazil	24,486	21,041	21,155	20,315	17,301	[6] 18,000
Chile	797,666	799,685	746,765	983,491	1,246,356	1,497,807
Colombia	147,507	106,590	115,711	129,773	123,175	117,385
Ecuador	247,800	264,300	273,200	33,600	82,297	86,600
Peru	12,247,246	10,609,648	13,367,700	14,959,129	18,386,141	19,290,445
Total	22,400,000	19,706,000	22,233,000	24,518,000	27,891,000	28,047,000
Europe:						
Austria	2,972	7,427	8,681	5,466	3,858	([5])
Czechoslovakia [6]	932,000	1,608,000	1,608,000	1,608,000	1,608,000	([5])
Finland	127,789	171,150	115,939	157,275	150,083	235,794
France	418,821	580,610	719,855	705,902	353,650	344,005
Germany:						
East [6]	[6] 2,684,200 (East and West)	3,215,000	3,215,000	3,536,600	3,536,600	([5])
West		1,601,782	1,637,116	1,819,957	1,877,700	2,314,435
Greece	([5])	----------	----------	64,300	72,403	61,665
Hungary [6]	[7] 135,900	32,200	48,200	48,200	64,300	([5])
Italy	265,925	793,545	850,998	809,234	838,041	832,383
Norway	189,689	170,399	167,184	163,969	147,893	128,603
Poland [6]	42,000	80,400	80,400	96,500	96,500	([5])
Portugal	8,552	31,958	68,288	65,459	77,740	59,447
Rumania [6]	308,500	482,300	578,700	643,000	643,000	([5])
Spain	584,455	514,283	823,831	735,908	553,128	472,000
Sweden	1,189,802	1,140,708	1,275,709	1,145,917	2,196,281	791,822
U. S. S. R.[6]	8,700,000	20,000,000	24,000,000	24,000,000	24,000,000	25,000,000
United Kingdom	24,985	13,996	18,153	26,777	30,734	([5])
Yugoslavia	[6] 780,800	1,917,792	2,386,839	3,032,008	2,577,043	3,048,019
Total [6]	16,600,000	32,000,000	38,000,000	39,000,000	39,000,000	39,000,000
Asia:						
Burma	[6] 110,000	[6] 250,000	1,800	280,720	242,307	579,239
China	([5])	160,000	320,000	320,000	[6] 400,000	([5])
India	12,699	11,275	15,676	14,612	17,675	16,864
Japan	3,391,620	2,887,265	3,964,572	4,609,924	5,288,707	6,022,091
Korea:						
North [6]	[6] 613,900 (North and Republic of)	([5])	([5])	([5])	([5])	([5])
Republic of		20,416	10,160	5,401	11,381	52,177
Philippines	45,302	218,419	216,034	274,602	693,751	572,046
Saudi Arabia	35,318	81,295	124,287	109,912	111,945	150,626
Taiwan (Formosa)	29,425	17,148	20,603	26,388	[6] 30,000	40,700
Total [6]	4,300,000	3,700,000	4,700,000	5,700,000	6,800,000	7,900,000

TABLE 20.—World production of silver, 1944–48 (average) and 1949–53, by countries,[1] in fine ounces [2]—Continued

Country	1944–48 (average)	1949	1950	1951	1952	1953
Africa:						
Algeria	31,489	32,472	31,765	9,600	(5)	(5)
Bechuanaland	1,116	27	39	70	281	463
Belgian Congo [8]	3,958,187	4,549,330	4,459,951	3,795,266	4,727,252	4,961,631
French Morocco	226,901	736,220	943,367	1,569,000	3,826,260	1,001,174
Gold Coast (exports)	46,963	40,051	43,317	52,542	44,116	44,949
Kenya	8,139	2,279	2,586	2,150	17,315	21,758
Mozambique	795	244	71	96	102	(5)
Nigeria	1,850	484	325	200	270	172
Rhodesia:						
Northern [9]	171,161	134,920	173,304	100,702	348,954	514,699
Southern	93,645	84,495	85,549	79,731	81,356	84,566
South-West Africa	[6] 142,700	642,500	843,737	1,030,066	1,064,335	795,702
Swaziland	115	120	60	18		
Tanganyika (exports)	21,079	27,631	31,014	35,697	35,900	41,580
Tunisia	39,912	67,517	73,947	61,119	61,086	39,095
Uganda (exports)	186	42	35	14	14	
Union of South Africa	1,196,499	1,159,375	1,119,135	1,162,588	1,176,433	1,193,152
Total	5,941,000	7,478,000	7,808,000	7,899,000	11,394,000	8,709,000
Oceania:						
Australia:						
Commonwealth	9,214,481	9,849,213	10,677,456	10,792,032	11,425,872	12,538,883
New Guinea [10]	13,432	31,786	30,399	33,603	51,275	[6] 50,000
Fiji	25,506	29,755	37,736	24,869	25,838	19,328
New Zealand	250,323	232,599	199,701	133,291	51,016	75,888
Total	9,503,800	10,143,000	10,945,000	10,984,000	11,554,000	12,684,000
World total (estimate)	166,600,000	179,200,000	203,000,000	199,100,000	216,800,000	216,400,000

[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 Gold and 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] Exports.
[5] Data not available; estimate included in total.
[6] Estimate.
[7] Data represents Trianon Hungary after October 1944.
[8] Includes Ruanda-Urundi.
[9] Recovered from an accumulation of refinery slimes.
[10] Year ended May 31 of year following that stated.

According to the Bureau of the Mint, the world output of silver from 1493 through 1953 was 19,821,763,100 troy ounces valued at $17,092,921,200. Of the total output, the New World produced 82 percent, with North America contributing 62 percent and South America 20. Mexico supplied 35, the United States 21, Bolivia 9, Peru 9, and Canada 4 percent of this total.

It has been estimated that about one-third of the total world output 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.—Production of silver in Australia in 1953 was 10 percent above that of the preceding year, thus continuing an uptrend that started in 1950. The increase in silver yield in the Commonwealth was related to an expanding output of base-metal ores containing silver.

Canada.—Canada ranks third in silver production in the world, exceeded by only Mexico and the United States. The silver output in 1953 rose sharply (12 percent) over that of 1952. Of the 1953 production, 87 percent was recovered as a byproduct of base-metal ores, 11 percent from cobalt-silver and silver ores, and 2 percent as a byproduct of gold mining. Over two-thirds of the 1953 output was exported to the United States, mostly as bullion and the remainder in concentrates.

Mexico.—Despite a 5-percent drop in silver production to 47,886,440 ounces, Mexico maintained its rank as the leading silver-producing country of the world in 1953. The decline reflected lower output of base-metal ores containing silver because of declining metal prices.

Peru.—Peru has held the position of the leading silver-producing country of South America for several decades. Compared with the output in 1952, there was a 5-percent gain in silver production in Peru in 1953. Most of Peru's silver yield is obtained as a byproduct or coproduct of complex ores mined principally for base metals.

Slag—Iron Blast-Furnace

By Oliver S. North [1]

HEAVY DEMAND for slag as a mineral aggregate resulted in the establishment of a new record tonnage processed by the iron-blast-furnace slag industry. Output was nearly 4 million tons higher than in 1952 and over 1 million tons higher than in 1951, the previous record year. The only category in which tonnage dropped was unscreened air-cooled slag. The other types showed percentage increases in tonnage as follows: Screened air-cooled, 14; granulated, 34; and expanded, 16.

Marked percentage increases were noted in the quantities of screened air-cooled slag used in bituminous construction, for railroad ballast, and as a sewage trickling filter medium; granulated slag in all of its applications except agricultural and liming; and expanded slag in the manufacture of lightweight concrete block.

Except for a few uses the average values of air-cooled screened, air-cooled unscreened, and expanded slag products were a few cents per ton higher in 1953 than in 1952. Wider variations were noted in granulated slag products where its unit value for use in concrete block, road fill, and miscellaneous applications was lower.

Because processed-slag stocks are relatively small and constant from year to year, production virtually equals sales, and therefore those terms are used interchangeably in this chapter.

TABLE 1.—Iron blast-furnace slag processed in the United States, 1944–48 (average) and 1949–53, 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					
1944–48 (av.)	14,171,915	$13,730,537	$0.97	566,408	$256,550	$0.45	1,022,560	$108,564	731,383	$1,313,643	$1.80
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

[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 1953 was estimated at 43 million short tons compared to an estimated 34,750,000 tons in 1952. The iron-blast-furnace slag industry utilized about 71 percent of the total blast-furnace slag produced in 1953 compared to 77 percent in 1952 and 75 percent in 1951.

According to reports of processors to the National Slag Association, the quantity of slag processed in the United States in 1953 for commercial use was 30,511,603 short tons valued at $40,067,294. These totals were 14 and 18 percent, respectively, above the preceding year's figures of 26,899,376 short tons valued at $33,874,209. The output in 1953 came from 45 companies operating 68 plants processing air-cooled slag, 16 plants processing granulated slag, and 20 plants expanding slag.

During 1953 iron blast-furnace slag was processed in the following States: Alabama, California, Colorado, Illinois, Indiana, Kentucky, Maryland, Michigan, Minnesota, New York, Ohio, Pennsylvania, Tennessee, Texas, and West Virginia. The majority of the plants were east of the Mississippi River.

As in 1952 and other recent years, the output of processed slag in Ohio was greater than in any other State. All States reported separately in table 2 processed approximately the same percentage of the national total as in 1952, indicating that the industry's increase was distributed evenly geographically. Alabama, Ohio, and Pennsylvania combined supplied 61 percent of the total tonnage reported for 1953 compared to 62 percent in 1952.

TABLE 2.—Iron blast-furnace slag processed in the United States, 1952–53, by States

[National Slag Association]

	Screened air-cooled			All types		
	Quantity		Value	Quantity		Value
	Short tons	Percent of total		Short tons	Percent of total	
1952						
Alabama	4,375,814	21	$4,911,511	5,314,333	20	$6,248,691
Ohio	5,037,045	24	7,155,350	5,985,416	22	8,643,132
Pennsylvania	3,786,269	18	5,677,735	5,510,624	20	7,002,658
Other States [1]	7,857,718	37	9,757,296	10,089,003	38	11,979,728
Total	21,056,846	100	27,501,892	26,899,376	100	33,874,209
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

[1] California, Colorado, Illinois, Indiana, Kentucky, Maryland, Michigan, Minnesota, New York, Tennessee, Texas, and West Virginia.

PREPARATION

Blast-furnace slag is processed for the market in three ways:

(1) By allowing molten slag to flow into pits adjacent to the furnace or by transporting it to a slag bank or modified pit and permitting it to cool and solidify under atmospheric conditions. This air-cooled slag is then processed in the same manner as are other mineral aggregates. Most of this type is crushed and screened to meet particle-size specifications, although some is crushed and used without screening. About four-fifths of all processed slag sold is the air-cooled screened type.

(2) By suddenly chilling the molten slag by immersing it in water. A granular, glassy product is formed, virtually all of which is utilized without screening.

(3) By expanding or "foaming" the slag. This is accomplished by applying a limited quantity of water to the molten slag. The quantity of water used is less than that required for granulation, forming a relatively dry, cellular lump product, which is crushed and screened.

A trade-journal article discussed slag-processing procedures, the geographic availability of processed slag, the extent to which slag produced in blast furnaces is commercialized, and the chemical composition of blast-furnace slag.[2]

TRANSPORTATION

As in past years, virtually the entire tonnage of processed slag in 1953 was moved by rail and truck, with waterway transportation again accounting for but 2 percent of the total. The quantity shipped by each method of transportation and the tonnage used locally by the producers are shown in table 3.

TABLE 3.—Shipments of iron blast-furnace slag in the United States, 1952–53, by method of transportation

[National Slag Association]

Method of transportation	1952		1953	
	Short tons	Percent of total	Short tons	Percent of total
Rail	11,839,427	45	13,742,136	45
Truck	14,023,030	53	16,229,800	53
Waterway	494,440	2	539,667	2
Total shipments	26,356,897	100	30,511,603	100
Interplant handling [1]	542,479			
Total processed	26,899,376		30,511,603	

[1] This tonnage is used by the processor locally in making such products as concrete block, asphaltic concrete, etc.

CONSUMPTION AND USES

Screened, air-cooled slag—the major type processed by the industry—constituted 79 percent of the total output of processed slag in 1953. The remaining 21 percent was divided among the other

[2] Hubbard, F., Production of Commercial Blast-Furnace Slag: Am. Concrete Inst. Jour., vol. 24, No. 8 April 1953, pp. 713–719.

types as follows: Unscreened air-cooled, 3 percent; granulated, 11 percent; and expanded, 7 percent.

Screened, Air-Cooled Slag.—Consumption of screened, air-cooled slag was about 3 million tons higher than in 1952. The 24,021,624 short tons of screened, air-cooled slag represented a slightly higher percentage of the total slag processed than in 1952 and about the same percentage as in the years immediately before 1952. The use of screened, air-cooled slag as aggregate in portland-cement concrete construction, bituminous construction, and highway and airport construction other than portland-cement and bituminous, and as railroad ballast consumed 21,349,845 short tons, or 89 percent of the total tonnage of screened, air-cooled slag. Major percentage increases in 1953 were noted in the quantities used for roofing (cover material and granules) and as sewage-trickling filter medium. Other important uses for the material were in the manufacture of concrete block, agricultural slag and liming, road fill (parking lots and driveways), concrete pipe, and manufacture of glass.

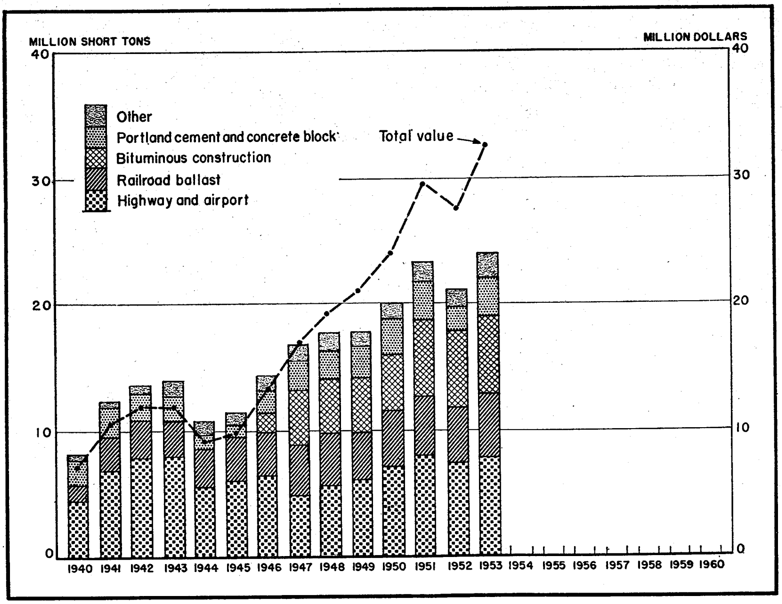

FIGURE 1.—Quantity of screened, air-cooled iron blast-furnace slag sold or used in the United States, 1940–53, by uses, and total value.

Unscreened, Air-Cooled Slag.—In 1953 the quantity of unscreened, air-cooled slag processed totaled 845,311 short tons valued at $581,083—decreases of 38 and 22 percent, respectively, from the 1952 figures. Over 63 percent of this material was used as aggregate in highway and airport construction.

Granulated Slag.—The consumption of granulated slag in 1953 amounted to 3,358,910 short tons—an increase of 34 percent over 1952. Of this quantity, 42 percent was used as a raw material in the manufacture of hydraulic cement, 39 percent as road fill, and the

TABLE 4.—Air-cooled iron blast-furnace slag sold or used by processors in the United States, 1952–53, by uses

[National Slag Association]

Use	Screened		Unscreened	
	Short tons	Value	Short tons	Value
1952				
Aggregate in:				
Portland-cement concrete construction	2, 192, 409	$2, 983, 031		
Bituminous construction (all types)	5, 010, 360	7, 114, 062		
Highway and airport construction [1]	7, 456, 701	10, 233, 228	528, 713	$340, 296
Manufacture of concrete block	743, 876	989, 577		
Railroad ballast	4, 343, 344	4, 248, 970	236, 519	82, 782
Mineral wool	560, 819	753, 272		
Roofing (cover material and granules)	328, 059	646, 492		
Sewage trickling filter medium	48, 168	81, 557		
Agricultural slag, liming	13, 572	19, 757		
Other uses	359, 538	431, 946	599, 231	326, 297
Total	21, 056, 846	27, 501, 892	1, 364, 463	749, 375
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

[1] Other than in portland-cement concrete and bituminous construction.

remainder for concrete-block manufacture, agricultural slag and liming, and miscellaneous applications. The quantity of granulated slag consumed in concrete-block manufacture was over three times as great as in the previous year.

TABLE 5.—Granulated and expanded iron blast-furnace slag sold or used by processors in the United States, 1952–53, by uses

[National Slag Association]

Use	Granulated		Expanded	
	Short tons	Value	Short tons	Value
1952				
Road fill, etc	1, 198, 137	$764, 851		
Agricultural slag, liming	72, 245	96, 564		
Manufacture of hydraulic cement	1, 077, 103	(1)		
Aggregate for concrete-block manufacture	90, 619	140, 420	1, 904, 519	$4, 409, 944
Aggregate in lightweight concrete			63, 498	166, 638
Other uses	69, 500	40, 000	2, 446	4, 525
Total	2, 507, 604	[2] 1, 041, 835	1, 970, 463	4, 581, 107
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

[1] Data not available.
[2] Excludes value of slag used for hydraulic cement manufacture.

Expanded Slag.—Expanded-slag production reached in 1953 a new record high of 2,285,758 short tons valued at $5,557,813—increases of 16 and 21 percent, respectively, over the 1952 figures. The bulk of this material was used in manufacturing lightweight concrete block, and a small percentage was employed as aggregate in lightweight concrete.

PRICES

Average values per ton for the various types of processed slag in 1953 are shown in table 6. Values for screened air-cooled slag ranged from $1.03 per short ton for railroad ballast to $2.02 for slag consumed in the roofing industry; all averages were a few cents higher than in 1952. Unscreened air-cooled-slag values ranged from 68 cents per short ton for aggregate in highway and airport construction to 75 cents for railroad ballast. Among the use classifications of granulated slag, the average value of agricultural slag increased a few cents, while road fill was slightly lower in average, and concrete-block aggregate dropped substantially. The values of expanded slag increased moderately in both of its major use classifications.

TABLE 6.—Average value per short ton of iron blast-furnace slag sold or used by processors in the United States, 1952–53, by uses

[National Slag Association]

Use	Air-cooled		Granulated	Expanded
	Screened	Unscreened		
1952				
Aggregate in:				
Portland-cement concrete construction	$1.36			[1] $2.62
Bituminous construction (all types)	1.42			
Highway and airport construction [2]	1.37	$0.64		
Manufacture of concrete block	1.33		$1.55	2.32
Railroad ballast	.98	.35		
Mineral wool	1.34			
Roofing (cover material and granules)	1.97			
Sewage trickling filter medium	1.69			
Agricultural slag, liming	1.46		1.34	
Road fill, etc			.64	
Other uses	1.20	.54	.58	1.85
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	.68		
Manufacture of concrete block	1.38		.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

[1] Lightweight concrete.
[2] Other than in portland-cement and bituminous construction.

RECOVERY OF IRON

The recovery of iron by slag processors during 1953 amounted to 353,833 short tons, an increase of 1 percent over the preceding year. Iron is recovered from slag either by magnetic methods or by hand picking; and the material is returned to the furnaces, where it becomes a useful contribution to the iron and steel industry.

The plant of a major producer of slag aggregate was described in an article. A feature of the plant is recovery, first by hand picking and then by using a magnetic separator, of iron nodules and "buttons." About 80,000 tons of iron per year are said to be recovered and returned to the steel mills from this plant.[3]

EMPLOYMENT

An average of 1,920 plant and yard personnel per active day worked 4,957,704 man-hours in producing processed slag during 1953. This compares with 4,957,740 man-hours and an average per active day of 1,975 plant and yard employees in 1952.

TECHNOLOGY

An abstract of a German article briefly described the production and usefulness of a slag-anhydrite cement that has shown high strength, low heat, and good resistance to acids and seawater. About 80 to 85 parts of high-alumina slag are mixed with 15 parts of anhydrite and a small quantity of portland-cement clinker.[4]

An article in a British publication describes in detail the production, use, and advantages of blast-furnace-slag cement in constructing two major dams in Scotland. The slag cement is made by the Trief process. Granulated slag is wet-ground in ball mills and fed into storage vats, where more water is added. Segregation is prevented by the use of large, rotating paddle agitators. The slurry is removed as needed and batched with stone, sand, a small quantity of portland cement, and enough water to achieve the optimum water-cement-slag ratio. Tests reportedly showed that the resulting concrete had the strength of a comparable mix made wholly with portland cement, with the additional advantage that less heat was produced during setting. The latter factor is particularly desirable in such mass-concrete structures as dams.[5]

Several of the lesser known uses for slag were mentioned. These include blending slag sand with natural sand in portland-cement concrete, using high-alumina slag sand in the manufacture of black opaque glass and amber glass, and selling bagged slag granules to be spread atop roof coatings.[6]

An article discussed factors involved in selecting and using expanded slag aggregate in the manufacture of lightweight concrete. Its author stressed the value of presoaking the slag, regardless of whether it is the light product derived from the Brosius or Caldwell machines or the darker material produced in pits. Other topics covered included the weight, color, and porosity of expanded slag aggregates, air entraining in slag concrete, grading and batching aggregate and port-

[3] Persons, H. C., Process 1,000 Tons of Slag Per Hour: Rock Products, vol. 56, No. 10, October 1953, pp. 117-118.
[4] Rock Products, Slag-Gypsum Cement: Vol. 56, No. 12, December 1953, p. 96.
[5] Engineering (London), Blast-Furnace Slag Cement Plant at Claunie Dam: Vol. 176, No. 4579, Oct. 30, 1953, p. 557.
[6] Steel, New Uses Reinforce Slag Markets: Vol. 133, No. 24, Dec. 14, 1953, p. 83.

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land cement, compacting the mix, and steam curing the product. The same subject was discussed by the same author at greater length in a series of short articles printed in a different publication.[8]

A slag-cement process patented in the United States specifies wet-grinding to extreme fineness of a high-iron slag, followed by drying. The inventor claims that in dry powder form the material can be stored indefinitely without marked loss of reactivity. Immediately before it is to be used as hydraulic cement, the powder is mixed with water and a catalyst.[9]

The various methods of producing expanded slag were discussed in detail. Descriptions included the operation of the Caldwell and Brosius machines, a semimachine method known as the cascade process, the pit process, and the Gallai-Hatchard and Potts batch processes. Numerous other processes were said to have been patented.[10]

Experiments were made to determine whether differences in crystal-glass ratio in blast-furnace slags affected the puzzolanic activity of cements. The investigators concluded that the greater the proportion of glass in commercial blast-furnace slag the greater is the tensile strength of the cement and that the thoroughly and rapidly quenched slags have the greatest puzzolanic activity. The slags containing the most glass were reported to have the fastest time of set, showing that the glass content markedly affects the pozzolanic qualities.[11]

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[7] DeWeerdt, H. E., Some Observations on Expanded Blast-Furnace Slag Concrete: Pit and Quarry, vol. 46, No. 6, December 1953, pp. 163–167.

[8] DeWeerdt, H. E., Short Talks on Lightweight Slag Concrete: Concrete, vol. 61, No. 7, July 1953, pp. 16 and 18; vol. 61, No. 8, August 1953, pp. 12 and 14; vol. 61, No. 11, November 1953, pp. 28–29; vol. 62, No. 1, January 1954, p. 30.

[9] Trief, V., Method for Producing Iron Cement in Powder Form: U. S. Patent 2,632,711, Mar. 24, 1953.

[10] Miller, R. W., Expanded Blast Furnace Slag for Use as Light Weight Concrete Aggregates: Blast Furnace and Steel Plant, vol. 41, No. 6, June 1953, pp. 635–638.

[11] Lied, R. C., Handwerk, J. H., and McVay, T. N., Puzzolanic Cements from Blast Furnace Slag: Rock Products, vol. 56, No. 12, December 1953, pp. 130, 136.

Slate

By Oliver Bowles [1] and Nan C. Jensen [2]

OVERALL sales of slate declined moderately from 1952, but the losses were mainly in the field of granules and flour. Total dimension-slate sales in 1953 increased 5 percent in quantity and 1 percent in value compared with 1952.

Roofing-slate sales, which had dropped relatively low in 1952, declined 2 percent more in both quantity and value. The average value per square increased from $21.06 to $21.12. Output in Pennsylvania and Vermont dropped. The Virginia output gained substantially, but was still below 1951.

The mill-stock branch of the industry gained 8 percent in both quantity and value. Structural and sanitary uses continued the upward trend in evidence in 1952, but electrical-slate sales were considerably lower. The largest gain in the principal uses was that for blackboards and bulletin boards. This item includes small quantities of school slates, which were made by so few producers that the figures cannot be shown separately. Among the smaller uses sales for vaults and covers increased nearly 50 percent, but slate sold for billiard-table tops decreased over 40 percent. Sales of flagstones and related products gained 10 percent in quantity but declined slightly in value.

Slate granules and flour are included in this chapter, although they have little connection with the dimension-slate industry. Small quantities of slate flour are made from waste that accumulates at slate quarries, but almost all of the crushed and ground products are obtained from separate quarries in rock that may be designated as slate but is unsuited for roofing or mill-stock manufacture. Granules are used chiefly for surfacing prepared roofing, and slate flour is used as a filler in such products as linoleum, paint, and roofing mastic. Sales of granules and flour declined 8 percent in quantity and 3 percent in value in 1953 compared with 1952. The value per ton was 60 cents higher. Figures for all types of granules, including slate, are given in a table in the chapter on Stone of this volume.

Sales of slate by uses in 1953 are listed in table 1, which also includes the percentage of change in each major item from the previous year.

DOMESTIC PRODUCTION

As indicated in table 1, total domestic production of slate declined 6 percent in quantity compared with 1952. Sixty-eight operators reported production during the year, 2 less than in 1952. Table 2 shows sales in 1952, by States and uses.

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

TABLE 1.—Salient statistics of the slate industry in the United States, 1952–53

Domestic production (sales by producers)	1952			1953			Percent of change in—	
	Quantity		Value	Quantity		Value	Quantity (unit as reported)	Value
	Unit of measurement	Approximate equivalent short tons		Unit of measurement	Approximate equivalent short tons			
Roofing slate	*Squares* 145,640	54,050	$3,067,513	*Squares* 142,292	53,470	$3,005,649	−2	−2
Mill stock:	*Sq. ft.*			*Sq. ft.*				
Electrical slate	311,710	2,250	519,619	274,205	1,990	504,698	−12	−3
Structural and sanitary slate	1,360,880	11,220	896,093	1,501,049	11,781	962,295	+10	+7
Grave vaults and covers	8,960	80	7,103	13,388	120	11,097	+49	+56
Blackboards and bulletin boards [1]	922,860	2,270	553,509	1,080,034	2,578	699,098	+17	+26
Billiard-table tops	121,250	900	73,571	71,851	526	43,316	−41	−41
Total mill stock	2,725,660	16,720	2,049,895	2,940,527	16,995	2,220,504	+8	+8
Flagstones, etc.[2]	12,274,890	75,480	1,469,396	13,493,948	82,438	1,458,651	+10	−1
Total slate as dimension stone		146,250	6,586,804		152,903	6,684,804	+5	+1
Granules and flour		593,390	6,119,847		545,686	5,953,661	−8	−3
Grand total		739,640	12,706,651		698,589	12,638,465	−6	−1

[1] A small quantity of school slates included with blackboards and bulletin boards.
[2] Includes slate used for walkways, stepping stones, and miscellaneous uses.

TABLE 2.—Slate sold by producers in the United States, 1944–48 (average) and 1949–53, by States and uses

	Operators	Roofing		Mill stock		Other uses (value)[1]	Total value
		Squares (100 square feet)	Value	Square feet	Value		
1944–48 (average)	62	145,284	$2,284,413	2,322,228	$1,107,094	$5,423,232	$8,814,739
1949	80	181,490	3,759,564	2,741,040	1,727,649	6,677,063	12,164,276
1950	94	197,570	4,098,842	3,180,600	2,130,430	8,818,209	15,047,481
1951	77	205,120	4,357,412	3,168,540	2,127,387	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							
Arkansas	1					315,858	315,858
California	2					(2)	(2)
Georgia	1					(2)	(2)
Maryland	1					(2)	(2)
New York	20	566	20,037			1,713,295	1,733,332
Pennsylvania	18	86,116	1,688,167	2,363,266	1,452,320	1,279,125	4,419,612
Vermont and Maine	20	33,920	709,847	577,261	768,184	2,922,408	4,400,439
Virginia	5	21,690	587,598			(2)	(2)
Undistributed						1,181,626	1,769,224
Total	68	142,292	3,005,649	2,940,527	2,220,504	7,412,312	12,638,465

[1] Flagging and similar products, granules, and flour.
[2] Included with "Undistributed" to avoid disclosure of individual company operations.

Electrical slate is the principal product of the Maine quarries, which are situated near Monson, Piscataquis County. Small quantities of flagging and slate flour were also produced. Only one company reported sales in 1953. Production was somewhat smaller than in 1952.

Twenty operators reported production in New York in 1953, the same as in 1952. The principal products were flagging, granules, and flour. A small quantity of roofing slate was sold. The value of output decreased 4 percent.

All types of slate products are made in Pennsylvania. Over 60 percent of the roofing-slate production originates in this State. Large quantities of other products, such as blackboards, stair treads, and baseboard, are also made. There were so few producers in Lehigh and York Counties that the figures cannot be shown separately. Therefore, in place of the county table previously published, table 3 presents data for Pennsylvania as a whole.

TABLE 3.—Slate sold by producers in Pennsylvania, 1944–48 (average) and 1949–53, by uses

Year	Operators	Roofing slate		Mill stock					
				Electrical		Structural and sanitary		Vaults and covers	
		Squares (100 square feet)	Value	Square feet	Value	Square feet	Value	Square feet	Value
1944–48 (average)	20	105,604	$1,510,838	75,344	$39,181	418,472	$221,127	171,138	$56,283
1949	26	112,870	2,124,573	3,480	3,894	645,060	463,980	15,200	12,472
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)

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		
1944–48 (average)	735,076	$288,117	247,242	$121,051	305,336	$9,267	$1,079,082	$3,324,946
1949	1,145,080	649,451	164,100	100,203	366,910	13,798	1,210,273	4,578,644
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

[1] To avoid disclosure of individual company operations, vaults and covers included with structural and sanitary.
[2] A small quantity of school slates included with blackboards and bulletin boards.

The Pennsylvania slate industry, which decreased greatly in 1952, declined 2 percent more in value of products sold in 1953 compared with 1952. Roofing-slate sales continued the downward trend, with a loss of 8 percent in quantity and 10 percent in value. Structural and sanitary slate production, on the other hand, has grown consistently since 1945. The 18-percent gain in quantity and 19-percent in value for 1953 over the preceding year is due partly to inclusion of figures for vaults and covers in this category; however, these items are relatively small. Blackboard- and bulletin-board sales gained 17 percent in quantity and 26 percent in value. Among the smaller uses, electrical-slate sales more than doubled but were still much lower than a few years ago. Billiard-table-top sales were 41 percent less in both quantity and value. As indicated in a footnote to table 3, vaults and covers were produced by so few operators that they could not be shown separately and were combined with figures for structural and sanitary slate.

The school-slate-producing industry, formerly important in the Slatington district of Pennsylvania, has almost disappeared. At the same time imports of school slates, as indicated in a later section of this chapter on Foreign Trade, have increased greatly. The most pronounced decline in domestic school-slate production coincided with the 50-percent decrease in import duty, effective in 1951.

Slate products other than those included in the preceding categories dropped 8 percent in value.

Maine has been included with Vermont in table 2 to avoid revealing the output of a single company. Slate production in these areas decreased 1 percent in value compared with 1952. Sales of roofing slate were 4 percent lower in both quantity and value, and mill stock declined 11 percent in quantity and 7 percent in value. Sales of other products, chiefly flagging, granules, and flour, increased 1 percent. The number of operators decreased from 22 to 20. Purple, green, mottled, and other types of so-called "colored" slates are produced in the Vermont area.

Roofing slate is the principal product of the Virginia quarries, which are situated in Buckingham County. In 1953 the industry recovered from the serious recession of the preceding year. Sales increased 30 percent in quantity and 34 percent in value. Granules are produced in substantial quantities in Virginia, but the output is concealed to avoid revealing the production of individual companies.

Granules and flour were produced in Montgomery County, Ark.; near Fairmount, Bartow County, Ga.; and in El Dorado County, Calif. The last county also produces slate flagging. Granules but no flour were produced near Whiteford, Harford County, Md.

SALES

Dimension Slate.—"Dimension slate" is a term applied to such products as roofing and mill stock that are cut to specified sizes and shapes. Table 4 shows sales of these products during recent years.

TABLE 4.—Dimension slate sold by producers in the United States, 1944–48 (average) and 1949–53

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
1944–48 (av.)	145,284	54,734	$2,284,413	12,322	$1,107,094	28,924	$419,707	95,980	$3,811,214
1949	181,490	68,260	3,759,564	12,730	1,727,649	51,000	912,503	131,990	6,399,716
1950	197,570	74,060	4,098,842	15,140	2,130,430	79,440	1,342,053	168,640	7,571,325
1951	205,120	77,500	4,357,412	16,890	2,127,387	76,760	1,522,911	171,150	8,007,710
1952	145,640	54,050	3,067,513	16,720	2,049,895	75,480	1,469,396	146,250	6,586,804
1953	142,292	53,470	3,005,649	16,995	2,220,504	82,438	1,458,651	152,903	6,684,804

[1] Includes flagstones, walkways, stepping stones, and miscellaneous slate.

The chief market for roofing slate is in residential building. In figure 1 the number of new dwelling units recorded for each year since 1935 has been plotted for comparison with the number of squares of roofing slate sold. The comparatively high level of roofing-slate sales before 1942 contrasts strikingly with that in later years. Figure 1 shows graphically that since 1948 roofing-slate sales have fallen far below the level of new dwelling unit construction. Products such as asbestos-cement shingles, asphalt composition, and metal roofing evidently have been replacing slate to a greater degree than in earlier years.

Mill-stock slate is used for blackboards in schools and colleges and for steps, baseboards, and other units in various nonresidential structures. Figure 1 is designed to compare mill-stock sales with the volume of those types of nonresidential building in which slate is commonly used, namely, public and private construction, comprising industrial, educational, hospital, and institutional buildings, stores, offices, and related structures. Figure 1 shows a reasonable parallelism between mill-stock sales and nonresidential construction until about 1950, except for the peak building year 1942. That abnormal condition was due to widespread, publicly financed, war-period, industrial construction of types that used little or no slate. Since 1950 sales of mill-stock slate have not paced the strong upward trend of nonresidential building of the types recorded in figure 1. As with roofing slate, the market is shared with diverse substitute materials,

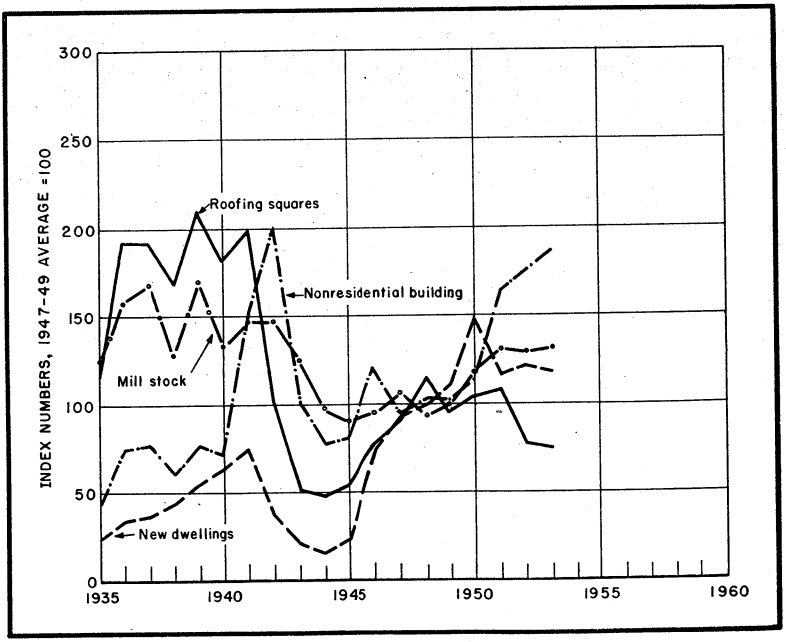

FIGURE 1.—Sales of roofing slate and mill stock compared with number of new dwelling units and value of certain new nonresidential construction, adjusted to 1947–49 prices, 1935–53. Data on number of new dwelling units in nonfarm areas from U. S. Department of Labor; data on nonresidential construction from U. S. Department of Commerce and U. S. Department of Labor.

including marble, soapstone, glass, metals, and various synthetic products. Slate evidently is losing ground in this competitive field.

Figure 2 shows the value of slate sold from 1920 to 1953, by principal uses. The peaks on the chart correspond with periods of active construction. The first trough corresponds with the industrial depression of the early 1930's and the second trough with World War II. Some industries are stimulated by military preparedness, but slate is used in limited quantities in defense activities.

Granules and Flour.—Sales of granules declined 12 percent in quantity and 5 percent in value in 1953 compared with 1952. The average value per ton increased from $11.93 to $12.90. Sales of slate flour increased 6 percent in quantity and 16 percent in value. The average sales price per ton in 1953 was $5.66, 50 cents higher than in 1952. Granules and flour were produced in Arkansas, California, Georgia, New York, Pennsylvania, and Vermont. Granules but no flour were sold in Maryland and Virginia. A small quantity of slate flour was sold in Maine. Sales of these products during recent years are shown in table 5.

TABLE 5.—Crushed slate (granules and flour) sold by producers in the United States, 1944–48 (average) and 1949–53

Year	Granules		Flour		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1944–48 (average)	458, 150	$4, 445, 928	138, 852	$557, 597	597, 002	$5, 003, 525
1949	463, 290	5, 136, 992	144, 980	627, 568	608, 270	5, 764, 560
1950	595, 200	6, 747, 325	166, 530	728, 831	761, 730	7, 476, 156
1951	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

The average value of mill stock was 76 cents per square foot, 1 cent higher than in 1952. The strong upward trend in electrical-slate prices continued, with an increase of 17 cents per square foot to $1.84. Blackboards and bulletin boards increased 5 cents (to $0.65); structural and sanitary slate declined 2 cents (to $0.64); vaults and covers increased 4 cents (to $0.83); and billiard-table tops declined 1 cent (to $0.60). The selling price of granules and flour advanced substantially, granules increasing 97 cents per ton (to $12.90), and flour 50 cents (to $5.66).

Price History.—The average selling price of roofing slate and mill stock compared with wholesale prices of all building materials over a period of 24 years is shown graphically in figure 3. Since 1950 roofing-slate prices have held lower than the average of all building materials, but mill-stock prices are relatively higher than that average.

PRICES

According to reports of operators to the Bureau of Mines, the value of roofing slate f. o. b. quarry or mill increased 6 cents per square to $21.12 in 1953. In Pennsylvania it was $19.60 per square, in New York $35.40, in Vermont and Maine $20.93, and in Virginia $27.09.

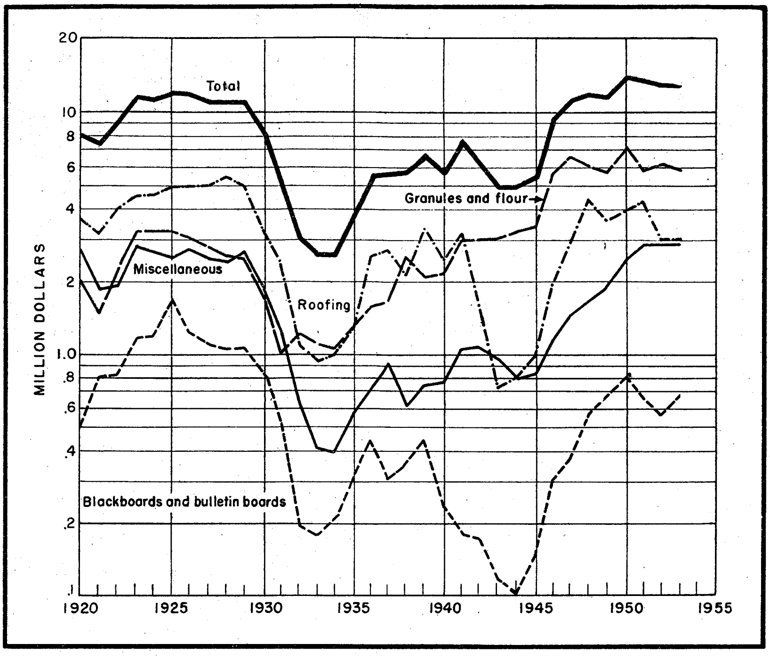

FIGURE 2.—Value of slate sold in the United States, 1920–53, by principal uses.

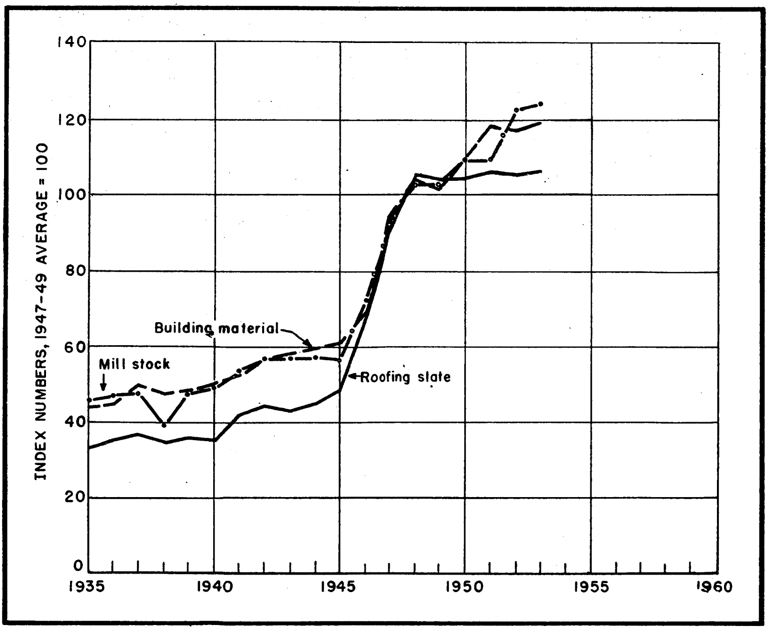

FIGURE 3.—Average selling price of slate compared with wholesale prices of building materials in general, 1935–53. Wholesale prices from U. S. Department of Labor.

FOREIGN TRADE[3]

Imports.—The value of slate imports was 5 percent lower in 1953 than in 1952; the chief drop was in shipments from Portugal. Imports from West Germany increased 33 percent. Imports consisted almost entirely of framed and unframed school slates. Those from Portugal were chiefly unframed. Most of the imports from West Germany consisted of 8- by 12-inch framed slates. School-slate production in the United States has declined greatly; domestic needs are evidently being supplied largely from foreign sources.

Exports.—The value of slate exports, as reported to the Bureau of Mines by shippers, is indicated in table 7. The downward trend that has characterized recent years continued in 1953, when the value of exports was 4 percent lower than in 1952. The progressive decline in exports of school slates is noteworthy.

TABLE 6.—Slate imported for consumption in the United States, 1944–48 (average) and 1949–53, by countries

[U. S. Department of Commerce]

Country	1944–48 (average)	1949	1950	1951	1952	1953
Australia				$70		
Brazil					$1,201	
Canada	$187	$1,125		10,257	4,117	$2,790
China	21	9	$123			
Germany			1	8,241	[2] 26,623	[2] 35,299
Italy	3,471	17,589	66,548	187,702	121,366	127,076
Japan	18	51	288	295	98	96
Mexico	[1] 59					
Netherlands					219	
Norway	2		967			
Portugal	153	1,549	27,320	45,561	79,743	57,481
Spain	85				846	
Switzerland	6	406	328	64	63	
United Kingdom	12	24	2,172	12	1,993	1,403
Total	4,014	20,753	97,747	252,202	236,269	224,145

[1] Revised figure.
[2] West Germany.

TABLE 7.—Slate exported from the United States, 1944–48 (average) and 1949–53, by uses[1]

Use	1944–48 (average)	1949	1950	1951	1952	1953
Roofing	$6,838	$9,503	$19,824	$4,138	$15,110	$9,132
School slates[2]	21,348	16,601	8,138	3,891	2,355	1,796
Electrical	3,760	10,151	14,635	13,819	10,041	23,225
Blackboards	37,678	65,052	107,466	51,056	62,992	89,346
Billiard tables	77,339	79,687	47,000	88,669	85,657	65,129
Structural (including floors and walkways); Slate granules and flour	337,016	414,029	417,148	294,007	201,748	175,770
Total	483,979	595,023	614,211	455,580	377,903	364,398

[1] Figures collected by the Bureau of Mines from shippers of products named.
[2] Includes slate used for pencils and educational toys.

[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.

TECHNOLOGY

A brief review of the North Wales and Cornwall slate industries has recently appeared.[4] It is pointed out that the Delabole slate quarries of Cornwall have been worked for production of roofing slate for over 400 years and that the main quarry is now about 1 mile wide and 500 feet deep. Channeling machines are used for making primary cuts in the quarries. Wire saws formerly used for subdividing slate blocks in the mills have been replaced to some extent by diamond-tooth reciprocating or circular saws; the latter equipment is said to be highly efficient. A 5-foot saw requires only a 20-horsepower motor and cuts at a rate of 62 square feet of medium-hard slate per hour. Electrical slate for British use comes chiefly from Norway, Spain, and Portugal. The dielectric strength of slate depends largely upon the absence of conducting minerals; but, according to this author, its moisture content is a very important factor. Thorough drying greatly increases its electrical resistance. Waste slate is said to be used in Europe for making a mineral wool.

Some degree of success has been attained in making brick and tile from waste slate at the Welsh quarries.[5]

A Welsh slate roof evidently requires no major repairs until it is nearly a century old. A Caernarvon firm has recently received an order for 3,000 roofing slates, 24 by 12 inches in size, to repair the roof of Government House, Hobart, Tasmania. This structure, built in 1857, was roofed with slate from the same quarry that is now furnishing the material for repairs.

The qualities of Vermont slate and methods of applying it on roofs are discussed in a recent article.[6]

The color effects obtained by using various types of roofing slates have been described.[7]

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[4] Williams, A. E., Slate: Mining Mag. (London), vol. 89, No. 6, December 1953, pp. 342–344.
[5] Quarry Managers' Journal (London), Bricks From Waste Slate: Vol. 37, No. 2, August 1953, p. 87.
[6] Hicks, R. B., Slate Roofing Shingles, What They Are Made of; How They Are Applied: Am. Roofer, vol. 43, No. 6, June 1953, pp. 12–14.
[7] American Roofer, Slate Roofing Shingles Are Used Naturally Colored as Quarried: Vol. 44, No. 6, June 1954, pp. 21, 32.

Sodium and Sodium Compounds

By Joseph C. Arundale[1] and Flora B. Mentch[2]

THE PRODUCTION of sodium compounds is one of the oldest chemical industries, and these compounds now are one of the most widely used groups of chemical commodities. It is fortunate that the reserves of sodium compounds or the raw material for their manufacture is inexhaustible. In 1953 ample supplies for all requirements were available.

DOMESTIC PRODUCTION

Sodium carbonate (soda ash) and sodium sulfate (salt cake) are recovered as naturally occurring minerals and also are manufactured. In 1953 soda ash was recovered from the brines of Searles and Owens Lakes in California and from a bedded deposit in Wyoming.

Production of natural soda ash in 1953 reached a record high of 419,206 short tons. Production of manufactured soda ash by the ammonia-soda process was only slightly less than in the record year 1951.

TABLE 1.—Manufactured sodium carbonate produced [1] and natural sodium carbonates sold or used by producers in the United States, 1944–48 (average) and 1949–53

Year	Manufactured soda ash (ammonia-soda process) [2]	Natural sodium carbonates [3]	
	Short tons	Short tons	Value
1944–48 (average)	4,459,553	[4] 235,263	[4] $4,363,181
1949	3,916,016	[4] 200,496	[4] 4,163,714
1950	3,991,199	351,075	7,543,769
1951	5,093,927	350,688	8,368,037
1952	4,442,450	323,479	7,828,033
1953	4,879,408	419,206	10,627,460

[1] U. S. Bureau of the Census.
[2] In 1953 reported as total crude bicarbonate. Before January 1953 reported as total wet and dry (98–100 percent Na_2CO_3). Includes quantities consumed in the manufacture of finished light and finished dense soda ash, caustic soda as well as quantities consumed in the manufacture of refined sodium bicarbonate.
[3] Soda ash and trona (sesquicarbonate).
[4] Excludes Wyoming in 1948–49.

Production of natural soda ash was reported by the following producers in California: American Potash & Chemical Corp., 3030 West Sixth St., Los Angeles 54, plant at Trona on Searles Lake; Columbia-

[1] Assistant chief, Construction and Chemical Materials Branch.
[2] Statistical assistant.

Southern Chemical Corp., a subsidiary of Pittsburgh Plate Glass Co., Bartlett; and West End Chemical Co., 608 Latham Square Bldg., Oakland 12, plant at Westend on Searles Lake.

In Wyoming, trona (natural sodium carbonate) and refined soda ash were produced near Green River by Intermountain Chemical Corp., a subsidiary of Food Machinery & Chemical Corp., Chrysler Bldg., 161 East 42d St., New York, N. Y.

The occurrence of sodium carbonate brines in Wyoming has been known for many years. A history and description of the deposits was published.[3]

Crude trona has been mined from bedded deposits in Wyoming for the past several years.[4] Early in 1953 Intermountain Chemical Corp. began operating a plant to produce refined soda ash from these trona deposits. The mine development work and plant construction were reported to have cost about 20 million dollars. Capacity is said to be about 700,000 tons of crude ore mined, from which about 300,000 tons of refined soda ash could be produced annually. The ore body averages about 10 feet in thickness and lies about 1,500 feet deep. It is reached by 2 circular shafts, 12 and 14 feet in diameter. Underground mining methods are similar to those in coal mining. Roof bolting is used for support. Mine-run ore is crushed underground to minus-3-inch. At the surface a portion of the screened ore is calcined to a crude soda ash; the remainder is crushed in a hammermill. This latter material is dissolved while being agitated and heated. It is then pumped to clarifiers, where the waste is allowed to settle. The clarified effluent containing the soda is filtered in leaf-type filters. Sodium sesquicarbonate is then crystallized from the filtered liquor in triple-effect vacuum crystallizers, and the crystals are allowed to settle out. These crystals are then calcined to light soda ash in steam-tube rotary calciners. A part of this light ash is converted to dense ash in a rotary mixer similar to a large concrete mixer and dried in a rotary steam-tube dryer.

It was reported that Solvay Process Division, Allied Chemical & Dye Corp., had completed its 2-year rebuilding program at the Baton Rouge, La., plant, thereby increasing capacity for manufacturing soda ash by one third, and, by modernization of its plant at Syracuse, N. Y., had increased capacity there by about 10 percent. It also was reported that Mathieson Chemical Corp. had completed a 50,000-ton-per-year plant at Saltville, Va., to produce a manufactured coarse light ash.[5]

Production of crude salt cake (natural and manufactured) in 1953 reached an alltime high of 734,024 short tons, but natural alone did not quite reach the peak of 1948. Strikes were reported to have restricted some production of byproduct Glauber's salt and sodium sulfate. The following firms and individuals reported production of natural[6] sodium sulfates: American Potash & Chemical Corp., 3030 West Sixth St., Los Angeles 54, Calif., plant at Trona; Ozark-Mahoning

[3] Lindeman, H. B., Sodium Carbonate Brine and Trona Deposits in Sweetwater County, Wyo.: Geol. Survey Circ. 235, 1954, 10 pp.

[4] Romano, C. A., Chemical Treatment of Ores: Pres. at meeting of Colorado Min. Assoc., Denver, Colo. Jan. 30, 1954.
Chemical Engineering, Trona—Soda Ash: Vol. 60, No. 5, May 1953, pp. 118–120.

[5] Chemical Engineering, vol. 61, No. 3, March 1954, p. 208.

[6] Oil, Paint and Drug Reporter, vol. 165, No. 5, sec. II, Feb. 1, 1954, p. 37.

Co., Box 449, Tulsa, Okla., plant at Monahans, Tex.; Wm. E. Pratt, Box 738, Casper, Wyo.; and Iowa Soda Products Co., Box 476, Council Bluffs, Iowa, plant at Rawlins, Wyo.

TABLE 2.—Sodium sulfate produced and sold or used, by producers in the United States, 1944–48 (average) and 1949–53

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
1944–48 (average)	599,554	197,233	117,579	213,811	$2,475,252
1949	537,843	156,634	136,276	186,223	2,733,853
1950	561,395	185,626	184,254	186,537	2,199,336
1951	707,388	219,942	233,666	(3)	(3)
1952	662,373	177,929	202,813	236,825	3,217,000
1953	734,024	204,159	219,937	248,230	3,340,760

[1] U. S. Bureau of the Census.
[2] Includes Glauber's salt converted to 100-percent Na_2SO_4 basis.
[3] Figures withheld to avoid disclosure of individual company operations.

Sodium sulfate occurs naturally as the minerals thenardite (Na_2SO_4), mirabilite (Glauber's salt, $Na_2SO_4.10H_2O$), and glauberite ($Na_2SO_4.CaSO_4$) and in solution in saline waters. Manufactured sodium sulfate is produced as a coproduct of hydrochloric acid by the reaction of salt (NaCl) and sulfuric acid in Mannheim furnaces. It is recovered as a byproduct in the manufacture of rayon, phenol, boric acid, lithium carbonate, bichromates, cellophane, and formic acid.

Sodium sulfate enters the market as crude salt cake, Glauber's salt, and anhydrous sodium sulfate.

According to the Bureau of the Census, United States Department of Commerce, 120,981 short tons of sodium metal was produced in the United States in 1953 compared with 123,187 short tons in 1952. Domestic capacity for production of sodium metal has been increased greatly in the past few years. Most of the present sodium-metal production is by the electrolysis of purified salt (NaCl) and calcium chloride in Downs cells. There are 3 domestic producers, operating 4 plants: National Distillers Chemical Co., Ashtabula, Ohio; E. I. du Pont de Nemours & Co., Inc., Niagara Falls, N. Y.; and Ethyl Corp. at Baton Rouge, La., and Houston, Tex.

CONSUMPTION AND USES

Sodium compounds are one of the most widely used groups of chemical commodities. They enter directly or indirectly into a multitude of products and services.

Estimated consumption of soda ash in 1953 was greater for nearly all major categories of uses except soap. Increased use in synthetic detergents compensated for the decrease in soap, as shown in table 3.[7]

[7] Chemical Engineering, vol. 61, No. 3, March 1954, p. 208.

TABLE 3.—Estimated consumption of sodium carbonate in the United States, 1944–48 (average) and 1949–53, by industries, in thousand short tons

[Chemical Engineering]

Industry	1944–48 (average)	1949	1950	1951	1952	1953
Glass	1,364	1,190	1,225	1,640	1,410	1,590
Caustic and bicarbonate	1,109	875	700	994	766	790
Nonferrous metals	212	210	245	333	320	430
Pulp and paper	205	200	200	320	305	330
Soap	139	125	105	120	115	101
Cleansers [1]	120	130	110	142	135	160
Water softeners	102	110	100	105	95	120
Textiles	69	55	65	56	39	40
Exports	106	76	50	152	106	160
Petroleum refining	22	24	24	29	31	33
Other chemicals	991	950	1,050	1,253	1,180	1,350
Miscellaneous	248	175	151	296	262	226
Total	4,687	4,120	4,025	5,440	4,764	5,330

[1] Includes modified sodas.

TABLE 4.—Consumption of soda ash in "other chemicals", 1952 and 1953, in thousand short tons

[Chemical Engineering]

	1952	1953		1952	1953
Calcium carbonate	180	190	Sodium phosphate- tripoly—Con.		
Sodium chromates	90	110	Other [1]	32	34
Sodium hydrosulfite	12	13	Sodium silicate	210	230
Sodium nitrate	160	170	Sodium sulfite	40	45
Sodium phosphate, tripoly	280	350	Sodium thiosulfate	14	15
Dibasic	60	70	Unaccounted-for	47	58
Tetra	55	65	Total	1,180	1,350

[1] Tribasic sodium phosphate consumes approximately 47 percent; monobasic, 27 percent; meta, 9 percent; acid pyro, 17 percent.

The glass-container industry produced by far the largest number of containers in any year of record, increasing consumption of soda ash for this purpose substantially. The increased soda-ash consumption in nonferrous metals production was largely for aluminum.

About three-fourths of the salt cake consumed goes into the manufacture of kraft pulp. The next greatest tonnages are used in glass and synthetic detergents. In all these industries production rose in 1953, resulting in greater consumption of salt cake.

One of the first important uses for sodium was in the reduction of metal salts to their metals. Aluminum metal at one time was made by reduction of aluminum chloride to aluminum. This method was superseded by the electrolytic process; but sodium has other metallurgical applications, such as in refining and purification of aluminum and lead, preparation of sodium-zinc and sodium-lead alloys, and use as bearing metal and as deoxidizers. The largest single use for sodium is in the production of tetraethyl lead. This process involves the reaction of ethyl chloride and a sodium-lead alloy. Another important use is in the reduction of fatty acid esters to the alcohols, which in turn are used in manufacturing synthetic detergents. Sodium also has applications in the production of dyes, amines, sodium amide, sodium peroxide, sodium hydride, and various drugs.

Intensified research and market-development programs have evolved many new and potential uses that have inspired considerable optimism as to future growth of the sodium industry.

The consumption of sodium in the United States in 1953 was estimated by Chemical Week at 250 million pounds,[8] of which 137 million pounds went into the manufacture of tetraethyl lead and 113 million into other chemical uses, as follows:

	Million pounds
Ester reduction	50
Sodium cyanide	45
Sodium peroxide	10
Alcoholates (pharmaceuticals etc.)	3
Hydride descaling	2
Miscellaneous	3

PRICES

Prices of some sodium compounds were advanced during the year, reportedly to compensate for producers' accumulated increases in costs of freight, labor, and materials.

According to Oil, Paint and Drug Reporter soda ash was quoted at \$1.60 per 100 pounds of dense ash, 58 percent, paper bags, Carlots, works, January through April, and \$1.75 per 100 pounds, May to the end of the year; bulk dense ash, same basis, was quoted at \$1.30 and \$1.45 in the same periods. Light ash, 58 percent, same basis, was quoted at \$1.50 per 100 pounds through April and \$1.65 from May to the end of the year. Bulk salt cake, works, 100 percent Na_2SO_4 basis, was quoted at \$17 per ton through May and \$19 per ton from June to the end of the year. Glauber's salt, anhydrous, crystalline, bags, carlots, works, freight allowed, was quoted at \$45 per ton throughout the year.

According to E&MJ Metal and Mineral Markets, the price of sodium metal, carlots, drums, was 16½ cents per pound throughout the year; less than carlots, 17 cents per pound.

FOREIGN TRADE[9]

The bulk of sodium sulfate imports came from Canada, Belgium, and West Germany. There were small shipments of soda ash from Canada, United Kingdom, and France.

TABLE 5.—Sodium sulfate imported for consumption in the United States 1944–48 (average) and 1949–53

[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
1944–48 (average)	30,563	\$428,244	18	\$352			30,581	\$428,596
1949	21,090	294,367	53	1,152	245	\$4,953	21,388	300,472
1950	61,612	737,118			5,565	107,330	67,177	844,448
1951	77,559	940,202			3,904	101,139	81,463	1,041,341
1952	50,822	803,054			5,105	141,254	55,927	944,308
1953	53,468	875,599			7,730	206,645	61,198	1,082,244

[8] Chemical Week, vol. 73, No. 20, Nov. 14, 1953, pp. 77-78.

[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 6.—Sodium carbonate and sodium sulfate exported from the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Year	Sodium carbonate		Sodium sulfate	
	Short tons	Value	Short tons	Value
1944–48 (average)	106,185	$4,961,765	(1)	(1)
1949	75,585	2,817,635	14,440	$500,000
1950	63,497	2,173,428	16,834	422,263
1951	155,146	6,903,150	25,634	797,360
1952	105,933	4,031,110	27,909	781,582
1953	165,405	5,819,304	28,192	804,887

1 Not separately classified before 1949.

TECHNOLOGY

A patent was granted on a method of recovering sodium sesquicarbonate from a brine.[10] The method comprises reacting the brine with sodium bicarbonate to precipitate sodium sesquicarbonate until a certain alkalinity is reached, then separating the precipitate of sodium sesquicarbonate from the mother liquor. The mother liquor is treated with carbon dioxide to precipitate sodium bicarbonate, and this material is used to react with a further quantity of brine to precipitate additional sodium sesquicarbonate.

A patent was granted on a method for producing sodium sesquicarbonate from crude trona.[11] The method involves dissolving the trona in a recirculating solution of sodium carbonate and sodium bicarbonate (containing a greater concentration of the normal carbonate than of the bicarbonate) at a temperature not substantially less than the boiling point of the recirculating solution. Sodium sesquicarbonate is crystallized and separated by cooling. The ratio of concentrations of sodium carbonate and sodium bicarbonate in the recirculating solution is kept substantially constant.

The process employed by Ozark-Mahoning Co. at Monahans, Tex., for recovering anhydrous sodium sulfate was described.[12] At this operation brine containing 7 to 8 percent sodium sulfate is found at a depth of about 60 feet and is utilized, with a limited supply of stronger brine, containing about 11 percent sodium sulfate, found at a depth of about 90 feet. Other constituents of the brine are sodium chloride and magnesium sulfate. The sodium sulfate is recovered by chilling the brine to about 15 to 20° F. Glauber's salt, because of its steeper solubility curve, is selectively crystallized from the brine.

The Glauber's salt is melted, and the water of crystallization is removed in gas-burning, submerged, combustion evaporators. The wet salt removed from the evaporators is dried in a rotary kiln to produce the anhydrous material. Recent tests at this plant are said to have demonstrated that, with special vaporizing equipment, high-grade fuel oils can be utilized in submerged combustion burners.

10 Byrns, Alva C. (assigned to Kaiser Aluminum & Chemical Corp.), Production of Sodium Sesquicarbonate From a Brine Containing a Substantial Sodium Carbonate Content: U. S. Patent 2,626,852, Jan. 27, 1953.

11 Pike, Robert D., Production of Sodium Sesquicarbonate From Crude Trona: U. S. Patent 2,639,217, May 19, 1953.

12 Chemical Engineering, vol. 60, No. 8, August 1953, pp. 242–245.

The operation of this plant was described in considerable detail in a second article.[13]

One domestic firm has announced development of a new, coarse, light soda ash with the necessary physical properties for use in glass-making.[14] The firm revealed that the new ash was prepared in equipment such as had been used by the milling industry for many years to sift flour. Heretofore glass plants ordinarily employed the dense ash because of materials-handling and furnace-life problems involved in using light ash.

A patent was granted on a process for recovering sodium carbonate from trona beds.[15] The process involves mining the trona then introducing water into the mined section of the bed to remove residual trona. Dry trona is dissolved in the trona solution brought to the surface and processed to produce sodium carbonate.

The relatively new sodium dispersion products are believed to have widened the field of potential applications for sodium. One form of these dispersions is produced by mixing molten sodium with such solid materials as salt, sodium carbonate, carbon, metal powder, or ceramic materials. Some of the advantages claimed are improved control of reaction rates and temperatures, greater safety, and high yield. Some new potential uses for these materials were discussed.[16] Other sodium dispersions have been described as sodium particles in hydrocarbon solvents.

A patent was issued on a process for disposing of the sludge of sodium and calcium formed as a byproduct in the electrolytic preparation of sodium.[17] The process comprises heating the sludge with air and siliceous materials, thereby producing a disposable solid product consisting of sodium silicate, calcium oxide, and silica.

WORLD REVIEW

Brazil.—It was reported that contracts were signed March 7, 1953, with a group of French banks for financing the National Alkali Co. of Brazil in its project of large scale production of soda ash and caustic soda at a proposed plant at Cabo Frio.[18] Anticipated production is 100,000 tons of soda ash and 40,000 tons of caustic soda annually. The plant will cost about 12 million dollars and would result ultimately in a saving in foreign exchange equivalent to more than 220 million cruzeiros expended annually for the importation of Brazilian requirements for soda ash and caustic soda.

Canada.—Production (shipments) of natural sodium sulfate in Canada in 1953 was 112,881 short tons compared with 122,590 short tons in 1952.[19] There were 4 producers of natural sodium sulfate in 1953—1 less than in the previous year. The four producers, all in Saskatchewan, were: Ormiston Mining & Smelting Co., Ltd., Ormis-

[13] Weisman, William I., and Anderson, Ross C., The Production of Sodium Sulfate From Natural Brines at Monahans, Tex.: Min. Eng., Trans. AIME, vol. 5, No. 7, July 1953, pp. 711–715.
[14] Ceramic Industry, vol. 61, No. 4, October 1953, p. 61.
[15] Pike, Robert D., and Seton, Max Y., (assigned to Food Machinery & Chemical Corp.), Mining Operation: U. S. Patent 2,625,384, Jan. 13, 1953.
[16] Chemical Engineering, Sodium Wears a New Harness: Vol. 60, No. 6, June 1953, pp. 270–271.
[17] Hodge, Benjamin E. (assigned to Ethyl Corp.), Disposal of Sludge from Electrolytic Preparation of Sodium: U. S. Patent 2,649,413, Aug. 18, 1953.
[18] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 5, May 1953, pp. 50–51.
[19] Department of Mines and Technology Services, Ottawa, Canada, Sodium Sulfate (Natural) in Canada 1953 (preliminary), 2 pp.

ton; Midwest Chemicals, Ltd., Palo; Sybouts Sodium Sulphate Co. Ltd., Gladmar; and Saskatchewan Minerals, Sodium Sulphate Division, Chaplin. A fifth company, Natural Sodium Products, Ltd., with plant at Bishopric, ceased operations in 1952. The sodium sulfate in this area occurs in lake brines, as a bedded deposit under a saturated brine, or as a bedded deposit in a dry lake. In late summer months the brine usually is almost saturated, and at this time it is pumped from the lake into enclosed ponds. As evaporation progresses, and with the advent of cooler weather, sodium sulfate crystallizes out, and the excess brine is returned to the lake. The sodium sulfate as Glauber's salt is collected and dehydrated to remove the water of crystallization. The dehydrating plants usually consist of a rotary kiln and crushing and screening equipment. The finished salt cake is shipped in bulk.

Colombia.—A new soda-ash plant was completed near Bogota during the year.[20] Reported to have cost 25 million pesos, the plant will produce about 100 tons of soda ash daily, about half of which will be sold and the remainder used to make caustic soda and bicarbonate of soda.

India.—Rohtas Industries, Ltd., was reported to be planning a soda-ash plant at Dalmianagar near Calcutta with an initial capacity of 120 tons per day. Equipment for the plant was being made in West Germany. Soda ash was being produced by two plants in India. Output in 1953 was 54,000 tons. A substantial tonnage of soda ash is imported into India from Kenya and the United Kingdom.[21]

Mexico.—It was reported that a new sodium sulfate plant had been opened in Coahuila with an expected monthly production rate of 1,200 tons.[22] The production was expected to be used in Mexican glass, paper, and cellulose industries.

[20] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 5, November 1953, pp. 77–78.
[21] U. S. Department of Commerce, Foreign Commerce Weekly, vol. 51, No. 7, Feb. 15, 1954, p. 23.
[22] Chemical Week, vol. 73, No. 6, August 8, 1953, p. 26.

Stone

By L. M. Otis[1] and Nan C. Jensen[2]

THE PERIOD since World War II has been one of unprecedented growth in the stone industries. Stone is used as a major raw material in a wide variety of construction and manufacturing activities. Output, which had declined sharply in 1943 owing to wartime restrictions on construction, increased steadily thereafter and in 1953 attained a record level—double that of the wartime low. During these 8 years average prices of stone also increased considerably.

TABLE 1.—Stone sold or used by producers in the United States,[1] 1944–48 (average) and 1949–53, by kinds

Year	Granite		Basalt and related rocks (traprock)		Marble		Limestone	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1944–48 (average)	10,476,822	$27,335,163	17,124,910	$22,209,406	206,616	$7,650,661	135,989,834	$159,528,065
1949	16,944,050	42,566,336	21,386,260	30,486,257	239,440	12,292,822	163,746,260	222,513,012
1950	22,553,180	52,220,660	22,894,830	34,372,735	267,220	10,932,234	180,918,910	252,755,827
1951	20,297,365	50,285,648	29,404,512	42,914,706	256,339	10,641,219	205,479,815	287,675,332
1952	22,288,843	52,480,380	[2] 29,760,760	[2] 46,437,787	238,048	10,888,353	217,255,454	308,924,214
1953	23,492,460	55,790,138	30,097,694	46,479,615	453,800	12,190,552	224,713,620	317,483,338

Year	Sandstone		Other stone [3]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1944–48 (average)	5,833,310	$13,148,002	14,553,974	$11,652,423	184,185,466	$241,523,720
1949	6,954,660	19,906,326	14,755,900	13,676,892	224,026,570	341,441,645
1950	9,100,890	23,787,019	16,378,020	16,513,622	252,113,050	390,582,097
1951	8,792,232	24,979,317	21,320,568	20,332,981	285,550,831	436,829,203
1952	8,649,584	25,004,372	[2] 23,553,491	[2] 22,730,718	[2] 301,746,180	[2] 466,465,824
1953	8,655,158	28,270,960	19,040,845	23,313,393	306,453,577	483,527,996

[1] Excludes stone used for abrasives and in making cement and lime. Includes Territories of the United States, possessions, and other areas administered by the United States.
[2] Revised figure.
[3] Includes mica schist, conglomerate, argillite, various light-color volcanic rocks, serpentine not used as marble, soapstone sold as dimension stone, etc.

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

TABLE 2.—Stone sold or used by producers in the United States,[1] 1952–53, by uses

Use	1952		1953	
	Quantity	Value	Quantity	Value
Dimension stone:				
Building stone:				
Rough construction ... short tons	281,646	$1,346,396	208,303	$1,196,506
Cut stone, slabs, and mill blocks [2] ... cubic feet	12,087,739	34,008,464	12,436,531	34,203,896
Approximate equivalent in short tons	917,771		940,291	
Rubble ... short tons	320,042	826,716	404,001	1,126,998
Monumental stone ... cubic feet	2,793,689	17,117,060	3,115,936	19,655,507
Approximate equivalent in short tons	230,490		257,438	
Paving blocks ... number	682,587	37,742	347,982	40,458
Approximate equivalent in short tons	2,256		2,346	
Curbing ... cubic feet	1,052,899	2,576,216	1,016,140	2,499,976
Approximate equivalent in short tons	86,179		82,942	
Flagging ... cubic feet	720,871	1,108,170	776,493	1,269,619
Approximate equivalent in short tons	57,946		62,023	
Total dimension stone (quantities approximate, in short tons)	1,896,330	57,020,764	1,957,344	59,992,960
Crushed and broken stone:				
Riprap ... short tons	8,778,585	11,156,047	7,733,737	10,052,102
Concrete and roadstone ... do	[3]187,264,075	[3]246,656,141	188,721,286	250,996,336
Railroad ballast ... do	21,383,068	20,019,095	20,778,410	20,533,252
Furnace flux (limestone) ... do	34,908,815	41,119,351	40,881,304	53,040,512
Refractory stone [4] ... do	1,950,786	7,262,048	1,937,292	8,079,005
Agriculture (limestone) ... do	21,152,208	34,463,963	18,452,513	30,133,864
Other uses ... do	24,412,313	48,768,415	25,991,691	50,699,965
Total crushed and broken stone ... do	[3]299,849,850	[3]409,445,060	304,496,233	423,535,036
Grand total (quantities approximate, in short tons)	[3]301,746,180	[3]466,465,824	306,453,577	483,527,996

[1] Excludes stone used for abrasives and in making cement and lime. Includes Territories of the United States, possessions, and other areas administered by the United States.
[2] To avoid disclosure of individual outputs, dimension stone for refractory use is included with building stone. Sawed building stone includes: 1952—437,935 cubic feet (31,760 tons) of stone for refractory use valued at $1,103,642; 1953—480,968 cubic feet (34,874 tons), $1,254,988.
[3] Revised figure.
[4] Ganister (sandstone), mica schist, soapstone, and dolomite.

TABLE 3.—Stone sold or used by noncommercial producers in the United States,[1] 1952–53, by uses

(Included in total production)

Use	1952		1953	
	Short tons	Value	Short tons	Value
Building stone	15,866	$30,088	13,652	$33,597
Rubble	70,784	162,617	28,369	48,203
Riprap	2,101,316	2,510,061	2,584,574	2,737,839
Concrete and roadstone	[2] 18,729,080	[2] 23,617,379	19,322,535	24,403,883
Agricultural (limestone)	468,660	660,718	309,593	447,374
Other uses	2,421,708	2,469,633	3,316,744	3,286,898
Total	[2] 23,807,414	[2] 29,450,496	25,575,467	30,957,794

[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, 1952–53, by States

State	1952		1953	
	Short tons	Value	Short tons	Value
Alabama	3,052,150	$7,948,410	4,111,889	$8,953,656
Arizona	235,020	355,709	442,358	618,748
Arkansas	[1] 2,967,479	[1] 3,346,201	3,061,464	3,865,114
California	14,374,930	17,697,085	[1] 14,514,180	[1] 18,479,152
Colorado	1,708,872	2,566,401	[1] 883,646	[1] 1,741,926
Connecticut	2,837,045	4,101,060	[1] 2,826,568	[1] 4,235,327
Delaware	94,911	251,759	80,364	215,382
Florida	7,836,634	9,577,541	[1] 9,428,959	[1] 11,309,421
Georgia	7,141,923	18,114,604	7,121,815	18,758,592
Idaho	[1] 1,630,034	[1] 2,441,236	1,141,626	2,260,875
Illinois	22,334,887	28,326,060	22,938,732	29,736,966
Indiana	9,126,837	21,965,454	8,714,106	21,695,890
Iowa	9,899,404	13,036,726	10,715,078	13,215,352
Kansas	8,830,871	12,051,740	8,769,152	11,303,950
Kentucky	[1] 8,817,859	[1] 10,816,707	[1] 7,429,505	[1] 9,268,237
Louisiana	(2)	(2)	-----------	-----------
Maine	[1] 316,874	[1] 1,795,768	[1] 248,501	[1] 1,215,439
Maryland	[1] 3,391,679	[1] 6,330,443	[1] 3,578,249	[1] 6,275,124
Massachusetts	[1] 3,355,819	[1] 9,331,871	3,457,708	8,821,108
Michigan	17,973,685	15,770,816	21,615,686	17,639,525
Minnesota	[1] 2,394,178	[1] 5,498,177	2,270,528	6,587,096
Mississippi	90,000	103,500	38,000	43,700
Missouri	15,106,544	20,676,958	[1] 13,942,531	[1] 19,908,540
Montana	[1] 690,081	[1] 792,897	[1] 802,735	[1] 1,124,731
Nebraska	1,245,106	1,946,448	1,407,158	2,069,984
Nevada	830,712	1,158,608	1,035,568	1,399,529
New Hampshire	69,850	546,177	76,701	538,897
New Jersey	6,102,324	12,307,480	6,036,259	13,307,856
New Mexico	[1] 317,894	[1] 191,642	624,528	510,713
New York	16,234,549	25,244,245	[1] 15,961,657	[1] 25,250,576
North Carolina	[1] 9,647,513	[1] 14,694,698	[1] 9,316,823	[1] 14,424,323
North Dakota	67,064	4,968	35,031	2,595
Ohio	[1] 24,693,189	[1] 36,197,485	[1] 25,784,561	[1] 39,642,601
Oklahoma	[1] 9,636,475	[1] 8,974,334	8,404,483	7,467,247
Oregon	6,250,849	8,893,368	[1] 4,939,080	[1] 6,301,639
Pennsylvania	[1] 25,609,812	[1] 44,676,456	[1] 26,192,607	[1] 48,094,029
Rhode Island	168,993	654,782	161,632	617,096
South Carolina	[1] 2,914,839	[1] 3,881,178	[1] 2,913,860	[1] 3,976,370
South Dakota	1,671,187	4,806,882	[1] 1,189,418	[1] 4,996,197
Tennessee	10,377,320	17,652,763	[1] 10,485,351	[1] 16,948,053
Texas	7,604,468	8,664,633	[1] 9,095,109	[1] 8,550,320
Utah	[1] 852,351	[1] 1,123,108	997,330	1,446,594
Vermont	404,391	6,016,530	527,150	8,859,703
Virginia	9,670,961	16,969,952	9,091,907	16,258,620
Washington	4,523,234	5,491,525	4,438,259	5,890,849
West Virginia	[1] 4,869,442	[1] 6,826,113	[1] 5,501,148	[1] 8,924,411
Wisconsin	8,578,882	16,754,675	7,450,396	16,039,183
Wyoming	1,466,567	1,688,890	1,431,372	1,839,922
Undistributed	989,683	2,799,985	629,440	2,647,725
Total [3]	299,005,371	461,064,048	301,860,208	473,278,883
Alaska	(2)	(2)	47,086	169,711
American Samoa	-----------	-----------	74,750	16,500
Canton Island	150	375	4,200	8,750
Guam	948,000	870,000	2,080,650	5,573,169
Hawaii	705,994	1,545,301	[4] 1,299,501	[4] 2,654,358
Midway Island	7,200	6,000	204	638
Panama Canal Zone	86,000	152,000	171,908	231,752
Puerto Rico	[4] 689,320	[4] 1,807,388	[4] 648,400	[4] 1,237,236
Virgin Island	12,900	51,900	10,789	45,853
Wake Island	4,260	8,000	11,980	20,615
Undistributed	286,985	960,812	243,901	290,531
Total [3]	[5] 2,740,809	[5] 5,401,776	4,593,369	10,249,113
Grand total [3]	[5] 301,746,180	[5] 466,465,824	306,453,577	483,527,996

[1] To avoid disclosing confidential information certain State totals are incomplete, the portion not included being combined with "Undistributed." The class of stone omitted from such State totals is noted in the State tables in the Statistical Summary chapter of this volume.
[2] Included with "Undistributed."
[3] Does not include stone used for abrasives and in making cement and lime.
[4] Certain territory or area totals are incomplete, the portion not included being combined with "Undistributed."
[5] Revised figure.

DIMENSION STONE

Dimension-stone producers may be divided into three main groups. One group quarries stone and sells it as rough blocks or slabs; another both quarries the stone and makes finished products; and the third purchases the sawed slabs or rough blocks of stone from which the finished products are manufactured. The Bureau of Mines statistical canvass covers the first two groups but not the third, because stone furnished this third group is reported by the prime producer. As the tabulations cover sales by primary producers they include some material sold as rough blocks and some as finished products.

Sales of dimension stone (including slate) in 1953 increased 3 percent in quantity over 1952, and the value was 5 percent greater. Although slate as dimension stone is included in the totals in table 5, detailed statistics on slate do not appear in this chapter but will be found in the Slate chapter.

TABLE 5.—Dimension stone sold or used by producers in the United States,[1] 1952–53, by kinds and uses

Kind and use	1952	1953	
		Amount	Percent of change from 1952
Granite:			
Building stone:			
Rough construction...short tons..	66,250	57,644	−13
Value	$573,743	$524,640	−9
Average per ton	$8.66	$9.10	+5
Cut stone, slabs, and mill blocks...cubic feet..	737,561	664,416	−10
Value	$4,669,886	$4,060,855	−13
Average per cubic foot	$6.33	$6.11	−3
Rubble...short tons..	102,629	178,526	+74
Value	$284,013	$425,144	+50
Monumental stone...cubic feet..	2,508,994	2,852,833	+14
Value	$14,458,426	$17,200,458	+19
Average per cubic foot	$5.76	$6.03	+5
Paving blocks...number..	682,587	347,982	−49
Value	$37,742	$40,458	+7
Curbing...cubic feet..	974,565	919,179	−6
Value	$2,373,604	$2,220,068	−6
Total:			
Quantity...approximate short tons..	518,838	604,398	+16
Value	$22,397,414	$24,471,623	+9
Basalt and related rocks (traprock):			
Building stone:			
Rough construction...short tons..	33,766	58,005	+72
Value	$106,912	$215,840	+102
Average per ton	$3.17	$3.72	+17
Rubble...short tons..	24,230	1,300	−95
Value	$31,250	$500	−98
Total:			
Quantity...short tons..	57,996	59,305	+2
Value	$138,162	$216,340	+57
Marble:			
Building stone (cut stone, slabs, and mill blocks)...cubic feet..	763,770	634,333	−17
Value	$6,620,584	$5,975,453	−10
Average per cubic foot	$8.67	$9.42	+9
Monumental stone...cubic feet..	284,695	263,103	−8
Value	$2,658,634	$2,455,049	−8
Average per cubic foot	$9.34	$9.33	-----------
Total:			
Quantity...approximate short tons....	89,051	76,255	−14
Value	$9,279,218	$8,430,502	−9

TABLE 5.—Dimension stone sold or used by producers in the United States,[1] 1952–53, by kinds and uses—Continued

Kind and use	1952	1953 Amount	1953 Percent of change from 1952
Limestone:			
Building stone:			
Rough construction……short tons	138,396	61,264	−56
Value	$400,304	$231,514	−42
Average per ton	$2.89	$3.78	+31
Cut stone, slabs, and mill blocks……cubic feet	7,098,075	7,340,467	+3
Value	$14,284,500	$14,612,815	+2
Average per cubic foot	$2.01	$1.99	−1
Rubble……short tons	111,092	181,673	+64
Value	$256,526	$517,653	+102
Flagging……cubic feet	145,418	169,550	+17
Value	$119,719	$134,176	+12
Total:			
Quantity……approximate short tons	786,757	798,911	+2
Value	$15,061,049	$15,496,158	+3
Sandstone:			
Building stone:			
Rough construction……short tons	43,234	31,390	−27
Value	$265,437	$224,512	−15
Average per ton	$6.14	$7.15	+16
Cut stone, slabs, and mill blocks……cubic feet	2,789,566	3,157,491	+13
Value	$6,026,975	$6,892,817	+14
Average per cubic foot	$2.16	$2.18	+1
Rubble……short tons	57,122	35,690	−38
Value	$192,487	$153,274	−20
Curbing……cubic feet	78,334	96,961	+24
Value	$202,612	$279,908	+38
Flagging……cubic feet	483,080	556,024	+15
Value	$891,969	$1,084,044	+22
Total:			
Quantity……approximate short tons	352,230	353,510	----------
Value	$7,579,480	$8,634,555	+14
Miscellaneous stone:[2]			
Building stone……cubic feet	698,767	639,824	−8
Value	$2,406,519	$2,661,956	+11
Average per cubic foot	$3.44	$4.16	+21
Rubble……short tons	24,969	6,812	−73
Value	$62,440	$30,427	−51
Flagging……cubic feet	92,373	50,919	−45
Value	$96,482	$51,399	−47
Total:			
Quantity……approximate short tons	91,458	64,965	−29
Value	$2,565,441	$2,743,782	+7
Total dimension stone, excluding slate:			
Quantity……approximate short tons	1,896,330	1,957,344	+3
Value	$57,020,764	$59,992,960	+5
Slate as dimension stone[3]……approximate short tons	146,250	152,903	+5
Value	$6,586,804	$6,684,804	+1
Total dimension stone, including slate:			
Quantity……approximate short tons	2,042,580	2,110,247	+3
Value	$63,607,568	$66,677,764	+5

[1] Includes Puerto Rico.
[2] Includes soapstone, mica schist, volcanic rocks, argillite, and other varieties that cannot be classified in the principal groups.
[3] Details of production, by uses, are given in the Slate chapter of this volume.

BUILDING STONE

The principal market for dimension stone was in the building industry. Sales of building stone in 1953 declined 3 percent in quantity, but the value remained about the same as in the previous year. Output of stone in the "rough construction" category declined 26 percent in quantity, and of rough architectural declined 5 percent; but the production of finished building stone increased. Table 6 gives the quantity and value of building-stone output in 1953.

TABLE 6.—Building stone sold or used by producers in the United States [1] in 1953, by kinds

Kind	Rough			
	Construction		Architectural	
	Cubic feet	Value	Cubic feet	Value
Granite	694,135	$524,640	182,053	$499,025
Basalt	690,167	215,840		
Marble			174,791	618,682
Limestone	752,000	231,514	2,547,321	3,061,114
Sandstone	402,085	224,512	1,111,883	1,793,542
Miscellaneous				
Total	2,538,387	1,196,506	4,016,048	5,972,363

Kind	Finished				Total	
	Sawed		Cut			
	Cubic feet	Value	Cubic feet	Value	Cubic feet	Value
Granite [2]	255,471	$1,275,048	226,892	$2,286,782	1,358,551	$4,585,495
Basalt					690,167	215,840
Marble	171,639	1,193,349	287,903	4,163,422	634,333	5,975,453
Limestone	3,598,455	5,613,542	1,194,691	5,938,159	8,092,467	14,844,329
Sandstone	1,854,526	4,171,115	191,082	928,160	3,559,576	7,117,329
Miscellaneous	[3] 639,824	[3] 2,661,956			639,824	2,661,956
Total	[3] 6,519,915	[3] 14,915,010	1,900,568	13,316,523	14,974,918	35,400,402

[1] Includes Puerto Rico.
[2] Sawed stone corresponds to dressed stone for construction work (walls, foundations, bridges) and cut stone to architectural stone for high-class buildings.
[3] Rough and cut miscellaneous stone included with sawed stone.

GRANITE

Sales of granite as dimension stone in 1953 increased 16 percent in quantity and 9 percent in value compared with 1952. The quantity of rubble reported was substantially higher than in the previous year, and the value of monumental granite rose to $17,201,000—19 percent more than in the previous year. The average value of all dimension granite products sold in 1953 dropped 6 percent, to $40.49 per ton.

Tables 8 and 9 record sales of monumental granite from the Barre district in Vermont, exclusive of small quantities sold for construction or as crushed stone. Subnormal sales in 1952 (mainly the result of a 5-month strike) make 1953 sales appear large by comparison. According to Bureau of Mines records, Vermont has led all the States both in quantity and value of memorial stone sold except in 1952, when, because of the strike, it fell to second place in quantity.

TABLE 7.—Granite (dimension stone) sold or used by producers in the United States in 1953, by States and uses

State	Active plants	Building								Monumental				Paving blocks		Curbing		Total	
		Rough				Dressed		Rubble		Rough		Dressed							
		Construction		Architectural															
		Short tons	Value	Cubic feet	Value	Cubic feet	Value	Short tons	Value	Cubic feet	Value	Cubic feet	Value	Number	Value	Cubic feet	Value	Short tons (approximate)	Value
California	10	44	$50	3,959	$75,450	3,921	$9,802	3,008	$4,950	10,739	$38,494	18,832	$110,329	------	------	------	------	6,098	$239,075
Colorado	3	25	37	------	------	------	------	------	------	------	------	3,471	33,454	------	------	------	------	317	33,491
Connecticut	6	1,859	6,720	(1)	(1)	26,266	78,927	(1)	(1)	10,680	84,380	(1)	(1)	------	------	(1)	(1)	6,348	205,060
Georgia	19	------	------	4,000	4,000	(1)	(1)	54,800	111,150	722,256	1,551,182	195,629	1,575,241	(1)	(1)	(1)	(1)	147,608	3,626,523
Maine	7	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	11,698	691,281
Maryland	4	14,688	159,600	5,902	6,590	------	------	28,915	92,393	------	------	------	------	------	------	17,377	$13,050	45,512	271,633
Massachusetts	5	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	10,435	52,744	(1)	(1)	(1)	(1)	(1)	(1)	85,384	3,346,096
Minnesota	16	------	------	------	------	39,844	450,744	12,995	29,275	16,771	59,263	171,725	2,191,194	------	------	------	------	31,947	2,730,476
Missouri	1	------	------	6,431	16,485	------	------	------	------	17,115	60,610	8,793	82,323	------	------	------	------	2,700	159,418
Montana	1	------	------	------	------	------	------	------	------	(1)	(1)	------	------	------	------	------	------	(1)	(1)
New Hampshire	3	(1)	(1)	(1)	(1)	(1)	(1)	200	600	2,000	6,000	(1)	(1)	------	------	(1)	(1)	(1)	(1)
New York	2	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	------	------	------	------	------	------	------	------	8,258	148,842
North Carolina	10	(1)	(1)	(1)	(1)	(1)	(1)	18,864	54,585	25,835	134,267	26,802	414,777	(1)	(1)	(1)	(1)	40,825	1,403,666
Oklahoma	4	------	------	------	------	------	------	------	------	10,491	29,462	42,865	292,347	------	------	------	------	4,402	321,809
Pennsylvania	7	25,851	166,308	4,930	26,903	(1)	(1)	(1)	(1)	------	------	(1)	(1)	------	------	------	------	32,233	449,516
Rhode Island	2	(1)	(1)	(1)	(1)	------	------	(1)	(1)	(1)	(1)	------	------	------	------	------	------	(1)	(1)
South Carolina	1	------	------	------	------	------	------	------	------	(1)	(1)	------	------	------	------	------	------	(1)	(1)
South Dakota	8	------	------	2,000	4,000	3,600	72,000	------	------	71,694	241,866	168,784	2,612,920	------	------	------	------	19,933	2,930,786
Texas	1	------	------	------	------	15,000	150,000	------	------	------	------	2,727	45,000	------	------	------	------	1,462	195,000
Vermont	3	------	------	------	------	------	------	(1)	(1)	975,735	5,043,890	------	------	------	------	------	------	(1)	(1)
Washington	2	------	------	------	------	------	------	95	900	------	------	970	8,060	------	------	1,840	3,800	327	12,760
Wisconsin	8	(1)	(1)	(1)	(1)	(1)	(1)	------	------	(1)	(1)	86,269	1,237,399	------	------	------	------	10,922	1,485,738
Undistributed	------	15,177	191,925	154,831	365,597	393,732	2,800,357	59,649	131,291	221,928	888,142	30,287	407,114	347,982	$40,458	899,962	2,203,218	148,424	6,220,453
Total	123	57,644	524,640	182,053	499,025	482,363	3,561,830	178,526	425,144	2,095,679	8,190,300	757,154	9,010,158	347,982	40,458	919,179	2,220,068	604,398	24,471,623
Average unit value	------	------	$9.10	------	$2.74	------	$7.38	------	$2.38	------	$3.91	------	$11.90	------	$0.12	------	$2.42	------	$40.49
Short tons (approximate)	------	(2)	------	15,036	------	39,874	------	------	------	172,675	------	62,399	------	2,346	------	75,898	------	------	------

[1] Included with "Undistributed" to avoid disclosure of individual company operations.
[2] 694,135 cubic feet (approximate).

TABLE 8.—Monumental granite sold by quarrymen in the Barre district, Vermont, 1944–48 (average) and 1949–53

Year	Cubic feet	Value	Year	Cubic feet	Value
1944–48 (average)	882,738	$3,162,282	1951	853,963	$4,100,912
1949	890,080	3,528,756	1952	599,544	3,010,130
1950	917,310	3,868,351	1953	975,735	5,043,890

TABLE 9.—Estimated output of monumental granite in the Barre district, Vermont, 1951–53

[Barre Granite Association, Inc.]

	1951	1952	1953
Total quarry output, rough stock cubic feet	863,265	462,280	976,176
Shipped out of Barre district in rough do	172,653	92,457	195,235
Manufactured in Barre district do	690,612	369,823	780,941
Light stock consumed in district do	460,408	246,549	520,627
Dark stock consumed in district do	230,204	123,274	260,314
Number of cutters in district	1,748	1,748	2,422
Average daily wage	$15.00	$15.38	$15.00
Average number of days worked	248	155	240
Total pay roll for year	$6,502,560	$4,166,805	$8,719,200
Estimated overhead	3,251,280	2,083,403	4,359,600
Estimated value of light stock	2,859,765	1,525,535	2,577,105
Estimated value of dark stock	1,495,326	801,289	1,728,482
Estimated polishing cost	1,737,220	930,344	1,964,554
Estimated sawing cost	1,359,642	728,096	1,537,477
Total value of granite	17,205,793	10,235,472	20,886,418

BASALT AND RELATED ROCKS (TRAPROCK)

Basalt and related dark igneous rocks were used in limited quantities as building stone. Total sales for 1953 were 2 percent higher than in the previous year. Rocks of this group when sold for memorials are classed in the trade as "black granite;" their output is included in the figures for monumental granite.

TABLE 10.—Basalt and related rocks (traprock) (dimension stone) sold or used by producers in the United States in 1953, by States and uses

State	Active plants	Building stone: Rough construction		Building stone: Rubble		Total	
		Short tons	Value	Short tons	Value	Short tons	Value
Connecticut	1	(1)	(1)			(1)	(1)
Oregon	2	2,620	$13,680	1,300	$500	3,920	$14,180
Pennsylvania	2	(1)	(1)			(1)	(1)
Undistributed		55,385	202,160			55,385	202,160
Total	5	[2] 58,005	215,840	1,300	500	59,305	216,340
Average unit value			$3.72		$0.38		$3.65

[1] Included with "Undistributed" to avoid disclosure of individual company operations.
[2] 690,167 cubic feet (approximate).

MARBLE

Rough blocks used for exterior building purposes was the only category of marble that increased appreciably in sales in 1953. Total dimension use declined 14 percent from 1952, although the average value increased from $8.85 to $9.39 per cubic foot.

Marble constituted about 8 percent of the combined marble and granite used for memorials and 12 percent of the value. The average value of marble sold for memorial purposes was $9.33 per cubic foot. Tables 11 and 12 give sales data for marble, by uses and States.

TABLE 11.—Marble (dimension stone) sold by producers in the United States, 1952–53, by uses

Use	1952		1953	
	Cubic feet	Value	Cubic feet	Value
Building stone:				
Rough:				
Exterior	25,562	$111,969	48,872	$201,845
Interior	254,555	674,189	125,919	416,837
Finished:				
Exterior	161,123	1,580,782	130,722	1,037,301
Interior	322,530	4,253,644	328,820	4,319,470
Total exterior	186,685	1,692,751	179,594	1,239,146
Total interior	577,085	4,927,833	454,739	4,736,307
Total building stone	763,770	6,620,584	634,333	5,975,453
Monumental stone:				
Rough / Finished	284,695	2,658,634	263,103	2,455,049
Total monumental stone	284,695	2,658,634	263,103	2,455,049
Total building and monumental	1,048,465	9,279,218	897,436	8,430,502
Approximate short tons	89,051		76,255	

TABLE 12.—Marble (dimension stone) sold by producers in the United States in 1953, 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	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Arizona	1			350	$1,800	350	30	$1,800
Arkansas	1	(1)	(1)			(1)	(1)	(1)
Colorado	2	4,440	$15,284			4,440	377	15,284
Georgia	1	44,714	734,305	139,125	1,400,972	183,839	15,626	2,135,277
Maryland	1	(1)	(1)			(1)	(1)	(1)
Minnesota	1	2,350	18,000			2,350	173	18,000
Missouri	2	(1)	(1)	(1)	(1)	(1)	(1)	(1)
North Carolina	1			(1)	(1)	(1)	(1)	(1)
Tennessee	8	(1)	(1)	(1)	(1)	292,070	24,826	2,743,733
Vermont	6	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Undistributed		582,829	5,207,864	123,628	1,052,277	414,387	35,223	3,516,408
Total	26	634,333	5,975,453	263,103	2,455,049	897,436	76,255	8,430,502
Average unit value			$9.42		$9.33			[2] $9.39
Short tons (approximate)		53,891		22,364				

[1] Included with "Undistributed" to avoid disclosure of individual company operations.
[2] Average value per cubic foot.

LIMESTONE

Limestone finished into blocks or slabs for building purposes comprised 44 percent of the total quantity and 75 percent of the value of dimension limestone sold in 1953. Limestone for rough building decreased from 1952, but all other classes increased in both quantity and value.

TABLE 13.—Limestone (dimension stone) sold or used by producers in the United States in 1953, by States and uses

State	Active plants	Building								Flagging		Total	
		Rough				Finished (cut and sawed)		Rubble					
		Construction		Architectural									
		Short tons	Value	Cubic feet	Value	Cubic feet	Value	Short tons	Value	Cubic feet	Value	Short tons (approximate)	Value
Alabama	1			(1)	(1)	(1)	(1)	(1)	(1)			(1)	(1)
Arkansas	1	246	$820									246	$820
California	1	(1)	(1)									(1)	(1)
Connecticut	1	428	2,111									428	2,111
Florida	3	(1)	(1)	(1)	(1)			(1)	(1)			(1)	(1)
Georgia	2	(1)	(1)					(1)	(1)			4,142	10,684
Illinois	7	75	525	(1)	(1)	3,824	$9,750	(1)	(1)	31,963	$18,349	25,980	150,289
Indiana	20			2,154,832	$2,380,991	3,894,510	8,552,997	22,339	$39,356			460,916	10,973,344
Iowa	4					(1)	(1)	(1)	(1)	4,500	3,000	4,586	23,394
Kansas	11	7,615	5,305	27,573	27,367	242,130	575,133	8,981	14,341	5,851	4,086	40,018	626,232
Maryland	1							(1)	(1)			(1)	(1)
Michigan	3	(1)	(1)			5,882	22,500	(1)	(1)	16,570	12,348	4,849	53,425
Minnesota	6	(1)	(1)	123,288	278,050	181,849	671,650	(1)	(1)	21,250	15,600	32,840	990,835
Missouri	10	2,769	9,870	(1)	(1)	8,236	12,500	(1)	(1)	15,484	13,050	43,389	225,892
Ohio	2	12,183	25,340					5,484	14,512			17,667	39,852
Oklahoma	1	260	1,300									260	1,300
Pennsylvania	3	(1)	(1)					(1)	(1)			42,430	133,663
Puerto Rico	4	(1)	(1)					(1)	(1)			16,552	33,733
South Dakota	1							6,000	12,000			6,000	12,000
Tennessee	2	1,789	1,314					425	425			2,214	1,739
Texas	4	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)			14,200	480,471
West Virginia	1	(1)	(1)									(1)	(1)
Wisconsin	20	18,561	49,041	96,504	183,736	262,468	686,507	10,799	29,351	73,932	67,743	63,992	1,016,378
Undistributed		17,338	135,888	145,124	190,970	194,247	1,020,664	127,645	407,668			18,202	719,996
Total	109	61,264	231,514	2,547,321	3,061,114	4,793,146	11,551,701	181,673	517,653	169,550	134,176	798,911	15,496,158
Average unit value			$3.78		$1.20		$2.41		$2.85		$0.79		$19.40
Short tons (approximate)		(2)		187,644		354,430				13,900			

[1] Included with "Undistributed" to avoid disclosure of individual company operations.
[2] 752,000 cubic feet (approximate).

The Bedford-Bloomington area, Indiana, contributed 82 percent of the United States total output of cut limestone slabs and mill blocks and 75 percent of the value, thus maintaining its position as the principal domestic producing area. Table 14 shows sales by firms operating quarries in this district. Table 15 shows sales, by mill operators, of finished limestone processed from purchased stone.

TABLE 14.—Limestone sold by producers in the Indiana oolitic limestone district, 1944–48 (average) and 1949–53, by classes

Year	Construction					
	Rough block		Sawed and semifinished		Cut	
	Cubic feet	Value	Cubic feet	Value	Cubic feet	Value
1944–48 (average)	1,527,126	$1,023,769	1,132,448	$1,198,364	410,488	$1,522,896
1949	1,896,780	1,742,517	2,215,940	2,805,866	803,140	3,377,699
1950	2,192,140	2,309,303	3,213,160	4,669,493	1,191,200	5,682,062
1951	2,517,714	2,591,339	3,159,924	4,990,385	976,600	5,901,568
1952	2,220,698	2,417,319	2,736,654	4,322,803	660,382	3,915,947
1953	2,154,832	2,380,991	3,212,325	4,813,448	682,185	3,739,549

Year	Construction—Continued			Other uses		Total	
	Total						
	Cubic feet	Short tons (approximate)	Value	Short tons	Value	Short tons (approximate)	Value
1944–48 (average)	3,070,062	222,592	$3,745,029	74,930	$143,625	297,522	$3,888,654
1949	4,915,860	356,400	7,926,082	48,320	149,753	404,720	8,075,835
1950	6,596,500	478,250	12,660,858	276,620	441,797	754,870	13,102,655
1951	6,654,238	482,432	13,483,292	156,084	281,102	638,516	13,764,394
1952	5,617,734	407,286	10,656,069	176,688	327,255	583,974	10,983,324
1953	6,049,342	438,577	10,933,988	154,556	284,068	593,133	11,218,056

TABLE 15.—Purchased Indiana limestone sold by mills in the Indiana oolitic limestone district, 1944–48 (average) and 1949–53, by classes

Year	Sawed and semifinished		Cut		Total	
	Cubic feet	Value	Cubic feet	Value	Cubic feet	Value
1944–48 (average)	102,996	$128,841	591,990	$2,082,578	694,986	$2,211,419
1949	117,270	166,809	1,016,050	5,365,837	1,133,320	5,532,646
1950	141,510	198,859	921,900	4,674,820	1,063,410	4,873,679
1951	127,159	179,946	742,745	4,579,979	869,904	4,759,925
1952	156,935	229,940	661,844	3,687,401	818,779	3,917,341
1953	173,991	308,338	605,824	3,168,816	779,815	3,477,154

TABLE 16.—Limestone and marble sold by producers in the Carthage district, Jasper County, Mo., 1944–48 (average) and 1949–53, 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
1944–48 (average)	43, 266	$323, 241	9, 560	$43, 849	52, 826	4, 460	$367, 090	247, 566	$476, 309	252, 026	$843, 399
1949	84, 810	934, 036	4, 530	26, 772	89, 340	7, 590	960, 808	238, 250	420, 833	245, 840	1,381,641
1950	75, 630	805, 532	2, 430	17, 185	78, 060	6, 640	822, 717	252, 960	467, 926	259, 600	1,290,643
1951	135, 715	872, 264	1, 850	12, 509	137, 565	11, 693	884, 773	257, 609	440, 496	269, 302	1,325.269
1952	107, 430	772, 513	2, 658	17, 681	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

SANDSTONE

The quantity of dimension sandstone sold in 1953 was virtually the same as in 1952, but the value was 14 percent higher. Sandstone for rough building construction and rubble declined during the year, though all other uses increased.

Ohio maintained its position as the leading producing State, quarrying 47 percent of all domestic dimension sandstone. Tennessee was next, followed in order by Pennsylvania, New York, Colorado, and Missouri.

Table 17 shows all domestic dimension sandstone reported as sold or used in 1953; and table 18 gives statistics on bluestone, a variety of sandstone that splits easily into thin, uniform slabs suitable for flagging, building, and curbing uses.

TABLE 17.—Sandstone (dimension stone) sold or used by producers in the United States in 1953, by States and uses

State	Active plants	Building: Rough construction: Short tons	Building: Rough construction: Value	Building: Rough architectural: Cubic feet	Building: Rough architectural: Value	Building: Dressed: Sawed: Cubic feet	Building: Dressed: Sawed: Value	Building: Dressed: Cut: Cubic feet	Building: Dressed: Cut: Value	Building: Rubble: Short tons	Building: Rubble: Value	Curbing: Cubic feet	Curbing: Value	Flagging: Cubic feet	Flagging: Value	Total: Short tons (approximate)	Total: Value
Alabama	1			6,808	$7,145											531	$7,145
Arizona	6	79	$474	1,388	2,029					333	$1,334			87,309	$67,063	7,180	70,900
Arkansas	3	42	126	(1)	(1)			(1)	(1)					(1)	(1)	7,703	132,802
California	3	(1)	(1)	(1)	(1)					(1)	(1)			(1)	(1)	5,746	32,754
Colorado	8	3,815	35,555	109,936	168,283	600	$9,000	4,667	$18,200	1,000	3,000			16,564	14,218	15,093	248,256
Indiana	2	32	160	3,936	6,750	25,897	49,150									2,359	56,060
Kentucky	2							(1)	(1)	1,200	4,800			(1)	(1)	(1)	(1)
Massachusetts	1							7,794	76,947							624	76,947
Michigan	1	11	110							309	1,854			613	660	369	2,624
Missouri	3	(1)	(1)							(1)	(1)			1,506	1,218	10,872	23,265
Nevada	2							29,133	64,372					6,494	10,000	2,753	74,372
New Mexico	2			39	90					94	150			323	750	122	990
New York (bluestone)	9	204	1,690	17,548	26,696	17,000	122,633	6,000	80,157	923	8,378	1,228	$618	154,610	227,035	17,722	467,207
Ohio	7			214,794	422,266	1,811,029	3,990,332	55,156	355,834			95,733	279,290	134,863	310,588	167,589	5,358,310
Oklahoma	2	450	2,400											1,250	800	548	3,200
Pennsylvania [2]	19	20,947	123,493	12,435	9,611					14,713	80,606			70,841	127,916	42,502	341,626
Tennessee	6			609,359	859,978			1,667	4,000	(1)	(1)			65,096	287,781	52,785	1,151,853
Texas	2	3,262	41,565											337	404	3,288	41,969
Utah	2	(1)	(1)	11,974	18,282											(1)	(1)
Virginia	1									(1)	(1)			(1)	(1)	(1)	(1)
Washington	2			56,145	181,375			19,290	219,130							6,030	400,505
Wisconsin	6			(1)	(1)			31,734	68,100	(1)	(1)			(1)	(1)	3,118	71,814
Undistributed		2,548	18,939	67,521	91,037			35,641	41,420	17,118	53,152			16,218	35,611	6,576	71,956
Total	90	31,390	224,512	1,111,883	1,793,542	1,854,526	4,171,115	191,082	928,160	35,690	153,274	96,961	279,908	556,024	1,084,044	353,510	8,634,555
Average unit value			$7.15		$1.61		$2.25		$4.86		$4.29		$2.89		$1.95		$24.43
Short tons (approximate)		(3)		85,901		134,803		14,827				7,044		43,855			

1 Included with "Undistributed" to avoid disclosure of individual company operations.
2 Includes 112,433 cubic feet of bluestone (approximately 9,501 tons) valued at $135,041 sold for rubble and flagging.
3 402,085 cubic feet (approximate).

TABLE 18.—Bluestone (dimension stone) sold or used in the United States, 1944–48 (average) and 1949–53 [1]

Year	Cubic feet	Value	Year	Cubic feet	Value
1944–48 (average)	227,966	$252,316	1951	253,935	$464,200
1949	395,500	533,727	1952	318,198	583,970
1950	390,460	604,137	1953	322,156	602,248

[1] New York and Pennsylvania were the only producing States.

MISCELLANEOUS STONE

Table 19 covers those varieties of stone not included in the major types already discussed. The principal types of stone in this classification are mica schist, argillite, soapstone, greenstone, and light-color volcanic rocks. The output of such miscellaneous stone declined sharply during 1953.

TABLE 19.—Miscellaneous varieties of stone (dimension stone) sold or used by producers in the United States in 1953, by States and uses

State	Active plants	Building				Flagging		Total	
		Rough and dressed		Rubble					
		Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Arkansas	1			(1)	(1)	(1)	(1)	(1)	(1)
California	6	847	$16,957	(1)	(1)	(1)	(1)	3,009	$19,064
Colorado	1			2,200	$880			2,200	880
Maryland	5	7,943	45,864	(1)	(1)	(1)	(1)	9,580	59,832
New York	4	(1)	(1)			(1)	(1)	603	13,331
Ohio	1	(1)	(1)					(1)	(1)
Oregon	1	525	26,165	25	390			550	26,555
Pennsylvania	4	32,833	153,665			626	$3,130	33,459	156,795
South Dakota	1	(1)	(1)					(1)	(1)
Virginia	4	(1)	(1)			947	22,856	(1)	(1)
Undistributed		11,737	2,419,305	4,587	29,157	2,695	25,413	15,564	2,467,325
Total	28	[2] 53,885	2,661,956	6,812	30,427	[3] 4,268	51,399	64,965	2,743,782
Average unit value			$49,40		$4.47		$12.04		$42.23

[1] Included with "Undistributed" to avoid disclosure of individual company operations.
[2] Approximately 639,824 cubic feet.
[3] Approximately 50,919 cubic feet.

CONSUMPTION AND USES

Figure 1 shows graphically a 38-year history of dimension-stone sales by kinds of stone. Figure 2 charts, for a 19-year period, the relationship of total building-stone and limestone sales to the contract value of nonresidential building (the type of construction using stone most extensively). The index number of nonresidential construction in 1953 was 14 times greater than in 1935, but that of the sales of total domestic building stone was only 5 times more than the 1935 sales. Factors affecting this divergence of trend are the wider use of alternate materials, such as concrete, cast stone, aluminum, stainless steel, glass block, and ceramic products, some of which are less costly than stone.

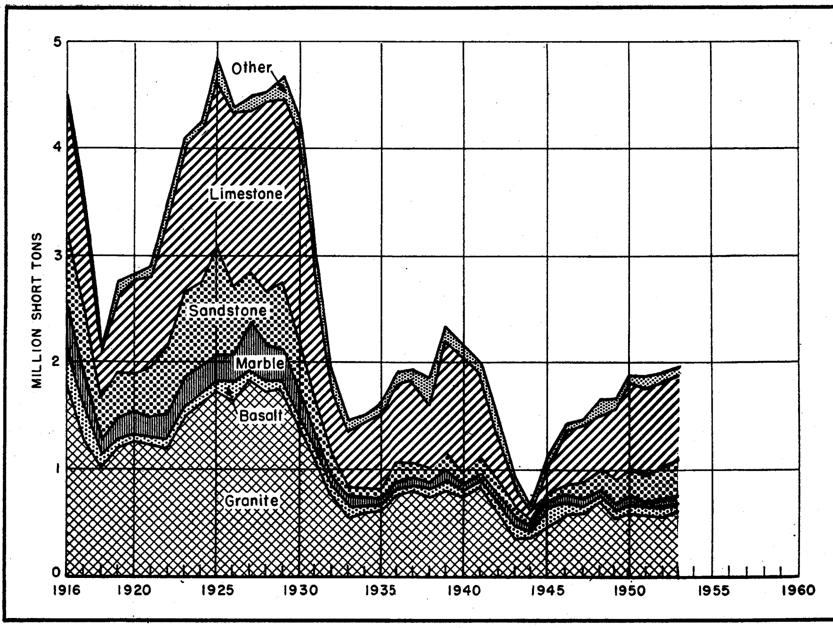

FIGURE 1.—Sales of dimension stone in the United States, by kinds, 1916–53.

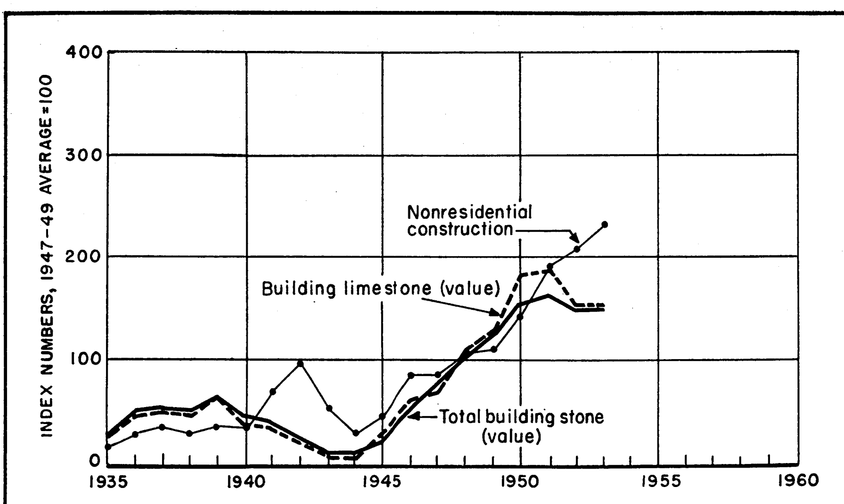

FIGURE 2.—Sales of all building stone compared with sales of building limestone and value of all nonresidential construction, 1935–53.

[Data on nonresidential-building construction from Survey of Current Business, U. S. Department of Commerce.]

TECHNOLOGY[3]

A new wire saw for shop use, designed for either straight or contour cutting of stone, appeared on the market. It used guide templates made from wood or other easily formed material.[4]

At the Barre, Vt., quarries, detachable tungsten carbide bits were used for deep-hole drilling. Bits required conditioning about every 50 feet of drilling and completed 500 to 600 feet of drill hole before wearing out.

Wire saws were used successfully in one quarry in the Bedford, Ind., limestone district. A 3-strand ¼-inch cable about 1,600 feet long was used, with sifted quartz sand as the abrasive; sand was fed to the wire as a slurry at the entry point. The rate of sawing varied with the rock hardness, but a cut 125 feet long and 10 feet deep usually required about 48 hours.

Steam-driven channeling machines were commonly used throughout the Bedford region for making primary cuts. The 2-inch channel cut offers some advantage in bed lifting, as it permits the block to tilt, whereas the ¼-inch wire-saw cut permits very little tilt.

In its mill operation one company in Barre, Vt., used a circular saw 11 feet in diameter. The saw was equipped with steel teeth, and steel shot fed to the saw with water was the cutting agent. The granite blocks were set in line on a traveling bed and the spaces between them filled with plaster of paris, which held the abrasive in the cut as the saw passed from one block to another. The rate of sawing was 1 to 2 inches a minute through blocks 24 to 30 inches thick.

In the shops single-strand wire saws were used successfully in cutting granite blocks into slabs. At 1 operation several independent wires, each 1,050 feet long, were used to make parallel cuts. Cuts 10 feet long were made at the rate of about 12 inches an hour with aluminum oxide abrasive and about 15 inches an hour with silicon carbide. A wire would make about four such cuts before it was worn out. The power requirement was approximately 10 hp. per wire.

The cost of wire sawing per square foot of surface obtained was higher than when conventional gang saws were used, but wire saws have several compensating advantages:

(1) The wire makes a cut only ¼ inch wide as against the gang-saw cut of 1¼ inches; thus much stone is conserved.

(2) Wire-saw work results in a smooth surface.

(3) The surface-finishing cost is lower than when gang-saw slabs are used.

Many monument-manufacturing shops are now equipped with wire saws.

WORLD REVIEW

NORTH AMERICA

Canada.—Although Canada continued to produce some dimension marble as mill blocks, most marble used for building and monuments

[3] By Oliver Bowles, Commodity specialist.
[4] Stone Trade Journal, New Wire Saw for Stone Cutting: Vol. 72, No. 3, March 1953, p. 37.

in 1953 was imported. The principal import source was Italy, with the United States next, followed by France and Belgium.[5]

Dimension limestone production in Canada in 1953 increased about 30 percent over the previous year and totaled 82,200 tons, valued at $2,281,000 (Canadian). Production came principally from Ontario with some operations in Quebec, Manitoba, New Brunswick and Newfoundland. About 100 tons was exported to the United States.[6]

The output of dimension granite in 1953 totaled about 40,000 tons. Quebec was the principal producing Province, and relatively small quantities came from New Brunswick, Ontario, Manitoba, Saskatchewan, and British Columbia. Some of these rocks are not true granites but are so known in the trade. In all, 3,400 tons was exported to the United States.[7]

EUROPE

Finland.—A mild recovery of the Finnish granite industry has taken place, and in 1953 dimension granite was produced from 15 quarries in the southwestern part of the country. In 1952, 600 men were employed, compared with a peak of 1,350 men in 1938. Granite paving stones continued to be an important part of production. In 1952 the United States was the largest customer for Finnish exports of granite, United States shipments being valued at 23.5 million Finnish marks.[8]

AFRICA

Union of South Africa.—An increase in the production of "wonderstone" from 343 tons in 1951 to 4,183 in 1952 was reported from the Union of South Africa.[9] Wonderstone is a fine-grained gray rock approximating pyrophyllite in chemical composition; it can be cut and formed with ordinary machine tools and hardened by baking with little danger of deformation. It is highly resistant to chemical action and abrasion and, like soapstone, is used for laboratory table tops and sinks. It derives its name from its versatility.

CRUSHED AND BROKEN STONE

In 1953 crushed- and broken-stone production (excluding stone used for making lime and cement) passed 300 million tons for the first time. Producers reported 2 percent greater tonnage and 3 percent higher value than in the preceding year. The average sales price increased 2 cents per ton to $1.39.

Table 20 shows the quantities and values of sales, by uses, for 1952 and 1953. Detailed data on asphaltic stone and slate granules and flour will be found in the Asphalt and Slate chapters of the Minerals Yearbook.

Tables 21 and 22 provide statistics on the output of crushed stone used for concrete and roadstone and for railroad ballast, 1944–53.

[5] Canada Department of Mines and Technical Survey, Marble in Canada, 1953 (Preliminary): Ottawa, 2 pp.

[6] Canada Department of Mines and Technical Survey, Limestone (Structural) in Canada, 1953 (Preliminary): Ottawa, 2 pp.

[7] Canada Department of Mines and Technical Survey, Granite in Canada, 1953 (Preliminary): Ottawa, 4 pp.

[8] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 2, February 1954, pp. 53–55.

[9] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 4, October 1953, p. 73.

TABLE 20.—Crushed and broken stone sold or used by producers in the United States,[1] 1952–53, by principal uses

Use	1952			1953		
	Short tons	Value		Short tons	Value	
		Total	Average		Total	Average
Concrete and roadstone	[2] 187,264,075	[2] $246,656,141	$1.32	188,721,286	$250,996,336	$1.33
Railroad ballast	21,383,068	20,019,095	.94	20,778,410	20,533,252	.99
Metallurgical	34,908,815	41,119,351	1.18	40,881,304	53,040,512	1.30
Alkali works	6,557,940	6,448,388	.98	6,786,390	6,507,117	.96
Riprap	8,778,585	11,156,047	1.27	7,733,737	10,052,102	1.30
Agricultural	[2] 21,152,208	[2] 34,463,963	1.63	18,452,513	30,133,864	1.63
Refractory (ganister, mica schist, dolomite, soapstone)	1,950,786	7,262,048	3.72	1,937,292	8,079,005	4.17
Asphalt filler	1,002,849	2,934,211	2.93	708,616	2,440,127	3.44
Calcium carbide works	722,729	762,257	1.05	764,752	564,165	.74
Sugar factories	541,419	1,404,391	2.59	677,296	1,740,270	2.57
Glass factories	814,302	1,933,165	2.37	910,989	2,248,590	2.47
Paper mills	359,904	820,769	2.28	324,673	785,806	2.42
Other uses	[2] 14,413,170	[2] 34,465,234	[2] 2.39	15,818,975	36,413,890	2.30
Total	[2] 299,849,850	[2] 409,445,060	1.37	304,496,233	423,535,036	1.39
Portland and natural cement (limestone and cement rock) [3]	64,305,000	(4)		66,251,000	(4)	
Lime [5]	16,146,000	(4)		19,348,000	(4)	
Abrasives and other uses [6]	871,546	6,474,181	7.43	863,736	6,873,207	7.96
Grand total	[2] 381,172,396	(4)		390,958,969	(4)	
Asphaltic stone	1,570,698	4,687,512	2.98	1,440,544	4,349,000	3.02
Slate granules and flour	593,390	6,119,847	10.31	545,686	5,953,661	10.91

[1] Includes Territories of the United States, possessions, and other areas administered by the United States.
[2] Revised figure.
[3] Value reported as cement in chapter on Cement.
[4] No value available for stone used in the manufacture of cement and lime.
[5] Value reported as lime in chapter on Lime.
[6] Ground sandstone, quartzite, and quartz from pegmatite veins or dikes, reported in chapter on Abrasive Materials.

TABLE 21.—Crushed stone for concrete and roadstone and railroad ballast sold or used by producers in the United States,[1] 1944–48 (average) and 1949–53

Year	Concrete and roadstone		Railroad ballast		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1944–48 (average)	89,576,468	$101,015,699	18,197,946	$14,092,131	107,774,414	$115,107,830
1949	124,367,210	158,357,911	17,054,180	15,376,880	141,421,390	173,734,791
1950	147,107,670	192,293,884	18,614,040	17,519,533	165,721,710	209,813,417
1951	168,766,088	216,418,613	21,368,552	20,336,868	190,134,640	236,755,481
1952	[2] 187,264,075	[2] 246,656,141	21,383,068	20,019,095	[2] 208,647,143	[2] 266,675,236
1953	188,721,286	250,996,336	20,778,410	20,533,252	209,499,696	271,529,588

[1] Includes Territories of the United States, possessions, and other areas administered by the United States.
[2] Revised figure.

COMMERCIAL AND NONCOMMERCIAL OPERATIONS

Stone produced primarily for sale in the open market is considered commercial. Noncommercial tonnages include those produced by or for States, counties, municipalities, and other Government units.

Table 23 shows the quantity and average value of crushed stone used for concrete and roadstone during recent years, by both types of operations. The proportion of crushed stone produced from commercial operations in 1953 was 90 percent.

GRANULES

Table 24 shows the output and value of roofing granules since 1944. Separate figures for slate granules are given in the Slate chapter of this volume.

TABLE 22.—Crushed stone for concrete and roadstone and railroad ballast sold or used by producers in the United States in 1953, by States

State	Concrete and road stone		Railroad ballast		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
Alabama	1,047,034	$2,033,496	107,313	$160,969	1,154,347	$2,194,465
Alaska	35,767	130,847			35,767	130,847
American Samoa	74,750	16,500			74,750	16,500
Arizona	[1] 40,509	[1] 55,873			[1] 40,509	[1] 55,873
Arkansas	[1] 257,204	[1] 300,028	(2)	(2)	[1] 257,204	[1] 300,028
California	10,434,506	10,771,937	704,729	697,948	11,139,235	11,469,885
Canton	4,200	8,750			4,200	8,750
Colorado	215,597	227,320	1,475	3,425	217,072	230,745
Connecticut	2,511,268	3,395,883	123,785	136,162	2,635,053	3,532,045
Delaware	72,364	195,382			72,364	195,382
Florida	7,120,875	8,047,598	153,147	182,358	7,274,022	8,229,956
Georgia	5,530,479	9,016,105	[1] 448,558	[1] 539,106	[1] 5,979,037	[1] 9,555,211
Guam	2,080,650	5,573,169			2,080,650	5,573,169
Hawaii	1,288,794	2,640,090			1,288,794	2,640,090
Idaho	376,875	624,925	82,420	81,800	459,295	706,725
Illinois	17,355,884	21,546,699	1,162,791	1,257,591	18,518,675	22,804,290
Indiana	5,648,649	6,897,528	336,577	398,641	5,985,226	7,296,169
Iowa	8,870,687	10,416,948	(2)	(2)	[1] 8,870,687	[1] 10,416,948
Kansas	[1] 5,734,120	[1] 7,610,581	[1] 325,032	[1] 437,998	7,197,949	8,497,159
Kentucky	6,108,354	7,813,930	607,073	560,678	6,715,427	8,374,608
Maine	225,863	506,006	1,165	2,330	227,028	508,336
Maryland	[1] 2,575,626	[1] 3,976,472	[1] 15,887	[1] 22,242	3,320,048	5,244,805
Massachusetts	[1] 2,289,832	[1] 3,252,638	[1] 165,654	[1] 171,752	3,052,069	4,337,549
Michigan	3,728,490	3,845,916	124,580	151,136	3,853,070	3,997,052
Midway	204	638			204	638
Minnesota	[1] 1,330,125	[1] 1,649,644	[1] 356,651	[1] 362,435	[1] 1,686,776	[1] 2,012,079
Missouri	7,936,483	10,650,071	1,468,901	616,074	9,405,384	11,266,145
Montana	3,795	2,250	407,000	445,405	410,795	447,655
Nebraska	435,527	650,753	(2)	(2)	[1] 435,527	[1] 650,753
Nevada	[1] 12,705	[1] 41,135	32,890	106,487	[1] 45,595	[1] 147,622
New Hampshire	(2)	(2)			(2)	(2)
New Jersey	5,454,153	11,186,900	135,220	242,760	5,589,373	11,429,660
New Mexico	(2)	(2)	(2)	(2)	591,522	448,482
New York	[1] 11,162,615	[1] 17,711,566	1,103,493	1,383,682	[1] 12,266,108	[1] 19,095,248
North Carolina	8,256,577	11,955,562	55,594	63,747	8,312,171	12,019,309
Ohio	11,106,715	13,532,741	1,630,225	1,815,459	12,736,940	15,348,200
Oklahoma	[1] 4,508,529	[1] 4,647,520	(2)	(2)	7,402,661	6,026,001
Oregon	4,180,670	5,503,039	255,530	234,604	4,436,200	5,737,643
Panama Canal Zone	170,582	229,382			170,582	229,382
Pennsylvania	[1] 11,947,404	[1] 17,833,345	[1] 531,507	[1] 737,357	13,594,967	20,093,938
Puerto Rico	[1] 612,584	[1] 1,165,675	(2)	(2)	[1] 612,584	1,165,675
Rhode Island	153,749	379,210			153,749	379,210
South Carolina	2,290,639	3,202,517	340,132	482,230	2,630,771	3,684,747
South Dakota	958,455	1,738,790	[1] 6,000	[1] 9,500	[1] 964,455	[1] 1,748,290
Tennessee	[1] 8,549,948	[1] 10,543,058	723,232	720,456	[1] 9,273,180	[1] 11,263,514
Texas	[1] 5,948,530	[1] 5,052,921	[1] 531,116	[1] 528,901	[1] 6,479,646	[1] 5,581,822
Utah	(2)	(2)	(2)	(2)	253,407	112,422
Vermont	(2)	(2)	(2)	(2)	127,081	174,274
Virginia	5,685,204	7,822,455	767,820	874,390	6,453,024	8,696,845
Wake	11,980	20,615			11,980	20,615
Washington	3,363,002	3,866,598	380,450	409,050	3,743,452	4,275,648
West Virginia	1,136,539	1,843,686	420,781	542,187	1,557,320	2,385,873
Wisconsin	[1] 5,239,102	[1] 5,592,996	[1] 12,267	[1] 22,852	5,416,880	5,824,781
Wyoming	207,013	153,406	[1] 589,850	[1] 614,218	[1] 796,863	[1] 767,624
Undistributed	4,430,080	5,115,242	6,669,565	5,517,322	3,488,021	4,178,906
Grand total	188,721,286	250,996,336	20,778,410	20,533,252	209,499,696	271,529,588

[1] To avoid disclosing confidential information, total is somewhat incomplete, the portion not included being combined as "Undistributed."
[2] Included with "Undistributed."

SIZE OF PLANTS

A 3-percent increase in the number of active stone-crushing plants brought the 1953 total to 1,671. The average annual production per plant dropped 2 percent to 167,000 tons. Plants producing less than 25,000 tons a year increased from 422 in 1952 to 491 in 1953 but supplied less than 2 percent of the total output. Forty-five plants producing over 900,000 tons each contributed 29 percent compared with 27 percent contributed in 1952 from the same number of plants. Table 25 shows the size pattern of stone-industry crushing units for 1953.

TABLE 23.—Crushed stone for concrete and roadstone sold or used by commercial and noncommercial operators in the United States,[1] 1944–48 (average) and 1949–53

(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
1944–48 (average)	80,650,130	$1.12	----------	90	8,926,338	$1.16	----------	10	89,576,468	----------
1949	111,094,390	1.27	+3	89	13,272,820	1.27	−2	11	124,367,210	+2
1950	130,977,250	1.32	+18	89	16,130,420	1.20	+22	11	147,107,670	+18
1951	149,995,593	1.30	+15	89	18,770,495	1.15	+16	11	168,766,088	+15
1952	168,534,995	1.32	+12	[2] 90	[2] 18,729,080	[2] 1.26	([3])	[2] 10	[2] 187,264,075	[2] +11
1953	169,398,751	1.34	+1	90	19,322,535	1.26	+3	10	188,721,286	+1

[1] Includes Territories of the United States, possessions, and other areas administered by the United States.
[2] Revised figure.
[3] Revised to none.

TABLE 24.—Roofing granules [1] sold or used in the United States, 1944–48 (average) and 1949–53, by kinds

Year	Natural		Artificially colored		Brick		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1944–48 (average)	408,792	$3,260,792	855,920	$13,100,068	54,678	$880,876	1,319,390	$17,241,736
1949	352,846	3,088,402	977,934	16,489,253	23,425	400,919	1,354,205	19,978,574
1950	489,794	4,312,531	1,294,275	22,276,565	13,660	263,752	1,797,729	26,852,848
1951	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

[1] Manfactured from stone, slate, slag, and brick.
[2] A small quantity of brick granules is included with artificially colored granules.

METHODS OF TRANSPORTATION

A noteworthy trend in methods of crushed-stone transportation has been a decline in the proportion hauled by rail, which reached a new low of 28 percent in 1953. The advantages of greater flexibility and convenience have caused stone producers to turn increasingly to truck transportation. Waterways provide relatively minor but locally important transportation facilities. Table 26 shows additional statistical detail on transportation methods in the crushed-stone industry during 1953.

GRANITE

Total sales of crushed and broken granite for 1953 increased 5 percent in quantity and 4 percent in value over 1952. The tonnage of riprap declined 23 percent, and that for miscellaneous uses increased 91 percent. Other uses were not greatly changed, nor was the

TABLE 25.—Number and production of commercial crushed-stone[1] plants in the United States in 1952–53, by size of output

Size of output	1952				1953			
	Number of plants	Total production of plants (short tons)	Percent of total	Cumulative total (short tons)	Number of plants	Total production of plants (short tons)	Percent of total	Cumulative total (short tons)
Less than 1,000 tons	39	18,220	0.01	18,220	59	25,125	0.01	25,125
1,000 to 25,000	383	4,091,743	1.48	4,109,963	432	4,910,468	1.76	4,935,593
25,000 to 50,000	227	8,209,243	2.98	12,319,206	209	7,682,157	2.76	12,617,750
50,000 to 75,000	183	11,294,205	4.09	23,613,411	186	11,649,006	4.18	24,266,756
75,000 to 100,000	133	11,382,893	4.13	34,996,304	148	12,730,244	4.57	36,997,000
100,000 to 200,000	280	38,978,620	14.12	73,974,924	277	39,419,406	14.15	76,416,406
200,000 to 300,000	130	31,708,725	11.49	105,683,649	132	32,430,760	11.64	108,847,166
300,000 to 400,000	75	26,141,876	9.47	131,825,525	70	23,873,462	8.57	132,720,628
400,000 to 500,000	47	20,955,656	7.59	152,781,181	48	21,410,101	7.68	154,130,729
500,000 to 600,000	32	17,366,000	6.29	170,147,181	23	13,025,734	4.68	167,156,463
600,000 to 700,000	19	11,983,764	4.34	182,130,945	21	13,579,270	4.87	180,735,733
700,000 to 800,000	16	11,944,498	4.33	194,075,443	10	7,541,860	2.71	188,277,593
800,000 to 900,000	8	6,738,334	2.44	200,813,777	11	9,575,463	3.44	197,853,056
900,000 tons and over	45	75,166,312	27.24	275,980,089	45	80,732,186	28.98	278,585,242
Total	1,617	275,980,089	100.00	275,980,089	1,671	278,585,242	100.00	278,585,242

[1] Excludes marble, primarily a dimension-stone industry, and excludes stone used for abrasives and in making cement and lime. Includes Hawaii and Puerto Rico.

TABLE 26.—Crushed stone sold or used in the United States[1] in 1953, 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	140,394,555	50	165,928,001	54
Rail	85,086,730	31	85,086,730	28
Waterway	30,129,216	11	30,129,216	10
Unspecified	23,352,286	8	23,352,286	8
Total	278,962,787	100	304,496,233	100

[1] Excludes stone used for abrasives and in making cement and lime. Includes Territories of the United States, possessions, and other areas administered by the United States.
[2] Entire output of noncommercial operations assumed to be moved by truck.

average price per ton. North Carolina remained the largest producing State, followed by Georgia, California, South Carolina, and Virginia, in that order.

BASALT AND RELATED ROCKS (TRAPROCK)

Basalt, gabbro, diorite, and other dark, igneous rocks, commercially classified as traprock, are widely used for concrete aggregate, roadstone and railroad ballast, and to a lesser extent for riprap and "other uses." Sales in 1953 were 1 percent greater than in 1952, but the total value remained about the same owing to a drop in unit value from $1.56 per ton to $1.54. There were no major changes in sales or total value for individual uses. New Jersey was again the principal producing State, with Washington next, followed in order by Oregon and Connecticut.

TABLE 27.—Granite (crushed and broken stone) sold or used by producers in the United States in 1953, 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	11,319	$38,864	31,427	$106,847					42,746	$145,711
Arizona			17,382	22,062					17,382	22,062
California	172,685	149,251	2,104,708	1,854,475	(2)	(2)	(2)	(2)	3,559,749	2,975,692
Colorado			1,800	666					1,800	666
Connecticut	(2)	(2)					(2)	(2)	1,536	4,026
Delaware			72,364	195,382			8,000	$20,000	80,364	215,382
Georgia	(2)	(2)	5,095,641	8,346,975	448,558	$539,106	(2)	(2)	5,866,434	9,177,989
Maine	1,901	3,103	46,806	114,260					48,707	117,363
Maryland	14,100	49,350	49,667	111,807					63,767	161,157
Massachusetts	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	686,205	1,086,875
Michigan			12,741	23,595					12,741	23,595
Minnesota	(2)	(2)	(2)	(2)	356,651	362,435	(2)	(2)	452,586	520,354
Missouri	3,182	5,374							3,182	5,374
Montana	118,645	181,876							118,645	181,876
New Hampshire	(2)	(2)	(2)	(2)			(2)	(2)	7,630	8,912
New Jersey	1,721	2,409	376,339	566,039	5,003	8,004			383,063	576,452
North Carolina	12,834	22,582	5,804,832	8,599,687	47,736	55,103	573,014	488,433	6,438,416	9,165,805
North Dakota	35,031	2,595							35,031	2,595
Oregon							(2)	(2)	(2)	(2)
Pennsylvania							3,051	1,526	3,051	1,526
Puerto Rico			(2)	(2)					(2)	(2)
Rhode Island	(2)	(2)	(2)	(2)			(2)	(2)	(2)	(2)
South Carolina	(2)	(2)	2,127,747	2,983,735	340,132	482,230	(2)	(2)	2,660,989	3,587,827
Tennessee			(2)	(2)					(2)	(2)
Vermont			(2)	(2)					(2)	(2)
Virginia	(2)	(2)	1,276,159	1,882,450	(2)	(2)	(2)	(2)	1,577,318	2,230,698
Washington			1,180	3,545			22,340	69,590	23,520	73,135
Wisconsin	(2)	(2)	204,844	173,363					(2)	(2)
Wyoming	14,969	71,660			443,118	522,879			458,087	594,539
Undistributed	101,457	178,878	544,564	809,300	637,014	860,261	1,747,400	1,408,818	345,113	438,904
Total	487,844	705,942	17,768,201	25,794,188	2,278,212	2,830,018	2,353,805	1,988,367	22,888,062	31,318,515
Average unit value		$1.45		$1.45		$1.24		$0.84		$1.37

[1] Includes stone used for fill material, poultry grit, road base, stone sand, and unspecified uses.
[2] Included with "Undistributed" to avoid disclosure of individual company operations.

TABLE 28.—Basalt and related rocks (traprock) (crushed and broken stone) sold or used by producers in the United States in 1953, 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			2, 750	$1, 500					2, 750	$1, 500
Arizona			140	300					140	300
California	66, 156	$96, 696	2, 296, 615	2, 452, 537	222, 395	$231, 404	78, 843	$19, 709	2, 664, 009	2, 800, 346
Colorado	(2)	(2)							(2)	(2)
Connecticut	33, 918	40, 414	2, 510, 878	3, 394, 741	123, 785	136, 162			2, 668, 581	3, 571, 317
Hawaii	(2)	(2)	(2)	(2)			(2)	(2)	1, 299, 501	2, 654, 358
Idaho	163, 620	181, 800	367, 975	616, 025			412, 711	1, 160, 350	944, 306	1, 958, 175
Maryland	(2)	(2)	(2)	(2)	(2)	(2)			729, 857	1, 248, 214
Massachusetts	22, 526	17, 406	1, 893, 002	2, 609, 885	165, 654	171, 752	3, 938	15, 284	2, 085, 120	2, 814, 327
Michigan			26, 310	37, 586					26, 310	37, 586
Montana	16, 795	16, 190			147, 675	176, 550	38, 260	7, 655	202, 730	200, 395
Nevada			(2)	(2)					(2)	(2)
New Jersey	84, 189	153, 112	5, 051, 296	10, 560, 504	130, 217	234, 756	70, 156	107, 757	5, 335, 858	11, 056, 129
New Mexico	30, 380	55, 800							30, 380	55, 800
New York			1, 872, 970	3, 264, 619	116, 318	169, 449			1, 989, 288	3, 434, 068
Oregon	58, 695	48, 606	3, 713, 325	4, 803, 894	223, 415	193, 938	72, 700	60, 250	4, 068, 135	5, 106, 688
Panama Canal Zone	1, 326	2, 370	170, 582	229, 382					171, 908	231, 752
Pennsylvania	3, 501	5, 329	1, 757, 986	2, 717, 322	(2)	(2)	(2)	(2)	2, 392, 625	4, 173, 771
Rhode Island			40, 000	80, 000					40, 000	80, 000
Texas	(2)	(2)	(2)	(2)	(2)	(2)			(2)	(2)
Virginia			590, 437	962, 669					590, 437	962, 669
Washington	389, 365	357, 561	3, 281, 857	3, 762, 703	380, 450	409, 050	68, 560	44, 135	4, 120, 232	4, 573, 449
Wisconsin	2, 191	4, 324	84, 626	185, 446	12, 267	22, 852	(2)	(2)	(2)	(2)
Undistributed	7, 027	20, 436	2, 097, 001	3, 662, 706	772, 856	1, 180, 619	360, 750	1, 579, 740	676, 222	1, 302, 431
Total	879, 689	1, 000, 044	25, 757, 750	39, 341, 819	2, 295, 032	2, 926, 532	1, 105, 918	2, 994, 880	30, 038, 389	46, 263, 275
Average unit value		$1. 14		$1. 53		$1. 28		$2. 71		$1. 54

[1] Includes stone sold for fill material, roofing granules, and unspecified uses.
[2] Included with "Undistributed," to avoid disclosure of individual company operations.

MARBLE

Crushed, broken, and pulverized marble are byproducts of quarries and milling operations that produce dimension marble. The footnote to table 29 lists the principal uses. As these products serve a variety of markets, there is considerable variation in unit value. Waste marble having virtually the same composition as limestone is sometimes substituted for it.

TABLE 29.—Marble (crushed and broken stone) sold by producers in the United States in 1953, by States [1]

State	Active plants	Short tons	Value	State	Active plants	Short tons	Value
Alabama	3	(2)	(2)	Tennessee	7	31,142	$173,398
Arizona	1	900	$18,000	Texas	1	19,400	384,120
California	1	(2)	(2)	Vermont	2	(2)	(2)
Georgia	1	(2)	(2)	Virginia	1	(2)	(2)
Maryland	1	(2)	(2)	Washington	4	3,325	15,920
Missouri	1	6,829	64,494	Undistributed		297,375	2,771,518
New Jersey	1	5,100	132,600				
New York	1	13,474	200,000	Total	26	[3]377,545	[3] 3,760,050
North Carolina	1	(2)	(2)	Average unit value			$9.96

[1] Includes stone used for agriculture, asphalt filler, cast stone, composition flooring, concrete and roadstone, magnesia, mineral food, plaster, poultry grit, roofing, stucco, terrazzo, tile, whiting (excluding marble whiting made by companies that purchase their marble), and unspecified uses.
[2] Included with "Undistributed" to avoid disclosure of individual company operations.
[3] Includes some byproduct marble formerly reported to the Bureau as crushed limestone.

LIMESTONE

Limestone was produced commercially in all but three States—Delaware, New Hampshire, and North Dakota. It is more widely distributed and has a greater variety of uses and a greater quantity is produced than any other stone. In 1953 it constituted 74 percent of the total crushed and broken stone (excluding that used in making cement and lime) produced in the United States. Total sales were 3 percent higher than in 1952. There was a substantial increase in sales of fluxing stone, aggregate for concrete and roadstone, and railroad ballast. Both riprap and agricultural limestone declined. The average unit value was 1 cent lower at $1.35 per ton.

Details of crushed- and broken-limestone production, by uses and States, are shown in table 30. The quantities and values of limestone applied to "Miscellaneous" uses is shown in table 31.

Dolomite (high-magnesium limestone) is used for many purposes to which high-calcium limestone is not applicable. Dead-burned dolomite is calcined at around 3,000 ° F. and is employed as a refractory lining in metallurgical furnaces. Dolomite is also used raw for patching furnace floors. Statistical data on dead-burned dolomite (also known as refractory lime) are given in the Lime chapter in this volume. Table 32 shows the quantity of dolomite and dolomitic lime consumed in several major markets.

Table 33 shows the tonnage and value of limestone used as fluxing stone in metallurgical operations, the second largest use after aggregate.

As the large tonnage of limestone used in making lime and cement is a major factor in the stone industry, it must be included in any comprehensive commodity review. Table 34 shows the total tonnage of limestone consumed for all purposes, including that of cement and lime.

SANDSTONE

Concrete and roadstone was the only important use classification of sandstone for which consumption increased during 1953. Quantities for all other principal classes decreased. Total sales for the year were virtually the same as in 1952, but the unit value increased 13 percent to $2.37 per ton. California was the largest producer, with over 2 million tons, followed in order by Pennsylvania, Texas, and South Dakota. Table 35 shows sandstone sales for 1953, by States and uses.

MISCELLANEOUS STONE

The miscellaneous stone category includes various types of stone, used in significant quantities, that are not among the five principal varieties already discussed. This group includes light-color volcanic rocks, schists, boulders, serpentine, flint, and chats. The latter is an ore-dressing byproduct of lead-zinc mining in the Missouri-Kansas-Oklahoma field. The output of these miscellaneous varieties declined 16 percent in quantity but increased 7 percent in value during 1953, compared with the previous year. The unit value rose from 86 cents to $1.08 per ton. California was the chief producing State.

TABLE 30.—Limestone (crushed and broken stone) sold or used by producers in the United States in 1953, 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	84,924	$124,232	2,289,242	$3,468,741	1,047,034	$2,033,496	107,313	$160,969	198,238	$255,596	242,762	$535,959	3,969,513	$6,578,993
Arizona			86,909	132,607	22,987	33,511					543	3,169	110,439	169,287
Arkansas			604,035	607,102	(1)	(1)			(1)	(1)	14,139	84,834	677,620	778,860
California	73,173	154,133	63,021	185,092	1,000,982	946,300			1,095	3,488	853,678	3,640,992	1,991,949	4,930,005
Colorado			506,358	858,333	(1)	(1)					(1)	(1)	678,926	1,234,607
Connecticut			(1)	(1)	390	1,142			(1)	(1)	(1)	(1)	149,675	452,813
Florida	12,000	9,600			7,120,875	8,047,598	153,147	182,358	428,221	1,436,612	1,714,716	1,633,253	9,428,959	11,309,421
Georgia	1,500	2,250			434,838	669,130	(1)	(1)	(1)	(1)	198,539	1,084,802	899,105	2,230,111
Hawaii					(1)	(1)					(1)	(1)	(1)	(1)
Idaho			20,000	33,500	8,900	8,900					86,000	178,500	114,900	220,900
Illinois	141,210	178,903	288,583	475,980	17,355,884	21,546,699	1,162,791	1,257,591	2,867,486	3,847,163	1,095,982	2,267,285	22,911,936	29,573,621
Indiana	147,456	268,975	86,683	105,385	5,648,649	6,897,528	336,577	398,641	1,890,843	2,410,352	140,623	585,605	8,250,831	10,666,486
Iowa	497,153	632,529	(1)	(1)	8,870,687	10,416,948	(1)	(1)	1,236,676	1,574,292	78,254	532,801	10,710,492	13,191,958
Kansas	625,389	786,671	30	45	5,536,396	7,247,288	220,482	291,628	528,363	827,016	76,193	266,231	6,986,853	9,418,879
Kentucky	36,377	40,254			6,108,354	7,813,930	607,073	560,678	677,701	853,375			7,429,505	9,268,237
Maine	(1)	(1)							(1)	(1)	(1)	(1)	(1)	(1)
Maryland	35,400	61,950			2,525,959	3,864,665	15,887	22,242	56,737	227,195	95,094	358,008	2,729,077	4,534,060
Massachusetts	463	373	(1)	(1)	400	350			102,270	366,379	(1)	(1)	191,945	838,460
Michigan	70,062	99,617	12,746,549	9,780,588	3,614,329	3,693,485	124,580	151,136	624,922	587,623	4,315,678	3,118,035	21,496,120	17,430,484
Minnesota	87,686	79,163	1,850	3,675	1,330,125	1,649,644	(1)	(1)	289,016	435,096	(1)	(1)	1,752,982	2,327,431
Mississippi									38,000	43,700			38,000	43,700
Missouri	1,651,517	1,857,803	(1)	(1)	7,717,996	10,530,601	620,461	290,205	1,888,620	2,665,960	(1)	(1)	12,683,640	18,698,526
Montana	11,510	2,850	(1)	(1)	3,795	2,250	96,445	106,645			(1)	(1)	315,615	578,750
Nebraska	551,547	539,620			435,527	650,753	(1)	(1)	171,683	273,032	(1)	(1)	1,407,158	2,069,984
Nevada			(1)	(1)							(1)	(1)	(1)	(1)
New Jersey			(1)	(1)	26,518	60,357			(1)	(1)	(1)	(1)	312,238	1,542,675
New York	141,350	313,953	131,942	184,867	9,289,645	14,446,947	911,814	1,128,322	983,161	1,893,247	2,474,400	3,019,792	13,932,312	20,987,128
North Carolina					2,317,475	3,237,675	7,858	8,644	5,946	7,136	26,219	19,761	2,357,498	3,273,216
Ohio	80,643	97,904	8,880,834	10,394,160	11,106,715	13,532,741	1,630,225	1,815,459	2,052,719	3,480,648	1,705,320	3,678,782	25,456,456	32,999,694
Oklahoma	(1)	(1)	(1)	(1)	4,508,529	4,647,520	(1)	(1)	205,311	229,439	(1)	(1)	5,570,713	5,944,909
Oregon					58,260	89,540			14,805	29,715	319,920	355,290	392,985	474,545
Pennsylvania	164,096	253,169	9,351,478	16,514,344	9,475,184	13,846,230	335,792	457,562	895,093	2,712,796	1,338,388	3,203,750	21,560,031	36,987,851
Puerto Rico	3,200	12,000			612,584	1,165,675	(1)	(1)	(1)	(1)	12,379	16,923	631,848	1,203,503
Rhode Island			(1)	(1)	(1)	(1)					(1)	(1)	(1)	(1)
South Carolina					162,892	218,782			89,979	169,761			252,871	388,543

South Dakota	2,720	4,550	----------	----------	278,032	554,897	6,000	9,500	----------	----------	10,500	21,000	297,252	589,947
Tennessee	(1)	(1)	(1)	(1)	8,549,948	10,543,058	723,232	720,456	712,004	918,100	172,799	436,165	10,373,162	12,870,198
Texas	69,501	84,740	285,020	282,693	4,394,645	4,182,927	531,116	528,901	51,089	39,449	901,423	805,757	6,232,794	5,924,467
Utah	59,256	84,766	(1)	(1)	(1)	(1)	(1)	(1)	----------	----------	154,712	509,480	947,014	1,288,444
Vermont	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	133,886	1,005,762	373,733	1,580,945
Virginia	(1)	(1)	429,108	660,190	3,753,294	4,844,350	501,493	557,731	808,147	1,388,442	(1)	(1)	6,715,906	10,061,182
Washington	----------	----------	16,500	45,450	630	2,420	----------	----------	68,155	309,795	90,440	320,360	175,725	678,025
West Virginia	----------	----------	3,689,511	5,960,661	1,030,908	1,653,363	420,781	542,187	49,410	95,910	204,907	481,967	5,395,517	8,734,088
Wisconsin	34,955	40,654	18,674	21,469	4,949,632	5,234,187	(1)	(1)	954,111	1,401,422	(1)	(1)	6,259,263	7,103,065
Wyoming	(1)	(1)	(1)	(1)	200,861	138,026	(1)	(1)	----------	----------	(1)	(1)	820,401	1,138,664
Undistributed	234,902	316,192	1,384,977	3,325,630	644,553	766,860	1,209,648	1,507,411	562,712	1,651,125	3,438,281	8,683,651	931,750	1,670,518
Total [2]	4,817,990	6,046,851	40,881,304	53,040,512	130,144,412	165,219,773	9,722,715	10,698,266	18,452,513	30,133,864	19,895,775	36,847,914	223,914,709	301,987,180
Average unit value	----------	$1.26	----------	$1.30	----------	$1.27	----------	$1.10	----------	$1.63	----------	$1.85	----------	$1.35

[1] Included with "Undistributed" to avoid disclosure of individual company operations.
[2] Excludes limestone used in making cement and lime, reported in chapters on Cement and Lime.

TABLE 31.—Limestone (crushed and broken stone) sold or used by producers in the United States [1] for miscellaneous uses, 1952–53

Use	1952		1953	
	Short tons	Value	Short tons	Value
Alkali works	6,557,940	$6,448,388	6,786,390	$6,507,117
Calcium carbide works	722,729	762,257	764,752	564,165
Coal-mine dusting	421,847	1,685,124	401,391	1,495,114
Filler (not whiting substitute):				
Asphalt	1,002,849	2,934,211	708,616	2,440,127
Fertilizer	599,856	1,165,437	437,986	809,916
Other	350,359	1,312,562	296,136	1,087,061
Filter beds	89,025	145,492	75,951	135,260
Glass factories	814,302	1,933,165	910,989	2,248,590
Limestone sand	1,697,657	2,157,633	1,754,023	2,265,817
Limestone whiting [2]	[3] 762,354	[3] 7,164,895	635,490	4,387,944
Magnesia works (dolomite) [4]	433,041	859,151	353,573	950,786
Mineral food	549,329	2,963,723	503,779	2,756,447
Mineral (rock) wool	10,811	14,119	12,210	18,150
Paper mills	359,904	820,769	324,673	785,806
Poultry grit	78,866	603,509	103,075	648,965
Refractory (dolomite)	707,741	1,047,662	766,404	1,098,153
Road base	1,370,970	1,244,975	2,283,041	1,967,440
Stucco, terrazzo, and artificial stone	121,192	1,085,853	104,195	997,266
Sugar factories	541,419	1,404,391	677,296	1,740,270
Other uses [5]	995,452	1,562,975	696,198	2,121,596
Use unspecified	1,140,872	1,568,586	1,299,607	1,821,924
Total	19,328,515	38,884,877	19,895,775	36,847,914

[1] Includes Hawaii and Puerto Rico.
[2] Includes stone for filler for calcimine, caulking compounds, ceramics, chewing gum, explosives, floor coverings, foundry compounds, glue, grease, insecticides, leather goods, paint, paper, phonograph records, picture-frame moldings, plastics, pottery, putty, roofing, rubber, toothpaste, wire coating, and unspecified uses. Excludes limestone whiting made by companies from purchased stone.
[3] Includes some whiting made from byproduct marble.
[4] Includes stone for refractory magnesia.
[5] Includes stone for acid neutralization, carbon dioxide, chemicals (unspecified), concrete blocks and pipes, dyes, electric products, fill material, magnesium metal, oil-well drilling, patching plaster, rayons, roofing granules, spalls, and water treatment.

TABLE 32.—Dolomite and dolomitic lime sold or used by producers in the United States for specified purposes, 1952–53

	1952		1953	
	Short tons	Value	Short tons	Value
Dolomite for—				
Basic magnesium carbonate [1]	433,041	$859,151	353,573	$950,786
Refractory uses	707,741	1,047,662	766,404	1,098,153
Dolomitic lime for—				
Refractory (dead-burned dolomite)	1,928,025	26,098,455	2,294,815	31,455,384
Paper mills	40,000	488,000	41,000	495,000
Total (calculated as raw stone) [2]	5,077,000	------------	5,792,000	------------

[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, 1944–48 (average) and 1949–53, 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
1944–48 (average)	23, 555, 780	$19 718 424	5, 999, 832	$5 687 754	505, 096	$546, 437	209, 256	$234, 644	30, 269, 964	$26,187,259
1949	23, 768, 970	24, 127, 897	5, 922, 020	6, 929, 134	728, 960	835, 962	332, 370	374, 649	30, 752, 320	32, 267, 642
1950	28, 397, 710	29, 222, 700	6, 936, 900	7, 948, 041	457, 630	587, 643	177, 580	174, 004	35, 969, 820	37, 932, 388
1951	32, 007, 284	35, 941, 217	6, 784, 102	8, 279, 021	842, 877	992, 651	295, 694	409, 236	39, 929, 957	45, 622, 125
1952	28, 158, 299	32, 857, 562	5, 629, 204	6, 879, 035	926, 063	1,142,894	195, 249	239, 860	34, 908, 815	41, 119, 351
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

[1] Includes flux for copper, gold, lead, zinc, and unspecified smelters.
[2] Includes flux for foundries and for cupola and electric furnaces.

TABLE 34.—Limestone (dimension, crushed, and broken) sold or used for all purposes in the United States [1], 1951–53, in short tons

Use	1951	1952	1953
Limestone (as given in this report) (approximate)	205, 480, 000	217, 255, 000	224, 714, 000
Portland and natural cement (limestone and cement rock) [2]	64, 284, 000	64, 305, 000	66, 251, 000
Lime [3]	16, 511, 000	16, 146, 000	19, 348, 000
Total	286, 275, 000	297, 706, 000	310, 313, 000

[1] Includes Hawaii and Puerto Rico.
[2] Reported in terms of cement in Cement chapter of this volume.
[3] Reported in terms of lime in Lime chapter of this volume.

TABLE 35.—Sandstone and quartzite (crushed and broken stone) sold or used by producers in the United States in 1953, by States and uses

State	Refractory stone (ganister)		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	Short tons	Value
Alabama	(2)	(2)									(2)	(2)
Arizona									(2)	(2)	(2)	(2)
Arkansas					257,204	$300,028					257,204	$300,028
California	(2)	(2)	306,165	$580,573	1,726,330	2,112,387	(2)	(2)	(2)	(2)	2,087,473	2,802,939
Colorado	28,416	$84,971	(2)	(2)	(2)	(2)	1,475	$3,425	300	$1,200	166,226	200,232
Idaho							82,420	81,800			82,420	81,800
Illinois	816	13,056									816	13,056
Kansas			270,400	280,845	197,724	363,293	104,550	146,370	18,750	9,500	591,424	800,008
Maine			7,874	12,719	179,057	391,746	1,165	2,330			188,096	406,795
Michigan			187	561							187	561
Missouri			100	148							100	148
Montana	2,340	1,255					162,880	162,210	525	245	165,745	163,710
New Mexico			(2)	(2)	(2)	(2)					722	3,085
Ohio	97,725	1,124,302	33,473	103,133					11,651	17,310	142,849	1,244,745
Oklahoma									228,347	134,207	228,347	134,207
Pennsylvania	588,583	3,481,474	39	78	714,234	1,269,793	195,715	279,795	16,156	49,589	1,514,727	5,080,729
South Dakota	(2)	(2)	(2)	(2)	564,213	1,119,440	(2)	(2)	(2)	(2)	750,023	1,399,011
Tennessee	1,122	6,732	100	400							1,222	7,132
Texas			1,892	946	243,750	155,000			556,052	278,028	801,694	433,974
Utah	(2)	(2)									(2)	(2)
Virginia	(2)	(2)			65,314	132,986	(2)	(2)	(2)	(2)	185,939	443,230
Washington			375	3,320							375	3,320
West Virginia					105,631	190,323					105,631	190,323
Wisconsin	243,100	1,326,239							(2)	(2)	(2)	(2)
Undistributed	190,810	841,267	156,558	206,657	135,009	108,135	33,633	45,659	769,488	4,212,930	1,030,428	5,927,372
Total [3]	1,152,912	6,879,296	777,163	1,189,380	4,188,466	6,143,131	581,838	721,589	1,601,269	4,703,009	8,301,648	19,636,405
Average unit value		$5.97		$1.53		$1.47		$1.24		$2.94		$2.37

[1] Includes sandstone for fill material, filter stone, road base, roofing granules, smelter flux, spalls, stone sand, and unspecified uses.
[2] Included with "Undistributed" to avoid disclosure of individual company operations.
[3] Excludes ground sandstone and quartzite used for abrasives; in manufacture of pottery, porcelain, and tile; fillers; and other uses, reported in chapter on Abrasive Materials.

TABLE 36.—Miscellaneous varieties of stone (crushed and broken stone) sold or used by producers in the United States in 1953, 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			4,340	$24,000					4,340	$24,000
American Samoa			72,000	15,000					72,000	15,000
Arizona			([2])	([2])			([2])	([2])	([2])	([2])
Arkansas	([2])	([2])	([2])	([2])	([2])	([2])	([2])	([2])	([2])	([2])
California	253,993	$558,616	3,305,871	3,406,238	356,647	$328,329	279,636	$386,094	4,196,147	4,679,277
Canton Island			4,200	8,750					4,200	8,750
Colorado			18,707	8,510					18,707	8,510
Guam			2,080,650	5,573,169					2,080,650	5,573,169
Kansas	12,060	10,251	([2])	([2])	([2])	([2])			1,150,857	458,831
Maryland	456	228							456	228
Massachusetts	12,000	16,000	396,430	642,403					408,430	658,403
Michigan			75,110	91,250					75,110	91,250
Midway Island			204	638					204	638
Missouri	641	1,282	218,487	119,470	848,440	325,869	124,251	284,802	1,191,819	731,423
Nevada	2,427	3,649	12,705	41,135	32,890	106,487			48,022	151,271
New Hampshire			([2])	([2])					([2])	([2])
New Mexico	([2])	([2])	([2])	([2])	([2])	([2])	([2])	([2])	593,304	450,838
New York			([2])	([2])	([2])	([2])	([2])	([2])	([2])	([2])
North Carolina			134,270	118,200			345,814	463,436	480,084	581,636
Oklahoma	([2])	([2])	([2])	([2])	([2])	([2])			2,600,213	1,061,822
Oregon	32,135	29,225	409,085	609,605	32,115	40,666	155	175	473,490	679,671
Pennsylvania			([2])	([2])			([2])	([2])	571,549	768,552
Puerto Rico			([2])	([2])	([2])	([2])			([2])	([2])
Rhode Island			([2])	([2])					([2])	([2])
South Dakota			116,210	64,453					116,210	64,453
Texas	([2])	([2])	1,310,135	714,994	([2])	([2])	([2])	([2])	2,022,271	1,090,319
Utah	16,556	30,146							16,556	30,146
Virgin Islands							10,789	45,853	10,789	45,853
Wake Island			11,980	20,615					11,980	20,615
Washington	14,960	12,715	79,335	97,930			14,430	23,090	108,725	133,735
Wisconsin			([2])	([2])			([2])	([2])	([2])	([2])
Wyoming			6,152	15,380	146,732	91,339			152,884	106,719
Undistributed	425,823	447,773	2,606,586	2,925,685	4,483,789	2,464,157	666,684	402,004	2,566,883	3,134,502
Total [3]	771,051	1,109,885	10,862,457	14,497,425	5,900,613	3,356,847	1,441,759	1,605,454	18,975,880	20,569,611
Average unit value		$1.44		$1,33		$0.57		$1.11		$1.08

[1] Includes stone used for agriculture, fill material, refractory, road base, roofing granules, spalls, and unspecified uses.
[2] Included with "Undistributed" to avoid disclosure of individual company operations.
[3] Excludes quartz from pegmatite veins or dikes used for abrasives, ferrosilicon manufacture, glassmaking, and other uses, reported in chapter on Abrasive Materials.

CONSUMPTION AND USES

Because the principal use of crushed stone is as aggregate in concrete, stone sales tend to have a definite relationship to portland-cement shipments and to the value of construction contracts. Figure 3 shows graphically these relationships over a period of 19 years.

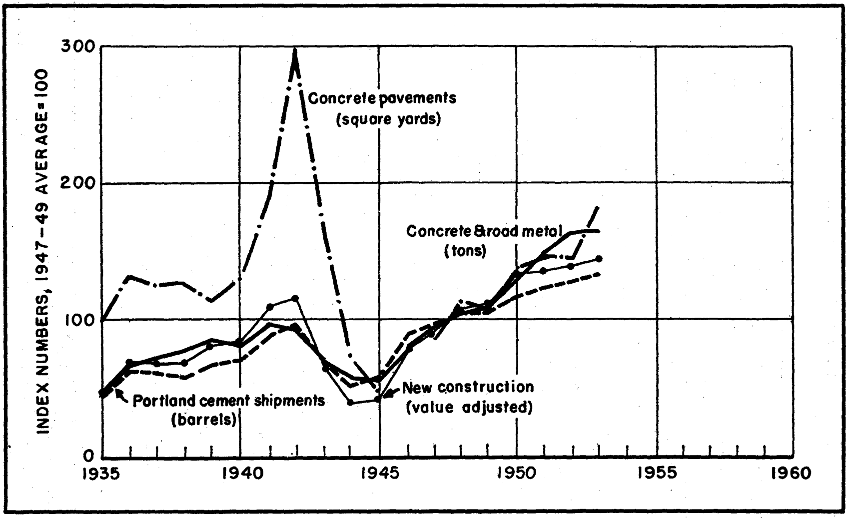

FIGURE 3.—Crushed-stone aggregates (concrete and road metal (roadstone)) sold or used in the United States compared with shipments of portland cement, total new construction (value), and concrete pavements (contract awards, square yards), 1935–53.

[Data on construction and concrete pavements from Survey of Current Business, U. S. Department of Commerce. Construction value adjusted to 1947–49 prices.]

Figure 4 charts the relationship of crushed stone used in the metallurgical industries to production of steel ingot and pig iron.

TECHNOLOGY

Theoretical calculations have been determined for the quantity of limestone required at various screen sizes to attain optimum soil conditioning.[10]

Experiments at Purdue University indicated that 4- to 10-mesh agricultural limestone is almost as effective on certain crops as 50-mesh fines.[11]

Operation of a rotary vacuum sand wheel for recovering fines in a stone-crushing plant was described. This device was used to dewater the discharge from a rod mill and increased recovery of fines.[12]

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[10] Coleman, O. T., Limestone Pays When Properly Used: Rock Products, vol. 56, No. 5, May 1953, p. 104.

[11] Simpson, Ralph E., Of What Value Are Coarse Particles in Agstone?: Rock Products, vol. 56, No. 12, December 1953, pp. 97, 144.

[12] Lenhart, Walter B., Processing Aggregates for Denver's Dam No. 22: Rock Products, vol. 56, No. 10, October 1953, pp. 94–96.

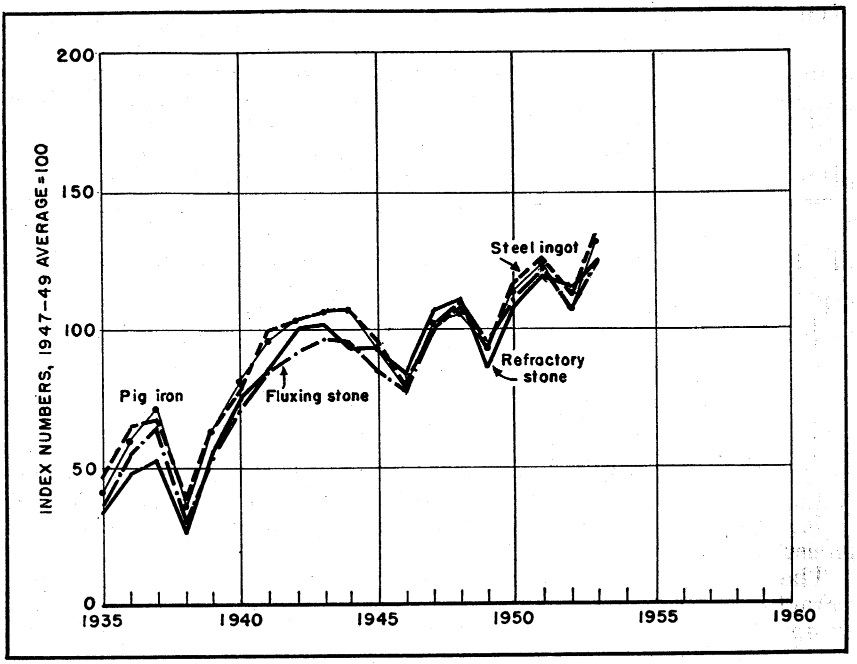

FIGURE 4.—Sales (tons) of fluxing stone and refractory stone (including that used in making dead-burned dolomite) compared with production of steel ingot and pig iron, 1935–53.

[Statistics of steel-ingot production compiled by American Iron and Steel Institute.]

An article described two methods of dust control in a rock-crushing plant.[13] The rock was sprayed at selected points in the system with water charged with a wetting agent. The wetting agent was diffused so thoroughly throughout the fragments that at a moisture content of 0.5 percent the dust count conformed to the limits specified by New York State. In a "black top" plant, dust was controlled by use of an air-cyclone system and high-velocity jets of water impinging on baffles within a dust collector.

Electric heaters to heat vibrating screens were being used to reduce screen blinding by particles that would otherwise adhere to the screen cloth. Adherence of fines to larger particles is also minimized. Heating units were connected to the screen cloth of double-deck screens via a copper distributor bar. A low-voltage, high-amperage current was transmitted to the screen cloth, heating it to a temperature of about 150° F.[14]

An English quarry producing crushed granite faced the problem of transporting its product from the primary crusher, at a very steep angle, to a loading station 460 feet below. Originally inclined skips on rails lowered the rock, but recently a gravity system was developed. The system includes storage capacity for 1,500 tons of stone; and move-

[13] Lenhart, Walter B., Making a Stone Plant Dust-Free: Rock Products, vol. 56, No. 12, December 1953, pp. 102–103, 110.

[14] Gutschick, Kenneth A., Dolese and Shepard Revamps Quarry Haulage System: Pit and Quarry, vol. 46, No. 5, November 1953, pp. 103–108.

ment is controlled by chutes, baffles, and a chain curtain made of 3-inch links that can be raised or lowered.[15]

In beneficiating dolomite that had been intruded by stringers of granite, a heavy-medium separation was used successfully. A silica content of 2.7 percent to 7.7 percent was reduced to 0.6 percent. A mixture of magnetite and ferrosilicon constituted the medium, loss of which was 0.4 pound per ton of beneficiated dolomite. Feed to the separatory cone was a washed and scrubbed plus-¼-inch, minus-4½-inch product.[16]

The hazards of churn drilling and advisable safety precautions were outlined in an article.[17]

An article described a plant in which dolomite was burned in an 11¼- by 390-foot kiln, the world's longest for producing refractory dolomite. Powdered coal was the fuel used.[18]

Jet piercing of blast holes was used experimentally in a granite gneiss quarry for holes more than 100 feet deep.[19]

The quarrying operations and processing facilities of a new silica-refractories plant which incorporates the latest feature of design and equipment known to the industry were described in an article.[20] The supply of rock was obtained from a 60-foot face of coarse quartz conglomerate.

A 73-inch roller mill has been installed to grind agricultural limestone. Feed to the mill was minus ¾-inch, and capacity was 35 tons per hour of approximately 65 percent passing 200-mesh. A 400-hp.-drive motor is required.[21]

WORLD REVIEW

Canada.—In 1953 production of granite in Canada totaled 1,946,000 tons valued at C$6,011,000. Rubble, riprap, and aggregate for concrete and road construction constituted 98 percent of this total. Production declined 22 percent from the previous year.

There was a 4-percent increase in the production of crushed and broken limestone, which totaled 16,555,000 tons in 1953, not including that used for making lime and cement. The value was C$22,744,000.

The output of crushed marble increased 15 percent to 66,000 tons in 1953 compared with 1952. Most of this was crushed material used for terrazzo flooring, artificial stone, poultry grit, and whiting.

Roofing granules produced in 1953 amounted to 127,000 tons—17 percent more than in the previous year.

A new high-calcium limestone deposit was found in Oxford County, Ontario, near Embro. Development was planned by a large steel company, principally for metallurgical flux.

[15] Mine and Quarry Engineering (London), Gravity Transport at Trevor: Vol. 19, No. 10, October 1953, pp. 340–349.

[16] Chemical Engineering, HMS Upgrades Dolomite: Vol. 60, No. 5, May 1953, pp. 114–116.

[17] Pit and Quarry, Drilling Blast Holes Safely With Churn Drills: Vol. 46, No. 3, September 1953, pp. 90–92.

[18] Gutschick, Kenneth A., 4-Million Dollar Expansion at Maple Grove: Pit and Quarry, vol. 45, No. 11, May 1953, pp. 94–100, 102.

[19] Thoenen, J. R., and Germain, G. D., Jet Piercing Blast Holes in Granite: Rock Products, vol. 56, No. 4, April 1953, pp. 132–135.

[20] Pit and Quarry, A Modern New Silica Refractories Plant: Vol. 46, No. 6, December 1953, pp. 91–94.

[21] Minsk, L. David, Fine-Grinding Capacity Increased: Rock Products, vol. 56, No. 6, June 1953, p. 115.

Dolomite was quarried and dead-burned at Dundas, Ontario, in a shaft-kiln plant. This is being replaced by a rotary-kiln plant.

Canadian sales of agricultural limestone in 1952 amounted to C$1,185,000.

Canadian production of whiting substitute (finely ground limestone) in 1953 was 16,900 tons valued at C$181,100 compared with 17,500 tons in 1952 valued at C$188,000. It was used largely for industrial filler. Quebec, Ontario, and British Columbia were the producing Provinces.

Sandstone and quartzite were mined in several Provinces and used for the manufacture of silica brick, abrasives, ferrosilicon, silicon, and ceramics. A large part of the Ontario production was exported to the United States.

FOREIGN TRADE [22]

The import value of all classes of chalk, whiting, and marble chip or granito declined in 1953 compared with 1952. However, the total value of all crushed- and broken-stone imports increased 35 percent during this period.

TABLE 37.—Stone and whiting imported for consumption in the United States, 1952–53, by classes

[U. S. Department of Commerce]

Class	1952		1953	
	Quantity	Value	Quantity	Value
Marble, breccia, and onyx:				
Sawed or dressed, over 2 inches thick---cubic feet--	1,330	$7,041	538	$3,905
In blocks, rough, etc.---do----	157,873	827,903	175,550	912,643
Slabs or paving tiles---superficial feet--	673,890	472,290	957,592	713,093
All other manufactures		553,311		1,042,985
Total		1,860,545		2,672,626
Granite:				
Dressed---cubic feet--	40,424	387,176	106,287	628,047
Rough---do----	44,562	156,139	53,226	218,395
Paving blocks, wholly or partly manufactured number------	611	13,991	1,207	37,123
Total		557,306		883,565
Quartzite---short tons--	184,467	627,616	213,487	703,623
Travertine stone---cubic feet--	40,921	134,190	69,718	130,544
Stone (other):				
Dressed		74,537		19,658
Rough (monumental or building stone)-cubic feet--	3,284	7,261	4,542	11,991
Rough (other)---short tons--	66,191	197,734	98,404	212,436
Marble chip or granito---do----	13,607	137,675	13,313	117,611
Crushed or ground, n. s. p. f.		9,982		102,928
Total		427,189		464,624
Whiting:				
Chalk or whiting, precipitated---short tons--	1,374	58,762	900	42,475
Whiting, dry, ground, or bolted---do----	12,286	182,860	10,727	173,720
Whiting, ground in oil (putty)---do----	24	6,591	7	2,071
Total		248,213		218,266
Grand total		3,855,059		5,073,248

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

In the dimension-stone category, imports of sawed or dressed marble, travertine, and certain other dressed stone declined during 1953. All other classifications increased, bringing the total imports of dimension stone to $2,675,000, 29 percent more than the 1952 value.

The total export value of crushed, ground, or broken stone increased 20 percent during 1953, while the value of building and monumental stone together with all other stone manufactures was 48 percent higher.

TABLE 38.—Stone exported from the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Year	Marble and other building and monumental stone		Crushed, ground or broken				Other manufactures of stone (value)
			Stone		Limestone		
	Cubic feet	Value	Short tons	Value	Short tons	Value	
1944–48 (average)	217, 515	$434, 030	(1)	(1)	(1)	(1)	$322, 426
1949	211, 334	523, 171	(1)	(1)	(1)	(1)	436, 705
1950	142, 955	378, 645	(1)	(1)	(1)	(1)	338, 207
1951	230, 239	585, 499	(1)	(1)	(1)	(1)	271, 461
1952	277, 551	648, 833	126, 123	$1, 631, 358	803, 029	$789, 733	314, 502
1953	411, 196	960, 468	153, 105	2, 204, 139	691, 811	703, 833	464, 692

[1] Not separately classified before January 1, 1952.

Strontium

By Joseph C. Arundale [1] and Flora B. Mentch [2]

THE MOST IMPORTANT strontium minerals of commerce are celestite (strontium sulfate) and strontianite (strontium carbonate). Celestite is the more common. Domestic production of strontium minerals has been small and sporadic for many years. Nearly all of the United States supply is celestite imported from United Kingdom and Mexico. The bulk of this material is converted to various strontium compounds. The industry is relatively small, but the products have important military and civilian applications.

DOMESTIC PRODUCTION

Small tonnages of celestite and strontianite were reported to have been shipped from deposits in California and Washington during 1953. In California the producer was Pan Chemical Co. This firm produces celestite in Imperial County and converts it to strontium carbonate in a plant at Los Angeles. Manufacturers Mineral Co. shipped for local use a mixed celestite-strontianite from Fidalgo Island near La Conner in Skagit County, Wash. In addition to these two States deposits are known in Texas, Arkansas, Arizona, Tennessee, Ohio, Michigan, and other States. In the past a considerable tonnage of celestite has been mined from the deposits in Texas for use as a substitute for barite in weighting oil-well drilling muds. This practice was largely discontinued when the patent on the use of barite for this purpose expired. Material from these same deposits was utilized for chemical purposes during World War II when the flow of supplies from foreign sources was restricted; but when celestite again was freely available, consumers resumed purchases from these sources because of the high grade and relatively low price of the material. Various strontium compounds are produced by 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. Small quantities of strontium hydride are made by Metal Hydrides, Inc., Beverly, Mass., and a small quantity of strontium metal is produced by King Laboratories, Inc., Syracuse, N. Y., and by Cooper Metallurgical Associates, Cleveland, Ohio.

A report on some occurrences of strontium minerals in southern California was published.[3] According to this report, celestite occurs

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[1] Assistant chief, Construction and Chemical Materials Branch.
[2] Statistical assistant.
[3] Durrell, Cordell, Geological Investigation of Strontium Deposits in Southern California: California Dept. of Natural Resources, Div. of Mines, Special Rept. 32, July 1953, 48 pp.

as a cap 2 to 8 feet thick on several small hills a few miles south of Ocotillo, San Diego County. Some celestite has been mined from this deposit. Concretions of celestite occur along the edge of Bristol Dry Lake near Amboy, San Bernardino County. Strontium also is present in the sediment below the concretions and in the water of the playa. Celestite deposits occur near the southern end of Death Valley. They are described as being beds and concretions in gypsum, clay, and sandstone. The largest of the bodies was reported to be 2,100 feet long, with a maximum thickness of 12.7 feet. Most of the bodies occur as lenses and concretions. Reserves have been estimated at roughly 250,000 to 300,000 tons of celestite rock to a depth of 50 feet. Deposits of strontianite occur in the Mud Hills northeast of Barstow in San Bernardino County. In 1 deposit 2 zones about 10 and 25 feet thick, separated by about 20 feet of barren clay, contain most of the strontianite. At another deposit numerous nodular and lenticular beds are distributed vertically through 186 feet of clay. Celestite deposits occur in beds and concretions in tuff and clay in the Cady Mountains northwest of Ludlow in San Bernardino County. These deposits are inferred to contain about 2½ million tons of celestite to a depth of 50 feet, but the total depth of the deposit is unknown.

CONSUMPTION AND USES

Most of the crude strontium mineral consumed is converted to various strontium compounds. The principal use of these strontium compounds is in pyrotechnical applications wherein the strontium imparts a characteristic brilliant red color to the flame. This property is utilized in manufacturing tracer bullets, marine distress-signal rockets and flares, red flares for tactical military signaling, railroad and truck emergency signal flares and fusees, and fireworks and pyrotechnical exhibitions. The principal strontium compound used is the nitrate. Other compounds are used in ceramics and in medicine. Minor quantities of ground celestite and strontianite have been used to purify caustic soda and to desulfurize steel. Small quantities of strontium metal and its alloys have been used as getters for extracting traces of gases from electronic tubes.

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 1953. These prices were unchanged from the previous year. Strontium carbonate, 92 percent, was quoted at 23 cents per pound for January through March, and pure 1-ton lots were quoted for the remainder of the year at 37 cents per pound. Strontium nitrate, barrels or cases, works, was quoted at 10¼ to 11 cents per pound for January through May and 11 to 12 cents per pound throughout the remainder of the year.

The average unit foreign value of imported strontium minerals in 1953 was $17.96 per short ton.

FOREIGN TRADE [4]

As for the past several years, imports of strontium minerals again came largely from United Kingdom and Mexico, but imports were down from 1952 and less than half of those in 1951.

TABLE 1.—Strontium minerals [1] imported for consumption in the United States, 1951–53, by countries, in short tons

[U. S. Department of Commerce]

Country	1951		1952		1953	
	Short tons	Value	Short tons	Value	Short tons	Value
Canada	38	$382	59	$607	43	$521
Mexico	2, 034	23, 730	1, 297	16, 870	2, 441	30, 248
United Kingdom	11, 972	280, 392	8, 161	168, 849	4, 413	93, 077
Total	14, 044	304, 504	9, 517	186, 326	6, 897	123, 846

[1] Strontianite or mineral strontium carbonate and celestite or mineral strontium sulfate.

TECHNOLOGY

A patent was issued on a highly refractive strontium titanate made by fusing strontium titanate particles as a boule.[5] It was reported that this material was water clear which, together with its high refractive index, made it suitable for gem stone and optical use.[6] The high dielectric constant of this material and its close relationship to ferroelectric barium titanate prompted the producing company to investigate its electrical properties.[7]

WORLD REVIEW

United Kingdom and Mexico, in that order, are the world's largest producers of strontium minerals, but in recent years production has been reported also from Pakistan, Tunisia, Germany, and Sicily. Deposits are known to occur widely distributed throughout the world and in many countries, but local demand often is not sufficient to warrant development of the deposits. Small requirements in most countries are satisfied by importation of prepared strontium compounds or the products into which they enter.

[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] Merker, Leon, and Lynd, Langtry, Jr. (assigned to National Lead Co.), Optically Glass-Like Material: U. S. Patent 2,628,156, Feb. 10, 1953.

[6] Paint Industry Magazine, National Lead Develops Strontium Titanate Compound: Vol. 68, No. 4, April 1953, p. 37.

[7] Linz, Arthur, Jr., Some Electrical Properties of Strontium Titanate: Phys. Rev., vol. 91, No. 3, Aug. 1, 1953, pp. 753–754.

Sulfur and Pyrites

By G. W. Josephson[1] and Annie L. Marks[2]

BY 1953 it had become apparent that enough sulfur was available to supply the free world; consequently, many adjustments took place in the industry. The pressure for the development of new sources of supply relaxed. Some projects were abandoned, but most of those well under way were retained. Substantial production capacity was added in the United States during the year, particularly at Frasch mines and at plants in which sulfur is recovered from natural and refinery gases. Major progress was made in constructing Frasch sulfur-production facilities in Mexico. Sulfur production in the United States declined slightly; and as demand was high, stocks in producers' hands were lower at the end of the year. Most of the Government controls on price and consumption that were enforced during the shortage period were greatly relaxed or terminated during 1953.

TABLE 1.—Salient statistics of the sulfur industry in the United States, 1944–48 (average) and 1949–53 (in long tons of sulfur content)

	1944–48 (average)	1949	1950	1951	1952	1953
Production (all forms)	4,656,337	5,387,278	5,986,482	6,196,859	6,284,191	6,247,971
Imports (pyrites and sulfur)	75,231	58,032	100,225	108,676	146,863	92,229
Producers' stocks (Frasch and recovered sulfur)	[1] 3,693,931	[1] 3,099,305	[1] 2,654,530	[1] 2,837,432	[2] 3,163,517	[2] 3,129,830
Exports (sulfur)	1,101,758	1,461,051	1,478,522	1,311,817	1,338,367	1,271,011
Apparent domestic consumption (all forms)	3,872,600	4,093,400	4,988,100	4,819,200	4,832,300	5,049,400

[1] Frasch sulfur only.
[2] Frasch and recovered sulfur.

DOMESTIC PRODUCTION

NATIVE SULFUR

Real progress was made in 1953 in the effort to increase Frasch-sulfur production capacity in the United States. Two mines were brought into production, and progress was made in construction of two others. As requirements had not met expectations, the Defense Production Administration revised its expansion goal for sulfur in all forms downward from 8.4 million long tons by 1955 to 7.7 million long tons.

Although native sulfur production capacity was increased considerably during the year, actual output was slightly lower than in

[1] Chief, Construction and Chemical Materials Branch.
[2] Statistical clerk.

TABLE 2.—Production of sulfur and sulfur-containing raw materials by producers in the United States, 1944–48 (average) and 1949–53, in long tons

	1944–48 (average)		1949		1950		1951		1952		1953	
	Gross weight	Sulfur content	Gross weight	Sulfur content	Gross weight	Sulfur content	Gross weight	Sulfur content	Gross weight	Sulfur content	Gross weight	Sulfur content
Native sulfur or sulfur ore:												
From Frasch-process mines	4,028,282	4,028,282	4,745,014	4,745,014	5,192,184	5,192,184	5,278,249	5,278,249	5,293,145	5,293,145	5,155,342	5,155,342
From other mines [1]	3,215	965	5,678	2,092	3,327	1,072	3,945	1,365	8,536	2,197	151,819	38,257
Total native sulfur		4,029,247		4,747,106		5,193,256		5,279,614		5,295,342		5,193,599
Recovered elemental sulfur:												
Brimstone	30,081	30,064	53,922	53,853	139,731	139,352	182,495	181,935	250,428	249,388	342,297	340,827
Paste	7,429	3,349	6,454	2,928	6,452	3,123	4,614	2,078	3,859	1,810	1,723	833
Total recovered elemental sulfur		33,413		56,781		142,475		184,013		251,198		341,660
Pyrites (including coal brasses)	838,736	349,465	888,388	378,456	931,163	392,788	1,017,769	432,819	994,342	418,139	922,647	379,545
Byproduct sulfuric acid (basis 100 percent) produced at Cu, Zn, and Pb plants	683,300	223,000	511,854	167,000	661,529	216,000	736,672	240,800	774,177	253,000	775,069	253,000
Other byproduct sulfur compounds [2]	22,829	21,212	44,369	37,935	46,977	41,963	70,257	59,613	77,307	66,512	92,787	80,167
Total equivalent sulfur		4,656,337		5,387,278		5,986,482		6,196,859		6,284,191		6,247,971

[1] Sulfur content estimated.
[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.

1952. There was a minor decrease in output at Frasch mines and an increase in production from surface or shallow deposits that were mined by methods other than the Frasch process in California and Nevada. Of the total output of native sulfur, Texas contributed about 68 percent and Louisiana nearly 32 percent.

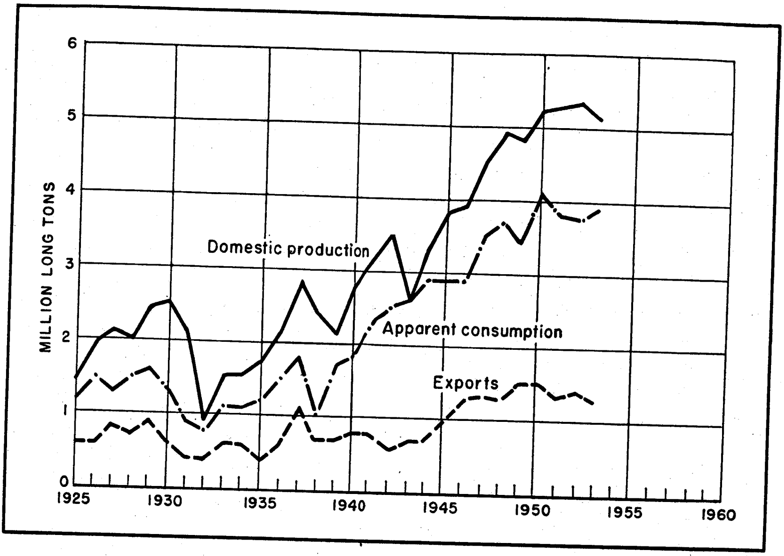

FIGURE 1.—Domestic production, apparent consumption, and exports of native sulfur, 1925–53, in long tons.

Frasch sulfur was produced by five firms in 1953. The mines of the Texas Gulf Sulphur Co., the largest producer, were all in Texas; at Boling, Moss Bluff, and Spindletop domes. Freeport Sulphur Co., the second largest producer, mined the Grande Ecaille and Bay Ste. Elaine domes in Louisiana and Hoskins Mound in Texas. This company also began production from a new mine at Garden Island Bay dome in Louisiana in November. The annual capacity of this plant was estimated at 500,000 long tons. Progress also was made by the company in its construction programs at Nash dome in Texas and Chacahoula dome in Louisiana. The Jefferson Lake Sulphur Co. produced sulfur at Starks dome in Louisiana and Clemens and Long Point domes in Texas. The Duval Sulphur & Potash Co. mined sulfur at Orchard dome in Texas.

The Standard Sulphur Co. installed a plant and began producing sulfur at Damon Mound, Tex. Although this is a relatively small operation, it was of particular interest to the industry because the facilities were designed to permit profitable mining of small deposits. An essential feature of this plant is its relatively easy movement to a new location when the original deposit is worked out.

The Lone Star Sulphur Corp. was reported to be planning construction of a Frasch sulfur plant at Long Point dome in Texas.

TABLE 3.—Sulfur produced and shipped from Frasch mines in the United States, 1944–48 (average) and 1949–53

Year	Produced (long tons)			Shipped	
	Texas	Louisiana	Total	Long tons	Approximate value
1944–48 (average)	3, 191, 249	837, 033	4, 028, 282	4, 257, 521	$71, 700, 000
1949	3, 610, 829	1, 134, 185	4, 745, 014	4, 789, 311	86, 200, 000
1950	3, 949, 164	1, 243, 020	5, 192, 184	5, 504, 714	104, 000, 000
1951	3, 966, 956	1, 311, 293	5, 278, 249	4, 988, 101	107, 300, 000
1952	3, 784, 595	1, 508, 550	5, 293, 145	5, 141, 392	110, 925, 000
1953	3, 514, 771	1, 640, 571	5, 155, 342	5, 224, 202	141, 054, 000

The growing difficulty of finding commercial sulfur deposits under dry land areas or coastal swamps has increased interest in prospecting for offshore domes. In 1953 the Congress passed the Outer Continental Shelf Act, authorizing the lease of sulfur resources of the outer continental shelf. The law specified that royalty payments on the sulfur leases should be set at not less than 5 percent of the value of the production saved, removed, or sold from the lease.[3]

Several surface or shallow deposits of sulfur that cannot be mined by the Frasch method were in various stages of development in 1953. The Anaconda Copper Mining Co. began producing sulfur at the Leviathan mine, Alpine County, Calif. Sulfur from this mine is to be used by the company at its copper operations at Yerington, Nev. Output was reported by Floyd J. Day at Sulphur, Nev. Sulfur was shipped from the Crater mine in Inyo County, Calif., by the Inyo Soil Sulphur Co.

The non-Frasch sulfur operations usually produce only for the soil sulfur market within a relatively short shipping range. Production from the Leviathan mine is to be used in making acid, but efforts of other potential producers to develop industrial markets met little success.

TABLE 4.—Sulfur ore (10–70 percent S) produced and shipped in the United States, 1944–48 (average) and 1949–53, in long tons[1]

Year	Produced (long tons)	Shipped	
		Long tons	Value
1944–48 (average)	3, 215	3, 120	$42, 399
1949	5, 678	5, 392	101, 991
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

[1] California, Colorado (1948–49 only), Nevada, Texas (1948 only), Utah (1952 only), and Wyoming (except 1948 and 1953).

RECOVERED ELEMENTAL SULFUR

Until recently the quantity of primary elemental sulfur recovered from the processing of coal and petroleum gases has been small, but in the past few years this source has become a significant factor in sulfur supply. The growth shown in table 2 is due almost entirely

[3] The Outer Continental Shelf Act of Aug. 7, 1953, Pub. Law 212, 83d Cong., 1st sess. (67 Stat. 462).

to output from plants processing sour natural and refinery gases. In 1953 additional facilities were brought into production, and consequently output of recovered sulfur increased 36 percent over the previous year.

A total of 34 plants reported output in 1953. Production was reported from the following States, which are listed in decreasing order of tonnage: Wyoming, Texas, Arkansas, California, Indiana, Pennsylvania, New Jersey, Louisiana, West Virginia, New Mexico, Oklahoma, Illinois, Massachusetts, and Ohio. During the year a number of articles on sulfur recovery operations appeared in the technical press.[4]

In a suit brought by Phillips Chemical Co. for recovery of taxes paid under protest on sulfur produced in processing of hydrogen sulfide gas in Texas, the district judge ruled that present Texas law is not broad enough to cover sulfur recovered from residue gas.[5]

PYRITES

Iron sulfide minerals are used in the United States in locations where they have transportation and other competitive advantages counterbalancing such disadvantages as high investment, processing complexities, and byproduct problems. In 1953 pyrites production in the United States was 7 percent lower than in 1952. The bulk of the tonnage was used by the producers. In 1953 they consumed 799,710 long tons of pyrites and sold 170,973 long tons. Most of the pyrites was produced in the eastern part of the United States. The largest producer was the Tennessee Copper Co. from mines at Copperhill, Tenn. The minerals mined were utilized by the company in producing sulfuric acid and a variety of other products.

TABLE 5.—Pyrites (ores and concentrates) produced in the United States, 1944–48 (average) and 1949–53, in long tons

Year	Quantity		Value	Year	Quantity		Value
	Gross weight	Sulfur content			Gross weight	Sulfur content	
1944–48 (average)	838,736	349,465	$3,309,200	1951	1,017,769	432,819	$4,656,000
1949	888,388	378,456	3,904,000	1952	994,342	418,139	4,947,000
1950	931,163	392,788	4,059,000	1953	922,647	379,545	5,007,000

At the Gossan mine in Virginia, the General Chemical Division of Allied Chemical & Dye Corp. produced pyrites, which was transported to its sulfuric acid plant at Pulaski, Va. The Bethlehem Cornwall Corp. produced pyrites in Pennsylvania, and the St. Joseph Lead Co. sold pyrites from the Balmat mine in New York. In Orange County, Vt., the Vermont Copper Co. recovered pyrites, which was shipped to the Brown Co. of Berlin, N. H.

[4] Huff, D. H., and Graff, R. A., Sulfur-Recovery Plant at Keystone Has Capacity of 15 Tons Daily: Oil and Gas Jour., vol. 51, No. 41, Feb. 16, 1953, pp. 118, 119, 152.
Chemical Engineering, Making Sulphur Recovery Pay: Vol. 60, No. 2, February 1953, pp. 138, 140. Shell Recovering Sulphur From Waste Refinery Gases: Vol. 60, No. 1, January 1953, p. 114.
Chemical Engineering Progress, vol. 49, No. 7, July 1953, p. 68.
[5] Chemical Engineering, No Tax on Sulfur From Sour Gas: Vol. 60, No. 12, December 1953, p. 106.

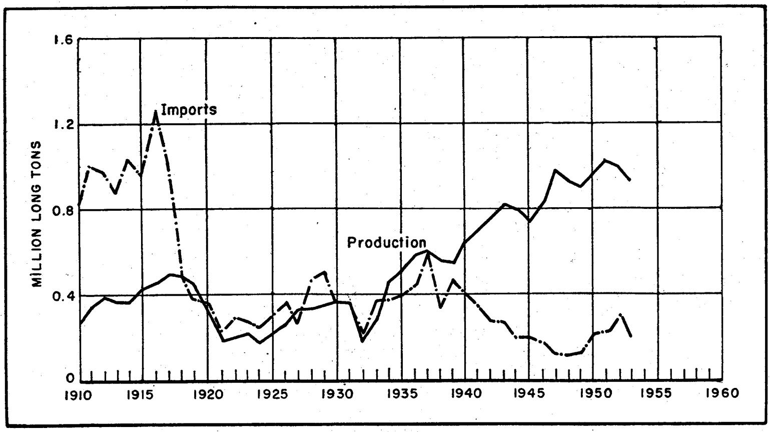

FIGURE 2.—Domestic production and imports of pyrites, 1910–53.

In the Midwest the only pyrites recovery reported in 1953 was at the coal-washing plant of the Talleydale mine of the Snow Hill Coal Corp. in Indiana.

Commercial recovery of pyrites was reported in a number of Western States. The Mountain Copper Co., Ltd., was a major producer at the Hornet mine in California. Pyrites was recovered by the Rico Argentine Mining Co. at the Mountain Springs mine in Colorado. The Climax Molybdenum Co. also recovered pyrites in Colorado. Pyrite was recovered by the Anaconda Copper Mining Co. from its base-metal operations in Montana.

The principal producing State in 1953 was Tennessee, followed by Virginia, Montana, California, Vermont, Pennsylvania, Colorado, and Indiana, in that order.

BYPRODUCT SULFURIC ACID

As shown in table 6, the output of byproduct sulfuric acid in 1953 was virtually the same as in the previous year. Because of the more favorable market situation, companies that operated metal sulfide smelters, where sulfur-bearing gases were available for recovery as sulfuric acid, gave serious consideration to expanding the facilities when the shortage was at its height. Several expansion programs were initiated, and it is anticipated that these will contribute to output of this type of primary sulfur in the future.

TABLE 6.—Byproduct sulfuric acid [1] (basis, 100 percent) produced at copper, zinc, and lead plants in the United States, 1944–48 (average) and 1949–53, in short tons

	1944–48 (average)	1949	1950	1951	1952	1953
Copper plants [2]	178, 166	96, 344	131, 342	189, 125	202, 364	231, 213
Zinc plants	587, 130	476, 932	609, 571	635, 948	664, 714	636, 864
Total	765, 296	573, 276	740, 913	825, 073	867, 078	868, 077

[1] Includes acid from foreign materials.
[2] Includes acid produced at a lead smelter. Excludes acid made from pyrites concentrates in Montana and Tennessee.

In 1953 smelter acid was produced by 16 plants in the following States—California, Illinois, Indiana, Missouri, Ohio, Oklahoma, Pennsylvania, Tennessee, Texas, Utah, and Washington.

OTHER BYPRODUCT SULFUR COMPOUNDS

The bulk of the sulfur obtained from industrial gases was recovered in the form of elemental sulfur, or sulfuric acid, but a considerable quantity (see table 2) also was recovered and used in the form of sulfur dioxide and hydrogen sulfide in 1953. Such output was recorded in the following States: California, Tennessee, New Jersey, Pennsylvania, and Louisiana.

CONSUMPTION AND USES

According to one dictionary, the word "sulfur" was derived from the Sanskrit "shulbari," meaning "enemy of copper," but in modern industry it is the affinity of sulfur for copper and many other elements that makes the manufacture of a great variety of products possible.[6]

Details of sulfur consumption are difficult to obtain due to the complexity and breadth of its utilization. The Bureau of Mines does not conduct a consumption canvass of its own and therefore use statistics compiled by other organizations are presented in this chapter. Tables 9, 10, and 12 contain statistics on sulfur consumption and sulfuric acid production compiled from reports of the United States Department of Commerce. Tables 11 and 13 contain data prepared by Chemical Engineering magazine.

As controls had been removed by the National Production Authority in November 1952, domestic consumption of sulfur was not restricted in 1953. As indicated in table 8, apparent consumption in the United States in 1953 was about 4 percent greater than in the previous year.

TABLE 7.—Apparent consumption of native sulfur in the United States, 1944–48 (average) and 1949–53, in long tons

	1944–48 (average)	1949	1950	1951	1952	1953
Apparent sales to consumers [1]	4, 275, 723	4, 870, 723	5, 636, 959	5, 095, 347	5, 061, 722	5, 201, 711
Imports	31	32	25	2, 376	4, 863	1, 229
Total	4, 275, 754	4, 870, 755	5, 636, 984	5, 097, 723	5, 066, 585	5, 202, 940
Exports:						
Crude	1, 064, 684	1, 430, 916	1, 440, 996	1, 287, 773	1, 304, 154	1, 241, 536
Refined	37, 074	30, 135	37, 526	24, 044	34, 213	29, 475
Total	1, 101, 758	1, 461, 051	1, 478, 522	1, 311, 817	1, 338, 367	1, 271, 011
Apparent consumption	3, 173, 996	3, 409, 704	4, 158, 462	3, 785, 906	3, 728, 218	3, 931, 929

[1] Production adjusted for net change in stocks during the year. In addition, a small quantity of native sulfur from mines that do not use the Frasch process was consumed.

[6] Chemical and Engineering News, Origin of "Sulfur" (or "Sulphur"): Vol. 31, No. 36, Sept. 7, 1953, p. 3681.

TABLE 8.—Apparent consumption of sulfur in all forms in the United States, 1944–48 (average) and 1949–53, in long tons [1]

	1944–48 (average)	1949	1950	1951	1952	1953
Native sulfur [2]	3,174,000	3,409,700	4,158,500	3,785,900	3,728,200	3,931,900
Recovered sulfur shipments	29,300	42,300	78,600	193,800	224,500	313,800
Pyrites:						
Domestic production	349,500	378,500	392,800	432,800	418,100	379,500
Imports	75,200	58,000	100,200	106,300	142,000	91,000
Total pyrites	424,700	436,500	493,000	539,100	560,100	470,500
Smelter acid production	223,400	167,000	216,000	240,800	253,000	253,000
Other production [3]	21,200	37,900	42,000	59,600	66,500	80,200
Total	3,872,600	4,093,400	4,988,100	4,819,200	4,832,300	5,049,400

[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.
[3] 1948–49, hydrogen sulfide; 1950–53, 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, 1949–53, in short tons

[U. S. Department of Commerce]

Division and State	1949	1950	1951	1952	1953
New England [1]	158,675	201,281	210,324	172,157	190,456
Middle Atlantic:					
Pennsylvania	619,923	772,103	808,334	747,226	798,484
New York and New Jersey	1,136,654	1,357,087	1,348,451	1,343,165	1,504,408
Total Middle Atlantic	1,756,577	2,129,190	2,156,785	2,090,391	2,302,892
North Central:					
Illinois	868,235	993,759	1,073,223	1,059,602	1,131,632
Indiana	415,766	464,680	464,896	433,150	487,892
Michigan	(2)	(2)	(2)	196,120	226,254
Ohio	617,673	672,190	654,321	624,184	661,492
Other [3]	618,032	741,998	798,472	522,963	548,985
Total North Central	2,519,706	2,872,627	2,990,912	2,836,019	3,056,255
South:					
Alabama	309,385	290,494	298,404	290,139	306,565
Florida	459,369	526,273	535,719	740,199	900,099
Georgia	232,005	223,949	247,307	239,833	229,104
North Carolina	163,446	159,466	160,087	159,469	163,762
South Carolina	204,203	188,993	206,779	197,323	188,514
Virginia	486,720	560,644	549,918	550,742	532,003
Kentucky and Tennessee	795,728	853,475	835,310	841,555	857,874
Texas	880,330	972,260	947,916	1,086,957	996,601
Delaware and Maryland	(2)	1,354,643	1,340,009	1,221,445	1,210,674
Louisiana	(2)	(2)	435,335	505,768	602,858
Other [4]	2,050,983	980,179	489,988	459,972	437,816
Total South	5,582,169	6,110,376	6,046,772	6,293,402	6,425,870
West [5]	709,849	829,317	984,075	951,928	1,051,435
Total United States	10,726,976	12,142,791	12,388,868	12,343,897	13,026,908

[1] Includes data for plants in Connecticut, Maine, Massachusetts, and Rhode Island.
[2] Included with "Other."
[3] Includes data for plants in Iowa (1949–53), Kansas (1950–53 only), Michigan (except 1952–53), Missouri, and Wisconsin.
[4] Includes data for plants in Arkansas, Delaware (1949 only), Louisiana (1949–50 only), Maryland (1949 only), Mississippi, Oklahoma, and West Virginia.
[5] Includes data for plants in Arizona, California, Colorado, Montana, Utah, Washington, and Wyoming.

TABLE 10.—Sulfur consumed in nonacid uses in the United States, 1950–52, in thousand long tons [1]

[U. S. Department of Commerce, Business and Defense Services Administration]

Use	1950	1951	1952
Carbon disulfide	183	214	186
Pulp and paper	418	391	371
Ground crude and refined for agricultural uses [2]	274	248	198
Rubber	46	42	39
Other chemicals	94	103	92
Miscellaneous	44	40	28
Total	1,059	1,038	914

[1] Consumers of less than 20 short tons per month were not required to report. It is estimated, however, that over 98 percent of consumption has been herein covered. Consumption in sulfuric acid was reported as 3,077,000 long tons in 1950, 3,074,000 tons in 1951, and 2,925,000 tons in 1952.
[2] Excludes industrial uses, but includes exports of ground, crude and refined.

TABLE 11.—Estimates of principal nonacid uses of sulfur and pyrites (sulfur equivalent) in the United States, 1952–53, in thousand long tons

[Chemical Engineering]

Use	1951	1952	1953 (preliminary)
Wood pulp	391	380	[1] 390
Carbon bisulfide	214	200	220
Other chemicals, dyes	100	90	95
Insecticides, fungicides	135	105	100
Rubber	75	75	80
Other	137	130	135
Total	1,052	980	1,020

[1] Includes an estimated 10,000 tons of S equivalent in pyrites used in making sulfite liquor.

STOCKS

On December 31, 1953, producers of Frasch sulfur had a total of 3,022,500 long tons of sulfur in stock. Of this total 2,761,200 long tons was held at the mines and 261,300 tons elsewhere. At the end of 1952 producers of Frasch sulfur had held 3,068,900 long tons, and therefore inventories declined slightly over 1 percent in 1953. There was little change during the year in stocks of recovered sulfur. At the end of 1953 they totaled 107,300 tons, which compares with 94,700 long tons at the end of 1952. No inventory statistics on pyrites are available.

TABLE 12.—Sulfuric acid [1] (basis, 100 percent) consumed in the United States, 1950–52, by industries, in thousand short tons [2]

[U. S. Department of Commerce, Business and Defense Services Administration]

Industry	1950	1951	1952
Fertilizers:			
Superphosphate	3,790	3,944	4,053
Ammonium sulfate	1,508	1,161	1,236
Petroleum and its products	1,679	1,872	1,973
Inorganic pigments	1,322	1,331	1,249
Chemicals not elsewhere classified [3]	984	1,197	1,245
Iron and steel	1,027	954	838
Other metallurgical	211	241	218
Rayon and cellulose film	670	687	634
Alcohols	516	648	650
Industrial explosives	375	403	375
Aluminum sulfate	363	393	360
Hydrochloric and hydrofluoric acids	243	274	263
Synthetic detergents	202	217	225
Dyes	196	202	150
Rubber (including synthetic)	103	135	110
Insecticides	99	125	130
Storage batteries	78	74	60
Chromium chemicals including chromic acid	64	86	60
Light oil refining (coke oven)	62	71	64
Tall oil	37	46	39
Textile finishing	37	31	28
Chlorine drying	32	39	40
Industrial water treatment	30	35	30
Medicinals	28	37	33
Copper sulfate	20	31	27
Fat splitting	18	16	15
Miscellaneous [4]	293	403	539
Total	13,987	14,653	14,644

[1] Includes virgin, fortified, and spent acid. Fortified and spent acids totaled 2,006,000 short tons in 1950; 2,433,000 tons in 1951, and 2,513,000 tons in 1952.

[2] Based on reports to the former National Production Authority and on a special survey covering the recovery of spent acid during 1950 and 1951. Data for 1952 were partly estimated.

[3] Includes boric acid, citric acid, ethylene dibromide, hydroquinone, oxalic acid, phenol, sebacic acid, sodium phosphates, and other chemicals.

[4] Includes "small orders" exempt from reporting, estimated as follows in thousand short tons for each of gross and net usage: 1950—118; 1951—172; 1952—140. The miscellaneous segment also includes export, military explosives, parchment paper, silica gel, and other uses, the disclosure of which may indicate individual company data.

TABLE 13.—Estimates of United States use of sulfuric acid [1] (basis, 100 percent), 1952–53, in thousand short tons

[Chemical Engineering]

Industry	1952 (revised)	1953 (preliminary)	Industry	1952 (revised)	1953 (preliminary)
Fertilizers:			Iron and steel	960	1,160
Superphosphate	4,150	4,050	Other metallurgical	200	220
Ammonium sulfate	1,250	1,200	Industrial explosives	110	[2] 420
Chemicals	3,870	4,180	Textile finishing	40	40
Petroleum refining	1,550	1,720	Miscellaneous	370	410
Paints and pigments	1,250	1,370			
Rayon and film	700	760	Total	14,450	15,530

[1] Recycled acid, including reused, concentrated, fortified, and reconstituted acid is estimated at about 2,106,000 short tons in 1952 and 2,330,000 tons in 1953.

[2] Includes estimated total acid going into military explosives (in 1953 only). About ⅔ goes later into recycled acid.

PRICES

One of the noteworthy aspects of the sulfur industry in 1953 was the change in price pattern. In the early months of 1953 sulfur prices were still frozen by the Office of Price Stabilization at the level of the 1950 base period. These differed somewhat, in accordance with the pricing practices of individual producers during the base period, but most crude sulfur prices ranged from $21 to $24 per long ton f. o. b. mines for domestic consumption and from about $25 to $27 at the port for export. Prices for recovered sulfur and native sulfur produced by non-Frasch methods were either frozen at their 1950 base levels or, where new production was involved, were in most instances priced locally competitive with Frasch sulfur. On March 17 all price controls on sulfur were revoked by the Office of Price Stabilization. Thereafter price adjustments were made by producers over a period of several months, and at the end of 1953 trade journals were quoting sulfur for domestic consumption at $25.50 to $27.50 f. o. b. mine and $28 to $30.50 f. o. b. port for export.

Prices of elemental sulfur in the international market, which had risen sharply during the previous 2 or 3 years, declined just as abruptly in 1953, when the shortage had eased. Consequently, demand disappeared for the high-cost elemental sulfur which could have been produced and exported from the United States under OPS Supplementary Regulation 3 of Ceiling Price Regulation 61.

Trade journals quoted nominal prices for pyrites. In 1953 E&MJ Metal and Mineral Markets quoted domestic and Canadian pyrites at $9 to $11 per long ton f. o. b. delivered to consumer's plant. However, the prices of pyrites differ so greatly from place to place that individual quotations are meaningful only for a specific location. F. o. b. mine valuations reported by domestic producers ranged from $2.95 to $11.03 per long ton in 1953, the average value of all domestic output being $5.43 and the average value of the tonnage sold being $6.33. One indicator of modifications taking place in the price structure of pyrites was the increase in the average value of imports. In 1951 the average value of imports of pyrites was $2.06 per long ton; in 1952 it was $2.98 and in 1953 had risen to $3.48.

FOREIGN TRADE [7]

Exports of sulfur from the United States were 5 percent lower in 1953 than in the previous year. The commodity remained under export control by the United States Government; but, as no special effort was made to reduce exports, the decline was due to market considerations rather than control measures. The sulfur committee of the International Materials Conference announced that its member governments had accepted its recommendation to discontinue international allocations for sulfur effective March 1, 1953. On April 30, 1953, the committee was dissolved.

[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.

In the fourth quarter of 1953 sulfur was put under a quota system by the Office of International Trade of the Department of Commerce, wherein no limits were set on the quantities but individual export licenses were required.[8]

As prices declined in the international market sales of high-cost sulfur by producers dwindled rapidly; however, many important projects in several countries, designed to expand the use of domestic raw materials, such as gypsum, pyrites, and spent oxides, were retained. Such projects had the dual advantage of utilizing domestic resources, preserving foreign exchange, and reducing raw-material supply problems during an emergency.

Of equal or greater importance to the international trade was the progress made toward developing of Frasch-sulfur production in Mexico. A large part of the projected capacity will be available for consumers outside of Mexico.

As indicated in table 14, the United States imported only a very small quantity of elemental sulfur. Imports of pyrites from Canada (table 16) continued to be substantial, even though only about two-thirds as much was imported in 1953 as in the previous year. Exports of pyrites are not available, as they are not separately classified in the foreign trade statistics of the United States Department of Commerce.

TABLE 14.—Sulfur imported into and exported from the United States, 1944–48 (average) and 1949–53

[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
1944–48 (average)	(1)	$4	31	$9,936	1,064,684	$20,527,382	37,074	$1,910,364
1949	5	89	27	5,768	1,430,916	30,489,876	30,135	1,682,965
1950			25	6,172	1,440,996	30,950,531	37,526	2,249,311
1951	1,875	94,496	501	63,131	1,287,773	31,760,539	24,044	1,947,860
1952	4,829	98,581	34	7,545	1,304,154	33,515,359	34,213	2,451,132
1953	525	18,456	704	32,658	1,241,536	34,553,709	29,475	2,027,158

1 Less than 1 ton.

8 Foreign Commerce Weekly, vol. 50, No. 15, Oct. 12, 1953, p. 19.

TABLE 15.—Sulfur exported from the United States, 1952–53, by countries of destination

[U. S. Department of Commerce]

Country	Crude				Crushed, ground, refined, sublimed, and flowers			
	1952		1953		1952		1953	
	Long tons	Value	Long tons	Value	Pounds	Value	Pounds	Value
North America:								
Canada	370,192	$9,261,956	317,630	$8,560,690	7,440,553	$274,183	7,644,696	$263,970
Central America	---	---	70	2,021	921,059	40,949	903,068	34,328
Mexico	---	---	40	1,520	8,403,865	219,312	7,477,672	193,608
West Indies	34,128	882,276	29,997	836,646	340,704	12,952	233,068	11,038
Total North America	404,320	10,144,232	347,737	9,400,877	17,106,181	547,396	16,258,504	502,944
South America:								
Argentina	2,500	64,613	14,881	427,071	212,170	39,111	169,400	21,856
Brazil	50,158	1,380,441	69,159	1,966,562	8,046,221	349,114	2,154,010	127,494
Colombia	---	---	---	---	281,516	14,138	1,415,155	51,555
Ecuador	72	2,780	36	1,391	53,954	3,058	58,698	2,800
Paraguay	72	1,990	65	4,851	---	---	667,685	31,106
Peru	1	109	---	---	4,742,878	141,467	846,621	25,744
Uruguay	3,700	96,353	2,500	64,200	73,600	2,164	77,500	2,373
Venezuela	58	2,430	655	21,307	279,895	16,529	542,184	27,202
Other South America	---	---	---	---	10,400	1,288	26,000	2,365
Total South America	56,561	1,548,716	87,296	2,485,382	13,700,634	566,869	5,957,253	292,495
Europe:								
Austria	14,900	398,766	18,505	545,152	---	---	---	---
Belgium-Luxembourg	39,700	1,039,268	34,000	957,975	959,492	24,513	622,415	15,505
France	52,095	1,362,123	93,333	2,631,186	---	---	---	---
Germany, West	24,000	633,550	12,500	349,315	37,530	7,578	349,060	67,784
Greece	---	---	778	22,711	19,615,584	495,778	17,467,963	362,941
Ireland	---	---	---	---	447,613	17,361	---	---
Netherlands	450	11,408	---	---	527,292	16,946	5,250	1,137
Norway	---	---	---	---	87,483	2,564	150,000	5,639
Portugal	---	---	---	---	5,000	780	25,240	4,677
Sweden	---	---	2,000	54,800	24,350	5,164	55,600	11,999
Switzerland	19,000	492,375	23,750	674,250	612,514	29,418	367,396	30,409
United Kingdom	377,884	9,570,107	182,032	5,024,056	---	---	---	---
Yugoslavia	---	---	197	7,880	6,535,740	156,999	6,400,264	130,058
Other Europe	---	---	---	---	32,400	6,650	25,300	5,187
Total Europe	528,029	13,507,597	367,095	10,267,325	28,884,998	763,751	25,468,488	635,336
Asia:								
Ceylon	---	---	---	---	29,190	2,455	---	---
India	52,069	1,379,703	50,949	1,415,237	6,946,082	227,632	8,087,251	247,919
Indonesia	7,534	190,706	3,100	84,480	2,737,602	94,561	862,846	31,112
Israel and Palestine	3,100	83,700	3,300	93,650	3,121,185	78,464	2,331,774	53,701
Korea, Republic of	---	---	---	---	---	---	1,530,990	40,583
Lebanon	40	1,546	20	773	436,920	9,800	656,770	14,897
Pakistan	497	14,113	248	6,913	215,480	7,322	55,740	2,138
Philippines	---	---	14,900	591,400	133,724	7,270	253,606	11,769
Syria	---	---	---	---	645,961	15,753	1,102,466	27,063
Other Asia	2,259	64,887	1,719	51,777	124,220	7,132	418,524	24,926
Total Asia	65,499	1,734,655	74,236	2,244,230	14,390,364	450,389	15,299,967	454,108
Africa:								
Algeria	6,430	163,001	21,816	580,374	---	---	---	---
Belgian Congo	---	---	---	---	221,660	7,756	244,562	8,461
British East Africa	190	5,380	---	---	87,948	3,040	---	---
Egypt	2,091	69,265	1,444	48,151	1,588,416	39,590	1,555,778	36,229
French Morocco	2,870	73,405	10,000	288,500	---	---	---	---
Mozambique	149	4,148	---	---	---	---	---	---
Tunisia	5,000	130,000	15,500	416,475	---	---	---	---
Union of South Africa	65,200	1,732,830	76,000	2,133,800	380,166	53,303	987,340	71,698
Other Africa	---	---	---	---	---	---	240	108
Total Africa	81,930	2,178,029	124,760	3,467,300	2,278,190	103,689	2,787,920	116,496
Oceania:								
Australia	98,665	2,594,592	139,875	3,885,788	113,440	12,150	57,300	7,099
New Zealand	69,150	1,807,538	100,537	2,802,807	163,235	6,888	194,600	18,680
Total Oceania	167,815	4,402,130	240,412	6,688,595	276,675	19,038	251,900	25,779
Grand Total	1,304,154	33,515,359	1,241,536	34,553,709	76,637,042	2,451,132	66,024,032	2,027,158

TABLE 16.—Pyrites, containing more than 25 percent sulfur, imported for consumption in the United States, 1944–48 (average) and 1949–53, by countries

[U. S. Department of Commerce]

Country	1944–48 (average)		1949		1950	
	Long tons	Value	Long tons	Value	Long tons	Value
Australia					22	$242
Canada	117,192	$257,001	107,951	$215,290	208,725	411,823
Germany, West						
Malta, Gozo, Cyprus					19	57
Mexico	11	32				
Norway	230	345				
Portugal	60	533				
Spain	39,332	107,396	12,986	36,331		
Total	156,825	365,307	120,937	251,621	208,766	412,122

Country	1951		1952		1953	
	Long tons	Value	Long tons	Value	Long tons	Value
Australia						
Canada	221,487	$457,365	295,820	$865,547	190,227	$662,566
Germany, West					(1)	182
Malta, Gozo, Cyprus						
Mexico					247	753
Norway						
Portugal			227	16,267		
Spain						
Total	221,487	457,365	296,047	881,814	190,474	663,501

[1] Less than 1 ton.

TABLE 17.—Pyrites, containing more than 25 percent sulfur, imported for consumption in the United States, 1944–48 (average) and 1949–53, by customs districts, in long tons

[U. S. Department of Commerce]

Customs district	1944–48 (average)	1949	1950	1951	1952	1953
Buffalo	97,504	106,862	208,569	221,391	295,626	172,375
Chicago			36			
Connecticut	14					
Duluth and Superior				46		
Galveston	4					
Michigan	7,840		5			
New York	60		41		227	(1)
Ohio	1					
Philadelphia	51,017	14,075				
Rochester				50		
St. Lawrence					194	2,656
San Diego	7					
Vermont			115			15,443
Washington	378					
Total	156,825	120,937	208,766	221,487	296,047	190,474

[1] Less than 1 ton.

TECHNOLOGY

Development of the Garden Island Bay mine in a marsh area near the mouth of the Mississippi River presented many technical difficulties. Enormous tonnages of mud were pumped to build up the plant site. Several thousand pilings were driven, and a concrete structure 16 feet high built on them supports the floor for the powerplant. The plant must be high enough to avoid flooding during storms. Very large reservoirs were built to store water taken from the river during periods in which salt-water encroachment from the Gulf is at a minimum. As storage of huge tonnages of sulfur at the mine is impractical, molten sulfur is transported in insulated barges to Port Sulphur, where it can be stockpiled and shipped to the consumer.[9]

In Germany a pyrites "fluidized-bed" roasting unit was put into operation in 1952. Fine-grained iron pyrites was fed to the roaster and air injected through the bottom in such a way as to fluidize the bed. Boiler tubes were arranged around the fluidized bed to absorb excess reaction heat and produce steam.[10]

Liquid sulfur dioxide was being produced in two plants by passing dust-free roaster gases through an absorbing tower in which the sulfur dioxide is absorbed in dimethylaniline. In this process the pregnant liquid is preheated in a heat exchanger and passed through a stripping tower, where it is heated further by indirect steam heat and stripped of its sulfur dioxide content. The stripped DMA liquid is recycled, and the sulfur dioxide is passed through another bubble-cap tower where its water content is reduced to less than 25 parts per million by concentrated sulfuric acid.[11]

Pyrites burned in a FluoSolids roaster by the Brown Co. at Berlin, N. H., provides a gas having about 13 percent sulfur dioxide. The pyrites, which are flotation concentrates, are received at about 10 percent moisture and are diluted to a slurry of about 75 percent solids before being fed to the reactor.[12]

High catalyst efficiency, lower plant investment, and easier temperature control are among the advantages claimed for a sulfuric acid production method reported from Toulouse University. Barium vanadate precipitated on silica gel is the catalyst. The SO_2 and SO_3 produced are condensed in vertical tube condensers and separated.[13]

The Kachkaroff-Guareschi process for manufacturing sulfuric acid was described in trade journals. The product is approximately 78 percent sulfuric acid. There is enough heat in the burner gases to concentrate the entire production to 80 percent or about 40 percent of the production to 96 percent sulfuric acid.[14]

A method wherein elemental sulfur could be obtained by oxidizing a slurry of pyrrhotite in an autoclave was described.[15]

Pyritic ore produced at the Mavrovouni mine of the Cyprus Mines Corp. contains copper sulfate which was not recoverable in the flotation plant. Research indicated that it could be recovered by leaching in a weak acid solution. Consequently, a plant was designed to leach raw ore that had been crushed to minus-½-inch with a 4-percent

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[9] Mining Congress Journal, New Freeport Sulphur Mine in Operation: Vol. 39, No. 12, December 1953, pp. 76–77.

[10] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 6, December 1953, pp. 65–67.

[11] Chemical Engineering, Hi-Purity Liquid SO_2 From Roaster Gases: Vol. 60, No. 4, April 1953, pp. 274–277.

[12] Chemical Engineering, SO_2 by Fluidization: Vol. 60, No. 1, January 1953, pp. 238–241.

[13] Chemical Age (London), New Sulfuric Acid Plant: Vol. 49, No. 1791, Nov. 7, 1953, pp. 965–966.

[14] Chemical Engineering Progress, New Process for Sulfuric Acid: Vol. 49, No. 8, August 1953, pp. 24–26. Nordengren, Sven, The Theory of the Kachkaroff Sulphuric Acid Process: Chemical Age (London), vol. 68, No. 1753, Feb. 14, 1953, pp. 269–273.

[15] Cadenhead, A. F. G., Sulphur Process by Mines Branch, Ottawa Uses Iron Sulphide Sources: Canadian Chem. Proc., vol. 37, No. 10, September 1953, p. 106.

sulfuric acid solution. After leaching, the sands and slimes are sent to the grinding and flotation plant.[16]

Selenium has been found in flash roasting plants in concentrations and quantities that have aroused interest in the byproduct potential of such operations.[17]

Petroleos Mexicanos, at Poza Rica, Mexico, uses a water-cooled steel belt 32 inches wide and 184 feet long to solidify the molten sulfur, which is poured on its top surface. The ribbon of solid sulfur breaks from the belt at the discharge end into chips about 5/16 inch thick and 3 to 4 inches long.[18]

An example of the changes that sometimes take place in the usage of trade terms appeared in a foreign periodical. It pointed out that the term "cupreous" pyrite in the past had been considered to contain 2½ percent or more copper but in recent years the percentage required has declined until a content of something like 1.2 to 1.3 percent copper is regarded as placing a pyrite in the cupreous category. Much depends upon the particular needs of the individual consumer, and consequently some materials that have as little as 0.5 percent of copper are acceptable to buyers, as the copper is commercially recoverable at their particular plants.[19]

Isotope studies tend to support the hypothesis that native sulfur found in the dome deposits of the gulf coast was formed by bacterial action on sulfates. Preliminary findings were that the differences in the sulfur 34 content of native sulfur and its associated sulfate are similar to those found in sulfur and sulfates from lakes in which bacterial reduction of sulfate is known to take place.[20]

RESERVES

The Cove Creek sulfur deposits in Utah have been known since the region was first settled, and from time to time some sulfur has been produced. However, relatively little information was available on the magnitude of reserves when the Chemical Corp. of America leased the property and consequently the company conducted an extensive drilling program. Statistics released by the company indicated that at least 2.1 million short tons of ore averaging 19.8 percent sulfur was available in these deposits. The company concentrated this ore in a pilot mill by flotation and filtration.[21]

A report on iron sulfide deposits in Aitkin and Carlton Counties, Minn., was published by the Bureau of Mines.[22]

The sulfides were predominantly pyrite and pyrrhotite, with minor quantities of marcasite. Sulfide concentrates containing 36.4 to 46.6 percent sulfur were produced by flotation. Detailed drill log records are included in the publication.

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[16] Mining Magazine (London), Leaching Cleaning Copper Pyrites: Vol. 88, No. 5, May 1953, pp. 280–281.
[17] Chemical and Engineering News, vol. 31, No. 45, Nov. 9, 1953, p. 4692.
[18] Mining World, vol. 15, No. 9, August 1953, p. 89.
[19] Metal Bulletin (London), Pyrites: No. 3757, Jan. 6, 1953, p. 31.
[20] Chemical and Engineering News, vol. 31, No. 47, November 1953, p. 4876.
[21] King, Clarence R., Cove Creek Sulphur: Min. Eng., vol. 5, No. 4, April 1953, pp. 375–378.
[22] Pennington, J., and Davis, V. C., Investigation of Iron Sulfide Deposits in South-Central Aitkin County and Carlton County, Minn.: Bureau of Mines Rept. of Investigations 4937, 1953, 33 pp.

WORLD REVIEW

NORTH AMERICA

Canada.—In 1953, 349,900 short tons of sulfur in all forms was produced in Canada; this was about 18 percent less than the 428,000 short tons in 1952. The decrease was attributed primarily to prolonged labor strikes, which reduced the output of pyrite in Western Quebec. On the other hand, smelter acid output was increased from 160,500 tons of contained sulfur in 1952 to 190,200 tons in 1953, and shipments of elemental sulfur recovered from natural gas rose from 4,200 tons to 16,100 tons. Pyrites was produced in Canada as byproducts of base metal ore mining and treatment. In 1953 pyrites output was reported by Noranda, Waite Amulet, Quemont, East Sullivan, Normetal and Weedon mines, all in Quebec, and from the Britannia mine in British Columbia. Near Welland, Ontario (Port Robinson), Noranda Mines, Ltd., was building a plant for the production of elemental sulfur, sulfur dioxide, and iron sinter. The plant was to have a roasting capacity for about 100,000 tons of pyrites annually. Pyrites for this plant was to come from the Horne mine in Noranda, Quebec, at first and later from a deposit near the Horne mine owned by West MacDonald Mines, Ltd. The MacDonald ore contains about 80 percent pyrites and some zinc. Construction of a mill by Noranda Mines at Noranda, Quebec, to treat the pyritic ore and convert concentrate into pellets, was scheduled. Reserves at the No. 5 ore body at the Horne mine are estimated at 100 million tons, containing about 50 percent pyrites.

TABLE 18.—World production of native sulfur, by countries,[1] 1944–48 (average), and 1949–53, in long tons [2]

[Compiled by Helen L. Hunt]

Country [1]	1944–48 (average)	1949	1950	1951	1952	1953
North America:						
Mexico	4,300	6,000	11,000	11,375	11,784	5,900
United States	4,028,282	4,745,014	5,192,184	5,278,249	5,293,145	5,155,342
South America:						
Argentina	9,899	9,912	7,662	7,560	[3] 8,000	10,826
Bolivia (exports)	2,444	4,398	4,307	9,100	5,497	2,458
Chile	15,873	7,599	22,065	29,672	[3] 36,000	[3] 12,000
Colombia	[4] 592	793	1,461	2,479	2,974	2,657
Ecuador	41	16	27	1	2,353	100
Peru	1,583	87	2,111	2,251	5,066	(5)
Europe:						
France (content of ore)	4,170	5,201	5,571	11,000	[3] 12,000	[3] 10,000
Italy (crude) [6]	121,775	198,274	209,767	197,382	232,706	224,161
Spain	4,244	5,000	6,800	6,700	4,800	5,100
Asia:						
Japan	42,888	61,414	90,940	139,364	177,158	184,244
Philippines	------	------	------	------	------	[3] 1,000
Taiwan (Formosa)	526	362	2,657	2,732	5,001	3,423
Turkey	3,116	3,046	5,911	7,273	8,232	9,626
Total (estimate) [1]	4,360,000	5,200,000	5,700,000	5,800,000	6,000,000	5,800,000

[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 1 year only, as 1948 was first year of production.
[5] Data not available; estimate by senior author of chapter included in total.
[6] In addition the following tonnages of ground sulfur rock (30 percent "S") were produced and used as an insecticide: 1944–48 (average), 20,950 tons; 1949, 19,213 tons; 1950, 15,778 tons; 1951, 22,120 tons; 1952, 21,482 tons; 1953, 16,940 tons.

TABLE 19.—World production of pyrites (including cupreous pyrites), by countries,[1] 1944–48 (average) and 1949–53, in metric tons[2]

[Compiled by Helen L. Hunt]

Country [1]	1944–48 (average) gross weight	1949 Gross weight	1949 Sulfur content	1950 Gross weight	1950 Sulfur content	1951 Gross weight	1951 Sulfur content	1952 Gross weight	1952 Sulfur content	1953 Gross weight	1953 Sulfur content
North America:											
Canada	189,068	227,227	106,667	283,596	136,519	403,648	195,373	502,566	238,807	356,189	169,325
Cuba								10,161	4,613	[4] 50,803	[4] 24,600
United States	852,198	905,746	385,518	946,108	399,092	1,034,104	439,766	1,010,301	424,850	937,455	385,637
South America: Brazil	3,640	(3)	(3)	(3)	(3)	(3)	(3)				
Europe:											
Austria	4,706	11,624	4,064	13,529	3,208	10,237	2,746	8,034	2,297	6,070	2,786
Czechoslovakia	4,786	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Finland	138,814	180,040	80,409	162,050	70,107	232,546	98,790	244,926	104,886	259,587	111,000
France	175,485	205,393	85,270	247,615	106,540	280,558	123,446	294,414	129,542	298,000	131,120
Germany, West	383,160	431,963	173,582	525,196	191,525	533,530	194,616	527,932	191,768	529,983	192,078
Greece	33,090	15,785	[4] 7,600	87,678	[4] 42,000	180,120	[4] 88,200	201,238	[4] 98,600	225,134	[4] 112,600
Italy	443,403	864,185	393,723	900,912	[4] 414,420	898,186	[4] 404,100	1,141,417	513,638	1,225,368	551,416
Norway	598,551	744,762	324,723	748,793	317,866	696,049	295,621	712,616	307,179	740,000	320,000
Poland	[4] 79,200	81,000	[4] 36,000	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Portugal	313,207	622,925	[4] 280,300	613,522	276,085	729,611	328,325	755,897	340,154	651,136	293,011
Rumania [4]	12,000	5,000	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Spain	1,053,868	1,559,044	[4] 748,300	1,653,699	[4] 794,000	2,004,126	[4] 962,000	2,378,607	[4] 1,142,000	1,786,548	[4] 857,500
Sweden	312,450	424,007	205,085	406,809	202,301	406,934	202,806	411,276	203,210	[4] 470,000	[4] 225,600
United Kingdom	19,454	17,191	[4] 6,900	13,501	[4] 5,400	13,501	[4] 5,400	15,836	6,400	(3)	(3)
Yugoslavia	95,400	244,775	[4] 110,800	117,167	[4] 53,000	153,779	[4] 69,600	188,129	84,866	173,003	[4] 78,300
Asia:											
China	[4] 43,500	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Cyprus	308,922	942,808	452,548	829,889	398,347	959,838	460,722	1,072,968	515,025	1,001,572	482,195
India	119					539	234	2,203	945	281	[4] 120
Japan	828,434	1,542,360	663,200	1,926,750	786,930	2,250,784	904,815	2,628,357	1,053,971	2,343,260	937,304
Korea, Republic of	(3)							755	[4] 340	777	[4] 350
Taiwan (Formosa)	6,736					6,728	2,153	33,232	10,634	25,291	[4] 6,300
Turkey [4]	[5] 1,767					50,000	25,000	55,000	27,500	60,000	30,000

Africa:											
Algeria	34,748	32,705	13,150	25,075	10,532	31,450	13,838	24,010	10,564	29,760	13,100
French Morocco	[6] 70	202	95	1,473	692	1,949	877	2,025	871	2,037	917
Southern Rhodesia	24,685	16,968	6,787	13,810	5,524	28,269	12,156	19,053	8,193	36,665	15,766
Tunisia	2,486	2,925	1,400	1,150	[4] 500	------	------	------	------	------	------
Union of South Africa	36,713	35,527	15,274	36,026	15,623	33,378	14,474	31,141	13,410	93,844	36,841
Australia	113,059	87,923	41,021	113,973	53,887	153,818	72,589	201,902	95,070	169,687	79,060
Total (estimate)	7,520,000	11,100,000	4,600,000	11,800,000	5,000,000	13,200,000	5,500,000	15,000,000	6,300,000	14,000,000	5,900,000

[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] Data not available; estimate by senior author of chapter included in total.

[4] Estimate.

[5] Average for 1946–48.

[6] Average for 1 year only, as 1948 was first year of production.

The Normetal Mining Corp., Ltd., whose mine is in Desmeloizes Township, western Quebec, can recover about 200 long tons of pyrites daily from the milling of its copper-zinc ore. About 200 tons of pyrites per day could also be recovered by the Barvue Mines, Ltd., as a byproduct of its zinc-mining operations. In British Columbia diamond drilling has indicated large tonnages of pyrites about 35 miles above Port Essington on the Ecstall River near its junction with the Skeena River. Large reserves of pyrite also are found with lead-zinc ores of the Bathurst area in New Brunswick.

The Shell Oil Co. was recovering sulfur from sour gas from the Jumping Pound field in Alberta, and the Royalite Oil Co. from the Turner Valley field in the same Province. Gas from the Pincher Creek field in Alberta contains about 8 percent hydrogen sulfide, from Jumping Pound 4, and Turner Valley 2. Increased production of elemental sulfur is anticipated when pipelines to carry the natural gas from these fields to consuming areas are built.

The delivered price of Frasch sulfur to Canadian consumers generally ranged from $35 to $45 per long ton in 1953. Pyrite prices usually ranged from $3 to $4 per long ton, f. o. b. producer's plant, although small quantities moved at prices ranging up to $7 per long ton.[23]

Mexico.—In 1953 native sulfur was produced in San Luis Potosi, Mexico, and sulfur was recovered by Petroleos Mexicanos in the Poza Rica oil fields in Vera Cruz. Efforts by the Texas International Co. to develop production facilities in the San Felipe area of Lower California also were reported. The most noteworthy activities, however, were in the salt-dome area of the Isthmus of Tehauntepec, where plants to produce Frasch sulfur were being installed. By the end of the year the Mexican Gulf Sulfur Co. had nearly completed its production facilities at the San Cristobal dome. Pan American Sulfur Co. was making rapid progress in its construction program, which was scheduled for completion in 1954.

Gulf Sulphur Co. also was preparing to develop a Frasch mine in Mexico.[24]

SOUTH AMERICA

Argentina.—In 1952 sulfur production in Argentina came from the Azufrera del Norte Mine in the Province of Salta. Two additional deposits were being developed; one was La Betty Tuzgle in Salta, and the other was the Sosneado in an extinct volcano about 140 miles from San Rafael, Mendoza.[25]

Brazil.—Opening of a plant to produce 6 to 8 tons of sulfur daily from coal brasses at Rio Maina, State of Santa Catarina, by the National Sulfur Co., Ltd., in November 1952 was reported.[26]

Chile.—Producers of sulfur in Chile expanded their production capacities rapidly during the shortage when demand was high and prices ranged up to $250 a ton. By the end of 1952 the annual production capacity in Chile was estimated at 100,000 tons. Output

[23] Department of Mines and Technical Surveys, Ottawa, Sulfur and Pyrites in Canada, 1953 (prelim.): 6 pp.
[24] Chemical and Engineering News, Is There a Sulfur Shortage?: Vol. 31, No. 19, May 11, 1953, p. 1969.
[25] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 6, June 1953, pp. 65-67.
[26] Foreign Commerce Weekly, Brazilian Sulfur Plant Opened: Vol. 49, No. 9, Mar. 2, 1953, p. 13.

however never approached this figure because demand had slackened and prices had plummeted. In 1953 output was back to the preshortage level.[27]

Colombia.—Sulfur was produced from the Puracé deposit near Popayan in 1953 at a rate somewhat below that of the previous year. High costs and difficulties encountered in the refinery operations were limiting factors.[28]

Ecuador.—Owing to difficulties encountered in marketing the product profitably, the Ecuadoran Mining Co. closed the Tixan sulfur mine early in 1953. It is reported that operations were resumed about 6 months later, but output for the year was very small.[29]

EUROPE

France.—At the Narbonne mine in Aude Province the Société Languedocienne de Recherches et d'Exploitationes Minières produced high-grade sulfur from an 8-percent sulfur ore. The gangue materials are bituminous argillaceous schist, gypsum, and chalky marl. At the plant an 80-percent sulfur concentrate is first made by flotation, and this concentrate is then refined. In the refining process the sulfur is melted and the gangue particles are agglomerated by adding a suitable reagent. When the gangue is agglomerated, the mass is screened; the molten sulfur passes through the screen, and the gangue is oversize. The bitumen content of the sulfur is removed by mixing in a quantity of clay which absorbs the organic matter and is then separated by filtration. The final yellow sulfur product contains 99.5 percent sulfur.[30]

Greece.—The Hellenic Co. of Chemical Products & Fertilizers, Ltd., of Athens stated that the pyrites produced by its Kassandra mines contained 44 to 48 percent sulfur.[31] Production of pyrites in Greece was about 12 percent higher in 1953 than in 1952. In 1952 the average f. o. b. price per metric ton varied from a low of $11.95 in February to $14.31 in December. In that year 93,082 metric tons was shipped to Germany, 34,920 to Austria, and 49,206 to other countries.[32]

Iceland.—Icelandic output of sulfur totaled about 200 metric tons in 1952. A refining plant was built by the Icelandic Sulphur Mining Co., Ltd., near Lake Myvatn. Experimental production started in October; locally mined raw sulfur was used.[33]

Italy.—In 1953 the Italian sulfur industry encountered serious difficulty. Production was maintained at a rate nearly as high as in the previous year, but the export market shrank sharply, and consequently most of the production went into stocks. Projects supported by Government funds aimed at improving production technology and reducing costs were continued; but relatively little progress was made, and Sicilian sulfur could not compete in the international market without a large subsidy.[34]

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27 Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 6, June 1953, pp. 61–62.
28 Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 5, November 1953, p. 78.
29 Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 6, December 1953, p. 71.
30 Mining World, New Sulphur Refining Process: Vol. 15, No. 6, May 1953, pp. 49–51.
31 Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 3, March 1953, p. 39.
32 Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 6, June 1953, p. 57.
33 Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 5, May 1953, p. 52.
34 Chemical and Engineering News, vol. 31, No. 44, Nov. 2, 1953, p. 4596.

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Norway.—In the period 1949 to 1953 pyrites output in Norway ranged between 696,000 and 749,000 metric tons annually. In 1953, the output of 740,000 was slightly higher than in the previous year. A new mine—the Skorovas mine—which had been opened in November 1952 by Electrokemisk was in operation in 1953. However, a number of technical problems, such as difficulties with the long cableway that is used to transport the product to tidewater and a somewhat unfavorable market situation, prevented this mine from reaching its designed capacity—150,000 tons. Development of the Skorovas mine was considered to be important, as it was the first major development in the Grong pyrites fields in North Trondelag. Reserves in sight at Skorovas were estimated at about 7 million tons of pyrites, and the rest of the Grong district probably contains at least twice that quantity.

Production by the pyrites mines in Norway in 1952 were reported as follows: Løkken, 408,700 metric tons; Sulitjelma, 59,300; Bjørkaasen, 70,000; Stordø, 61,400; Folldal, 34,100; Killingdal, 31,600; Vigsnes, 22,700; and others 26,200. The average sulfur content of Norwegian pyrites was 43.4 percent, the lowest sulfur content for the individual mines was 39 percent and the highest 48. Pyrites reserves in Norway are believed to total at least 50 million tons. Løkken had 8 million tons of reserves, Sulitjelma 4 million, and Folldal well over 1 million.[35]

Portugal.—Fear was expressed that exports of pyrites may have to be curbed to retain enough reserve to protect the national production of sulfur, copper sulfate, and ammonium sulfate.[36]

Output of pyrites in Portugal in 1953 was about 13 percent lower than in 1952. Mason & Barry, Ltd., reported that pyrites reserves at the San Domingo mine at the end of 1952 approximated 1.6 million tons. A diamond-drilling program within and in the near vicinity of the mine had not been successful in locating additional reserves.[37]

Spain.—In 1953 demand for Spanish pyrites declined and output was 25 percent lower than in 1952; however, Spain was the second largest producer—only Japan reported a greater tonnage.[38]

ASIA

India.—Tests by the Fuel Research Institute of Bihar indicated that about 48 tons of pyrites a day could be washed from the Vindhya Pradesh coals.[39]

Iraq.—Continued negotiations were reported between the Government of Iraq and the Texas Gulf Sulphur Co. for the exploration and development of sulfur resources in that country.[40]

The Iraq Sulphur Co., Ltd., was reported to be producing 200 tons of crude sulfur per month. Its concessions were on the Tigris River at Fetha, Baija area, about 130 miles north of Baghdad, and on the Euphrates River about 93 miles northeast of Baghdad. The refinery

[35] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 6, December 1953, pp. 67–69.
[36] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 5, November 1953, p. 70.
[37] Metal Bulletin (London), No. 3803, June 23, 1953, pp. 24–25.
[38] Metal Bulletin (London), No. 3803, June 23, 1953, p. 22.
[39] Iron and Coal Trades Review (London), Sulphur From Indian Coals: Vol. 157, No. 4465, Nov. 6, 1953, p. 1078.
[40] Chemical Age (London), New Sulphur Agreement: Vol. 69, No 1797, Dec. 19, 1953, p. 1268.

was at Kadhimiyah on the Tigris River near Baghdad. The ore, mined from the surface, ranged from 40 to 60 percent sulfur and was being beneficiated in a Calcarone kiln.[41]

Japan.—In 1953 the production of native sulfur in Japan was slightly higher than in the previous year. On the other hand, the monthly production rate, which had approximated 17,000 tons at the beginning, declined during the year. A buyers' market developed, and export prices slumped to about $60 or $70 per ton f. o. b.—about half the price that sulfur sold for in 1952. The chief overseas markets, to which Japan shipped about 40,000 metric tons in 1952, were in Australia, New Zealand, and India. A mission was sent to Australia and New Zealand to try to make long-term sales contracts. Prices in 1953 in the export market were below the Japanese market price and also below the production cost of some producers. Added attention was being given to increasing efficiency and lowering cost. A 300-ton-per-month plant was being built by the Tamatsukuri Sulfur Co. to concentrate lean ore. It is believed that 20-percent ores could be treated by the process at about half the present cost.[42]

Korea.—Pyrite produced in Korea averaged about 45 percent sulfur content.[43]

Philippines.—Development of the Maria Cristina Chemical Fertilizer plant has encouraged the search for a source of sulfur in the Philippines. Teams of mining and geological engineers were sent to study the known occurrences, and the findings were compiled in a report in which the various occurrences were discussed. The Maria Cristina Chemical Fertilizer Plant, through the National Power Corp., has a contract with Nielson & Co. wherein the latter company agrees to supply 10,000 metric tons annually of pyrite concentrates. Nielson & Co. operates the Hixbar Mining Co. at Karogkog, Rapu-Rapu, Albay. The National Power Corp. has a similar contract with the Camiguin Mining Co., Inc., for 4,000 metric tons of sulfataric sulfur annually. Total known Philippine reserves of sulfur-bearing ore have been estimated at 440,880 metric tons, containing 186,450 tons of elemental sulfur.[44]

Turkey.—Sulfur-production capacity was being increased in Turkey, and output in 1953 was about 16 percent higher than in the previous year. A 100-ton-per-day flotation plant scheduled for completion during the year at Keciborlu was expected to permit an output of about 15,000 tons per year of sulfur concentrate. Recovery of iron pyrites from the Ergani mine also was projected.[45]

AFRICA

French Morocco.—Iron pyrites was produced by two companies in French Morocco in 1952. Société Minière des Rehamna produced 1,888 metric tons containing 43 percent sulfur, and Société Minière des Gundafa 137 metric tons containing 46 percent sulfur.[46]

[41] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 4, April 1953, pp. 44–46.
[42] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 5, November 1953, pp. 78–80.
[43] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 5, November 1953, p. 70.
[44] Roa, C. G., Sulphur and Pyrite in the Philippines: Philippine Soc. Min., Met. and Geol. Eng., Mining News Letter, vol 5, No. 2, November 1953.
[45] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 5, November 1953, pp. 80–81.
[46] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 1, July 1953, p. 59.

Southern Rhodesia.—Most of the pyrite produced in Southern Rhodesia is exported to Northern Rhodesia and the Union of South Africa.[47]

Union of South Africa.—A new large market for sulfuric acid was developing in South Africa. Several new acid plants were required to supply uranium-extraction operations. By the end of the year 3 new acid plants had reached production stage, and at least 2 more were being built. They have been located at points suitable to serve several uranium plants and convenient to the best available sources of pyrites. Both pyrite and uranium are obtained as byproducts of large gold mining operations. FluoSolids roasters are used in burning the pyrites.[48]

OCEANIA

Australia.—To assure the continued use of domestic pyrites the Tariff Board recommended that a subsidy be paid the sulfuric acid industry on the sulfuric acid produced from Australian raw materials.[49]

In 1953 the capacity of existing sulfuric acid plants in Australia was estimated at about 650,000 tons annually. Large expansion programs were in progress at a number of localities, and many of these expansions were based on the use of local pyrites or sulfide ores. It was anticipated that by 1955, when the new plants were in production and some old plants had been torn down, the acid-production capacity would approximate 800,000 tons per year.[50]

Gold-mining operations of Norseman Gold Mines, at Norseman, Western Australia, have become unprofitable, but pyrite mining is profitable. Further expansion of production capacity was planned. Reserves in the Iron King ore body totaled 3,706,000 tons. A new shaft, being sunk, was expected to be in operation early in 1954.[51]

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47 Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 3, March 1953, p. 39.
48 Chemical Age (London), vol. 69, No. 1797, Dec. 19, 1953, p. 1285.
49 Mining Magazine (London), vol. 89, No. 5, November 1953, p. 293.
50 Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 5, May 1953, p. 52.
51 Mining Magazine (London), vol. 88, No. 3, March 1953, pp. 160, 161.

Talc, Soapstone, and Pyrophyllite

By Donald R. Irving [1] and Frances P. Uswald [2]

INCREASES in the combined mine production of talc, soapstone,[3] and pyrophyllite and the quantity of these commodities sold by producers were reported in 1953 over 1952. The 1953 production was exceeded only by the alltime high production reported in 1951. The combined value of talc, soapstone, and pyrophyllite sold by producers in 1953 increased slightly from the comparable 1952 figure. Imports for consumption increased 12 percent in quantity and decreased 1 percent in value in 1953 compared with 1952; exports were about the same in quantity and value.

GOVERNMENT PROGRAM UNDER THE DEFENSE PRODUCTION ACT OF 1950

The contract executed by the Defense Minerals Exploration Administration in 1951 with the Hitchcock Corp., Murphy, N. C., to explore for block steatite talc on property of the Nancy Jordan and Carolina mines, Cherokee County, N. C., was terminated during 1953. A certification of discovery or development of nonstrategic talc was issued after tests on core samples showed the talc was not suitable for block steatite talc. A total of $12,958.13 was expended on the project, of which the Government advanced 90 percent or $11,662.33.

DOMESTIC PRODUCTION

Mine production of crude talc, soapstone, and pyrophyllite increased 5 percent in quantity in 1953 compared with 1952 and was the second highest on record; it was exceeded only by the output in 1951, according to reports by producers (tables 1 and 2).

Pyrophyllite production and sales in 1953 were 2 percent less in quantity than in 1952, but the value of sales was nearly the same (table 3).

In 1953, as in 1952, New York, California, and North Carolina ranked first, second, and third, respectively, in production of talc, soapstone, and pyrophyllite and supplied 64 percent of total domestic production (table 4). Decreased production was reported from Georgia, Texas, and Washington; all other producing States reported increases. New producing States in 1953 were Arkansas (soapstone) and Pennsylvania (sericite schist, with properties and uses similar to those of pyrophyllite).

[1] Commodity-industry analyst.
[2] Statistical clerk.
[3] Excludes soapstone sold in slabs or blocks, which is part of the stone industry.

TABLE 1.—Salient statistics of the talc, soapstone, and pyrophyllite industries in the United States, 1952–53

	1952		1953	
	Short tons	Value	Short tons	Value
Mined	600, 908	(1)	631, 518	[2] $3, 524, 035
Sold by producers:				
Crude to consumers	19, 029	$203, 895	18, 423	185, 184
Sawed and manufactured	976	309, 271	935	354, 847
Ground [3]	573, 142	10, 834, 151	589, 516	10, 840, 283
Total sales	593, 147	11, 347, 317	608, 874	11, 380, 314
Imports for consumption: [4]				
Crude and unground	284	57, 991	198	35, 474
Cut and sawed	64	18, 900	127	39, 903
Ground, washed, or pulverized	19, 954	649, 955	22, 478	641, 332
Total imports	20, 302	726, 846	22, 803	716, 709
Exports:				
Talc, steatite, soapstone, and pyrophyllite, crude and ground [5]	23, 223	757, 516	23, 230	698, 232
Powder—talcum (in packages), face and compact	(1)	1, 244, 801	(1)	1, 295, 533
Total exports		2, 002, 317		1, 993, 765

[1] Figure not available.
[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: 1952: $1,922; 1953: $7,974. Quantities not available.
[5] Includes manufactures, n.e.s.

TABLE 2.—Talc, soapstone, and pyrophyllite,[1] sold by producers in the United States, 1944–48 (average) and 1949–53, by classes

Year	Crude			Sawed and manufactured		
	Short tons	Value at shipping point		Short tons	Value at shipping point	
		Total	Average		Total	Average
1944–48 (average)	12, 239	$96, 246	$7. 86	873	$220, 390	$252. 45
1949	15, 731	170, 414	10. 83	636	253, 704	398. 91
1950	18, 805	186, 120	9. 90	805	312, 776	388. 54
1951	20, 166	211, 241	10. 48	1, 097	375, 141	341. 97
1952	19, 029	203, 895	10. 71	976	309, 271	316. 88
1953	18, 423	185, 184	10. 05	935	354, 847	379. 52

Year	Ground [2]			Total		
	Short tons	Value at shipping point		Short tons	Value at shipping point	
		Total	Average		Total	Average
1944–48 (average)	444, 719	$6, 246, 941	$14. 05	457, 831	$6, 563, 577	$14. 34
1949	445, 529	7, 099, 360	15. 93	461, 896	7, 523, 478	16. 29
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

[1] Includes pinite 1944, 1947 and 1948, and sericite schist, 1953.
[2] Includes some crushed material.

TABLE 3.—Pyrophyllite [1] produced and sold by producers in the United States, 1944–48 (average) and 1949–53

Year	Production (short tons)	Sales					
		Crude		Ground		Total	
		Short tons	Value	Short tons	Value	Short tons	Value
1944–48 (average)	91,814	6,799	$45,781	83,492	$895,888	90,291	$941,669
1949	90,920	5,927	31,489	82,934	1,070,838	88,861	1,102,327
1950	116,800	5,690	30,016	112,119	1,504,141	117,809	1,534,157
1951	120,031	4,446	23,741	114,398	1,664,058	118,844	1,687,799
1952	125,496	4,720	29,922	119,767	1,569,471	124,487	1,599,393
1953 [2]	123,457	2,480	15,564	119,057	1,581,826	121,537	1,597,390

[1] Exclusive of pinite.
[2] Includes sericite schist.

TABLE 4.—Crude talc, soapstone, and pyrophyllite produced in the United States, 1952–53, by States

State	1952		1953	
	Short tons	Value [1]	Short tons	Value [2]
California	123,793	(1)	126,422	$1,132,700
Georgia	58,411	(1)	57,891	202,619
Maryland and Virginia	36,963	(1)	37,358	131,744
Nevada	7,580	(1)	10,906	72,971
New York	150,138	(1)	156,299	940,541
North Carolina	116,722	(1)	119,341	578,239
Pennsylvania			[3] 2,463	4,926
Texas	17,495	(1)	16,210	70,658
Vermont	72,533	(1)	80,209	240,627
Washington	(4)	(1)	5,351	28,833
Other States [5]	17,273	(1)	19,068	120,177
Total	600,908	(1)	631,518	3,524,035

[1] Data not available.
[2] Partly estimated.
[3] Sericite schist.
[4] Included with "Other States."
[5] Includes Arkansas (1953), Montana (1952–53), and Washington (1952).

The bulk 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 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 combined quantity sales of ground talc, soapstone, and pyrophyllite in 1953, followed by North Carolina, and California, although the value of the California output exceeded that of North Carolina (table 5).

TABLE 5.—Ground talc, soapstone, and pyrophyllite sold by grinders in the United States, 1952–53, by States

State	1952		1953	
	Short tons	Value	Short tons	Value
California	117, 717	$2, 904, 806	106, 606	$2, 759, 314
Georgia	56, 181	575, 033	57, 581	594, 900
Maryland and Virginia	36, 024	323, 803	35, 524	320, 285
New York	149, 103	4, 059, 116	155, 995	3, 950, 035
North Carolina	111, 291	1, 564, 341	115, 794	1, 675, 308
Pennsylvania			1, 283	10, 893
Texas	15, 601	202, 274	16, 290	223, 457
Vermont	70, 623	899, 966	74, 778	712, 303
Washington	6, 064	52, 963	2, 563	35, 294
Other States [1]	[2] 10, 538	[2] 251, 849	23, 102	558, 494
Total	573, 142	10, 834, 151	589, 516	10, 840, 283

[1] Includes Nebraska, Oregon, and Utah.
[2] Revised figure.

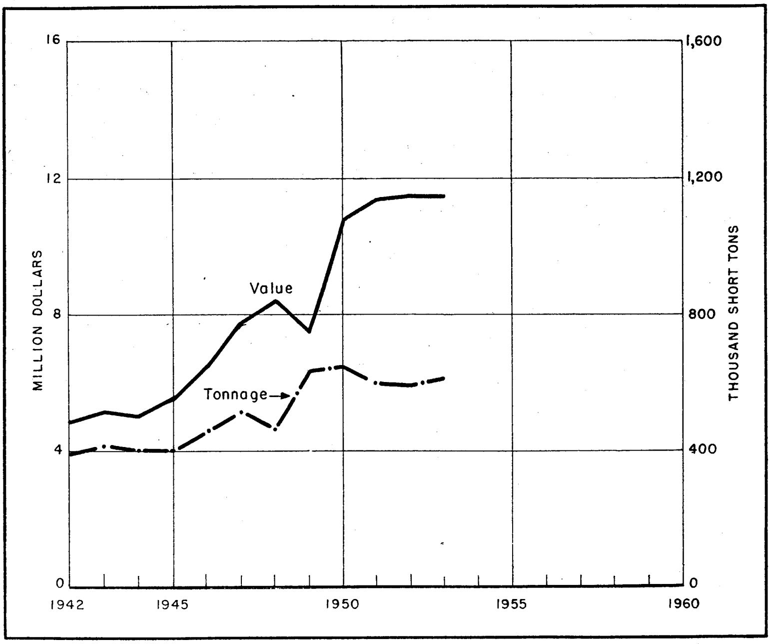

FIGURE 1.—Sales of domestic talc, pyrophillite, and ground soapstone, 1942–53.

CONSUMPTION AND USES

Sales to 6 industries—ceramics, paint, insecticides, roofing, rubber, and paper—made up 83 percent of the domestic production of talc and soapstone in 1953, according to reports from producers, compared with 85 percent in 1952 and 88 percent in 1951 (table 6).

Four industries—insecticides, rubber, ceramics, and refractories—consumed 87 percent of the pyrophyllite sold by producers in 1953 compared with 86 percent in 1952 and 90 percent in 1951 (table 7).

TABLE 6.—Talc and soapstone sold by producers in the United States, 1951–53, by uses

Use	1951		1952		1953	
	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total
Ceramics	142,852	28	117,046	25	120,794	25
Paint	119,938	23	120,404	26	113,406	23
Rubber	46,334	9	33,305	7	32,137	7
Roofing	63,568	12	48,721	10	53,858	11
Insecticides	53,781	11	52,280	11	57,762	12
Paper	27,884	5	26,327	6	25,018	5
Asphalt filler	11,229	2	23,005	5	21,305	4
Textiles	11,414	2	12,029	3	9,811	2
Toilet preparations	7,916	2	8,361	2	8,126	2
Foundry facings	7,986	2	7,279	1	7,502	1
Rice polish	1,944	(1)	1,438	(1)	2,624	1
Crayons	738	(1)	703	(1)	660	(1)
Other	21,640	4	17,762	4	34,334	7
Total	517,224	100	468,660	100	487,337	100

[1] Less than 0.5 percent.

TABLE 7.—Pyrophyllite sold by producers in the United States, 1951–53, by uses

Use	1951		1952		1953	
	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total
Insecticides	36,637	31	35,081	28	34,865	29
Rubber	27,086	23	31,171	25	29,271	24
Ceramics	27,669	23	26,115	21	26,213	21
Refractories	15,020	13	15,507	12	15,565	13
Plaster products	7,916	7	10,570	9	6,929	6
Paint	2,619	2	4,722	4	4,977	4
Roofing	1,200	1	840	1	1,500	1
Other	697	(1)	481	(1)	2,217	2
Total	118,844	100	124,487	100	121,537	100

[1] Less than 0.5 percent.

PRICES

Table 8 shows the prices of ground talc and pyrophyllite at the beginning of 1952 and 1953 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.

The average value per ton of domestic talc, soapstone, and pyrophyllite sold by producers, which had been increasing for many years, decreased 2 percent in 1953 (table 2).

TABLE 8.—Prices quoted on talc and pyrophyllite, carlots, 1952–53, per short ton

[Oil, Paint and Drug Reporter]

Mineral and grade	Jan. 7, 1952	Jan. 5, 1953	Dec. 28, 1953
GROUND TALC (BAGGED)			
Domestic, f. o. b., works:			
Ordinary:			
California	$25.00–$35.00	$25.00–$35.00	[1] $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	(2)	36.00	36.00
Imported (Canadian), f. o. b. mines [3]	15.25–35.00	15.25–35.00	15.25–35.00
PYROPHYLLITE			
Standard, bulk, mines [4]:			
200-mesh	12.50	12.50	12.50
230-mesh	13.50	13.50	13.50
325-mesh	16.75	16.75	16.75
No. 3: 200-mesh, bulk, mines [4]	11.00	11.00	11.00
Insecticide grade: 200-mesh, bags, mines	13.50–14.00	13.00–13.50	13.00–13.50
Rubber grade: 140-mesh, bags, mines	13.50	11.50–12.00	11.50–12.00

[1] Changed May 11, 1953.
[2] Not quoted.
[3] Refer, also, to Canada, under World Review.
[4] Standard and No. 3, in paper bags, $3 to $3.50 per ton extra.

TABLE 9.—Prices quoted on talc, carlots, 1952–53, per short ton, f. o. b. works

[E&MJ Metal and Mineral Markets]

Grade [1]	Jan. 3, 1952	Jan. 1, 1953	Dec. 24, 1953
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	18.50–20.00	[2] 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 [4]

Imports.—A 12-percent increase in quantity and a 1-percent decrease in value were reported in 1953 from 1952 for the total quantity of unmanufactured "talc, steatite or soapstone, and French chalk" imported for consumption in the United States. The value of imports for consumption of manufactures (not specifically provided for, except toilet preparations) increased 315 percent. Detailed data on imports are given in table 10.

Exports.—Crude and ground talc, steatite, soapstone, and pyrophyllite exports increased slightly in quantity but decreased 2 percent in value in 1953 from 1952. Exports of manufactures decreased 40 percent in quantity and 33 percent in value during the same period.

[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.

The value of exports of "powders—talcum (in packages), face and compact" was $50,732 more than in 1952 (table 11).

TABLE 10.—Talc, steatite or soapstone, and French chalk imported for consumption in the United States, by classes in 1944–48 (average) and 1949–51 and by classes and countries in 1952–53

[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	
1944–48 (average)	244	$17,689	13,614	$289,186	83	$16,096	13,941	$322,971	$8,814
1949	47	4,981	18,648	537,061	121	35,072	18,816	577,114	9,012
1950	177	10,052	23,054	637,262	156	44,364	23,387	691,678	7,574
1951	109	20,326	20,404	631,707	127	42,033	20,640	694,066	2,178
1952									
Canada	20	275	3,204	44,673	15	1,564	3,239	46,512	71
China									509
France			1,566	38,979	12	3,201	1,578	42,180	3
Germany, West									804
India	113	14,908	546	31,967			659	46,875	
Italy	151	42,808	14,638	534,336	9	4,220	14,798	581,364	198
Japan					16	6,451	16	6,451	
Netherlands									24
Norway					12	3,464	12	3,464	
Peru									3
Switzerland									256
United Kingdom									54
Total	284	57,991	19,954	649,955	64	18,900	20,302	726,846	1,922
1953									
Brazil			(1)	4			(1)	4	
Canada			2,737	38,277	1	293	2,738	38,570	898
China									11
France			2,362	52,614	5	1,322	2,367	53,936	
Germany, West									4,207
India	142	19,855	794	25,333			936	45,188	
Italy	56	15,619	16,585	525,104	98	27,929	16,739	568,652	1,800
Japan					18	8,832	18	8,832	
Norway					5	1,527	5	1,527	
Switzerland									1,041
United Kingdom									17
Total	198	35,474	22,478	641,332	127	39,903	22,803	716,709	7,974

[1] Less than 1 ton.

TABLE 11.—Talc, pyrophyllite, and talcum powders exported from the United States, 1944–48 (average) and 1949–53

[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	
1944–48 (average)	[1] 14,456	[1] $353,332	(2)	(2)	$2,720,918
1949	15,840	439,686	1	$455	1,636,505
1950	20,593	560,752	51	25,492	1,233,609
1951	22,903	645,217	106	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

[1] Excludes shipments under the Army Civilian Supply Program.
[2] Not separately classified before January 1949.

TECHNOLOGY

A paper describing the properties of phosphate-bonded talc was delivered at a symposium on ceramics and ceramics-to-metal seals. The paper was scheduled for publication in the Journal of the American Ceramic Society and Ceramic Age in 1954. Phosphate-bonded talc, formed by dry pressing, hydrostatic pressing, or hot pressing from domestic talc, develops mechanical and dielectric properties comparable with those of natural block talc.[5] Steatite ceramic bodies with exceptionally low dielectric losses were developed utilizing Montana talc and other readily available raw materials.[6] The production of glazed wall tile from a body composed of 60 to 70 percent ground talc and the balance clay was described.[7] Control of the quality of ground talc by chemical and physical tests and by the use of test bodies was described. The need for coordinating mining, milling, and laboratory activities was discussed.[8] Studies indicated that a commercial product could be produced from Wake County, N. C., talc by froth flotation, magnetic separation, and desliming. The quality of the purified talc increased with decreasing particle size.[9] The mineralogical and chemical composition and manner of occurrence of soapstone were reviewed on the basis of samples from Finland, the United States, Greenland, Norway, Sweden, Switzerland, Czechoslovakia, and U. S. S. R.[10] Patents were issued during the year for the manufacture of metal-marking crayons [11] and "artificial marble",[12] using ground talc as an ingredient. The volume stability and resistance to deformation under load at high temperatures of a number of pyrophyllite-clay mixtures were reported.[13]

WORLD REVIEW

The production of talc, soapstone, and pyrophyllite, by countries, 1944–48 (average) and 1949–53, is shown in table 12. The estimated world production increased 3 percent in quantity in 1953 over 1952 and was the second highest on record.

Argentina.—In an attempt to increase mineral production, a new Five-Year Mining Plan was approved permitting the Government to spend up to $600 million to aid mineral development. Intensified exploration of talc deposits was reported, particularly in Mendoza, the first-ranking State in talc output. Six mines were producing in

[5] Comeforo, J. E., Breedlove, J. G., and Thurnauer, Hans, Phosphate-Bonded Talc, a Superior Block-Talc Substitute: Symp. pres. under sponsorship of Subpanel on Tube Techniques of Panel on Electron Tubes, Research and Development Board, Rutgers University, New Brunswick, N. J., Apr. 21, 1953.

[6] Lamar, R. S., Further Development in Low-Loss Steatite Bodies, Using Yellowstone Talc: Bull. Am. Ceram. Soc., vol. 32, No. 1, 1953, pp. 12–15.

[7] Wright, L. A., Production of Glazed Wall Tile in Southern California: California Div. of Mines, Min. Inf. Service, vol. 6, No. 6, 1953, pp. 5–6.

[8] Gaskins, W. W., Raw-Material Control by the Talc Producer: Bull. Am. Ceram. Soc., vol. 32, No. 4, April 1953, pp. 162–163.

[9] Dillender, R. D., Jr., and Gower, I. W., Preliminary Report on the Froth Flotation of Wake County Talc: North Carolina State Coll. Agr. and Eng., Univ. of North Carolina, Dept. Eng. Research, Ind. Inf. Ser., Bull. 7, November 1953, 16 pp.

[10] Wiik, H. B., Composition and Origin of Soapstone: Comm. Geol. Finlande, Bull. 165, 1953, 56 pp. (in English); Chem. Abs., vol. 48, No. 7, Apr. 10, 1954, p. 3866e.

[11] Norwood, Jack E., Talc Crayons for Marking Metals: U. S. Patent 2,627,089, Feb. 3, 1953.

[12] Lucassen, Lucas, Artificial Marble: Netherland Patent 73,009, Aug. 15, 1953; Chem. Abs., vol. 48, No. 6, Mar., 25 1954, p. 3660g.

[13] Bell, W. C., Gower, I. W., and Hart, J. R., Some Properties of Pyrophyllite as a Refractory Raw Material Brick and Clay Record, vol. 123, No. 6, December 1953, pp. 62–63, 65–66.

Mendoza—3 in Uspallata, 2 in the Bonilla Range, and 1 in Tunuyan—and the Cooperativa del Talce (producer of talc) planned to install a grinding mill.[14]

TABLE 12.—World production of talc, soapstone, and pyrophyllite, by countries[1] 1944–48 (average) and 1949–53, in metric tons[2]

[Compiled by Helen L. Hunt]

Country[1]	1944–48 (average)	1949	1950	1951	1952	1953
North America:						
Canada (shipments)	26,585	24,423	29,578	22,540	22,709	24,370
United States	417,112	416,709	559,440	581,009	545,132	572,900
South America:						
Argentina[3]	3,670	(4)	(4)	15,000	16,000	(4)
Brazil	4,271	17,782	12,632	11,304	(4)	(4)
Chile	681	110	142	25	(4)	(4)
Paraguay	----	----	----	----	----	90
Peru	----	----	----	131	124	(4)
Uruguay	2,311	660	681	959	679	891
Europe:						
Austria	28,542	56,050	58,681	72,784	50,822	51,335
Finland	182	----	300	5,000	6,000	3,688
France	58,405	100,055	87,416	103,236	107,701	103,900
Germany, West	15,160	17,700	27,300	35,200	27,589	40,789
Greece	500	1,700	2,500	2,625	1,200	(4)
Italy	46,985	61,462	67,616	75,996	80,336	80,282
Norway	38,249	54,305	64,099	76,479	64,074	(4)
Portugal	[5] 21	3	2	1	6	16
Rumania[3]	633	(4)	(4)	(4)	(4)	(4)
Spain	24,411	38,208	25,131	36,034	27,859	28,447
Sweden	10,259	11,293	13,843	13,332	8,787	(4)
United Kingdom	3,163	2,616	1,727	2,540	2,628	(4)
Asia:						
Afghanistan	----	100	75	840	800	600
India	36,007	21,535	25,894	32,314	20,373	(4)
Indochina	106	----	----	(4)	(4)	(4)
Japan	208,929	262,433	283,566	400,626	318,386	(4)
Korea, Republic of	10,647	2,773	7,485	3,208	3,964	24,479
Taiwan (Formosa)	----	76	700	2,057	1,093	1,764
Africa:						
Egypt	4,609	5,573	3,731	3,754	4,903	2,198
Kenya	287	590	334	337	235	155
Union of South Africa	3,220	5,386	3,978	5,663	8,674	7,234
Oceania:						
Australia	5,802	8,717	9,851	13,359	7,772	9,963
New Zealand	5	----	----	----	----	----
Total (estimate)[1]	1,025,000	1,275,000	1,450,000	1,650,000	1,500,000	1,550,000

[1] In addition to countries listed, talc or pyrophyllite is reported in China and U. S. S. R., but data on production are not available; estimates included in total.
[2] This table incorporates a number of revisions of data published in previous Talc, Pyrophyllite, and Ground Soapstone chapters.
[3] Estimate.
[4] Data not available; estimate by senior author of chapter included in total.
[5] Average for 1 year only, as 1948 was first year of production.

Austria.—New talc deposits were reported to have been found near Mautern in Styria Province. The deposits may be too small to warrant large capital investment in development. Talc was being produced from the Oberfeistritz, St. Kathrein, and Naintsch mines in Styria.[15]

Talc exports for 1950–53, by countries of destination, are given in table 13.

[14] Mining World, vol. 15, No. 2, February 1953, p. 61; No. 3, March 1953, p. 65; No. 8, July 1953, p. 70.
[15] Mining World, vol. 15, No. 8, July 1953, p. 73.

TABLE 13.—Talc exports from Austria, by countries of destination, 1950–53, in metric tons [1] [2]

Country of destination	1950	1951	1952	1953
Argentina	74	35		
Belgium-Luxembourg	705	938	660	979
Czechoslovakia	597	92		
Denmark			25	15
France	536	901	668	909
Germany:				
East	1,224	3,618	1,536	2,310
West	14,229	15,641	12,192	13,957
Hungary	2,705	3,668	3,095	1,980
Italy		21	48	268
Netherlands	1,459	1,449	1,994	649
Poland	4,757	6,916	8,812	9,578
Sweden		15		10
Switzerland	1,119	1,756	1,264	1,640
Trieste			24	15
United Kingdom	45	403	527	784
Yugoslavia	125	92	86	15
Others	11			3
Total	27,586	35,545	30,931	33,112

[1] Compiled by John E. McDaniel, Division of Foreign Activities, Bureau of Mines, from Customs Returns of Austria.

[2] This table incorporates a number of revisions of data published in Talc, Pyrophyllite, and Ground Soapstone chapter for 1952.

Canada.—According to the official preliminary estimates, Canada produced 13,000 short tons of talc (value Can$160,000) in 1953, and 13,863 tons of soapstone (value Can$134,250), compared with final revised 1952 figures of 12,454 tons of talc (value Can$149,711) and 12,578 tons of soapstone (value Can$130,901).[16] Imports of talc and soapstone in 1953 were given as 11,867 tons (value Can$732,628) and exports of talc 2,937 tons (value Can$38,193). In 1952, the value of the Canadian dollar ranged from US$0.99 to US$1.04; in 1953, the value ranged from US$1.01 to US$1.03.

The Canadian talc and soapstone industry in 1952 was described as follows:[17]

> Talc and soapstone shipped by producers in 1952 amounted to 25,032 tons valued at $280,612, compared with 24,846 tons worth $283,624 in 1951. Most of the production in Ontario was high grade milled talc. The output from Quebec included crayons, blocks, and ground soapstone. Operations in British Columbia were for experimental test purposes.
>
> Employees numbered 54 persons to whom $117,144 were paid in salaries and wages. Fuel cost $6,551 and 1,165,433 kw.-hr. of electricity were purchased for $17,879.
>
> Imports of talc and soapstone amounted to 8,749 tons valued at $276,496 during 1952. Exports totaled 3,435 tons worth $44,925.

[16] Canada, Department of Trade and Commerce, Dominion o fStatistics, Preliminary Report on Mineral Production—1953: Min., Met., and Chem. Sec., Industry and Merchandising Div., Dominion Bur. of Statistics, Ottawa, Canada, 1953, 36 pp.

[17] Canada, Department of Trade and Commerce, Dominion Bureau of Statistics, The Talc and Soapstone Industry, 1952: Industry and Merchandising Div., Dominion Bur. of Statistics, Min., Met., and Chem. Sec., Ottawa, Canada, 1953, 5 pp.

TABLE 14.—Available statistics on the consumption of ground talc and soapstone, in Canada, 1949–51, by uses, in short tons

Use	1949	1950	1951
Paints	5,378	9,023	6,921
Roofing	8,595	9,739	8,861
Pulp and paper	3,827	1,634	1,974
Rubber	3,002	3,290	1,684
Toilet and medicinal preparations	864	861	778
Electrical apparatus	815	475	641
Clay products	882	716	894
Soaps and cleaning preparations	215	159	192
Textiles	484	571	518
Insecticides and miscellaneous chemicals	4,674	6,006	6,419
Polishes	----------	25	12
Prepared foundry facings	846	21	96
Iron foundries	110	110	----------
Tanneries	50	50	8
Asbestos products	----------	----------	2
Linoleum	5	----------	1
Coal-tar distillation	----------	98	305
Total	29,747	32,778	29,306

Canada Talc Industries, Ltd., Madoc, Ontario, continued to produce white talc, mostly from the Conley mine. During 1953 the company conducted underground development and diamond drilling at the Henderson mine, which adjoins the Conley.[18] Quotations on the various grades of ground talc produced by the company, f. o. b. Madoc, bags included, were reported in 1953 as follows:[19]

	Per short ton
Filler grades	$11.50–$15.50
Cosmetic grades	26.00– 50.00
Ceramics grades	17.50– 26.00
Roofing grades	10.00– 13.75

Specifications: Grinding specifications for cosmetic, ceramics, and filler grades vary from 95 percent to 99.8 percent minus-325-mesh; for roofing grades there are various specifications in the minus-80-plus-200-mesh range. Note that prices vary considerably within the ranges shown, with variations affected by such factors as quality, color, loss of ignition, and fineness of grind.

Finland.—Talc occurs in Finland associated with dolomite-magnesite at Talvivaara in the commune of Sotkano, at Haaralanniemi in the commune of Polvijarvi, and at Joruma near the city of Kajaani. The Joruna deposit is being mined by Suomen Mineraali Oy. Production was begun in 1950, when 300 metric tons was produced. Production for subsequent years was: 1951, 5,000; 1952, 6,000; and 1953, 3,688 metric tons. The principal domestic consuming industry, the roofing industry, met requirements before production by imports, which in recent years were 4,000 to 5,000 tons per year.[20]

France.—Exports of talc and soapstone, 1950–52, by countries of destination are given in table 15.

[18] Bruce, C. G., Talc and Soapstone in Canada, 1953 (Preliminary): Dept. of Mines and Tech. Surveys, Ottawa, Canada, 3 pp.
[19] Northern Miner (Toronto); vol. 38, No. 50, Mar 5, 1953, p. 10.
[20] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 6, December 1953, p. 72.

TABLE 15.—Exports of talc and soapstone from France, 1950–52, by countries of destination, in metric tons [1]

Country of destination	1950	1951	1952
Belgium-Luxembourg	3,432	4,037	2,786
Finland	593	1,139	----------
Germany, West	2,759	3,099	2,016
Netherlands	1,463	1,548	1,094
Sweden	----------	1,058	777
Switzerland	6,391	8,416	5,361
United Kingdom	6,106	8,806	5,557
United States	1,979	1,610	1,432
Others	5,765	2,199	3,681
French Overseas Territories	2,110	3,732	782
Total	30,598	35,644	23,486

[1] Compiled by John E. McDaniel, Division of Foreign Activities, Bureau of Mines, from Customs Returns of France.

India.—The talc deposits of Bheraghat, Jubbulpore,[21] and Dogeta, Rajasthan,[22] were described in articles published in 1953.

Italy.—Exports of talc from Italy, 1950–52, by countries of destination, are given in table 16.

TABLE 16.—Exports of talc from Italy, 1950–52, by countries of destination, in metric tons [1]

Country of destination	1950	1951	1952
Belgium-Luxembourg	255	339	265
Canada	418	674	708
France	578	1,171	377
Germany:			
East	----------	353	125
West	3,409	4,422	3,565
Netherlands	104	209	367
Portugal	2,075	133	159
Switzerland	663	207	340
Union of South Africa	1,016	1,170	340
United Kingdom	5,649	7,034	5,599
United States	7,021	12,691	11,731
Others	6,323	4,143	2,967
Total	27,511	32,546	26,543

[1] Compiled by John E. McDaniel, Division of Foreign Activities, Bureau of Mines, from Customs Returns of Italy.

Japan.—Most of the production reported from Japan is pyrophyllite, associated with diaspore, andalusite, corundum, kaolin, and quartz. The Yokomichi ore, Nagasaki Prefecture, contains about 50 percent diaspore and 50 percent pyrophyllite.[23] Talc production in 1952, according to the Japanese Ministry of International Trade and Industry, was 10,568 metric tons, and imports were 6,750 metric tons. Talc is produced from several localities along the Okamotsu and Kokamotsu Rivers, Oshima, Hokkaido, for use in the cosmetic, pharmaceutical, paper, and rubber industries.[24]

[21] Chhibber, V. N., Steatite Deposits of Bheraghat, Jabalpur District, M. P., India: Econ. Geol., vol. 48, No. 1, January-February 1953, pp. 53–58.

[22] Roy, B. C., Talc Deposits at Dogeta, near Dausa, Rajasthan Province: Indian Minerals, vol. 6, 1952, pp. 141–146.

[23] Hamachi, T., Microscopic Observation of the Pyrophyllite in the Goto Island, Nagasaki Prefecture: Bull. Geol. Survey Japan, vol. 4, 1953, pp. 97–104.

Iwao, S., Hamachi, T., Yamada, M., and Inoue, H., Pyrophyllite and Diaspore Deposits in Goto Island, Kyushu: Bull. Geol. Survey Japan, vol. 4, 1953, pp. 81–97.

Watanabe, Manjiro, Diaspore Pyrophyllite Deposits of Tukue Island, Nagasaki Prefecture: Sci. Repts. Tohôku Univ., Ser. 3, vol. 4, 1953, pp. 171–183.

[24] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 5, November 1953, p. 81.

Korea Republic.—Production of talc in 1953 was 8,599 metric tons valued at $222,000. Production of pyrophyllite was 15,880 metric tons valued at $241,000.[25]

Norway.—Exports of talc and soapstone, 1950–52, by countries of destination, are given in table 17.

TABLE 17.—Exports of talc and soapstone from Norway, 1950–52, by countries of destination, in metric tons [1]

Country of destination	1950	1951	1952
Belgium-Luxembourg	1,454	2,697	3,351
Denmark	4,867	5,639	4,447
Finland	3,321	3,827	2,489
France	249	634	606
Germany, West	5,020	4,072	4,138
Indonesia	-----------	1,870	1,943
Netherlands	8,454	7,377	5,533
Poland	199	-----------	205
Sweden	8,152	8,350	4,846
Switzerland	-----------	185	134
United Kingdom	11,280	15,387	11,125
Others	1,988	1,337	1,500
Total	44,984	51,375	40,317

[1] Compiled by John E. McDaniel, Division of Foreign Activities, Bureau of Mines, from Customs Returns of Norway.

[25] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 4, October 1954, p. 75.

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Tin

By Abbott Renick[1] and John B. Umhau[2]

WORLD mine production of tin increased slightly in 1953, substantially exceeding world consumption. United States Government controls over consumption, inventories, and prices were removed early in the year; a sudden and severe drop in price occurred in the second quarter; and United States imports, primary tin consumption, and inventories all increased substantially. In December the text of an international agreement designed to stablize the tin industry was accepted by a United Nations conference for submission to producing and consuming nations.

World mine production of tin totaled 179,000 long tons in 1953—the highest since 1941—was 5,000 tons (3 percent) greater than in 1952 and represented an increase of 4 percent from the 1935–39 average (171,400 tons). World smelter production totaled 183,000 long tons, an increase of 7 percent over the 1952 output of 171,000 long tons, and resulted largely from a 65-percent increase in the output of the Government-owned smelter at Texas City, Tex. In 1953 world mine production exceeded world consumption by about 48,500 long tons.

The United States mine output of tin continued to be negligible, although the Government, under the Defense Production Act of 1950, provided assistance to tin-mining ventures in Alaska. A small production of tin resulted as a byproduct from the mining of molybdenite in Colorado.

Effective January 1, the National Production Authority removed allocation controls and on February 6 all restrictions on inventory and use of tin but retained monthly reporting until June 30. On February 13 the Office of Price Stabilization removed the ceiling price on tin.

The outstanding feature of the tin market in 1953 was the sharp fall in price during the second quarter. The selling price, which had averaged about $1.20 per pound over the first 3 months of 1953, began to decline in the first week of April and reached the year's low of 78.25 cents per pound on July 21, 1953. Thereafter a recovery developed in the tin market with Straits prompt tin quoted at 86.5 cents a pound on December 17, 1953. The annual average for 1953 was 95.77 cents per pound and 20 percent below 1952's average price of $1.20 per pound.

Metal imports decreased 7 percent and represented 67 percent of the total tin imported. Receipts of concentrates, in terms of metal, were 36 percent higher than in 1952. The increase was due chiefly to larger receipts from Bolivia. In 1953 imports were augmented by 6,800 long tons of tin alloys, mainly from Denmark, in the form of a 94-percent tin alloy.

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

Consumption of tin in 1953 in the United States, which was relatively free from Government controls through the year, increased 9 percent compared with the previous year; consumption of primary tin increased 19 percent, whereas secondary tin decreased 4 percent. Domestic production of tinplate established a new record in 1953 at 5 million short tons, a 19 percent increase from the previous year. Secondary tin production was 4 percent less than in 1952.

The total stocks of tin in the United States, exclusive of the National Strategic Stockpile, as of December 31, 1953, were 62,100 long tons or nearly 9 percent less than on January 1. Pig tin, tin content of concentrates, and other tin-bearing materials held by Reconstruction Finance Corporation on December 31 were 34,400 long tons, while those stocks held by industry totaled 27,700 long tons.

In January 1953 the RFC entered into a purchase agreement with the Bolivian Government for the supply of 5,000 tons of tin, at a price of $1.175, South American ports of shipment. On September 23 the second contract with Bolivia provided for 10,000 long tons of tin in concentrates. Procurement of concentrates from Thailand continued to be made by RFC's special representative in Bangkok, and purchases were made under short-term contracts covering small tonnages from various sources. Concentrates continued to be received under long-term contracts with Belgian Congo and Indonesian producers.

TABLE 1.—Salient statistics of tin in the United States, 1944–48 (average) and 1949–53

	1944–48 (average)	1949	1950	1951	1952	1953
Production:						
From domestic mines [1] ----long tons--	2.2	68.4	94.1	88.0	98.7	56.0
From domestic smelters [2] --------do----	36,972	35,834	33,118	31,852	22,805	37,562
From secondary sources---------do----	27,780	22,230	31,680	30,745	28,800	27,600
Consumption:						
Primary------------------------do----	57,691	47,163	71,191	56,884	45,323	53,959
Secondary----------------------do----	28,986	25,243	33,273	31,285	[3] 33,095	31,681
Imports for consumption:						
Metal--------------------------do----	22,297	60,224	82,838	28,255	80,543	74,538
Ore (tin content)--------------do----	34,800	38,311	25,960	29,621	26,491	35,973
Exports (domestic and foreign)-----do----	623	154	799	1,513	380	203
Monthly price of Straits tin at New York:						
Highest-------------cents per pound--	74.20	103.00	163.50	184.00	121.50	121.50
Lowest-------------------------do----	64.00	77.50	74.125	103.00	103.00	78.25
Average------------------------do----	67.15	99.316	95.557	128.31	120.44	95.77
World mine production---------long tons--	109,100	[4] 161,300	[4] 169,300	[4] 169,500	[4] 173,900	179,000

[1] Includes Alaska.
[2] Including tin content of alloys made directly from ores.
[3] Includes tin contained in imported tin-base alloys.
[4] Revised figure.

GOVERNMENT CONTROLS

All controls over uses and inventories of tin were removed in 1953. Allocation controls over pig tin were removed, effective January 1, 1953, but consumption continued to be restricted and limited by the greatly relaxed provisions of Tin-Control Order M–8 until February 6, 1953. On that date all controls over uses and inventories of tin were removed, and the National Production Authority announced revocation of orders M–8 (tin), M–24 (tinplate and terneplate), M–25 (cans), M–26 (closures), M–27 (collapsible tubes), and amendment of regulation 1 (inventory provisions). Mandatory reporting by consumers and dealers on tin stocks, receipts, shipments, and consumption was not discontinued until June 30, 1953. On February 9, 1953, tin was withdrawn from Designation of Scarce Materials 1 (formerly NPA Notice 1, of December 27, 1950). On February 10 Inventory-Control Regulation 1 was amended to conform with the revocations of the tin orders so as to free all the commodities covered by these orders of inventory control. On February 13 the Office of Price Stabilization issued a sweeping decontrol order which removed the ceiling price on tin, as well as many other commodities.

On March 2 the Office of International Trade announced the ending of tin export quotas but still required licensing to prevent exports that might endanger the defense program. Collapsible tubes were not under export control after the first quarter of 1953.

Defense Minerals Administration Order MO–1, designating scarce materials hoarding of which was prohibited, including tin ores and concentrates, was revoked March 12, 1953. NPA Order M–98, issued February 14, 1952, to assure an adequate supply of used cans for copper production, was revoked March 20, 1953.

DOMESTIC PRODUCTION

MINE OUTPUT

Domestic mine production of tin was again insignificant in terms of United States demand. Only 60 long tons valued at $120,000 was produced in 1953 compared with 100 tons valued at $266,300 in 1952. As usual, Alaska was the principal producer. The placer deposits of the Northern Tin Co., Inc., on Buck Creek on Seward Penisula were the source of the entire recorded production of 50 long tons of tin in Alaska in 1953. The United States Tin Corp. at Lost River on Seward Pensinsula shipped no tin in 1953, but 76.7 short tons of concentrate containing about 43 percent tin was produced from lode mining; the management planned to upgrade it by re-treatment in 1954 to reduce smelter charges and shipping expense. The operation of this mine was supported by a Government-guaranteed loan and advances on a $2 million Defense Materials Procurement Agency purchase contract. The Climax Molybdenum Corp., Climax, Colo., and the Foote Mineral Co., Kings Mountain, N. C., recovered small quantities of tin as a byproduct of mining for molybdenum and spodumene, respectively.

In 1953 the Defense Minerals Exploration Administration approved a placer-tin exploration project with the Alaska Tin Corp., Ear Mountain, Port Clarence district, Seward Pensinsula, Alaska, amounting to $18,000 (Government participation, $16,200). By amendment the tin-placer exploration contract with the Zenda Gold Mining Co., was increased to $159,300 (Government participation, $143,370). In addition DMEA contracts were in effect with the Keenan Properties in South Dakota (Government participation, $44,038, total $48,931), and the United States Tin Corp. at Lost River, Alaska (Government participation, $203,400; total, $226,000). At the end of 1953 the total amounted to $452,231, in which Government participation was $407,008.

SMELTER OUTPUT

Domestic tin-smelter production was 37,560 long tons in 1953—the largest since 1946 (22,800 in 1952, including 200 tons of tin contained in Copan alloy). No Copan was produced in 1953. In 1953 all of the production came from the Government-owned Longhorn smelter at Texas City, as no privately owned tin smelter was in operation in the United States.

The Longhorn smelter received 81,600 long tons of concentrates containing 38,200 tons of tin in 1953 compared with 51,500 tons containing 24,800 tons in 1952. Bolivia continued to be the main source of supply. Receipts therefrom (tin content) increased 60 percent in 1953 compared with 1952 but declined 12 percent during the last 6 months of 1953. No tin concentrates were imported from Bolivia in August 1953. In January 1953 RFC negotiated a short-term contract for purchasing Bolivian concentrates containing 5,000 tons of tin that had been mined during or before the last quarter of 1952. This was the first RFC purchase of concentrates from Bolivia since that nation nationalized the major tin properties on October 31, 1952. In September 1953 another contract was signed by RFC for purchasing Bolivian concentrates containing 10,000 tons of tin. By the end of 1953 over three-fourths of the contracted tonnage had been delivered. Concentrates continued to be received under the long-term contracts with Belgian Congo and Indonesian producers. The tonnage of concentrates arriving from Thailand reached an alltime high in 1953. In March 1953 small tonnages of concentrate began arriving in the United States from Canada. These were from the tin-concentrating plant of the Consolidated Mining & Smelting Co. of Canada, Ltd., and formerly had been treated by the company smelter at Kimberley, British Columbia. Table 3 shows a breakdown of receipts by countries and grades of concentrate in 1952 and 1953.

In the fiscal year 1953 the Longhorn smelter treated 80,000 tons of concentrates, of which 56,000 tons was Bolivian, with an average grade of 33.8 percent, and 24,000 tons alluvial, with an average grade of 72.8 percent. The smelter produced 35,000 long tons of refined tin at a cost of $93,241,000, of which $87,662,000 represented ore cost and $5,579,000 processing costs, a unit cost of 120.1 cents per pound of tin metal produced. Results during the fiscal year 1953 showed a net loss of $1,869,000 after all costs and expenses compared to a net loss of $703,000 for the preceding fiscal year (1952).

TABLE 2.—Production of Longhorn tin at the Texas City, Tex., smelter, by months, 1944–48 (average) and 1949–53, in long tons

Month	1944–48 (average)	1949	1950	1951	1952	1953
January	3, 055	3, 257	2, 627	3, 211	1, 802	3, 960
February	3, 004	3, 254	2, 362	3, 096	1, 800	3, 391
March	3, 037	3, 104	2, 729	3, 123	1, 800	3, 850
April	3, 126	2, 851	2, 484	3, 058	1, 800	3, 750
May	3, 236	3, 007	2, 852	3, 059	1, 800	3, 060
June	3, 232	3, 006	2, 204	2, 655		3, 000
July	3, 209	2, 910	2, 256	2, 406		3, 000
August	2, 977	3, 005	2, 396	2, 505	50	2, 600
September	2, 872	2, 910	2, 805	2, 155	2, 450	2, 700
October	2, 932	2, 964	3, 209	2, 055	3, 364	2, 751
November	3, 053	2, 994	3, 207	1, 806	4, 020	2, 750
December	3, 197	2, 791	3, 005	1, 805	3, 706	2, 750
Total	36, 930	36, 053	32, 136	30, 934	22, 592	37, 562

TABLE 3.—Tin concentrates received at Longhorn smelter, 1952–53

[Reconstruction Finance Corporation]

Countries [1]	1952				1953			
	Concentrates received (long tons)	Content		Percent of tin content of receipts	Concentrates received (long tons)	Content		Percent of tin content of receipts
		Long tons	Tin, percent			Long tons	Tin, percent	
Bolivia	32,756	11,332	34.60	45.61	54,551	18,707	34.29	49
Indonesia	9,644	7,034	72.94	28.31	13,172	9,676	73.45	25
Thailand	5,014	3,701	73.81	14.90	7,334	5,366	73.17	14
Belgian Congo	1,763	1,293	73.34	5.20	3,969	2,903	73.14	8
Miscellaneous	2,312	1,487	64.32	5.98	2,594	1,595	61.49	4
Total	51,489	24,847	48.26	100.00	81,620	38,247	46.86	100

[1] Listed in order of quantity received.

Since its inception the Texas City smelter has been operated by the Tin Processing Corp. (a Delaware corporation and a subsidiary of N. V. Billiton Maatschappij) as an independent contractor under an operating agreement with RFC. In conjunction with this arrangement, RFC purchases all concentrates, pays all operating costs, and disposes of the resulting tin. The agreement was to run until June 30, 1954, but could be canceled by RFC on 90 days' notice.

Under the provisions of the RFC Liquidation Act (Public Law 163, 83d Cong., Chapter 282, 1st session, approved July 30, 1953) the smelter was to be transferred to some other Government agency by June 30, 1954.

SECONDARY TIN

Total recovery of secondary tin decreased 4 percent in quantity and 24 percent in value in 1953 compared with 1952. Most of the tin recovered was contained in copper-, tin-, and lead-base alloys and chemical compounds. Only 10 percent of the total was recovered in the form of unalloyed metallic tin, and most of this was accomplished at detinning plants. The tonnage of metallic tin recovered in 1953 was virtually the same as in 1952.

In 1953 the recoverable tin content of copper-base scrap processed decreased 4 percent, while tin recovered from scrap processed into brass and bronze decreased 13 percent. Reports from brass-ingot makers and miscellaneous remelters indicated that 5 percent less tin was recoverable from copper-base materials processed than in 1952. Recoverable tin in copper-base scrap processed by copper manufacturers and foundries was virtually unchanged from 1952. At brass mills the tin content of copper-base scrap processed decreased nearly 50 percent in 1953 compared with 1952.

The total tonnage of tin recoverable from white-metal scrap decreased 7 percent compared with 1952, while the quantity recovered in the form of solder, babbitt, and lead-base alloys increased 4 percent. Secondary tin recovered in the form of "common" babbitt was 1,890 long tons in 1953—the highest recorded. The tin content of "genuine" babbitt from scrap was only 270 long tons in 1953—the lowest recorded for this item. Secondary tin recovered in chemicals increased 45 percent in 1953.

Detinning plants treated 526,000 long tons of tin-plate clippings in 1953—the largest tonnage on record, exceeding the previous peak reached in 1951 by 9 percent. In addition, old cans processed decreased from 26,000 long tons in 1952 to only 11,000 tons in 1953; these were very small figures compared with the record use of 176,000 tons in 1943. Tin recovered from tin-plate clippings in 1953 was 3,030 long tons, 9 percent more than in 1952, while that from old cans—70 tons—decreased nearly 60 percent. Billions of cans are discarded annually, but little progress has been made in conserving the large quantities of tin and iron dissipated in this manner. Recovery of tin from old cans is metallurgically feasible and has been practiced commercially; but, due largely to the collection and cleaning problem, it has seldom proved economical.

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, 1944–48 (average), and 1949–53, 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
1944–48 (average)	2,926	348	3,274	3,140	24,640	27,780	$41,456,172
1949	2,850	410	3,260	3,170	19,060	22,230	49,461,354
1950	3,300	575	3,875	3,615	28,065	31,680	67,809,158
1951	3,150	415	3,565	3,300	27,445	30,745	88,363,153
1952	2,640	310	2,950	2,860	25,940	28,800	77,710,297
1953	2,650	450	3,100	2,850	24,750	27,600	59,212,676

The electrolytic tin recovery plant designed, built and operated by the Bureau of Mines at Albany, Oreg., on behalf of the Atomic Energy Commission, finished the treatment of accumulated scrap materials and was closed and placed in a standby condition. The plant was in operation from October 1951 until April 1953 and recovered tin from scrap produced in considerable quantity at a Government plant in the Northwest. The project not only reclaimed substantial quantities of tin but offered an excellent opportunity for developing and perfecting an electrolytic tin-refining process.

CONSUMPTION BY USES

Total consumption of tin in the United States exceeded that in 1952 by 9 percent. The use of primary tin increased 19 percent, whereas the use of secondary tin decreased 4 percent. Consumption (tin content of manufactured products) was 86,000 long tons in 1953 (54,000 of primary and 32,000 of secondary) compared with 78,000 tons in 1952 (45,000 tons of primary and 33,000 of secondary). The figures on secondary include 5,200 tons in 1952 and 3,500 in 1953 of tin contained in imported tin-base alloys. The tinplate and terneplate industry increased its use of tin 15 percent and all other industries 6 percent.

Five items—tinplate and terneplate, solder, bronze and brass, babbitt, and tinning—consumed most of the tin used in 1953 and 1952. Tinplate and terneplate, the largest consumers of primary tin, took about 60 percent of the totals for 1953 and 1952. Tonnage-wise the use of primary tin for tinplate and terneplate increased 4,300 long tons, which was more than the increase for any other item. Solder again resumed its prewar position as the second largest user of tin, requiring 2,400 long tons more of primary tin than in 1952. The total tin used for bronze decreased 840 tons (primary increased 160, and secondary decreased 1,000). The total for babbitt increased 80 tons (primary increased 530, and secondary decreased 450). Tinning increased 15 percent.

TABLE 5.—Consumption of primary and secondary tin in the United States, 1944–48 (average) and 1949–53, in long tons

	1944–48 (average)	1949	1950	1951	1952	1953
Stocks on hand Jan. 1.[1]	28,152	27,070	24,621	31,856	20,764	23,105
Net receipts during year:						
Primary	57,718	47,782	79,992	48,298	48,657	57,969
Secondary	2,647	2,606	3,371	3,273	2,338	2,582
Terne	379	470	997	594	622	604
Scrap	27,975	22,193	30,839	28,974	[2] 32,917	29,754
Total receipts	88,719	73,051	115,199	81,139	[2] 84,534	90,909
Available	116,871	100,121	139,820	112,995	[2] 105,298	114,014
Stocks on hand Dec. 31 [1]	26,619	24,621	31,856	20,764	[2] 23,105	24,525
Total processed during year	90,252	75,500	107,964	92,231	[2] 82,193	89,489
Intercompany transactions in scrap	2,605	2,167	2,168	2,726	2,397	2,566
Total consumed in manufacturing	87,647	73,333	105,796	89,505	[2] 79,796	86,923
Plant losses	970	927	1,332	1,336	1,378	1,283
Tin content of manufactured products	86,677	72,406	104,464	88,169	[2] 78,418	85,640
Primary	57,691	47,163	71,191	56,884	45,323	53,959
Secondary	28,986	25,243	33,273	31,285	[2] 33,095	31,681

[1] Stocks shown exclude tin in transit or in other warehouses on Jan. 1, as follows: 1949, 328 tons; 1950, 61 tons; 1951, 1,355 tons; 1952, 971 tons, 1953, 525 tons; and 1954, 240 tons.
[2] Includes tin contained in imported tin-base alloys.

TABLE 6.—Consumer receipts of primary tin, by brands, 1944–48 (average) and 1949–53, in long tons

	Banka	Chinese	English	Katanga	Longhorn	Straits	Others	Total
1944–48 (average)	2,781	1,326	(1)	6,286	35,236	8,920	3,169	57,718
1949	3,491	3,310	(1)	8,435	13,369	14,874	4,303	47,782
1950	1,273	1,500	5,172	5,661	4,912	54,350	7,124	79,992
1951	6,159	352	1,406	4,602	20,263	12,163	3,353	48,298
1952	4,208	(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

[1] Included in others not separately reported.

In 1953 the quantity of tin used to make tinplate was divided about equally between hot-dipped and electrolytic. In 1952 about 58 percent was for hot-dipped and 42 percent for electrolytic. Tinplate production rose to a new high in 1953 or 19 percent more than in 1952, and 6 percent above the previous record year 1950. Electrolytic tinplate production represented 71 percent (67 percent in 1952) and hot-dipped only 29 percent (33 percent in 1952) of the total output in 1953. Electrolytic tinplate requires considerably less tin per unit of product than hot-dipped. Production of tinplate by electrolytic lines was 23 percent higher than in 1952 and 18 percent above the high record established for this product in 1951. Hot-dipped tinplate production increased 5 percent. In 1953 there was growing acceptance of differential-coated electrolytic tinplate having a different coating weight applied to each side of the sheet. Terneplate production required 11 percent more tin in 1953 than in 1952. Short-terne output increased 4 percent, whereas long ternes increased 30 percent. About 80 percent of terneplate is now produced in the form of long ternes.

According to statistics published by the American Iron and Steel Institute, 4,661,000 short tons of tinplate (including short ternes) was shipped in 1953, or 11 percent more than in 1952 but 2 percent below the peak year of 1950. Of the total shipped in 1953, 84 percent was for cans and closures, 11 percent for export, and 5 percent for other classifications. In 1953 the portion for cans and closures was larger than in 1952, for export smaller, and for other markets unchanged. The total quantity of tinplate for sanitary cans in 1953 was virtually unchanged from 1952, but the quantity for general-line cans increased 416,000 short tons. The largest increase in metal can shipments in 1953 was for beer cans, which have been mostly a general line item made from electrolytic tinplate. The use of tinplate for general-line cans has increased fivefold since 1946. The quantity of tinplate for export decreased 30,000 tons (hot dip increased 22,000 tons, while electrolytic decreased 52,000 tons). Shipments to other categories increased 30,000 tons. Table 9 shows a breakdown of tinplate shipments by market classification from 1946 to 1953, inclusive. In addition, in 1953 shipments of black plate were 750,000 short tons (880,000 in 1952), of which 400,000 tons (600,000 tons in 1952) was for cans.

Industrial receipts of tin in 1953 were 91,000 long tons—8 percent more than in 1952—of which 64 percent was primary pig tin. Receipts of primary tin increased 19 percent, whereas other raw materials decreased 8 percent. "Straits," the principal brand of tin acquired, composed nearly three-fourths of the primary receipts in 1953. Longhorn brand, produced by the Government-owned tin smelter at Texas City, Tex., represented about 2 percent of pig tin receipts in 1953. Other brands received in 1953 included English 12 percent, Katanga 5 percent, Banka 3 percent, and miscellaneous the remaining 3 percent.

TABLE 7.—Tin content of tinplate and terneplate produced in the United States, 1944–48 (average) and 1949–53

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
1944–48 (ave.)	3, 096, 344	27, 932	20. 6	1, 785, 129	21, 319	26. 8	1, 208, 075	5, 841	11. 2	103, 140	772	17. 3
1949	3, 863, 801	29, 617	17. 2	1, 648, 001	19, 613	26. 7	2, 030, 567	8, 814	9. 7	185, 233	1, 190	14. 4
1950	4, 767, 274	35, 380	16. 6	1, 845, 009	21, 875	26. 6	2, 693, 777	12, 110	10. 1	228, 488	1, 395	13. 7
1951	4, 591, 431	30, 522	14. 9	1, 557, 006	17, 789	25. 6	2, 832, 044	11, 595	9. 2	202, 381	1, 138	12. 6
1952	4, 249, 393	[1] 27, 316	14. 4	1, 308, 173	15, 012	25. 7	2, 712, 657	11, 022	9. 1	228, 563	1, 282	12. 6
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
	Total terneplate			Short ternes			Long ternes			Terneplate waste-waste		
1944–48 (ave.)	303, 777	620	4. 6	142, 990	329	5. 2	155, 596	280	4. 0	5, 191	10	4. 5
1949	239, 641	626	5. 9	81, 682	177	4. 9	150, 143	435	6. 5	7, 816	14	4. 0
1950	274, 963	952	7. 8	60, 952	188	6. 9	209, 223	753	8. 1	4, 788	11	5. 1
1951	273, 244	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

[1] Includes small tonnage of secondary pig tin and tin acquired in chemicals.

TABLE 8.—Consumption of tin in the United States, 1951–53, by finished products, in long tons of contained tin

Product	1951			1952			1953		
	Primary	Secondary	Total	Primary	Secondary [1]	Total	Primary	Secondary [1]	Total
Tinplate	30, 522		30, 522	[2] 27, 316		[2] 27, 316	[2] 31, 327		[2] 31, 327
Terneplate	84	683	767	85	495	580	333	310	643
Solder	13, 066	6, 744	19, 810	7, 678	10, 245	17, 923	10, 110	10, 063	20, 173
Babbitt	2, 493	3, 360	5, 853	1, 968	2, 637	4, 605	2, 492	2, 191	4, 683
Bronze and brass	4, 838	16, 934	21, 772	3, 612	16, 740	20, 352	3, 777	15, 738	19, 515
Collapsible tubes and foil	832	208	1, 040	604	104	708	917	127	1, 044
Tinning	2, 431	277	2, 708	2, 095	221	2, 316	2, 473	179	2, 652
Pipe and tubing	133	94	227	139	18	157	97	80	177
Type metal	120	1, 694	1, 814	86	1, 602	1, 688	171	1, 619	1, 790
Bar tin	875	54	929	642	36	678	835	71	906
Miscellaneous alloys	844	183	[3] 1, 027	[3] 485	297	[3] 782	294	279	573
White metal	134	146	280	81	53	134	516	150	666
Chemicals including tin oxide	374	826	1, 200	414	596	1, 010	481	828	1, 309
Miscellaneous	138	82	220	118	51	169	136	46	182
Total	56, 884	31, 285	[3] 88, 169	45, 323	33, 095	[3] 78, 418	53, 959	31, 681	85, 640

[1] Includes 5,180 long tons of tin contained in imported tin-base alloys in 1952 and 3,530 in 1953.
[2] Includes small tonnage of secondary pig tin and tin acquired in chemicals.
[3] Includes 592 tons of tin in Copan produced in 1951 and 213 in 1952.

TABLE 9.—Tinplate shipments by market classifications, 1946–53, in thousands of short tons

[American Iron and Steel Institute Annual Report on Shipment of Steel Products, by Market Classifications, AIS 16.]

Market classifications	1946	1947	1948	1949	1950	1951	1952	1953
Sanitary cans:								
Hot-dip	1,311	1,274	1,235	1,053	1,268	1,067	875	798
Electrolytic	660	770	852	804	1,179	1,429	1,362	1,446
Total	1,971	2,044	2,087	1,857	2,447	2,496	2,237	2,244
General-line cans:								
Hot-dip	129	178	311	168	137	104	92	82
Electrolytic	140	609	596	823	1,168	812	854	1,280
Total	269	787	907	991	1,305	916	946	1,362
Total	2,240	2,831	2,994	2,848	3,752	3,412	3,183	3,606
Closures—crown, caps, and others:								
Hot-dip	34	31	22	16	25	20	4	12
Electrolytic	47	119	169	204	297	289	250	297
Total	81	150	191	220	322	309	254	309
Total cans and closures	2,321	2,981	3,185	3,068	4,074	3,721	3,437	3,915
Other uses:								
Hot-dip	96	103	91	60	88	91	96	105
Electrolytic	35	60	74	45	99	122	116	137
Total	131	163	165	105	187	213	212	242
Export:								
Hot-dip	354	507	509	403	393	346	299	321
Electrolytic	27	59	93	117	98	235	235	183
Total	381	566	602	520	491	581	534	504
Total:								
Hot-dip	1,924	2,093	2,168	1,699	1,911	1,628	1,366	1,318
Electrolytic	909	1,617	1,784	1,993	2,841	2,887	2,817	3,343
Grand total	2,833	3,710	3,952	3,692	4,752	4,515	4,183	4,661

STOCKS

Tin stocks held by RFC and industry, comprising pig tin, tin in ore, raw materials in process, and other but excluding the National Strategic Stockpile, decreased from 67,900 long tons at the beginning of 1953 to 62,100 tons at the end. However, industrial stocks of virgin pig tin in the United States (excluding metal afloat) increased from 12,900 long tons at the beginning of 1953 to 14,300 at the end. Tinplate plants increased their stocks of pig tin 2,000 tons and inventories of tin in process 250 tons. Tinplate mills held nearly 75 percent of the plant stocks of pig tin in the United States at the end of 1953. Other industrial plants increased their pig-tin stocks 40 tons. Total stocks of tin in scrap at industrial plants decreased 800 tons. The overall industrial inventories of tin in process (including secondary, terne metal, and other) were drawn upon for 570 long tons and thereby reduced to 10,700 tons, the same as at the beginning of 1952.

Total RFC stocks of tin decreased 4,100 long tons; tin in concentrates decreased 9,300 tons while metallic tin increased 5,200 tons. From June 30, 1953 to December 31, 1953, RFC stocks of pig tin increased 16,500 long tons, which approximated the quantity of metal produced during that period by the Texas City smelter, as RFC made no sales of tin to industry after April 1, 1953. By the end of the fiscal year 1954 the Government was to have completed purchases of tin for the National Stockpile[3] and in addition, as noted elsewhere, would hold excess stocks amounting to 38,000 to 40,000 long tons. In this connection, according to a United States Department of State press release, announcement was made of:[4]

> * * * the decision of the United States Government to hold off the market excess tin stocks it holds and expects to acquire * * *.
>
> The Department explained that under the decision not to dispose of the excess tin stocks held or to be acquired by the United States Government these stocks would be held in insulation. Withdrawals could be made only at the direction of the President, as in the case of regular stockpile materials.

According to a semiannual progress report by the Office of the Secretary of Defense on the national stockpiling program:[5]

> Tin, when exposed for any great length of time to cold temperatures, sometimes tends to undergo a disintegration or granulation. In the early stages of the stockpile program a research laboratory was consulted concerning this "tin disease," and advice was received that normal storage in areas south of the Great Lakes region would not encourage this condition. However, investigation has revealed slight granulation in certain lots of tin at four depots. The General Services Administration and the Tin Research Institute made detailed inspections of the tin in storage at these locations to study the progress of the disease, and a detailed report of the findings and recommendations is in preparation. The Tin Research Institute undertook an extensive research program in its laboratories at the Battelle Memorial Institute and in England with respect to the cause and prevention of the disease.

A. J. Walsh, Commissioner of Emergency Procurement Service, General Services Administration states:[6]

> * * * only one-tenth of 1 percent of stockpile tin has acquired "tin disease," and losses to date are negligible.
>
> This service initiated a study of this problem which has been effected through the Tin Research Institute, Inc., Columbus, Ohio. This study recommends the storage of the very highest grades of tin in heated warehouses or in outdoor storage in climates where winter temperatures are consistently moderate. * * *

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[3] The Budget of the United States for Fiscal Year 1955, Jan. 21, 1954, p. M94.
[4] United States Department of State for the Press, No. 115, Mar. 5, 1954.
[5] Munitions Board, Stockpile Report to the Congress, Covering the Period From January 1 to June 30, 1953: Aug. 15, 1953, p. 22.
[6] American Metal Market, vol 60, No. 201, Oct. 16, 1953, p. 1.

TABLE 10.—Tin stocks in the United States, Dec. 31, 1949–53, in long tons [1]

	1949	1950	1951	1952	1953
Industry:					
Pig tin—virgin	13,771	20,576	10,043	11,819	13,812
In process [2]	10,850	11,280	10,721	11,286	10,713
Total at plants	24,621	31,856	20,764	23,105	24,525
Other pig tin:					
In transit in United States	61	1,355	971	525	240
Jobbers—Importers	292	384	82	531	260
Afloat to United States	8,500	3,500	895	5,300	2,700
Total—other pig tin	8,853	5,239	1,948	6,356	3,200
Total industry	33,474	37,095	22,712	29,461	27,725
Government (RFC):					
Pig tin [1] total	22,452	18,618	6,753	13,265	18,467
Concentrates—ores:					
In foreign ports or afloat	2,919	5,606	1,107	11,868	4,600
In United States	21,117	15,068	10,771	13,341	11,318
Total concentrates—ores	24,036	20,674	11,878	25,209	15,918
Total Government	46,488	39,292	18,631	38,474	34,385
Grand total	79,962	76,387	41,343	67,935	62,110

[1] Excludes Copan (gross weight, long tons) at end of year as follows: 1950, 939; 1951, 260; 1952, 191; and 1953, 60.
[2] Includes secondary pig tin (long tons) as follows: 1949, 230; 1950, 230; 1951, 341; 1952, 306; and 1953, 326

PRICES

Tin prices underwent substantial readjustment in 1953. The average price of Straits tin for prompt delivery in New York was 95.766 cents a pound in 1953 or 20 percent below 1952. The market was characterized by abrupt price movements between March 26 and April 23. On February 13, 1953, the Government removed the ceiling price on tin. During 1953 the market was affected by the Korean truce, the growing realization that the United States stockpiling program was nearing completion, and other depressing factors, including political conditions in the Far East, the proposed International Tin Agreement, and excess world tin production.

From March 12, 1951, until March 26, 1953, the price was virtually the selling price of the RFC. The price began falling on March 27, with news of possible resumption of Korean armistice negotiations. Moreover, late in March the United States delegation to the Tin Study Group meeting in London announced that completion of the United States stockpile was in sight and that no additional purchases would be made for this purpose. By April 1 the price had declined to $1.185. The price dropped sharply from then until April 23, when it had reached $0.92. On April 7 the price declined 5.25 cents a pound and on April 10, 4 cents. After April 23 the price rallied, and ominous political news from Indochina gave brief strength to the market, which carried the quotation to 100.75 cents on May 7. Thereafter the price trended downward through June, July, and

August. The price reached 78.25 cents on July 21, the lowest for 1953. The Korean truce was signed July 26, 1953. Following this, the price was unsettled until after August 15. In September the price averaged higher. During the third week in September a threatened dock strike caused the price to advance slowly, as buying absorbed spot and prompt metal. In October the price moved within narrow limits and averaged downward. However, after October 15 (on which date the price was 79 cents) the trend was upward, mostly without a very active market, and by November 24 the price had advanced 7.25 cents to 86.25 cents. (The United Nations conference on tin was reconvened in Geneva on November 16.) The advance ended suddenly with the State Department announcement from Geneva on Saturday, November 28, that the United States would hold 38,000 to 40,000 long tons of tin surplus over the National Strategic Stockpile goal and that no decision had been reached as to its disposition. This was interpreted adversely, and the price dropped, the quotation being 81.75 cents on December 2. Following this, with more favorable events of the United Nations Geneva Tin Conference, which ended December 9, the market recovered, and the quotation was again 86.25 on December 17, but by December 31 the price had settled to 84.50 cents, with an inactive market.

On the London market the average price for standard tin was £730.5 a long ton in 1953 compared with £964.5 in 1952. The monthly average price fluctuated from the high of £965.9 in January to the low of £598 in July. In 1953 the London price opened at £948, having advanced £2 over the New Year holidays. On an average, the price moved upward through January until February 4, when the price reached £980, the highest for the year. After that the price trend was downward, reaching £568 on July 27, the lowest for the year. The truce in Korea on June 26 caused the market to dip, but the price steadied in later dealings. During August and each month up through December the average price moved upward. On September 17 the reduction in the Bank of England discount rate from 4 percent to 3½ precipitated a sharp advance in price. The rally was maintained until £635 was reached on September 23, but uncertainty brought the price to £595 on October 12. Thereafter, a firmer tone developed that gradually carried the price to £665 on November 24. Following the announcement on November 28 by the United States delegation at the Geneva conference concerning the disposition of surplus tin held by RFC, the price was marked down sharply, reaching £622.5 on December 2. However, the price rebounded and reached £670 on December 8. Following conclusion of the Geneva conference on December 9, the price tended to weaken and move without any pronounced trend. On the morning session of the London Metal Exchange, December 11, no business was transacted. Trading was described as very thin, and the market went through a period of uncertainty. The market closed the year in a dubious atmosphere over the situation in Indochina. The price on December 31 was £655.

TABLE 11.—Monthly prices of Straits tin for prompt delivery in New York, 1952–53, in cents per pound [1]

Month	1952							1953		
	RFC			Open market			Average RFC open market	High	Low	Average
	High	Low	Average	High	Low	Average				
January	121.50	103.00	109.73				109.73	121.50	121.500	121.50
February	121.50	121.50	121.50				121.50	121.50	121.500	121.50
March	121.50	121.50	121.50				121.50	121.50	120.000	121.40
April	121.50	121.50	121.50				121.50	118.50	92.000	101.11
May	121.50	121.50	121.50				121.50	100.75	93.000	97.46
June	121.50	121.50	121.50				121.50	95.75	90.500	92.95
July	121.50	121.50	121.50				121.50	89.50	78.250	81.63
August	121.50	121.50	121.50	121.375	120.750	[2]121.15	[3]121.15	83.00	78.250	80.68
September	121.50	121.50	121.50	121.500	121.250	121.38	121.38	83.75	81.125	82.31
October	121.50	121.50	121.50	121.500	120.750	121.23	121.23	82.75	79.000	80.85
November	121.50	121.50	121.50	121.375	121.125	121.27	121.27	86.25	81.500	83.19
December	121.50	121.50	121.50	121.500	121.375	121.47	121.47	86.25	81.750	84.61
Total	121.50	103.00	120.52	121.500	120.750	121.31	120.44	121.50	78.250	95.77

[1] Compiled from quotations published in the American Metal Market.
[2] Outside market reopened Aug. 1, 1952, although a prompt price was not quoted until Aug. 11, 1952.
[3] Open-market prices since August 1952.

On the Singapore market the monthly price for Straits tin ex-works was £714 for 1953, against £944.9 in 1952. The highest monthly average in 1953 was £928.8 in March and the lowest £586.5 in August. The largest fluctuation of any month during 1953 was £211 in April when the high for that month was £889 and the low £677.8. The highest price for the year was £931.8 on March 17 and 18. The lowest price for the year was £551.8 on August 4, when the market resumed after the Bank Holiday.

FOREIGN TRADE [7]

Tin has been one of the principal imports of the United States and ranked eighth in value among all commodities in 1953. The relative position of tin in value among metals and minerals imported (net imports) in 1953 was exceeded only by copper. The principal items in the foreign trade of the United States in tin in 1953 were imports of metallic tin, concentrates, and 94-percent tin alloys and exports of tinplate and tin cans. Exports of metallic tin amounted to 200 long tons in 1953. 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.

Imports of metallic tin in 1953 decreased 7 percent, or 6,000 long tons. Of the total, Malaya, the principal source, furnished 58 percent, but the quantity received from that country decreased 3,100 tons

[7] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, Division of Foreign Activities Bureau of Mines, from records o 1the U. S. Department of Commerce.

in 1953. Other important sources of metal in 1953 include the Netherlands (18 percent—receipts declined 3,200 tons) Belgium-Belgian Congo (13 percent—receipts increased 1,400 tons), and the United Kingdom (11 percent—receipts decreased 1,000 tons). Imports of tin concentrates were consigned to the Government tin smelter at Texas City, Tex. Receipts of concentrates, in terms of metal, were 36 percent more than in 1952, principally due to an increase of almost 50 percent in imports from Bolivia—the main source of tin concentrate (accounting for 52 percent of the total). Bolivia furnished 18,600 long tons in 1953, or nearly 6,000 tons more than in 1952. Bolivia provided two-thirds of the tin in concentrates imported from 1941 to 1953, inclusive. Thailand supplied 4,700 tons of tin in concentrates in 1953—the largest annual tonnage received from that source. Imports of metal and concentrates were augmented by 6,800 long tons (7,400 in 1952)—gross weight, chief value tin—of alloys brought into the United States in 1953, mainly from Denmark, Netherlands, and West Germany in the form of 94-percent tin alloys.

Canada was the principal destination of the metallic tin exported in 1952 and 1953. The major tin-export item of the United States, as usual, was tinplate. Gains were made in the export markets of Asia, but deliveries from the United States to Europe, Latin America, and Africa decreased. Tonnagewise, shipments to Turkey showed the largest increase and those to Australia-New Zealand the largest decrease. Exports of hot-dipped tinplate totaled 230,800 long tons valued at $52,028,400 in 1953, a 7-percent decrease in quantity and 9-percent in value compared with 248,500 tons valued at $57,469,000 in 1952. The principal countries of destination were Netherlands, Brazil, Argentina, Australia, Switzerland, Mexico, Spain, and Sweden. Exports of electrolytic tinplate were 149,500 long tons valued at $30,999,400, or nearly 30 percent less in tonnage and value compared with 1952 (210,000 long tons, valued at $44,081,200). The leading destinations were Brazil, Turkey, Philippines, Argentina, Cuba, and Netherlands. Exports of tin cans were mainly to Venezuela, Philippines, Canada, and Mexico. In 1953, 350 short tons of terneplate was imported (none in 1952), mainly from the United Kingdom.

According to the American Iron and Steel Institute, producers in 1953 shipped for export 503,700 short tons (534,200 in 1952) of tinplate, of which 321,100 tons was hot dipped (298,700 in 1952) and 182,600 was electrolytic (235,500 in 1952).

Tariff.—There has been no import duty on tin since 1895. Paragraph 1785 of the Tariff Act of 1930 reads as follows:

> Tin ore or cassiterite, and black oxide of tin: *Provided*, that there shall be imposed and paid upon cassiterite, or black oxide of tin, a duty of 4 cents per pound, and upon bar, block, pig tin and grain or granulated, a duty of 6 cents per pound when it is made to appear to the satisfaction of the President of the United States that the mines of the United States are producing one thousand five hundred tons of cassiterite and bar, block, and pig tin per year. The President shall make known this fact by proclamation, and thereafter said duties shall go into effect.

Manufactured forms of tin that carry a duty include tinplate and terneplate, foil, powder, chemicals, bottle caps, collapsible tubes and manufactures not specially provided for.

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TABLE 12.—Foreign trade of the United States in tin concentrates and tin, 1944–48 (average) and 1949–53

[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
1944–48 (average)	34,800	$50,550,438	22,297	$37,765,025	493	$669,339	130	$165,202
1949	38,311	78,175,836	60,224	133,707,223	76	176,795	78	145,370
1950	25,960	47,163,305	82,838	152,952,294	287	594,587	512	990,000
1951	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	[1] 215,603,146	301	580,855	79	209,539
1953	35,973	82,713,269	74,538	175,858,286	128	297,695	75	141,901

[1] Revised figure.

TABLE 13.—Tin concentrates (tin content) imported for consumption in the United States, 1952–53, by countries

[U. S. Department of Commerce]

Country	1952		1953	
	Long tons	Value	Long tons	Value
Australia			(1)	$464
Belgian Congo	1,192	$3,157,360	2,638	6,868,748
Bolivia	12,639	30,779,772	18,571	38,193,628
Burma	8	16,685		
Cameroon			43	125,000
Canada			280	687,643
Egypt			5	11,154
Indochina	42	105,000	50	80,568
Indonesia	7,321	18,593,128	8,678	22,861,512
Mexico	154	197,482	223	384,107
Portugal	808	2,028,192	795	1,972,923
Thailand	4,327	10,409,318	4,690	11,527,522
Total	26,491	65,286,937	35,973	82,713,269

[1] Less than 1 ton.

TABLE 14.—Tin [1] imported for consumption in the United States, 1952–53, by countries

[U. S. Department of Commerce]

Country	1952		1953	
	Long tons	Value	Long tons	Value
Australia	30	$79,154	5	$13,193
Belgian Congo	1,275	3,449,279	1,605	4,345,939
Belgium-Luxembourg	7,029	19,007,989	8,152	20,578,710
Bolivia	105	268,470	66	168,535
Denmark			76	170,135
Germany, West	155	418,461	161	382,487
Malaya	45,992	[2] 123,246,516	42,899	98,779,330
Netherlands	16,861	44,817,745	13,651	35,167,736
Portugal	151	381,276	20	49,262
Syria	15	39,984		
United Kingdom	8,930	23,894,272	7,903	16,202,959
Total	80,543	[2] 215,603,146	74,538	175,858,286

[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, 1944–48 (average) and 1949–53, 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
1944–48 (average)	265	473,055	3,119	14,268	283	26,361	148
1949	12,218	498,371	3,018	41,865	227	41,028	----------
1950	3,829	442,851	6,981	54,622	144	42,394	562
1951	398	498,808	12,995	55,955	144	51,571	810
1952	2,277	[1] 534,964	9,945	(2)	----------	42,659	3,570
1953	374	[1] 459,639	11,445	(2)	----------	37,582	5,195

[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, 1952–53 by countries of destination

[U. S. Department of Commerce]

Destination	1952		1953	
	Long tons	Value	Long tons	Value
Algeria	906	$200,052	----------	----------
Argentina	37,592	8,452,766	33,155	$7,564,799
Australia	50,429	11,090,387	15,318	3,428,885
Austria	1,377	293,269	1,252	338,790
Belgium-Luxembourg	14,724	3,125,324	13,549	2,836,270
Brazil	52,742	11,766,673	50,101	10,908,611
British East Africa	1,822	363,940	415	78,666
Canada	2,194	341,229	7,099	1,333,224
Chile	1,424	330,267	163	39,384
Colombia	8,463	1,816,647	11,171	2,310,938
Cuba	19,750	4,428,335	16,384	3,688,854
Denmark	14,416	3,061,510	7,216	1,627,728
Egypt	3,213	698,522	2,241	401,008
Finland	2,194	458,394	1,276	268,628
French Morocco	8,724	1,915,033	1,111	232,007
Greece	8,906	1,751,633	5,140	970,871
Hong Kong	1,097	177,442	2,560	330,932
India	19,805	3,972,249	14,434	1,731,792
Indonesia	4,543	1,069,897	6,473	1,481,558
Iran	2,504	469,505	5,434	921,297
Ireland	1,893	433,227	858	158,532
Israel and Palestine	2,618	596,140	4,101	834,037
Italy	25,882	6,131,282	18,765	3,342,208
Japan	4,033	595,574	14,177	1,789,061
Lebanon	2,719	527,234	2,219	416,246
Madagascar	1,322	310,046	22	5,080
Malaya	4,596	852,934	2,051	264,075
Mexico	16,001	3,306,793	17,089	3,625,353
Netherlands	57,710	12,807,471	47,022	10,535,906
New Zealand	5,363	1,114,477	718	161,576
Norway	14,109	2,965,558	11,329	2,347,170
Pakistan	5,246	1,064,332	83	16,995
Peru	4,797	1,079,450	5,459	1,220,840
Philippines	12,164	2,402,471	21,204	4,067,698
Portugal	14,519	3,309,027	9,936	2,182,563
Spain	6,449	1,610,195	9,209	2,038,380
Sweden	18,242	3,847,785	13,469	2,894,982
Switzerland	10,423	2,376,026	12,573	2,752,313
Taiwan	2,513	556,037	4,046	787,737
Thailand	3,772	721,053	2,266	380,081
Turkey	15,432	3,180,938	29,135	5,748,192
Union of South Africa	23,119	5,029,598	14,018	2,970,678
Uruguay	10,364	2,386,950	7,580	1,666,784
Venezuela	3,734	855,899	6,065	1,443,340
Yugoslavia	2,846	630,607	4,363	977,892
Other countries	8,273	1,851,647	7,390	1,568,145
Total	534,964	116,325,825	459,639	94,690,106

TABLE 17.—Foreign trade of the United States in miscellaneous tin, tin manufactures, and tin compounds, 1944–48 (average) and 1949–53

[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)	Exports (pounds)
		Pounds	Value	Long tons	Value			
1944–48 (average)	$85, 625	431, 120	$139, 810	19, 361	$5, 580, 308	$820, 967	8, 402	12, 220
1949	189, 564	1, 163, 875	424, 908	31, 087	10, 263, 790	2, 245, 217	980	41, 004
1950	215, 484	6, 293, 459	2, 146, 340	28, 946	10, 448, 917	869, 404	75, 825	122, 716
1951	365, 741	2, 566, 000	1, 897, 991	33, 171	14, 048, 409	2, 403, 354	102, 212	136, 179
1952	447, 925	[1]18,351,019	[1]17,454,460	41, 624	16, 842, 755	[2] 2, 086, 612	1, 358	73, 131
1953	605, 609	15, 898, 269	11, 878, 331	29, 841	12, 916, 664	[2] 2, 418, 061	5, 115	183, 328

[1] Revised figure.
[2] Due to changes in classifications data not strictly comparable to earlier years.

TECHNOLOGY

In the United States the industrial application of centrifugal force for separating phase constituents of liquids has been confined almost entirely to aqueous systems at room temperature. In 1953 successful results were obtained by centrifugation at the Eastern Experiment Station of the Bureau of Mines in separating intermetallic compounds from molten solutions of tin-magnesium and tin-iron alloys.[8]

Research was continued along two lines: (1) To explore the separatory behavior of the centrifuge apparatus on several low-melting alloys in the liquid-solid range; (2) to compare actual centrifugal separation efficiencies with the theoretically perfect recoveries, as represented by the equilibrium phase diagrams. Centrifugal separation of tin-iron intermetallic compounds from molten tin appears feasible.

The tin volume of the Materials Survey series prepared by the Division of Mineral Economics of the Pennsylvania State College for the National Security Resources Board was published in 1953.[9] It describes the occurrence, mining, milling, and smelting of tin and gives considerable statistical information on the industry in the United States and abroad.

An informative article [10] published in July described gravel pump mining in Malaya. It stated:

The location of the alluvial deposits in many parts of Malaya is particularly suitable for dredging, as the bedrock is flat and soft, but the method is less efficient

[8] Schellinger, A. K., and Spendlove, M. J., Centrifugal Separation of Liquid and Solid Phases From Some Binary Alloys: Bureau of Mines Rept. of Investigations 5007, 1953, 19 pp.
[9] Pennsylvania State College, Materials Survey—Tin: Compiled for the NSRB Washington, D. C., June 1953.
[10] Tyrrell, P. J., Gravel Pump Mining in Malaya: Min. Jour. (London), vol. 241, No. 6150, July 3, 1953, pp. 15–17.

where the bedrock is undulating as the rich deposits in the hollows between pinnacles cannot be reached. This latter fact, coupled with the first low cost of equipment, has made gravel pump mining of considerable importance in Malaya. The method is particularly favored by the many Chinese operators and today the output from gravel pump mines is approaching 80 percent of the total dredged output.

An average Malayan ground yields 0.3 to 0.6 lb. per cu. yd. of tin ore which is between approximately 0.01 percent and 0.02 percent by weight on the basis of an average ground weight of 3,200 lb. per cu. yd.

A new method toward the ultimate goal of ultrapure metal was the subject of an article. It stated:[11]

With this new tool metallurgists have a potent instrument for making really pure metals. Important and sometimes drastic changes in metallic properties have already been observed as the limit of purity is approached. As more materials are brought toward this limit, there will be both opportunity and challenge to exploit their properties. Tin * * * has been pruified to new levels by zone-melting.

A technical paper on the effect of germanium on the transformation of white to gray tin, at comparatively low temperature, was abstracted by the authors as follows:[12]

At a comparatively low temperature, gray tin may appear on white tin where the latter (a) is in contact with elementary germanium, (b) contains a certain proportion of germanium in the form of an alloy, or (c) is in contact with solutions in which certain germanium compounds have been dissolved. Data also are presented regarding the rate of spread of grey tin on white tin castings and coatings containing various proportions of germanium.

In a recent article new developments of tin were described.[13] Among other things, the following topics are discussed in the article: New tin-containing materials, new bearing alloys, new solder alloys and methods for joining and tinning aluminium, new materials containing inorganic tin compounds, and the corrosion resistance of tin and tin alloys.

A technical paper on a new titanium alloy containing tin, the "All-Alpha," was presented; among other things it stated:[14]

It is seen from the foregoing that the promise for A-type alloys—particularly with respect to high toughness, hot strength, and weldability—has been realized in the 5Al–2, 5Sn alloy, A–110At. Rem-Cru plans to continue its experimental production and anticipates that this first A-type alloy will usefully complement the C-type titanium alloys currently available.

The Tin Research Institute, Inc., with headquarters at Greenford, Middlesex, England, maintains an office at 492 West 6th Avenue, Columbus, Ohio, and offers free service for technical inquiries and general information on tin. The institute maintains a technical library on tin and has a number of publications available for free distribution. Among those made available in 1953 were: Tin and Its Uses, Nos. 28 and 29; The Structure and Mechanical Properties of

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[11] Schumacher, Earle E., Ultra-Pure Metals Produced by Zone-Melting Technique: Jour. Metals, vol. 5, No. 11, sect. 1, November 1953, pp. 1428–1429.

[12] Rogers, R. R., and Fydell, J. F., Effect of Germanium on the Transformation of White to Gray Tin at Comparatively Low Temperature: Canada Dept. of Mines and Tech. Surveys, Tech. Paper 5, 1953, pp. 11.

[13] Nekervis, Robert J., Tin and Its Alloys: Ind. Eng. Chem., vol. 45, No. 10, October 1953, pp. 2254–2260.

[14] Finlay, W. L., Jaffee, R. I., Parcel, R. W., and Durstein, R. C., A New Titanium Alloy Type, the All Alpha: AIME, Institute of Metals Div., Tech Paper, Cleveland, Ohio, Oct. 20, 1953.

Copper-Manganese-Tin Alloys; Technical Service to Industry, available from Tin Research Institute, Inc.; and Report of the Work of the Tin Research Institute, 1953.

Investigations in the field of organic coatings were recently reported:[15]

The Multiple Fellowship (Protective Coatings) of Stoner-Mudge, Inc., Pittsburgh, Pa., completing 17 years of investigations in the field of organic coatings, has developed a coating, which, when applied to sheet steel, may be a satisfactory replacement for tinplate in the manufacture of containers and closures for food and other products. Also, organic adhesives have been compounded and evaluated as possible replacements for solder in the fabrication of food cans.

A faster method for determining the tin content of brasses and bronzes, according to a recent article,[16] is desirable for much control work. It stated:

In the fast assay method, the sample is dissolved in a flask with concentrated hydrochloric acid and 30 pct hydrogen peroxide solution. Sodium hypophosphite or hypophosphorus acid is added to reduce copper and tin. A little mercuric chloride is added to catalyze the tin reduction and the solution is boiled for a few minutes. A sodium bicarbonate trap is placed in the mouth of the flask and the solution cooled to 15° C. After cooling, the trap is removed, ammonium thiocyanate added to precipitate the cuprous copper as cuprous thiocyanate, and the solution is titrated with iodine solution.

The application of a nonmetallic organic solder to reduce the use of tin was discussed in an article published during the year.[17]

An article on the action of inhibitors on the autoxidation of tin solutions, with particular respect to the relationship between oxidation rate and inhibitor concentration, was abstracted by its author as follows:[18]

The action of some inhibitors on the autoxidation rates of aqueous stannous solutions has been studied. Two complex organic amino-compounds, Bandrowski's base and Barsilowski's compound, were found to exert a powerful inhibitory effect on the oxidation of stannous chloride, thus confirming that the reaction involves a chain mechanism. Iron salts were found to have a similar effect on stannous acetate; this shows that the autoxidation likewise involves a chain process.

An article [19] on plating tin on aluminum discussed research on a chemical displacement process, among other things. It stated:

Soldering aluminum with alloys of tin involves difficulties which are well-known. The surface film of oxide prevents the solder from binding effectively with the underlying metal. For this reason, normal electroplating technique for plating metals on aluminum is unsatisfactory and the most successful method developed for commercial use depends upon the replacement of the oxide film with zinc by treating the metal in alkaline sodium zincate solution. The zinc binds well to the aluminum and provides a base for the electrodeposition of various metals. Recently, the use of ultrasonic methods for disrupting the film has proved helpful in solving soldering difficulties.

An excellent review of the modern uses for tin was published during the year.[20]

[15] Mellon Institute, Scientific Research as it Proceeds in Mellon Institute: Ann. Rept. Ser. 40, Pittsburgh, Pa., 1953, pp. 44–45.

[16] Goldberg, C., Tin Assay Shortcut Speeds Control: Iron Age, vol. 171, No. 22, May 28, 1953, pp. 130–131.

[17] Chemical and Engineering News, Organic Solder Reduces Use of Tin in Tin Cans: Vol. 31, No. 18, May 4, 1953, p. 1918.

[18] Baker, E. H., Autoxidation of Tin Solutions; the Action of Inhibitors: Jour. Appl. Chem., vol. 3, pt. 7 July 1953, pp. 323–327.

[19] Bryan, J. M., Plating Tin on Aluminum: Metal Ind., vol. 83, No. 23, Dec. 4, 1953, pp. 461–463.

[20] Nekervis, R. J., and Gonser, B. W., Modern Uses for Tin: AIME, Modern Uses of Nonferrous Metals, 2d ed., 1953, pp. 410–431.

United States patents issued during 1953 relative to tin include the following:

HEIMAN, SAMUAL. Method and Composition for Coating Aluminum With Tin. U. S. Patent 2,624,684, Jan. 6, 1953.
ANDREWS, J. W. Relates to a Bath for the Electrodeposition of Tin. U. S. Patent 2,633,450, Mar. 31, 1953.
HAYES, N. P. Process Which Comprises Electrodepositing Tin-Nickle Alloy Coatings From an Aqueous Solution Bath. U. S. Patent 2,658,866, Nov. 10, 1953.
SMITH, E. J. Method of Flow-Brightening Tinplate. U. S. Patent 2,661,328 Dec. 1, 1953.

WORLD REVIEW

INTERNATIONAL TIN STUDY GROUP

Representatives of eight major tin producing and consuming countries met in London in October 1946 and agreed that a study group should be established; in consequence, the International Tin Study Group was organized at a meeting in Brussels in April 1947. A brief report on its meetings through 1953 has been published.[21] Regarding the 1953 meeting, the following was given:

The seventh meeting of the Study Group in London in March 1953 considered the future position in Tin. It agreed to set up a Working Party to consider proposals for international action and to report to the chairman of the Steering Committee of the U. N. Conference on tin whether in its views conditions existed for the resumption of that conference.

The Working Party met in Brussels in June 1953. Progress was made in clarifying the main points involved in any international agreement and in reconciling the divergent views hitherto expressed. Governments were asked to examine the report of the Working Party and to state their views on an early resumption of the meetings of the U. N. Conference. A drafting Committee was appointed to produce a revised version of the Paris and Geneva Drafts embodying articles based on the proposals which had been put before the Working Party.

The Drafting Committee met in London in August and prepared a report and a draft Agreement (the London Draft).

Note.—See Minerals Yearbook, 1950, pages 1220 and 1221, for reports on the first five meetings, and Minerals Yearbook, 1951, page 1257, for the sixth meeting.

The United Nations Commodity Conference on Tin, which was held at Geneva, Switzerland, from November 16 to December 9, 1953, approved, with amendments, the draft of an International Tin Agreement prepared by the International Tin Study Group at a meeting in London in August 1953. The text of this agreement—described as the International Tin Agreement of 1953 [22]—was submitted to governments for their consideration and was to be open for signature from March 1 to June 30, 1954.

The representation at the Conference included delegations from 23 countries and observers from 7. The delegations represented, on the basis of tin figures for 1952, about 113,000 long tons of tin consumption out of a known world tin consumption of 130,000 tons and about 160,000 tons of tin production out of a known world total of 174,000 tons.

[21] International Tin Study Group, Statistical Bulletin: Vol. 7, No. 1, January 1954, inside cover page.
[22] American Metal Market, International Tin Agreement of 1953: Vol. 60, No. 244, pp. 10–11.

At the close of the Tin Conference the following release [23] was issued by the United Nations Information Center in Geneva:

The Agreement is to be open for signature from March 1 to June 30, 1954. Governments will signify their approval of the Agreement by signature and ratification through constitutional processes.

As soon as the instruments of ratification or acceptance have been deposited by nine countries holding one-third of the total votes provided for consuming countries represented at the conference, and by countries holding 90 percent, of votes for producing countries represented at the conference, a meeting will be held to decide the date the Agreement will enter into force.

The agreement recognises the importance of international trade in Tin to many countries concerned either with production or consumption. It aims at preventing instability in international trade in Tin by preventing burdensome surpluses developing and preventing occurrences of shortages. The Agreement aims at stabilising market conditions for industry through the establishment of a buffer stock and through the acquisition of 25,000 tons of Tin metal to be contributed by producing countries. It also provides for the setting up of export controls when the buffer stock has absorbed a minimum of 10,000 tons and when such controls are warranted by market conditions.

The Agreement establishes, as an initial basis for operation, a floor price of £640 sterling (US$0.80) and a ceiling price of £880 sterling (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.

An International Tin Council will be established in London to administer the Agreement and to supervise its operations.

The United States delegation to the United Nations Commodity Conference on Tin in Geneva issued an official press release on Saturday, November 28, 1953. The statement given out to all the press services accredited to the European office of the United Nations read: [24]

The United States delegation to the second session of the United Nations Tin Conference disclosed today that, by next March, the United States Government will have 38,000 to 40,000 long tons of tin in excess of present requirements for its strategic stockpile.

No decision has yet been reached concerning the disposition of the surplus tin held by the Reconstruction Finance Corporation. The Government is still studying the question of its disposal with the aim of minimizing the effect on the tin market.

The United States has announced previously that its stock of tin on hand or under contract would more than fill its strategic stockpile, but this is the first disclosure of the extent of the overage.

WORLD MINE PRODUCTION

World mine production, exclusive of U. S. S. R., increased 3 percent in 1953 and was the highest since 1941. Of the total output Asia supplied 63 percent, South America 20 percent, Africa 14 percent, and other sources 3 percent. Most of the increase was provided by Bolivia and Belgian Congo, where output increased 2,900 and 1,500 tons, respectively. World production was 10 percent above the 1925–29 average, 4 percent above the 1935–39 average and about 73 percent of the 1941 peak. The world total in 1953 was the same in 1936, although individual country totals for the years differed widely.

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[23] Tin (London), January 1954, p. 1.
[24] United Nations Conference on Tin, 1953, Notes on Tin: Special Issue, December 1953, p. 600.

TABLE 18.—World mine production of tin (content of ore), by countries, 1944–48 (average) and 1949–53, in long tons [1]

[Compiled by Berenice B. Mitchell]

Country	1944-48 (average)	1949	1950	1951	1952	1953
North America:						
Canada	326	276	356	155	95	293
Mexico	221	358	440	366	361	477
United States	2	68	94	88	99	56
Total	549	702	890	609	555	826
South America:						
Argentina	671	268	267	242	265	[2] 162
Bolivia (exports)	37,886	34,115	31,213	33,132	31,959	34,813
Brazil	277	325	180	197	229	[2] 180
Peru [3]	49	51	38	86	31	----------
Total	38,883	34,759	31,698	33,657	32,484	35,155
Europe:						
France	28	73	81	190	282	498
Germany, East	120	157	191	257	364	[2] 480
Italy	46	----------	----------	----------	----------	----------
Portugal [4]	432	785	690	902	1,028	1,083
Spain	613	454	633	940	733	795
United Kingdom	[5] 1,083	898	890	841	903	1,103
Total [6]	2,322	2,367	2,485	3,130	3,310	3,959
Africa:						
Belgian Congo [7]	15,281	13,760	13,464	13,669	13,795	15,293
French Cameroon	122	73	67	72	87	86
French Morocco	5	----------	----------	13	15	8
French West Africa	1	26	51	65	110	94
Mozambique	3	1	1	8	3	----------
Nigeria	10,488	8,824	8,258	8,529	8,318	8,228
Northern Rhodesia	6	7	4	2	11	7
Southern Rhodesia	115	70	65	40	30	25
South-West Africa	149	120	100	76	99	168
Swaziland	42	32	37	32	36	37
Tanganyika (exports)	114	109	97	67	47	45
Uganda (exports)	208	128	192	118	110	95
Union of South Africa	487	471	643	746	935	1,360
Total	27,021	23,621	22,979	23,437	23,596	25,446
Asia:						
Burma	836	1,781	1,520	1,400	1,600	1,400
China [2]	3,880	4,300	7,500	7,500	8,600	9,600
Indochina	86	40	49	92	156	264
Indonesia	12,191	28,965	32,102	30,986	35,003	33,752
Japan	142	190	326	426	638	732
Malaya	18,547	54,910	57,537	57,167	56,838	56,255
Thailand	2,354	7,815	10,364	9,502	9,479	10,124
Total	38,036	98,001	109,398	107,073	112,314	112,127
Australia	2,262	1,886	1,854	1,559	1,611	1,494
World total (estimate) [6]	109,100	161,300	169,300	169,500	173,900	179,000

1 The table incorporates a number of revisions of data published in previous Tin chapters.
2 Estimated by authors of the chapter and in a few instances from the Statistical Bulletin of the International Tin Study Group, The Hague.
3 Minor constituent of other base-metal ores.
4 Excluding mixed concentrates.
5 Intake by smelters.
6 Excluding production of U. S. S. R.
7 Including Ruanda-Urundi.

WORLD SMELTER PRODUCTION

World smelter production of tin, exclusive of U. S. S. R., was 7 percent more in 1953 than in 1952 and was the largest since 1941.

The increase was due for the most part to the high rate of output by the United States Government-owned smelter at Texas City, Tex. Excluding National Strategic Stockpile accumulations world smelter production was 52,400 long tons over world consumption. The Malayan tin-smelting plants at Penang and Singapore, the world's most important source of pig tin, decreased their output 400 tons but supplied 34 percent (37 percent in 1952) of the total. Next in rank were the United States, United Kingdom, Netherlands, and Belgium. Smelters in these 5 countries supplied 90 percent of the world's tin in 1953. About half of the world smelter output in 1953 was for the United States (61 percent in 1952).

TABLE 19.—World smelter production of tin, by countries, 1944–48 (average) and 1949–53, in long tons [1]

[Compiled by Berenice B. Mitchell]

Country	1944–48 (average)	1949	1950	1951	1952	1953
North America:						
Canada	325	276	356	155	95	
Mexico	211	358	290	366	140	209
United States	36,972	35,834	33,118	31,852	22,805	37,562
Total	37,508	36,468	33,764	32,373	23,040	37,771
South America:						
Argentina	531	235	253	206	[2] 250	[2] 240
Bolivia (exports)	26	405	392	39	257	174
Brazil	193	157	118	133	116	[2] 240
Peru [3]	49	51	38	86	31	
Total	799	848	801	464	[2] 654	[2] 654
Europe:						
Belgium	4,787	8,996	9,512	8,360	10,585	9,039
Germany:						
East	(4)	157	191	257	364	[2] 480
West		[2] 130	586	581	758	694
Italy	26					
Netherlands	5,266	19,247	21,027	20,977	27,913	26,950
Portugal	327	218	209	313	340	472
Spain	851	803	1,597	766	687	781
United Kingdom [5]	28,869	28,384	28,750	26,053	29,521	28,860
Total	40,126	57,935	61,872	57,307	70,168	67,276
Africa:						
Belgian Congo	5,781	3,246	3,238	3,011	2,765	2,715
French Morocco					15	
Southern Rhodesia	116	75	80	63	37	27
Union of South Africa	839	595	718	829	960	828
Total	6,736	3,916	4,036	3,903	3,777	3,570
Asia:						
China [2]	3,615	4,000	7,000	7,000	8,000	9,000
Indochina	48	3				
Indonesia	1,410	126				
Japan	224	290	389	574	637	805
Malaya	20,916	62,737	68,747	65,914	62,829	62,410
Thailand	1,143		2		17	
Total	27,356	67,156	76,138	73,488	71,483	72,215
Australia	2,256	1,955	2,014	1,459	1,700	1,443
World total (estimate)	115,000	168,300	178,600	169,000	170,800	182,900

[1] This table incorporates a number of revisions of data published in previous Tin chapters.
[2] Estimated by authors of the chapter and in a few instances from Statistical Bulletin of the International Tin Study Group, The Hague.
[3] Tin content of dross.
[4] Data not available.
[5] Beginning January 1948 includes production from imported scrap and residues refined on toll.

WORLD CONSUMPTION

World consumption of tin in 1953 was virtually unchanged from 1952. Table 20 gives the reported real consumption of tin for the United States, United Kingdom, West Germany, Japan, Netherlands, Canada, and Belgium-Luxembourg. In 1953 these countries represented 71 percent of total world consumption. Among these only the United States and Japan increased their use of tin in 1953. The United States, which consumed 35 percent of the total in 1952, took 41 percent in 1953. Figures for other countries (except small tonnages for Indonesia and Malaya included in "Others") are apparent consumption, determined on the basis of production of metal within the country concerned plus imports of metal and minus exports of metal and with known changes in stocks also being taken into account. Figures for U. S. S. R. are omitted from the totals.

TABLE 20.—World consumption of tin, by countries, 1944–48 (average) and 1949–53, in long tons [1]

Countries	1944–48 (average)	1949	1950	1951	1952	1953
Argentina	1, 139	865	1, 250	1, 250	1, 200	1, 200
Australia and New Zealand	2, 533	2, 504	2, 552	2, 760	2, 661	2, 624
Belgium and Luxembourg	1, 104	986	1, 363	1, 770	1, 224	1, 164
Brazil	929	1, 104	1, 670	1, 500	1, 500	1, 500
Canada	3, 614	4, 317	4, 526	4, 731	4, 190	3, 950
Czechoslovakia	448	1, 200	1, 300	1, 500	1, 600	1, 700
Denmark	395	226	637	880	1, 140	2, 650
Finland	244	407	418	385	240	240
France	4, 910	7, 200	7, 400	7, 500	7, 300	7, 370
Germany, West	578	2, 300	7, 782	7, 506	7, 270	5, 814
India	3, 795	5, 539	4, 718	3, 772	2, 379	2, 507
Italy	720	2, 500	3, 000	3, 600	2, 700	2, 780
Japan	3, 616	3, 568	4, 616	4, 091	4, 536	4, 650
Netherlands	2, 007	3, 277	3, 029	2, 400	8, 700	4, 330
Poland	791	2, 000	2, 000	2, 000	1, 900	1, 800
Spain	880	832	1, 106	1, 253	891	840
Sweden	680	1, 000	1, 000	1, 000	850	600
Switzerland	444	700	750	800	750	720
Turkey	502	567	550	600	600	840
United Kingdom	22, 811	20, 823	23, 254	23, 892	22, 554	18, 634
United States	57, 691	47, 163	71, 191	56, 884	45, 323	53, 959
Others	4, 869	7, 922	9, 388	10, 426	10, 492	10, 628
World total [2]	114, 700	117, 000	153, 500	140, 500	130, 000	130, 500

[1] Statistical Bulletin of the International Tin Study Group, July 1954, p. 26.
[2] Excludes U. S. S. R.

WORLD REVIEW BY COUNTRIES

Australia.—Production of tin in concentrates in Australia was about 1,500 long tons, equivalent to a 7-percent decrease from the 1952 figure. Domestic smelter production declined 15 percent from 1952 to 1,443 tons. Consumption of tin in Australia amounted to 2,350 tons during 1953, unchanged from the previous year. In Queensland the Tableland Tin Dredging N. L. resumed operations on a new lease at Smith's Creek. An article published in December described [25] the Tableland tin dredge.

Belgian Congo.—Although the increased production of tin in 1953 did not reach the peak level of World War II years, it exceeded that of any year since 1945. Production of tin in concentrates was 15,000 long tons compared with 13,800 tons in 1952. Belgian Congo, including Ruanda-Urundi, contributed 59 percent of Africa's 1953

[25] Chemical Engineering and Mining Review (Australia), Dismantling and Removal of Tableland Tin Dredge: Vol. 46, No. 3, Dec. 10, 1953, p. 100.

tin production. Tin contained in exports of concentrates totaled 13,300 tons, of which the United States received 2,600 long tons and Belgium 10,700. Exports of metal from Belgian Congo were 2,900 long tons, of which the United States received 1,600 tons and Belgium 1,300 long tons.

Stocks of tin metal increased from 150 tons at the beginning of 1953 to 350 at the end. Stocks of tin in concentrates increased from 500 tons at the beginning of 1953 to 1,000 at the end.

The Symetain Co. (Société Congolaise) continued to be the main producer of tin in the Belgian Congo: the company produced 5,550 metric tons of cassiterite from its operations in the Kalima and Punia area of Maniema compared with 1952 output of 5,113 tons.

A recent despatch reporting on the tin operations in Belgian Congo in 1953 stated: [26]

> Katanga Province reported cassiterite produced at 4,879 tons, of which 4,027 was by Geomines and 852 tons by Sermikat, against 3,537 and 857 tons, respectively, in 1952. The cassiterite smelted by Geomines was 4,058 tons, compared with 4,138 tons in 1952. This was the company's own production from the operations in kaolinized pegmatite and that of the affiliated Georuanda operations at Rwinkwava in eastern Ruanda. The cassiterite from the hard rock workings in both years, because of a high arsenic content, was shipped to Texas City for smelting. Thus ingot tin yielded per ton of concentrates smelted was 680 kilos in 1953 and 679 in 1952, so smelting efficiency and tenor of feed were approximately the same.
>
> The increased 1953 output was undoubtedly due to the efforts of the producers to get out as much cassiterite as possible before there was a further depreciation in prices and in expectation that the existing contract with the U. S. would not be renewed. Although the Ruanda-Urundi producers are still under the handicap of high power costs they were still able to continue operations through the end of the year and even showed an increase over the 1952 total.

Bolivia.—In 1953 Bolivia was the third largest tin producer in the world. Production of tin contained in concentrates was estimated at 29,900 long tons.[27]

Exports of tin concentrates, which composed about 60 percent of foreign exchange income from all sources, totaled about 34,800 tons of fine tin content, or about 3,000 tons more than was shipped in 1952 and more than at any time in the past 4 years. The gross value of Bolivian tin exports, however, was at its lowest point since 1950—$72.4 million compared with $84.7 million in 1952 and $93.3 million in 1951. This decline therefore reflected low market prices, which prevailed after the break in the tin market in March. In the ensuing months the price continued to decline steadily. The Bolivian Ministry of Mines has calculated that the average price which Bolivian producers received during the year was $0.92851 per pound.

The first noteworthy occurrence in 1953 was the announcement, on January 16, that the RFC had purchased at $1.175 f. o. b., South American ports, Bolivian concentrates containing about 5,000 long tons of tin. On January 25 the Corporacion Minera de Bolivia, which is operating nationalized mining properties under the decree of October 31, 1952, entered into an agreement with Williams, Harvey & Co., Ltd. (smelters in England) for the sale of 50 percent of the entire Bolivian tin concentrate (high-grade material) during the next 3 years.

[26] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 1, July 1954, pp. 19–21.
[27] United States Embassy, La Paz, Bolivia, State Department Dispatch 608, May 4, 1954: P. 1 of Enclosure 2.

A tin-purchase agreement between the United States and Bolivia was signed in Washington on September 23, 1953. The agreement provided for the sale of 10,000 long tons of tin in concentrates. Under the terms of the contract, the total tonnage was to be delivered at Pacific ports by March 31, 1954, payments to be based on New York market prices taken on a monthly average.

TABLE 21.—Receipts of Bolivian ore (concentrate) at the Texas City, Tex., smelter 1953, in long tons

Grade	Concentrates, tons	Tin		Percent of total content
		Percent	Tons	
High	11,645	59.6	6,943	37.1
Medium	12,539	45.0	5,640	30.2
Low	30,367	20.2	6,124	32.7
Total	54,551	34.3	18,707	100.0

Burma.—An interesting development in 1953 was the recapture of Mawchi mine from the Karen insurgents. The Mawchi property—a mining lease of tin and tungsten mines at Mawchi in the Bawlake State of Karenni, Southern Shan States, Burma—has been idle since operations ceased in June 1949. In August 1953 the Burmese Government called a meeting of the representatives of the tin-mining companies of Lower Burma, at which it was proposed to the companies that they should enter into a joint operating venture with the Government.

Production of tin in concentrates was estimated at 1,400 long tons in 1953. This represented an increase of about 200 tons (27 percent) over the previous year. In the Mergui district (Lower Burma) the Thabawleik Tin Dredging, Ltd., was the only company with a tin dredge at work in Burma. During 1953 its production was 542 long tons of tin concentrates.[28]

The 1953 Annual Report of the Directors to stockholders of the Tavoy Tin Dredging Corp., Ltd., contained the following statement:

> There is, I regret, little if any progress to record in respect of the year under review and this is again due to the continuing unsatisfactory security conditions. Since the close of the year the Government offensive in the north of Burma has been concluded and it is hoped that attention can now be turned to the mining areas in the south where unhappily disturbances and lawlessness have prevented mining on anything but the smallest scale.
>
> As a result Burma, as well as the mining interests, has been deprived of much revenue and this unhappy state will, I am afraid, continue until such time as order is restored and people can go about their business with confidence.
>
> There is no need to remind you how much we would welcome a return to a peaceful period of co-operation with its attendant advantages to all concerned.
>
> Shortly after our Annual General Meeting last year we had notice that the Government of Burma, who we know has always been keen to develop mining to the fullest extent, wished to enter into a joint venture with tin mining companies on similar lines to those agreed with other concerns. Preliminary proposals were made by the Burmese Government as the result of which a draft scheme was prepared by your Corporation and submitted through the Foreign Office. No further progress has been made and the matter has for the present been left in abeyance but it may be expected to be raised again when sufficient progress has been made with the restoration of law and order in the Tavoy and Mergui districts.

[28] Mining World, Annual Catalog: Vol. 16, No. 5, Apr. 15, 1954, p. 109.

Canada.—Tin production in Canada in 1953 was 293 long tons. This represented an increase of about 198 tons (208 percent) over the previous year. Canadian output is in the form of concentrates derived from the tailings in the concentration of lead-zinc-silver ore from the Sullivan mine of the Consolidated Mining & Smelting Co. of Canada, Ltd., Kimberley, British Columbia.

The imports, consumption, and tariffs for tin in Canada are shown in table 22.[29]

TABLE 22.—Imports, consumption, and tariffs for tin in Canada, 1952–53

	1953		1952	
	Long tons	Value	Long tons	Value
IMPORTS				
Blocks, pigs, bars from:				
Malaya	1,459	$3,407,141	2,165	$5,822,781
Belgium	984	2,144,617	735	1,966,570
Netherlands	643	1,570,715	459	1,222,182
United Kingdom	575	1,059,452	237	644,323
United States	41	81,605	313	830,714
Italy			40	108,815
Total	3,702	8,263,530	3,949	10,595,385
Tinplate from:				
United States	5,406	1,007,450	896	158,185
United Kingdom	1,036	206,952	391	134,858
Total	6,442	1,214,402	1,287	293,043
	Pounds	Value	Pounds	Value
Tinfoil from:				
United States	16,565	$17,022	2,585	$3,702
United Kingdom			194	167
Total	16,565	17,022	2,779	3,869
Babbitt metal from:				
United States	41,700	16,759	37,500	22,636
United Kingdom	6,700	4,799	3,200	2,084
Total	48,400	21,558	40,700	24,720

	1953	1952
	Long tons	
Consumption:		
Tinplate and tinning	1,965	2,517
Solder	1,325	1,080
Babbitt metal	244	212
Brass and bronze	237	225
Tinfoil and collapsible tubes	36	31
Miscellaneous	96	125
Total	3,903	4,190

Tariffs:	
Tin in blocks, pigs, or bars for use in Canadian manufacture and tin-strip waste and tinfoil.	Enter Canada duty free
Tinplate and other manufactures of tin:	
British preferential	15 percent ad valorem
Most favored nation	20 percent ad valorem
General	30 percent ad valorem
Tin in blocks, pigs, and bars, not for specific use in Canadian manufacture:	
British preferential	Free
Most favored nation	5 percent ad valorem
General	5 percent ad valorem

[29] Canadian Department of Mines and Technical Surveys Tin in Canada: 1953 (preliminary), p. 3.

Indochina.—Production of tin in concentrate was 264 long tons in 1953, an 80-percent increase from 1952. The tin-producing areas of Indochina lie in northern Vietnam and in central Laos. Before World War II Indochina was a developing field that had reached an annual production of about 1,500 tons. The average annual production of tin in concentrate for the 5 years 1949–53 was 120 tons. A brief account on the operations of two tin producers in 1952 was recently published.[30] The articles stated:

In 1952 the production of the Société d'Etudes et d'Éxploitations Miniéres de l'Indochine was 278 metric tons of concentrates (149 metric tons tin content) against 170 metric tons of concentrates (90 metric tons tin content) in 1951. Circumstances prevented the Company from realizing its anticipated program (250 tons tin content); the Company, however, was able to continue the rehabilitation of its enterprise, thanks to the recruitment in Saigon of specialist Vietnam labor. A very sharp improvement was also seen in transport conditions from Saigon to the mine, although transport prices were at a very high level.

La Compagnie Fermière des Étains d'Extreme-Orient was still unable to undertake extractive work; its activity was limited to the conservation of its plant and a small production by hand labor. Production in 1952 rose to 21 metric tons at 45/50 percent tin content.

Indonesia.—In 1953 Indonesia was the second largest tin producer in the world. Production of tin in concentrates was 33,800 long tons. This represented a decrease of 1,200 tons or 3 percent from the previous year. The Indonesian output represented 19 percent of the world mine production. Tin production in Indonesia is confined to the islands of Bangka, Billiton, and Singkep, which in 1953 supplied 63, 29, and 8 percent, respectively. Exports of tin in concentrates from Indonesia in 1953 in long tons were as follows:

United States	7, 205
Netherlands	25, 527
Total	32, 732

A recent despatch reported on the government's decision not to renew the interim operational contract entered into with the Billiton Co. in 1948.[31]

On February 28, 1953, the Indonesian Government formally took over operation of the Bangka island tin mines, formerly managed by N. V. Gemeenschappelijke Mijnbouwmattschappij Billiton (GMB), a joint enterprise, in which the Indonesian Government owned 62½ percent of the shares and the Dutch concern N. V. Billiton Maatschappij the remainder. Normally the Bangka mines produce two-thirds of Indonesia's tin supply.

The Government indicated that the status quo with respect to general labor conditions, including wages, working conditions, etc., would in general be maintained in order to assure continuity in operations.

At the end of 1953 tin in concentrate and stocks in Indonesia amounted to: 1,916 long tons on Bangka, 662 tons on Billiton, and 183 on Singkep or 2,761 tons in the tin-producing areas of Indonesia. Also on Bangka were 236 long tons of metallic tin and 179 tons of tin in slag.

Malaya.—It is noteworthy that, despite numerous difficulties which beset the Malayan mining industry, mine production of tin in 1953 amounted to 56,300 long tons. This represented a decrease of about 500 tons or 1 percent from the previous year.

[30] International Tin Study Group, Notes on Tin: No. 33, September 1953, pp. 542–543.
[31] United States Embassy, Djakarta, Indonesia State Department Dispatch ,737: Mar. 2, 1953, p. 1.

During the fourth quarter of the year several areas in Kedah and Selangor were opened for prospecting for the first time since the emergency. A recent article commented as follows on large-scale prospecting by tin companies in Malaya.[32]

It is estimated that some five years will be necessary to install new dredges in stanniferous land yet to be located at a cost of something like £1,000,000 for a big new installation. Moreover, the high level of expropriatary taxation makes it doubtful whether capital for adequate development would be forthcoming, even if new ground were available.

In 1953 about 90 percent of the total Malayan production of tin was obtained by dredging (51 percent) and gravel pumping (39 percent). The percentages from other methods of mining were hydraulicking, 2 percent; open-cast mining, 2 percent; underground mining, 4 percent; dulang washing, 2 percent.

The total number of mines in operation, totaling 632 at the end of June, dropped to 608 at the end of October, then increased to 629 at the end of the year. During this same period the number of dredges in operation fell from 77 at the end of June to 72 in August, then increased to 76 at the end of December. Gravel pump mines operating fell from 488 at June 30 to 466 at the end of October but increased to 482 at the year end.

Table 23 shows the number of mines of various types operating on January 1, June 30, and December 31, 1953.

TABLE 23.—Number of Malayan mines in operation during 1953 [1]

	Jan. 1, 1953	June 30, 1953	Dec. 31, 1953
Dredges	80	77	76
Gravel pump:			
European	22	20	21
Others	530	468	461
Hydraulicking:			
European	9	9	6
Others	4	2	4
Open-cast:			
European	1	2	2
Others	3	1	1
Underground:			
European	1	1	1
Others	10	6	10
Small workings:			
European	1	1	2
Others	45	45	45
Total:			
European	114	110	108
Others	592	522	521
Grand total	706	632	629

[1] U. S. Embassy, Singapore, Malaya, State Department Dispatch 897: Mar. 23, 1954, p. 9.

The yearly movements of tin concentrates (Malayan producers), average yearly price, and export duty paid in 1952–53 were as follows:

Year	Tin concentrates (long tons)	Tin-metal content (long tons)	Export duty paid (M $)	Average price per picul (M $)	Average price per pound (US $)
1952	76, 887	57, 665	68, 553, 218	480. 04	1. 1922
1953	75, 550	56, 663	50, 552, 825	364. 10	. 9042

NOTE: US\$1=M\$3.02; M\$1=US\$0.33; picul=133⅓ pounds.

[32] Mining Journal (London), Annual Review Edition: May 1954, p. 167.

The smelting of tin ores in Malaya is 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 concentrates is smelted by a Chinese smelter for local consumption. The total smelter production in Malaya was 62,400 long tons during 1953. This represented a decrease of about 400 tons (1 percent) from the previous year. The Malayan smelting industry supplied 34 percent of the world smelter production in 1953. The tin content of concentrates available from Malaya was 56,700 long tons compared with 57,700 (revised) in 1952. Imports contained 6,300 tons of tin compared with 7,900 tons in 1952.

TABLE 24.—Imports of tin in concentrates in Malaya in 1953

Country of origin:	*Long tons*
Burma	983
French Indochina	11
Indonesia	1
Thailand	5, 116
Other countries	209
Total	6, 320

In 1953 the exports of tin metal amounted to 61,752 long tons valued at M$391,473,429 (US $129,186,231) compared with 64,119 tons valued at M$515,568,044 (US$170,137,455) in 1952. Table 25 shows exports of tin metal from Malaya during 1953.

Stocks of tin metal at the end of 1953 totaled 2,100 tons compared with 1,500 at the beginning of the year; stocks of tin in concentrates increased from 5,200 tons at the beginning to 5,700 at the end.

TABLE 25.—Malayan exports of tin metal in 1953

Destination:	*Long tons*
United States	30, 313
United Kingdom	6, 558
Japan	5, 018
France	3, 898
Republic of India	2, 814
Italy	2, 143
Netherlands	2, 548
Canada	1, 400
Czechoslovakia	613
Poland	580
Germany	182
All other countries	5, 689
Total	61, 752

Nigeria.—Nigeria was the second largest African tin producer and ranked seventh among the countries of the world. In 1953, 17 companies were mining tin. Production costs increased approximately 10 percent, chiefly owing to the continued rise in the cost of supplies and African labor.

A recent article commented on mine operations in Nigeria in 1953:[33]

Broadly speaking, Nigerian tin and columbite producers achieved better results in 1953 than in the previous year, particularly in the case of columbite, which showed a big improvement. Whilst the average price per ton of tin showed a considerable decline as compared with 1952, the average price obtained for columbite was much higher. All producers are, therefore, stepping up their production of columbite as much as possible.

[33] Work cited in footnote 32, p. 137.

Production of tin in concentrate in Nigeria totaled 8,200 long tons in 1953, a 1-percent decrease from 1952. The entire output of Nigerian tin concentrate was exported to United Kingdom.

Portugal.—Portugal was the second largest producer of tin in concentrates of Europe in 1953.

The Beralt Tin & Wolfram, Ltd., operating tin and wolframite mines at Panasqueria, Province of Biera Baixa, continued to be one of the most important tin producers in Portugal in 1953. The firm expanded both its River and Panasqueria mills during the year and developed important ore reserves below the main adit.[34]

Production of tin in concentrates in Portugal was estimated at 1,500 long tons in 1953, a 50-percent increase from 1952.

South-West Africa.—A recent despatch commented as follows on the operation of two small tin producers in South-West Africa in 1953.[35]

> Uis Tin Mines, Ltd., completed construction of its 1,000-ton-per-day gravity concentrator about mid-1953 but was unable, because of financial and labor troubles, to exceed a production rate in excess of 500 tons per month during the balance of the year.
>
> The South West Africa Company, which has been operating an eluvial tin property on the west slopes of the Brantberg Mountain, northeast of Walvis Bay, has developed a large area of fairly closely spaced parallel quartz veins bearing tin and is planning an operation wherein 500 tons of quartz ore will be milled daily. To produce 500 tons of ore daily, 5,000 tons of rock separating the veins will be handled. At the proposed rate of mining, tin production is expected to be in excess of 100 tons of concentrates per month.

Thailand.—Production of tin in concentrate in Thailand totaled 10,000 long tons in 1953, a 7-percent increase from 1952.

In 1952 exports of tin concentrate had an approximate value of $22.3 million and composed roughly 6.5 percent of Thailand's total exports. Government revenues from tin-mining royalties in 1953 were estimated at 45 million baht.[36] Table 26 presents exports and countries of destination.

TABLE 26.—Exports of tin in concentrates from Thailand, in long tons [1]

Destination:	*1952*	*1953*
Malaya	4,560	5,165
United States	4,677	3,452
Brazil	-------	1,532
Netherlands	504	42
Total	9,741	10,191

[1] Metal content of Thailand tin concentrates is between 72–74 percent tin.

A recent dispatch commented as follows on the operating costs and Government regulations in Thailand in 1953.[37]

> After the price break of March 1953, there was much apprehension on the part of most miners that prices would drop to a level which could not support the operations of the majority of native mines as well as the high-cost, steam-operating dredges. According to miners, it is not possible to ascertain any specific price level at which operations of the various types of mines becomes marginal, as no two mines operate under identical conditions. However, they all agreed that the gravel-pump mines producing less than 100 piculs (about 6

[34] Work cited in footnote 28, pp. 86–88.
[35] U. S. Consulate, Johannesburg, South Africa. State Department Dispatch 255: June 10, 1954, p.8.
[36] Nominal 1953 exchange rate, 18.16=$1.00.
[37] U. S. Embassy, Bangkok, State Department Dispatch 612: Mar. 30, 1953, p. 6.

long tons) monthly would not be able to continue unless prices were maintained at a high level. The average monthly operating cost of gravel-pump mines is estimated between Bs100,000 to Bs120,000; the amount of ore he will have to produce to make expenses will of course, depend on the net proceeds from the sale of each picul of ore and its relation to the actual operation costs. A reliable miner in Phuket supplied the following cost statement for gravel-pump mining:

Average monthly operating expenses—Bs110,000.

Estimated monthly working capacity—16,000 cu. yd.

Ore price after deducting royalty (baht per picul)	*Output necessary to meet operating expenses (piculs)*	*Minimum contained tin per cubic yard (catty [1] per cu. yd.)*
1, 200	92	0. 58
1, 150	96	. 60
1, 100	100	. 63
1, 050	105	. 66
1, 000	110	. 69
950	116	. 73
900	122	. 77

[1] 1 catty=1⅓ lb.

According to the source supplying the above data, the average mine operates on ground which contains about .50 catty of contained tin per cubic yard and therefore when low prices prevail the miners will, if possible, concentrate on rich ground. In the months of July and August the net price to the miner was in the vicinity of Bs725 to Bs750 per picul. By late July, thirteen small gravel-pump mines were known to have closed in Phuket province alone.

Monthly operating costs for dredges are reported to vary between Bs350,000 to Bs450,000, depending on the size of the dredge and the type of fuel used. A typical operating cost statement of a high-cost dredge is as follows:

Average monthly operating expense—Bs450,000

Estimated working capacity—130,000 cu. yd.

Ore price after deducting royalty (baht per picul)	*Output necessary to meet operating expenses (piculs)*	*Minimum contained tin per cubic yard (catty per cu. yd.)*
1, 200	375	0. 29
1, 100	410	. 32
1, 000	450	. 35
900	500	. 39

In July and August, one steam-operated dredge was known to be operating at a large loss and one other was forced to suspend operations indefinitely. Well-informed sources state that if the royalty rate had not been reduced in September the tin industry would have been hard hit.

The most significant changes in government regulations during the year 1953 were: (1) the royalty rate increase of April twenty fourth, (2) the amendment to the Royalty Act reducing the rate by fifty per cent, (3) import control legislation of November 17, and (4) changes in administrative procedures governing applications for mining permits.

On April twenty fourth, coinciding with falling world tin prices, the government increased the royalty rate from Bs226.10 to Bs273.00 on each picul of 72% Sn ore—a move which was not well received by the mining industry. A delegation of the Thai Mining Association of Phuket made representations to the Thai Government, appealing not only for a reduction in the royalty rate but also for the elimination of the 20 per cent foreign exchange surrender requirements at official rates, and for permission to import rice for their account. As tin prices continued to decline and the closure of many small mines reported, the National Assembly voted during September to amend the Royalty Act calling for a 50 percent reduction in the royalty rate. As a result the royalty payment on one long ton of tin concentrates was reduced by approximately $110.00 and reportedly saved many mines from stopping operations entirely.

United Kingdom.—Mine production in the United Kingdom (Cornwall and Devon) in 1953 was 1,100 long tons, a 22-percent increase over that in the preceding year. United Kingdom smelter production of tin ranked third among the countries of the world and was the leading tin-smelting industry in Europe. The output of tin amounted to 29,000 tons, a decline of 700 tons from the previous year. Year-end stocks of tin in concentrates were 2,450 tons (virtually unchanged from the beginning of the year) and of metal 3,000 tons (4,200 at the beginning). Total stocks, including tin metal and concentrates afloat and visible consumers' stocks, were reported to be 7,700 tons at the end of 1953—a 10-percent increase from 7,000 tons at the beginning of the year. Exports of tin metal from the United Kingdom in 1953 were 13,800 long tons compared with 12,600 in the previous year.

Tin consumption in the United Kingdom in 1953 declined 4,000 tons from the previous year and was about 5,000 tons lower than in 1951. Table 27 presents tin consumption in the United Kingdom, by uses, 1951–53.[38] The use of tin in most categories presents a considerable decline over the previous year. The most substantial decrease was in the consumption of tin for tinplate and in tin alloys. The decrease in consumption of tin in tinplate was due principally to the closing of the old hand mills in Wales during the early months of the year.

TABLE 27.—United Kingdom tin consumption, 1951–53, excluding tin scrap long tons [1]

Use	1951	1952	1953
Tin plate	9,417	11,491	8,911
Tinning:			
Copper wire	528	506	405
Steel wire	114	108	78
Other	833	787	796
Total	1,475	1,401	1,279
Solder	3,277	1,849	1,651
Alloys:			
Whitemetal	4,372	3,457	2,901
Bronze and gunmetal	2,825	2,601	2,001
Other [2]	442	405	373
Total	7,639	6,463	5,275
Wrought tin: [3]			
Foil and sheets	474	299	255
Collapsible tubes	391	243	306
Pipes, wire and capsules	88	63	71
Total	953	605	632
Chemicals [4]	971	632	766
Other uses [5]	165	113	120
Total	23,897	22.554	18,634

[1] Tin (London), March 1954.
[2] Includes siphon top alloy.
[3] Includes compo and "B" metal.
[4] Mainly tin oxide.
[5] Mainly powder.

[38] Tin (London), March 1954, p. 56.

Titanium

By Alfred F. Tumin [1]

NECESSITY for titanium metal for high-priority military applications expedited negotiations of Government production contracts with immediate and potential producers of titanium metal in 1953. Although domestic titanium sponge-metal production in 1953 more than doubled 1952 output, the supply was inadequate to meet reported military demand. Because of the rapid development of uses for titanium in military equipment, a special Senate subcommittee conducted hearings to study the various phases of the titanium-metal industry. Representatives of the titanium-metal producers, fabricators, consumers, and Federal agencies informed members of the committee of the availability, importance, and applications of titanium minerals and metal for national defense and peacetime purposes. The committee recommended an increased production goal for titanium and the awarding of additional Government production contracts without delay to qualified concerns contributing toward this goal.[2]

Much progress was reported from research directed toward the development of new methods for melting and fabricating titanium metal and on the utilization of titanium scrap. Improved processing techniques provided consumers with more reliable titanium alloys.

Although titanium metal was highly publicized and discussed in 1953 the manufacture of titanium dioxide pigments continued to be the basis of the titanium industry. A slight drop in domestic ilmenite production was supplemented by a sharp increase in imports of titanium slag from Canada.

DOMESTIC PRODUCTION

Concentrates.—Production and shipments of ilmenite in 1953 were 513,696 and 512,176 short tons, respectively, a decrease from 1952 of 3 percent in production and 2 percent in shipments. Ilmenite data in 1953 included a mixed product containing ilmenite, rutile, and leucoxene. Factors that contributed to lower production and shipments of ilmenite in 1953 were the inactivity of the Yadkin Mica & Ilmenite Co., Finley, N. C., which ceased operations in October 1952, and increased imports of Canadian titanium slag.

Increased output of ilmenite in 1953 from 1952 was reported by the American Cyanamid Co., Piney River, Va.; Florida Ore Processing Co., Melbourne, Fla.; and the National Lead Co., Tahawus, N. Y.

[1] Commodity-industry analyst.

[2] Hearings before the Special Subcommittee on Minerals, Materials, and Fuels Economics of the Committee on Interior and Insular Affairs, U. S. Senate, 83d Cong., 1st and 2d Sess., S. Res. 143: Titanium, part 3, 1954, 781 pp.

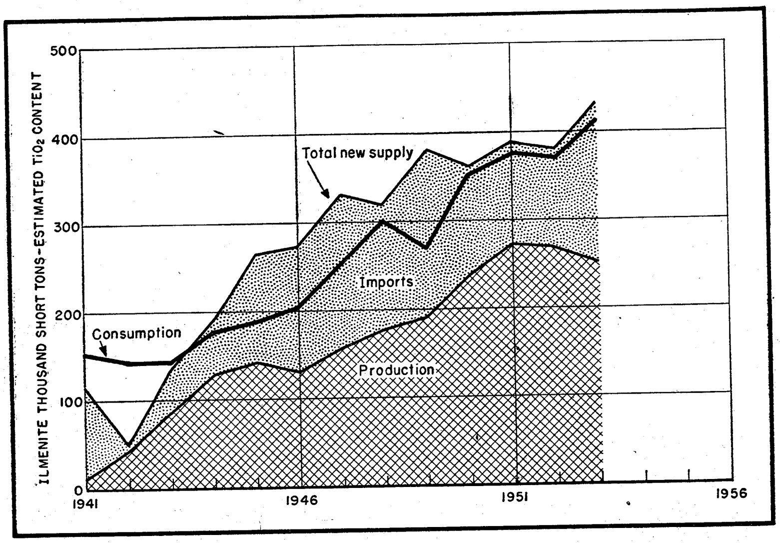

FIGURE 1.—Domestic production, imports, and consumption of ilmenite (includes titanium slag and a mixed product) and rutile, 1941–53.

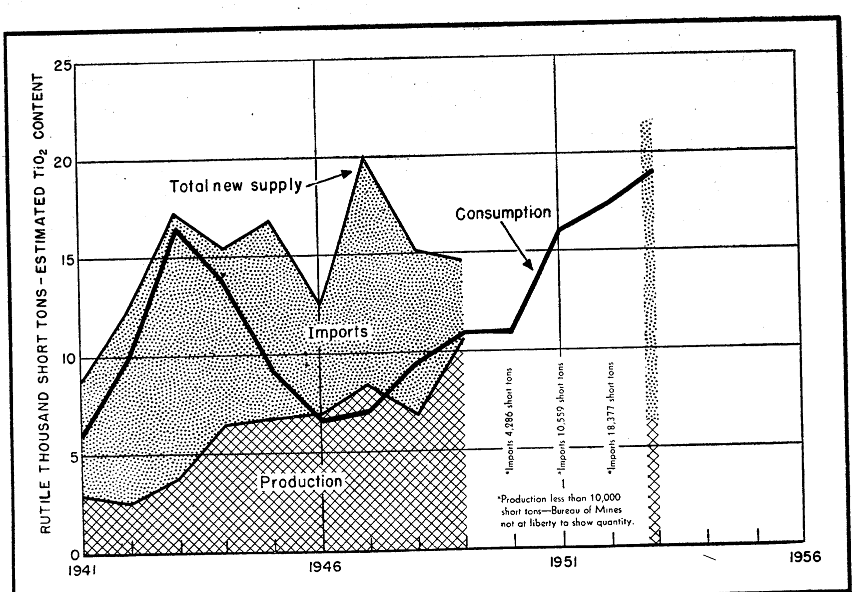

FIGURE 2.—Domestic production, imports and consumption of rutile 1941–53.

Other ilmenite producers in 1953 were Baumhoff-Marshall, Inc., Boise, Idaho (production of Baumhoff-Marshall, Inc., included output of the Idaho-Canadian Dredging Co. and Warren Dredging Corp.); E. I. du Pont de Nemours & Co., Inc., Starke, Fla.; National Lead Co., Jacksonville, Fla.; and the Rutile Mining Co. of Florida, Jacksonville, Fla. The National Lead Co., New York, N. Y., reported the initial operation in 1953 of its plant at Jacksonville, Fla., adjacent to the facilities of the Rutile Mining Co. of Florida. Of the total ilmenite production New York continued to supply over one-half and Florida about one-third; the remainder came from Virginia and Idaho. A small quantity of ilmenite, produced in California and Idaho for nontitanium use, was not included in the production and shipments of titanium concentrates. Ilmenite shipped in 1953 ranged from 45 to 66 percent titanium dioxide.

Rutile production and shipments in 1953 totaled 6,835 and 6,476 short tons, respectively. Production was by the National Lead Co., Jacksonville, Fla.; Rutile Mining Co. of Florida, Jacksonville, Fla.; and the Florida Ore Processing Co., Melbourne, Fla. The National Lead Co. reported initial rutile production in 1953 from a deposit that bordered the Rutile Mining Co. of Florida operations at Jacksonville, Fla. Rutile shipped in 1953 ranged from 93 to 97 percent titanium dioxide.

Mining and beneficiating equipment and methods in recovering titanium minerals from beach sands were described in an article. About 20,000 tons of feed per day was processed in a wet mill; the dry mill with a capacity of 700 tons of feed per day extracted about 300 tons of titanium minerals and 120 tons of staurolite per day by electrostatic and high intensity magnetic separation.[3]

The National Lead Co. signed a contract with the Defense Materials Procurement Agency, April 1953, to perform research on the commercial utilization of brookite (TiO_2) from the Magnet Cove, Ark., deposit. This contract required the National Lead Co. to mine about 50 tons of ore from the Arkansas deposit and to determine the feasibility of using this material in producing welding-rod coatings and titanium metal.

A $3 million plant to mine and process ilmenite was under construction in 1953 near Lawtey, Fla., for E. I. du Pont de Nemours & Co., Inc., Wilmington, Del. The new plant, to be known as the Highland plant, was to be built on about 5½ square miles of land about 17 miles north of Du Pont's present plant at Starke, Fla. As at Starke, the new facilities are being built and will be operated for Du Pont by the Humphreys Gold Corp., Denver, Colo. Operations are expected to begin early in 1955.[4]

The American Mining & Development Co., St. Augustine, Fla., announced in 1953 construction of a $100,000 experimental pilot plant for processing minerals found in deposits along the east coast of Florida. The plant was to include a wet-processing plant to separate the heavy minerals and metals from beach sand; a stationary drying plant; and a separation plant that was to contain 40,000-volt separators to divide magnetic and nonmagnetic elements. Plans of the company

[3] Carpenter, J. H., and others, Mining and Concentration of Ilmenite and Associated Minerals at Trail Ridge, Fla.: Min. Eng., vol. 5, No. 8, August 1953, pp. 789–795.
[4] Chemical and Engineering News, Industry: Vol. 31, No. 39, Sept. 28, 1953, p. 4014.

were to concentrate ilmenite, rutile, zircon, thorium, and uranium from Florida sands. The company received an extension of time on a mineral lease along 100 miles of coastline in Florida. The lease from the State of Florida provided that the State would get $1, or 3 percent, of the sale price of the minerals mined, whichever was greater.[5]

TABLE 1.—Production and mine shipments of titanium concentrates from domestic ores in the United States, 1944–48 (average) and 1949–53, in short tons

Year	Ilmenite				Rutile			
	Production (gross weight)	Shipments			Production (gross weight)	Shipments		
		Gross weight	TiO_2 content	Value		Gross weight	TiO_2 content	Value
1944–48 (average)	317,970	317,917	147,069	$6,086,566	7,499	7,237	6,762	$827,181
1949	402,334	389,234	186,535	6,212,348	[1] 11,988	[1] 10,559	[1] 9,414	[1] 489,798
1950	[1] 468,320	[1] 452,370	[1] 230,826	[1] 5,606,584	(2)	(2)	(2)	(2)
1951	[1] 535,835	[1] 510,840	[1] 261,982	[1] 7,689,272	(2)	(2)	(2)	(2)
1952	[1] 528,588	[1] 522,515	[1] 265,596	[1] 8,022,752	(2)	(2)	(2)	(2)
1953	[1] 513,696	[1] 512,176	[1] 258,247	[1] 7,222,641	6,825	6,476	6,043	702,791

[1] Includes a mixed product containing altered ilmenite, leucoxene, and rutile.
[2] Bureau of Mines not at liberty to publish.

Metal.—Commercial titanium-sponge production in 1953 was 2,241 short tons, more than double the 1952 output of 1,075 tons. This production included material from E. I. du Pont de Nemours & Co., Newport, Del.; Titanium Metals Corp. of America, Henderson, Nev.; and the Federal Bureau of Mines pilot plant, Boulder City, Nev. At the end of 1953 Titanium Metals Corp. of America was producing titanium sponge under a Government contract calling for 18,000 short tons over a 5-year period, and E. I. du Pont de Nemours & Co. produced titanium under a Government contract that called for production of 13,500 tons over a 5-year period. Du Pont's Government production contract was in addition to its private production facilities that had a capacity for producing 4,500 tons over the 5-year period.

Due to the shortage in 1953 and the anticipated future insufficiency of titanium for national defense, the Defense Materials Procurement Agency (DMPA) entered into an agreement on April 30, 1953, with the Bureau of Mines for the production of titanium sponge at the Bureau of Mines pilot plant, Boulder City, Nev. Under the contract (DMP–76) the Bureau of Mines was to endeavor to produce within a period of 18 months, following the effective date of the agreement, a minimum of 360,000 pounds and a maximum of 500,000 pounds of usable ductile titanium at a minimum rate of 1,000 pounds and an optimum rate of 1,400 pounds daily. DMPA was to advance funds to the Bureau of Mines based on production costs, not to exceed a maximum of $2,250,000. The Bureau of Mines production was to supplement, but not compete with, private production.

The DMPA contracted (DMP–75) on August 3, 1953, with the Cramet Co., Chattanooga, Tenn., a wholly owned subsidiary of the Crane Co., Chicago, Ill., for the construction and operation of a plant

[5] Engineering and Mining Journal, This Month in Mining: Vol. 154, No. 5, May 1953, p. 135.

to produce 30,000 short tons of titanium sponge over a period of 5 years. The DMPA was to advance the company up to $24,950,000 for construction and equipment costs, to be repaid with interest as titanium sponge was produced. The Government had an option to buy up to 7,500 tons of titanium sponge during the term of the contract at $5 per pound for any sponge purchased during the first year of production and $4 per pound or market price, whichever was greater, thereafter. On the other hand, the company could require that the Government buy up to 6,000 tons of sponge during the life of the contract at $5 per pound during the first year of production (not to exceed 1,000 tons) and $4 per pound thereafter.

The Government-sponsored titanium-expansion program, as of December 1, 1953, called for a production capacity of 25,000 annual short tons of titanium sponge by 1956. This goal, determined by the Office of Defense Mobilization, was based largely on requirements submitted by the Department of Defense.

The General Services Administration established a revolving fund of $5 million in August 1951 for the purchase and resale of not more than 1 million pounds of titanium sponge at a price not to exceed $5 per pound. Titanium sponge in this revolving-fund stockpile, purchased by the Government from E. I. du Pont de Nemours & Co., Wilmington, Del., totaled 298 short tons in January 1953. Due to the increasing military demand for titanium metal this material was resold to titanium fabricators, and by June 22, 1953, the stockpile was depleted. No titanium sponge was purchased by the Government in 1953 under this fund.

Titanium products, namely, sponge, tubes, extrusions, titanium-bearing alloys, and titanium-base alloys, were designated as scarce materials in List A of the National Production Authority (NPA) Designations of Scarce Materials 1, as amended February 18, 1953. These products were removed from this status by amendment of June 18, 1953, but were reinstated in Schedule A of Defense Production Order 1, Supplement 1, on July 16, 1953. NPA Regulation 1, as amended October 22, 1951, which placed inventory controls on titanium products, was abolished May 1, 1953. Business and Defense Services Administration (BDSA) Notice 1 and Schedule A, issued by BDSA on November 18, 1953, placed controls on the general distribution of titanium sponge and metal (ingot and milled products) in the civilian market

Expansion of melting and fabricating facilities of Rem-Cru Titanium, Inc., at Midland, Pa., was announced in October 1953. Plans called for the production of 10 ingot-tons of titanium metal per day in 1954, as compared with the 1953 rate of 3 ingot-tons of titanium per day.

Extremely pure titanium (99.9 percent Ti) was produced by thermal decomposition of volatile titanium iodides by the Foote Mineral Co., Philadelphia, Pa., in 1953. The metal was consumed for research purposes.

Metal Hydrides, Inc., Beverly, Mass., produced 68,000 pounds of titanium metal powder (96–98 percent Ti) by the Hydrimet process in 1953. The plant also produced titanium hydride for powder metallurgy and chemical reactions, and titanium alloys. Titanium-metal powder was packaged in press-top metal cans with distilled water added to approximately 20 percent by weight. The cans were packed in wooden boxes suitable for either domestic or foreign shipment. Under Interstate Commerce Commission regulations the material was shipped as flammable solids. The company also conducted development work on alloy powders and alloys of titanium with copper, chromium, nickel, etc.[6]

Pigments.—Production and shipments of titanium pigments in 1953 increased 5 and 13 percent, respectively, from 1952, and both established a record high over that set in 1951. Titanium pigments were produced by the American Cyanamid Co., Calco Chemical Division, Bound Brook, N. J.; Chemical & Pigment Co., Division of the Glidden Co., Baltimore, Md.; E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.; and the National Lead Co., New York, N. Y. Statistics in this industry were supplied on a confidential basis and consequently could not be published.

The American Cyanamid Co. (Calco Chemical Division, Bound Brook, N. J.) announced in July 1953 plans for constructing a $14 million titanium-pigment plant at Savannah, Ga. The new plant, scheduled for completion in early 1955, was to be the company's third facility for producing titanium pigments; the other two were at Piney River, Va., and Gloucester City, N. J.[7]

Welding-Rod Coatings.—Production of titanium-coated welding rods was 245,100 short tons in 1953, a decrease of 8 percent from the 266,400 tons in 1952. Of the 1953 tonnage 40 percent was coated with natural rutile, 29 percent with ilmenite, 20 percent with manufactured titanium dioxide, 11 percent with a mixture of rutile and manufactured titanium dioxide, and less than 1 percent with titanium slag.

CONSUMPTION AND USES

Consumption of ilmenite increased 2 percent (12,694 tons), titanium slag 203 percent (49,292 tons), and rutile 10 percent (1,853 tons) in 1953 from 1952. Ilmenite consumption followed the pattern of previous years, 98 percent being consumed in titanium pigment production. Titanium slag averaging 70 percent titanium dioxide was also consumed in the titanium-pigment industry, with small quantities used for welding-rod coatings and research purposes. Of the total rutile consumption 52 percent went into the manufacture of welding rods.

Data compiled by the Aircraft Industries Association on the use of titanium by the airframe industry showed that the industry average for commercially pure titanium that could be utilized in present and near future design would be 2 percent of the airframe weight and future requirements about 3.5 percent; titanium alloys would constitute from 3 percent of airframe weight in present design to roughly 30 percent in future designs. Specific items, such as sizes and gages, and minimum required properties, were included in a summary report.[8]

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[6] Metal Hydrides, Inc., The Hydrimet Process: Beverly, Mass., 15 pp.
[7] Daily Metal Reporter, American Cyanamid Plans Titanium Dioxide Plant: Vol. 53, No. 141, July 22, 1953, p. 1.
[8] Work cited in footnote 2, pp. 563–575.

TABLE 2.—Consumption of titanium concentrates (ilmenite, titanium slag, and rutile) in the United States, 1944–48 average, 1949–51 total, and 1952–53, by products, in short tons

	Ilmenite		Titanium slag		Rutile	
	Gross weight	Estimated TiO_2 content	Gross weight	Estimated TiO_2 content	Gross weight	Estimated TiO_2 content
1944–48 (average)	438,185	223,397			9,932	9,244
1949	510,608	268,000			[1] 11,888	[1] 10,863
1950	[1] 679,244	[1] 351,675			11,721	10,869
1951	[1] 713,363	[1] 373,037			17,227	16,018
1952						
Pigments (mfg. TiO_2) [1,2]	670,829	345,368	24,236	16,746	(3)	(3)
Welding-rod coatings [2]	719	416			11,418	10,798
Alloys and carbide	11,293	5,763			2,997	2,858
Ceramics	5	3			281	265
Miscellaneous	4	3			[4] 3,621	[4] 3,432
Total	682,850	351,553	24,236	16,746	18,317	17,353
1953						
Pigments (mfg. TiO_2) [1,2]	684,707	353,354	73,324	52,368	(3)	(3)
Welding-rod coatings [2]	990	584			10,476	9,812
Alloys and carbide	9,823	4,888			4,000	3,821
Ceramics	5	3			317	295
Miscellaneous	19	11	[5] 204	[5] 143	[4] 5,377	[4] 5,105
Total	695,544	358,840	73,528	52,511	20,170	19,033

[1] Includes a mixed product containing altered ilmenite, leucoxene, and rutile used to make pigments and metal.
[2] "Pigments" include all manufactured titanium dioxide, consumption of which in welding-rod coatings was 1,770 tons in 1951, 2,209 tons in 1952, and 1,986 tons in 1953.
[3] Included with "Miscellaneous," to avoid disclosure of individual company operations.
[4] Includes consumption for chemicals, metal, and fiberglass.
[5] Includes consumption for welding-rod coatings and research purposes.

TABLE 3.—Distribution of titanium-pigment shipments, by industries, 1944–48 (average) and 1949–53, in percent of total

Industry	1944–48 (average)	1949	1950	1951	1952	1953
Distribution by gross weight:						
Paints, varnishes, and lacquers	79.1	74.5	74.5	73.3	70.9	67.1
Paper	6.0	6.6	6.2	5.9	7.0	9.7
Floor coverings (linoleum and felt base)	2.9	4.6	4.2	4.4	5.0	4.8
Rubber	1.8	3.1	3.0	2.5	2.8	3.4
Coated fabrics and textiles (oilcloth, shade cloth, artificial leather, etc.)	1.9	1.6	1.5	1.5	2.1	2.0
Printing ink	.9	.9	.9	1.3	1.0	1.2
Other	7.4	8.7	9.7	11.1	11.2	11.8
Total	100.0	100.0	100.0	100.0	100.0	100.0
Distribution by titanium dioxide content:						
Paints, varnishes, and lacquers	72.3	67.5	66.9	64.9	62.9	58.8
Paper	8.3	9.6	9.1	8.9	10.4	14.1
Floor coverings (linoleum and felt base)	3.8	5.8	5.2	5.7	5.6	5.4
Rubber	2.4	3.9	3.9	3.4	3.6	4.5
Coated fabrics and textiles (oilcloth, shade cloth, artificial leather, etc.)	2.4	2.1	2.0	2.1	2.9	2.6
Printing ink	1.4	1.4	1.4	1.8	1.6	1.6
Other	9.4	9.7	11.5	13.2	13.0	13.0
Total	100.0	100.0	100.0	100.0	100.0	100.0

Development of titanium primer cups for ammunition was reported by the Worcester Pressed Steel Co., Worcester, Mass. The company also conducted experiments in deep drawing commercially pure titanium sheet.[9]

Kentanium, a lightweight titanium carbide suitable where conditions of abrasion in combination with high temperatures are encountered, was applied in 1953 to tools used for flash removal, hot spinning, and hot steel cutoffs at temperatures as high as 1,850° F. Other applications included its use in flame rods, anvils for spot welding, hot extrusion die inserts, thermocouple tubes, etc.[10]

Seamless titanium tubing was produced in 1953 by the Superior Tube Co., Norristown, Pa., and progress was attained over initial tube production in which titanium tubing had to be welded and drawn. Potential applications for titanium tubing are as hydraulic fuel lines of jet engines and valve push rods for reciprocating engines.[11]

Commercially pure titanium, precision-rolled to very close tolerances and to thin gage and foil, was produced for industrial use in 1953 by the American Silver Co., Inc., 36–07 Prince Street, Flushing, N. Y. Typical uses for titanium strip were reported to be for cowlings, ducts, fire walls, structural parts, power plant components, aircraft fittings and fasteners, mufflers, metering equipment, valves, and pump and chemical processing equipment.[12]

Titanium locknuts were produced commercially in 1953 by the Elastic Stop Nut Corp. of America, Union, N. J. Republic Aviation Corp., which is conducting investigations on titanium aircraft components, estimated that substitution of titanium for steel in aircraft fasteners could save as much as 213 pounds on a fighter plane.[13]

The largest titanium die forging made, as of October 1953, was reported by the Ladish Co., Cudahy, Wis. The company produced a 100-inch-long forged-titanium propeller blade destined for use in a special United States Air Force research project.[14]

STOCKS

Year-end stocks of ilmenite, titanium slag, and rutile in 1953 were equivalent (titanium dioxide content basis) to 10½, 12½, and 10 months' requirements, respectively, at the rate of consumption in 1953. Stock reports in 1953 showed an 8-percent decrease in ilmenite concentrates from 1952; however, lower ilmenite stocks were offset by an increase (368 percent) in stocks of titanium slag. Inventories of rutile in 1953 increased 19 percent from 1952.

Mineral Order 1, which prohibited excessive inventory supply of titanium minerals, was revoked by the DMPA March 12, 1953. This order had been in effect since December 29, 1950.

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9 Steel, vol. 133, No. 18, Nov. 2, 1953, p. 41.
10 Kennametal Inc., Latrobe, Pa., 1953 Annual Report.: P. 15.
11 Steel, Titanium Tubing: Vol. 132, No. 2, Jan. 19, 1953, p. 73.
12 Modern Metals, Thin-Gauge Pure Titanium Strip: Vol. 9, No. 7, August 1953, p. 79.
13 American Metal Market, Titanium Locknuts Now Being Produced by Stop Nut Corp.: Vol. 60, No. 241, Dec. 16, 1953, pp. 1, 7.
14 Light Metals Age, Drop-Forging Huge Titanium Aircraft Propellers: Vol. 11, Nos. 9 and 10, October 1953, p. 10.

TABLE 4.—Stocks of titanium concentrates in the United States at end of year 1952–53, 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
1952 [1]						
Mine	54,061	26,347			306	285
Distributors [2]	958	574			5,279	5,040
Consumers	610,499	308,046	16,617	12,101	8,153	7,753
Total stocks	665,518	334,967	16,617	12,101	13,738	13,078
1953						
Mine	55,581	27,706			655	611
Distributors [2]	422	253			4,013	3,844
Consumers	553,330	284,891	77,845	54,943	11,729	11,140
Total stocks	609,333	312,850	77,845	54,943	16,397	15,595

[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 1953: Ilmenite, 59.5 percent TiO_2, f. o. b. Atlantic seaboard, $18 to $20 per gross ton throughout 1953; rutile, 94 percent TiO_2, 7 to 8½ cents per pound at the beginning of 1953, 6 to 6½ cents in April, 5½ to 6 cents in May, and 5 to 6 cents from June to the end of 1953. Price quotations for titanium dioxide in concentrates, metallurgical grade, were published in the Oil, Paint and Drug Reporter in December 1953 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 were higher in 1953 than in 1952. Anatase, chalk-resistant, regular, and ceramic grades increased 1 cent per pound, and titanium pigment, calcium-rutile grade increased ⅜ cent per pound. Price quotations on manufactured titanium dioxide at the end of 1953, 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.—Price quotations for titanium tetrachloride remained the same in 1953 as in December 1952 and were published in the Oil, Paint and Drug Reporter as follows:

Tank cars, works	$0.44½
Drums, carlots, works	.45½
Less than carlots, works	.48½–.56½

Metal.—Market prices of titanium metal (sponge, iodide, powder, mill products, ferrotitanium) remained the same in 1953 as in 1952 and were as follows:

Sponge (99.3 percent Ti, min.) lots less than 100 pounds, per pound	$7.50
Lots of 100 pounds or more, per pound	5.00
Iodide (99.9 percent Ti, min.) as quoted by Foote Mineral Co., Philadelphia, Pa., lots less than 100 pounds, per pound	125.00
Lots of 100 pounds or more, per pound	95.00
Powder (96–98 percent Ti) as quoted by Metal Hydrides, Inc., Beverly, Mass., lots less than 5,000 pounds, per pound	9.00
Lots of 5,000 pounds or more, per pound	7.95

Mill products, as quoted in Steel Magazine, base prices, per pound, in lots of 10,000 pounds and over, commercially pure and alloy grades, f. o. b. mill, were:

Hot- and cold-rolled sheets	$15
Cold-rolled strip	15
Hot-rolled sheared mill plates	12
Rolled or cold-drawn bar, small diameters	10
Round wire	10
Forgings (rounds, disks, and round-cornered squares and rectangles)	6
Hot-rolled bars (rounds, flats, squares)	6

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

The above prices were f. o. b. Niagara Falls, N. Y., freight allowed to St. Louis, spot, add 5 cents.

High-carbon (Ti, 15–18 percent; C, 6–8 percent) contract per net ton, f. o. b. Niagara Falls, N. Y., freight allowed to destination east of Mississippi River and north of Baltimore and St. Louis	$177
Medium-carbon (Ti, 17–21 percent; C, 2–4.5 percent) contract per ton, f. o. b. Niagara Falls, N. Y., freight not exceeding St. Louis rate allowed	195

FOREIGN TRADE [15]

Imports.—Canadian titanium slag, averaging 70 percent titanium dioxide, composed 49 percent (gross basis) of the ilmenite concentrates shipped to the United States in 1953. Titanium slag was shipped chiefly to the United States pigment industry with minor quantities purchased by the chemical industry for research purposes. Receipts of titanium slag increased 263 percent in 1953 from 1952 as production by the Quebec Iron & Titanium Corp. at Sorel, Canada, increased. Ilmenite imported from India, the major supplier, and from Australia averaged 59 percent titanium dioxide. Imports of rutile concentrates decreased 17 percent in 1953 from 1952 as producer-dealer contracts that were initiated during the rutile shortage at the beginning of 1952 began to expire.

Value of titanium metal imported from Canada (10 pounds) and Japan (71,299 pounds) totaled $269,259 in 1953. Imports of titanium

[15] 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.—Titanium concentrates[1] imported for consumption in the United States, 1944–48 (average) and 1949–53, by countries, in short tons

[U. S. Department of Commerce]

Country of origin	1944–48 (average)	1949	1950	1951	1952	1953
ILMENITE						
Australia	698		112	100		54
Brazil	4,946			1		
Canada	10,492	540	1,357	[2] 3,776	[3] 38,451	[3] 139,585
Ceylon	930	2				
Egypt		721				
France			1			
India	181,439	289,739	187,834	185,145	145,562	147,005
Malaya	667			56		
Norway	20,449	33,155	27,155			
Total as reported	219,621	324,157	216,459	189,078	184,013	286,644
Australia: In "zirconium ore"[4]	1,338					
Grand total	220,959	324,157	216,459	189,078	184,013	286,644
Value of "as reported"	$1,360,671	$2,479,071	$1,198,545	$1,323,438	$2,478,077	$5,463,526
RUTILE						
Australia	5,115	3,085	3,427	11,023	19,394	16,098
Brazil	387					
French Cameroon[5]	(6)					
India	50					
Norway	(6)					
Total as reported	5,552	3,085	3,427	11,023	19,394	16,098
Australia:						
In "zirconium ore"[7]	3,015	1,096	1,133	210	156	84
In "ilmenite"[8]	1,012					
Grand total	9,579	4,181	4,560	11,233	19,550	16,182
Value of "as reported"	$328,354	$179,746	$149,733	$491,383	$1,728,803	$1,791,494

[1] Classified as "ore" by U. S. Department of Commerce.
[2] Includes titanium slag.
[3] Chiefly all titanium slag averaging about 70 percent TiO_2.
[4] Ilmenite content of zirconium ore as reported to the Bureau of Mines by importers.
[5] Includes quantities reported by U. S. Department of Commerce as originating in French Equatorial Africa, from which no rutile production was recorded during 1944–48.
[6] Less than 1 ton.
[7] Rutile content of zirconium ore as reported to the Bureau of Mines by importers.
[8] Rutile content of ilmenite ore as reported to the Bureau of Mines by importers.

TABLE 6.—Exports of titanium products from the United States, 1944–48[1] (average) and 1949–53, 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
1944–48 (average)	1,001	$150,915	(2)	$232	(3)	(3)	615	$95,212	17,612	$3,914,102
1949	1,505	143,412	(3)	(3)	(3)	(3)	179	40,918	29,621	8,140,991
1950	600	57,753	(3)	(3)	(3)	(3)	171	42,741	32,660	8,799,758
1951	646	63,050	(3)	(3)	(3)	(3)	175	107,718	39,242	13,274,143
1952	870	110,737	[4] 762	[4] 31,134	3	$38,979	325	88,664	35,636	10,691,698
1953	3,233	128,046	[4] 1,137	[4] 26,148	31	796,301	185	48,722	39,780	11,715,798

[1] Changes in table 6, Minerals Yearbook, 1952, are as follows: 1943–47 average—Metal and alloys in crude form and scrap: 2 short tons ($3,085); ferroalloys, 669 short tons, ($99,264).
[2] Less than 1 ton.
[3] Not separately classified.
[4] Believed to include material other than commercially pure titanium metal.

potassium oxalate and compounds and mixtures containing titanium including titanium pigments totaled 84,760 pounds ($17,464) in 1953 and came from Canada (4,404), Italy (77,161), United Kingdom (3,190) and Western Germany (5). This was a quantity increase of 17 percent from 1952; however, the value decreased slightly.

Exports.—New high records were established in 1953 in exportation of the following titanium products: Dioxide and pigments, ores and concentrates, metal and alloys in crude form and scrap, and primary forms. Exports of titanium dioxide and pigments increased 1 percent over the previous peak set in 1951 and 12 percent from 1952. Canada, the major recipient of titanium pigments, received 23,905 short tons. Other countries that received 1,000 tons or more were as follows: Australia 1,694; Belgium and Luxembourg 1,661; Mexico 1,655; France 1,256; Japan 1,232; Cuba 1,134; and Netherlands 1,055. The remainder was distributed among 52 countries. Exports of titanium concentrates increased 115 percent from the previous peak set in 1949 and 272 percent from 1952. Canada received 3,163 short tons and 4 other countries the remainder (70 tons). Exports of metal, alloys, and scrap containing titanium increased 49 percent from 1952, when yearly export of this classification commenced. This titanium classification was shipped in 1953 to Canada (2,269,526 pounds), Belgium and Luxembourg (3,305 pounds), United Kingdom (429 pounds), West Germany (30 pounds), and Japan (5 pounds). Titanium-metal exports in primary forms increased to 31 short tons in 1953 from 1952, as shipments were to United Kingdom (62,205 pounds), Sweden (384 pounds), Canada (286 pounds), and Western Germany (6 pounds). Export of titanium ferroalloys decreased 43 percent in 1953 from 1952, as shipments to Canada, the major recipient, totaled 147 tons. The remaining quantity of 38 tons was shipped to Italy (26), France (9) and Chile (3).

TECHNOLOGY

Titaniferous magnetite deposits in Shanton, Albany County, Wyo., were diamond-drilled by Bureau of Mines engineers to determine the subsurface extent of the outcropping deposits. A total of 1,042 feet was drilled in 8 holes, from which 54 samples were taken and analyzed. Results of the chemical analyses were issued in a Bureau of Mines publication.[16]

Research conducted by the Bureau of Mines laboratory, Boulder City, Nev., on methods for determining the major impurity elements found in titanium metal resulted in development of a spectrochemical procedure that made possible the determination of magnesium, iron, silicon, and manganese in ductile titanium metal. Methods were developed to provide accurate, reasonably rapid analyses and were based on excitation of a dilute hydrochloric acid solution of the metal using a commercially available solution-excitation apparatus.[17] Spectrochemical techniques were also published by another organization.[18]

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[16] Hild, J. H., Diamond Drilling on the Shanton Magnetite-Ilmenite Deposits, Albany County, Wyo.: Bureau of Mines Rept. of Investigations 5012, 1953, 17 pp.

[17] Heller, H. A., and Lewis, R. W., Spectrochemical Determination of Magnesium, Iron, Silicon, and Manganese in Titanium Metal: Anal. Chem., vol. 25, July 1953, pp. 1038–1042.

[18] Rozsa, J. T., Spectrochemical Techniques Advance Titanium Technology: Iron Age, vol. 172, No. 12, Sept. 17, 1953, pp. 166–170.

Studies were conducted by the Bureau of Mines, College Park, Md., laboratory on welds in titanium and chemical and galvanic corrosion of titanium metal. The effect of gaseous contaminants in helium on the properties of inert-gas arc welds in titanium was studied to determine the maximum content of each that would have a detrimental effect under different welding conditions on the bend and tensile properties of the weld. A weld in titanium made in a pure helium atmosphere showed tension and bending properties comparable to those of the parent metal. Welds produced in contaminated helium atmospheres of less than 5 percent relative humidity, considerably less than 1 percent nitrogen and oxygen by volume, and 1 percent hydrogen had properties comparable to those made in pure helium.[19] Experiments on the corrosion properties of titanium metal showed no chemical or galvanic corrosion of titanium in 3-percent sodium chloride solution during galvanic couple tests in open beakers. However, magnesium, zinc, aluminum, iron, and copper corroded as a result of being coupled with titanium. Titanium, coupled with copper in various concentrations of hydrochloric acid in sealed bottles with a flow of helium, was generally anodic (electronegative, corroding).[20] The corrosive action of various organic compounds, both anhydrous and in aqueous solution, at several temperatures exhibited the resistance of titanium to attack by all concentrations of air-aerated formic acid; acetic acid; boiling chloro-acetic acid; air-aerated lactic, tannic, tartaric, and citric acids; and boiling chlorinated hydrocarbon-water mixtures. Titanium gave zero corrosion rates in air-aerated aniline hydrochloride solutions.[21]

Articles covering other tests by industry on welds in titanium were also published.[22]

A weldable titanium-base (all alpha) alloy developed to maintain high strength at temperatures above 900° F. was reported by Rem-Cru Titanium, Inc., Midland, Pa. The alloy contained 2.5 percent tin and 5 percent aluminum and was recommended by the company for use in welded rings, compressor blades and all parts requiring elevated temperature strength. Yield strength of the alloy was reported to be about 110,000 p. s. i.[23]

Development of a simple method to determine the approximate concentration of titanium dioxide in rocks was reported by the Federal Geological Survey, Beltsville, Md.[24] Rock powder was fused with potassium bisulfate, tiron was added, and the cool melt was dissolved in a buffer solution. With the addition of sodium dithionite, the approximate concentration of titanium dioxide was determined by comparing the color of the resulting yellow solution with permanent standards. According to the report a person with meager

[19] Barrett, J. C., Lane, I. R., Jr., and Huber, R. W., Effects of Atmospheric Contaminants on Arc Welds in Titanium: Welding Jour., vol. 32, June 1953, sup., pp. 283–291.

[20] Schlain, David, Certain Aspects of the Galvanic Corrosion Behavior of Titanium: Bureau of Mines Rept. of Investigations 4965, 1953, 22 pp.

[21] Lane, I. R., Jr., Golden, L. B., and Acherman, W. L., Corrosion Resistance of Titanium, Ziconium, and Stainess Steel in Organic Compounds: Ind. Eng. Chem., vol. 45, No. 5, May 1953, pp. 1067–1070.

[22] Martin, D. C., Effects of Carbon, Oxygen, and Nitrogen on Welds in Titanium: Welding Jour., vol. 32, March 1953, sup., pp. 139–154.

Voldrich, C. B., Welding of Titanium Alloys: Welding Jour., vol. 32, June 1953, pp. 497–515.

Rosenberg, A. J., and others, Restoration of Ductility in Alloy Titanium Welds: Welding Jour., vol. 32, August 1953, pp. 708–714.

Faulknew, G. E., and others, Effect of Alloying Elements on Welds in Titanium: Welding Jour., vol. 32, October 1953, sup., pp. 481–497.

[23] Chemical and Engineering News, Titanium-Base Alloy: Vol. 32, No. 8, Feb. 22, 1954, p. 769.

[24] Shapiro, L., and Brannock, W. W., A Field Test for Titanium in Rocks: Geol. Survey open file series Rept. 157, 1952, pp. 1–3.

experience in chemical analysis and with simple and inexpensive apparatus could differentiate easily rocks containing 0, 0.5, 1, and 2 percent titanium dioxide. Rocks with higher concentrations of the oxide could be differentiated by appropriate dilution of the colored solutions used in the test.

A titanium casting process involving the use of a vacuum and an inert atmosphere and a special molding material to withstand the attack of molten titanium was developed in 1953 by the National Research Corp., Cambridge, Mass.[25] The firm produced titanium-alloy castings weighing several pounds and reported that the surface of its titanium casting was equal to that of good sand-cast metals. An announcement by the firm stated that it would grant licenses on the process to qualified licensees on a nonexclusive basis. A laboratory method for centrifugally casting titanium was also reported.[26]

Booklets published in 1953 by the titanium industry described various properties of titanium and its alloys as to production methods, types of alloys, testing procedures, machining, corrosion resistance, etc.[27]

A new $500,000 circular kiln with a capacity up to 35 tons per day to roast a product containing rutile ore, coke, and coal tar, was put into operation by the Titanium Metals Corp. of America, Henderson, Nev., in October 1953. The kiln, over 50 feet in diameter, was rotated by a hydraulic ram mechanism at 1 revolution per 3 hours, and processing was claimed to be increased 7 times the rate of the original batch kiln.[28]

Electrical resistance of high-purity iodide titanium and a commercial purity titanium measured at −325° to +2,800° F. showed that the resistance of titanium increased continuously up to 1,625° F. Above the transformation point the resistance of titanium changed only slightly but did increase with increasing temperature.[29]

Investigations of titanium-base phase equilibrium diagrams may be of potential technical importance to titanium alloy development.[30]

Large-scale laboratory experiments on two fundamental electrolytic processes were performed by the Horizons Titanium Corp., Cleveland, Ohio. Design data were studied in 1953 for the construction of a production prototype cell with which to test both processes on a commercial scale.[31] A process for electrolytic reduction of titanium

[25] Iron Age, Technical Briefs; Titanium: Vol. 172, No. 27, Dec. 31, 1953, p. 84.
[26] Simmons, O. W., Edelman, R. E., and Markus, H., A Method of Centrifugally Casting Titanium: Met. Prog., vol. 63, No. 3, March 1953, pp. 72–74.
[27] Mallory-Sharon Titanium Corp., Properties of Titanium and Titanium Alloys: Niles, Ohio, February 1953, pp. 1–15. Preliminary Machining Recommendations for Titanium: Niles, Ohio, March 1953, pp. 1–7. Titanium Test Procedures: Niles, Ohio, December 1953, pp. 1–4.
Rem-Cru Titanium, Inc., Corrosion Rate of RC-70 in Sea Water 0.001 Inch in 1,250 Years: Rem-Cru Titanium Rev., vol. 1, No. 6, October 1953, pp. 1–8. Rem-Cru Produces Largest Titanium Ingot: Rem-Cru Titanium Rev., vol. 1, No. 3, January 1953, pp. 1–8.
Titanium Metals Corp. of America, Handbook on Titanium Metal: New York, N. Y., 7th ed., Aug. 1, 1953, pp. 1–119.
[28] Iron Age, Titanium Metals Boosts Capacity: Vol. 172, No. 18, Oct. 29, 1953, p. 67.
[29] Wyatt, James L., Electrical Resistance of Titanium Metal: Jour. Metals, vol. 5, No. 7, July 1953, pp. 903–905.
[30] Maykuth, D. J., and others, Ti-Mn System: Jour. Metals, vol. 5, No. 2, February 1953, pp. 225–230. Ti-W and Ti-Ta Systems: Jour. Metals, vol. 5, No. 2, February 1953, pp. 231–247.
Margolin, H., and others, Ti-Ni Phase Diagram: Jour. Metals, vol. 5, No. 2, February 1953, pp. 243–247.
Cadoff, I., and Nielsen, J. P., Ti-C Phase Diagram: Jour. Metals, vol. 5, No. 2, February 1953, pp. 248–252.
Taylor, J. L., and Durez, P., Constitution of Ti-Rich Ti-Cr-Al Alloys at 1,800 degrees and 1,400 degrees F.: Jour. Metals, vol. 5, No. 2, February 1953, pp. 253–256.
Elliott, R. P., and others, System Ti-Cr-Mo: Jour. Metals, vol. 5, No. 11, November 1953, pp. 1544–1548.
Stone, L., and Margolin, H., Ti-Rich Regions of the Ti-C-N, Ti-C-O and Ti-N-O Phase Diagrams: Jour. Metals, vol. 5, No. 11, November 1953, pp. 1498–1502.
[31] American Metal Market, Ferro Corp. Reports ———: Vol. 60, No. 207, Oct. 24, 1953, p. 9.

dioxide was announced in 1953 by United International Research, Inc., Long Island City, N. Y. In the reported process titanium dioxide was dissolved in a fused salt bath of undisclosed composition at 700° C. and sealed under inert gas that would contain a small quantity of vaporized electrolyte. When electrolysis was completed a mixture of titanium sponge wetted with electrolyte remained. The metal and electrolyte were leached with cold water. According to the report laboratory batches averaging 50 grams per batch ranged from 99.5 to 99.8 percent titanium.[32]

The Mallory-Sharon Titanium Corp., Niles, Ohio, announced in June and August 1953, respectively, the opening of a titanium research and development laboratory and the development of a new titanium-melting process (ingot forms). The company claimed that by this process ingots were homogeneous, carbon content could be controlled and held as low as the quantity inherent in the sponge, and more metallic titanium could be produced from a given quantity of sponge because scrap loss was reduced.[33]

Bibliographies listing references that pertain to titanium minerals and metal as to mining, beneficiating, metallurgy, uses, etc., were published in 1953.[34]

RESERVES

A Government open-file report on titanium-bearing deposits of the world was prepared in 1953. The report, available for reference only at the Federal Geological Survey Library, Washington, D. C., described domestic and foreign titanium deposits as to location, type of deposit, grade, production and reserve information.[35] References to other literature published by the Government and industry, up to 1953, on the occurrence, exploration, mining, and treatment of titanium ores were listed in a bibliography prepared by the Federal Geological Survey.[36]

The Defense Minerals Exploration Administration (DMEA) removed the titanium minerals, brookite and rutile, from the list of minerals eligible for Government exploration assistance on May 16, 1953, in DMEA Order 1, as amended. These titanium minerals were placed in this classification by DMEA Order 1, issued March 7, 1952, which set forth provisions granting the Government permission to contribute up to 75 percent of the total exploration cost of these minerals.

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[32] Hatschek, R. L., Titanium; New Process Leaves Lab: Iron Age, vol. 172, No. 2, July 9, 1953, p. 73.

[33] Light Metal Age, Titanium—New Melting Process Improves Yield and Quality: Vol. 11, Nos. 7 and 8, August 1953, p. 16.

[34] Vores, H. E., U. S. Atomic Energy Commission Rept. TID-3039: Titanium Metallurgy—a Bibliography of Unclassified Report Literature: Apr. 14, 1953, 57 pp. Available from the Office of Technical Services, Department of Commerce, Washington 25, D. C. ($0.55).

Brophy, C. A., Archer, B. J., Gibson, R. W., and others, Titanium Bibliography, 1900–51: Battelle Memorial Institute, Columbus, Ohio, 1952, 197 pp. Available from the Office of Technical Services, Department of Commerce, Washington 25, D. C., Code No. of Rept. PB 111196 ($3).

Carpenter, J. R., and Luttrell, G. W., Bibliography on Titanium (Including Supplementary List of Reports 1949–53): Geol. Survey Circ. 87, 1953, pp. 1–23. Free upon application to the Geological Survey, Washington 25, D. C.

Meier, J. W., Bibliography on Titanium Metal and Alloys (1951–52): Canada Dept. of Mines and Tech. Surveys, Ottawa, Ontario, Inf. Mem. 341, Jan. 15, 1953, 25 pp.

[35] Lawthers, Robert, Titanium Resources of the World: Geol. Survey open file series, Rept. 239, pp. 6–283.

[36] Carpenter, J. R., and Luttrell, G. W., Bibliography on Titanium (to Jan. 1, 1950), Including Supplementary List of Reports 1949–53: Geol. Survey Circ. 87, 1953, 21 pp.

WORLD REVIEW

Ductile titanium metal, produced commercially in the United States, was manufactured on a pilot-plant basis in England and Japan in 1953 by modifications of the Kroll process. Laboratory production was reported in Australia, Canada, France, Germany, and Norway. The United States, the world's largest producer of ilmenite, supplied about 47 percent of the ilmenite concentrates in 1953; Australia remained the leader in the production of rutile as output totaled about 86 percent of the world production. Canada showed a sharp increase in titanium slag production and shipments, and was the only country that reported output of titanium slag.

TABLE 7.—World production of titanium concentrates (ilmenite and rutile), by countries, 1944–48 (average) and 1949–53, in metric tons [1]

[Compiled by Berenice B. Mitchell]

Country	1944–48 (average)	1949	1950	1951	1952	1953
ILMENITE						
Australia [2]	8,946	9,884	12,417	12,091	47	(3)
Brazil	3,230	650	---	---	---	---
Canada	11,081	490	[4] 3,177	[4] 19,235	[4] 38,276	[4] 132,940
Egypt	360	635	260	317	1,998	765
India	192,699	313,126	216,076	227,681	228,505	[5] 263,649
Malaya	5,240	20,034	[5] 25,315	[5] 44,191	[5] 22,046	[5] 26,996
Norway	60,918	99,013	105,150	105,150	118,270	90,000
Portugal	266	919	66	169	432	462
Senegal	4,473	8,338	540	2,500	4,622	3,500
Spain	245	376	637	700	1,279	1,591
United States	288,456	364,989	[6] 424,851	[6] 486,099	[6] 479,524	[6] 466,015
Total ilmenite [7]	575,900	818,500	788,500	898,100	895,000	986,000
RUTILE						
Australia [8]	11,156	13,958	17,985	35,534	38,624	[7] 40,000
Brazil	341	---	(9)	---	---	---
French Cameroon	1,470	403	25	106	294	53
French Equatorial Africa	---	---	6	---	---	---
India	569	---	(9)	(9)	(3)	(3)
Norway	55	16	(9)	(9)	43	(3)
Senegal	---	---	---	(9)	(9)	---
United States	6,803	[6] 10,875	(10)	(10)	(10)	6,192
Total rutile [7]	20,400	25,300	25,300	42,000	47,000	46,300

1 This table incorporates a number of revisions of data published in previous Titanium chapters.
2 Estimated ilmenite content of all ilmenite-bearing concentrates.
3 Data not available; estimate by author of chapter included in total.
4 Includes titanium slag containing approx. 70 percent TiO_2; see Canada under World Review.
5 Exports.
6 Includes a mixed product containing altered ilmenite, leucoxene, and rutile.
7 Estimate.
8 Estimated rutile content of all rutile-bearing concentrates.
9 Figure withheld in order to avoid disclosure of United States production by differences; see footnote 10.
10 Figure withheld in order to avoid disclosure of individual company operation.

Africa.—Mineral deposits containing a high percentage of ilmenite were reported at Morgan's Bay, near Keimouth, in the Cape Eastern Province.[37] Additional claims were reported 25 miles northwest of Springbok, Namaqualand, containing rutile averaging 97 percent TiO_2 when concentrated, and in the Carolina district, 26 miles south of Carolina and about 200 miles from Lourenco Marques, the nearest port from Marchadodorp station, containing ilmenite ore that assayed

37 Chemical Age, More Titanium in South Africa: Vol. 68, No. 1766, May 16, 1953, p. 758.

48 percent SiO_2, 20.88 percent TiO_2, 0.12 percent Fe, 30.02 percent $ZrSiO_3$, and 0.03 percent Hf.[38]

The Titanium Corp. of South Africa, at Umgababa, 24 miles south of Durban on the main coast road, announced in 1953 that its property of 800 acres contained over 21 million long tons of ore reserves in which recoverable ilmenite and rutile concentrates were estimated at 2,000,000 and 100,000 tons, respectively.[39] The company constructed a large pilot plant to recover titanium minerals at Illovo Beach, Natal, South Africa. Humphreys spirals were to be used to make a bulk gravity concentrate that was to be dried and the ilmenite removed by a magnetic separator. The tailing was to be treated by electrostatic machines to recover the rutile and zircon.[40]

British Titan Products, Ltd., of York, England, conducted an exploration program for ilmenite in the latter part of 1953 at Gambia. A preliminary survey showed that the ore extended from the surface to a depth of 9 feet near Sanyang, a village in Kombo South Division, about 30 miles south of Bathurst.[41]

Argentina.—The government of Buenos Aires Province sponsored a $1 million geological and mining survey in 1953 in an attempt to locate titaniferous sands along the Atlantic coast between Miramar and Monte Hermoso. The survey is to cover the mountain ranges of Tandil, Pillahuinco, de las Tunas, Ventana, and Bravard.[42]

Australia.—Research scientists at the Naillieu Laboratory, University of Melbourne, the chief center of titanium research in Australia, were exploring the potentialities of titanium in various alloy systems, investigating various methods for extracting titanium concentrates from sand, and experimenting with the production of pure titanium by use of an electric current passed through a solution containing compounds of metal.[43]

The Titanium Minerals, Ltd., one of the newest rutile producers in New South Wales, suspended rutile production temporarily in the latter part of 1953 because of flood damages and reductions in the price of rutile.[44]

Beach-sand deposits on the east coast of Australia within 50 miles of the Queensland and New South Wales border were reported to contain over 2 million long tons of heavy mineral concentrates (based on about 450 pounds of heavy minerals per cubic yard of sand), averaging 42 percent zircon, 34 percent rutile, 21 percent ilmenite, 0.8 percent garnet, and 0.5 percent monazite. In addition, lower grade materials found in North Stradbroke Island deposits were reported to contain 6 million tons of heavy minerals in sands averaging 86 pounds per cubic yard.[45]

Principal titanium-mineral operations in Australia were concentrated within a 90-mile stretch extending from Byron Bay, New

[38] Consular Report, Titanium in South Africa: Dispatch 453, Amcongen, Johannesburg, May 18, 1953 (unpub.).
[39] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 3, September 1953, pp. 34–35.
[40] Mining World, Beach Sand Minerals to be Recovered in South Africa: Vol. 15, No. 4, Apr. 1, 1953, p. 51
[41] Mining World, Gambia: Vol. 15, No. 13, December 1953, p. 74.
[42] Mining World, Latin America: Vol. 15, No. 4, Apr. 1, 1953, p. 67.
[43] Chemical and Engineering News, Titanium Work Progresses in Australia: Vol. 31, No. 14, Apr. 6, 1953 p. 1444.
American Metal Market, Titanium Research Is Being Pushed in Australia—Raw Materials Abundant Vol. 60, No. 181, Sept. 17, 1953, p. 1.
[44] Mining World, New South Wales: Vol. 15, No. 13, December 1953, p. 71.
[45] Edwards, A. B., Geology of Australian Ore Deposits: Office of the Congress and of Australasian Inst. Min. and Met., Melbourne, Australia, 1953, p. 31.

South Wales, to North Stradbroke Island, Queensland. Companies that extracted rutile from deposits in this area are listed as follows:

Associated Minerals Pty., Ltd.—Excavated beach and dune deposits in the Coolangatta-Southport area, Queensland, and on South Stradbroke Island. The company operated a spiral plant on South Stradbroke Island and a treatment plant at Southport.

Cudgen, R. Z.—Mined dunes south of Cudgen Headland and operated a separation plant near the mining operations.

Metal Recoveries Pty., Ltd.—Worked beach deposits near Crabbe's Creek, 24 miles south of the New South Wales-Queensland border, and operated a separation plant at Mooball Siding.

Mineral Deposits Syndicate.—Conducted mining operations on dune deposits in the Fingal, New South Wales district. The company also operated a gravity plant at Fingal and a separation plant at Southport, Queensland.

New South Wales Rutile Mining Co. Pty., Ltd.—Previously Rutile Mineral Sands, then Tweed Rutile Syndicate; extracted rutile from dune deposits between Cudgen Headland and Norries Head. Its treatment plant was 1 mile north of the National Lead Co. plant at Cudgen Headland.

Titanium Alloy Manufacturing Div., National Lead Co.—Stripped beach and dune deposits between Cudgen Headland and Norries Head. Its separation plant was 2 miles south of Cudgen Headland.

Rutile Sands Pty., Ltd.—Mined beaches in the area of Coolangatta-Burleigh, Queensland, and operated a separation plant at Currumbin, Queensland.

Titanium & Zirconium Industries Pty., Ltd.—Worked beach, dune, and swamp deposits on the east coast of North Stradbroke Island and separated minerals at its Dunwich plant on the west coast of North Stradbroke Island.

Zircon Rutile, Ltd.—Dredged mineral deposits on Tallow and Seven Mile Beach, both south of Cape Byron. The company operated 3 gravity plants at Tallow Beach and 1 at Seven Mile Beach and a separation plant at Byron Bay.

A typical analysis of a final rutile concentrate produced by one Australian firm showed the following constituents, in percent: TiO_2, 97.60; Fe_2O_3, 0.21; Cr_2O_3, 0.10; V_2O_5, 0.59; ZrO_2, 0.26; SiO_2 (combined), 0.12; and SiO_2 (free), 0.10.[46]

Canada. The Quebec Iron & Titanium Corp., subsidiary of the Kennecott Copper Corp. and the New Jersey Zinc Co., placed in operation in March and April 1953 two electric furnaces for treating titanium ores at its Sorel smelting plant. Five electric furnaces, including the latter two, were operated by the firm from April to the end of 1953 at various capacities and on a variable schedule. The company also continued to mine titanium-hematite ore from its Lac Tio deposit in the Allard Lake region, Quebec. The ore, mined by open-pit methods and averaging about 32 percent titanium dioxide and 36 percent iron, was smelted at Sorel to produce a titanium slag containing about 70 percent titanium dioxide and a marketable iron product. The titanium slag was consumed chiefly by the United States titanium-pigment industry; minor quantities were shipped

[46] Dunkin, H. H., and McKeown, M. R., Ore-Dressing Methods in Australia and Adjacent Territories: 5th Empire Min. and Met. Cong., Australia and New Zealand, vol. 3, 1953, pp. 230–273.

to various chemical companies for experimental work on the use of titanium slag in the production of titanium tetrachloride, the basic material consumed in titanium metal production in 1953. The iron product was sold to the steel industry. Data on company operations are shown in long tons as follows: [47]

	1951	1952	1953
Ore mined and crushed	339, 224	237, 249	141, 266
Ore treated	44, 299	93, 005	297, 199
Iron and steel produced	12, 877	28, 948	95, 424
Titanium slag produced	17, 259	37, 626	126, 681
Titanium slag shipped	7, 179	34, 739	129, 823

The Shawinigan Water & Power Co., Shawinigan Falls, Quebec, and the Dominion Magnesium, Ltd., Haley, Ontario, were engaged in experimental work on the production of titanium metal. No commercial production of ductile titanium metal was reported by the Canadian titanium industry in 1953.

The Canadian Javelin Foundries & Machine Works, Ltd., and Industrial Associates, Inc., of Cleveland. Ohio, reached an agreement in June 1953 whereby the Cleveland firm was to market annually 150,000 and 1,000,000 tons of titanium and iron ore, respectively, for the next 10 years from Canadian Javelin's Tache Bourget property. Only the North American rights had been assigned to Industrial Associates. The ore was to be mined and beneficiated on a contract basis.[48]

The Baie St. Paul Titanic Iron Ore Co., Ltd., and the American Titanic Iron Co., Ltd., both in the St. Urbain area of Quebec, produced a combined total of 4,658 short tons of ilmenite concentrates in 1953 as compared with 51 tons in 1952.

Canadian exploration projects reported were diamond drillings by Pershing Amalgamated Mines, Ltd., at its Desgrosbois, Quebec, titaniferous magnetite deposit; ore-dressing tests by the Titanium Development Corp. on material from its ilmenite property near Ivry, Quebec; and surface and geophysical work by Laurentian Titanium Mines, Ltd., on a titaniferous iron prospect in Wexford and Chertsey Townships, Terrebonne and Montcalm Counties, Quebec. Canadian Javelin Foundries & Machine Works, Ltd., explored the St. Charles titaniferous magnetite deposits in the townships of Tache and Bourget, Chicoutimi County, Quebec. Hollinger (Quebec) Exploration Co., Ltd., carried out preliminary exploration on a group of 74 claims covering a large iron titanium deposit at Marybelle Lake, Saguenay County, Quebec, about 75 miles north of Mingan, Quebec.

Five ilmenite deposits were reported in the St. Urbain area of Quebec (Coulombe, Furnace, General Electric, Bignell, and Joseph Bouchard). Titaniferous magnetite occurrences in Quebec were reported also in the Ste. Marguerite area near the Bay of Seven Islands, Natashquan black sands, and in the Chibougamau district; also near Mine Centre, Ontario; Burmis, Alberta; St. Georges, Newfoundland;

[47] Kennecott Copper Corp., Annual Report for 1953: New York, N. Y., pp. 13–14.
[48] Mining World, vol. 15, No. 7, June 1953, p. 85.

White Bay in northeast Newfoundland; and the Ramsay Brooke district about 35 miles south of Campbellton, New Brunswick.[49]

French Cameroon.—Production of rutile in French Cameroon in 1953 totaled 53 metric tons valued at Fr. 1,534,274 (CFA Fr. 165 equals US$1), a decrease from 294 tons in 1952 valued at Fr. 14,704,200. Exports of rutile in 1953 were reported at 63 tons valued at Fr. 2,104,355 compared with 193 tons valued at Fr. 11,400,000 in 1952. Total output from 1940 (first recorded) to 1953, inclusive, totaled 16,112 tons. Rutile was produced during this period by Société Africaine des Mines and the following individual operations: Contizas, N. El Aridi, Welter, Batalla, Dubreuil, Corneillet, Nikitopoulus, Noveiheid, Marinos, and others.[50]

Hawaii.—The College of Agriculture at the University of Hawaii in the past years conducted several studies on the titanium oxide content found in Hawaiian soils. Studies were made to determine the titanium oxide content of typical soils of each great soil group occurring in the Hawaiian Islands and the nature of the occurrence of titanium oxide and its relationship to soil formation.[51]

India.—The Government of India prohibited the export of ilmenite concentrates, except under license, during 1953. No license to export ilmenite concentrates was granted until certification by the Indian Atomic Energy Commission that the content was less than 0.1 percent monazite.[52]

Japan.—Titanium sponge-metal production in Japan totaled 154,542 pounds in 1953 compared with 17,988 pounds in 1952. Exports of titanium sponge metal from Japan totaled 69,927 pounds for the period from January to October 1953 compared with 2,205 pounds for the year 1952.

The titanium metal and pigment industry in Japan in 1953 comprised the following companies:

Osaka Titanium Manufacturing Co., Ltd., 1.—Higashi-Hamacho, Amagasaki, Hyogo Prefecture, financially affiliated with Sumitomo Metal Industries, Ltd., and Kobe Steel Works, Ltd., had a rated monthly capacity of 9 metric tons of titanium sponge metal produced by the Kroll process. The installation of additional equipment at the end of 1953 is expected to increase its monthly output to 50 metric tons in 1954.

Nippon Electric Metallurgical Co., Ltd., 4.—Ginza-Higashi 2-chome, Chuo-ku, Tokyo, operated a pilot plant for experimental production of titanium sponge metal by the Kroll process with a rated production capacity of 1,800 pounds per month. A plant under construction was expected to increase monthly production to 20 metric tons at the end of 1954.

Nippon Soda Co., Ltd., 1.—Akasaka-Omotemachi 4-chrome, Minato-ku, Tokyo, produced titanium sponge metal by the Kroll process on a pilot-plant scale. The officials of the firm decided upon full-

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49 Buck, Keith W., Titanium in Canada, 1953 (Preliminary): Canada Dept. of Mines and Technical Surveys, Ottawa, Canada, pp. 1–4.

50 Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 6, June 1954, p. 27.

51 Sherman, Donald G., The Titanium Content of Hawaiian Soils and Its Significance: Proc. Soil Science Soc. America, vol. 16, No. 1, January 1952, pp. 15–18. The Chemical Composition of the Separated Mineral Fractions of a Ferruginous Humic Latosol Profile: Proc. Soil Science Soc. America, vol. 13, 1948, pp. 166–169.

52 Chemical and Engineering News, India Limits Ilmenite-Ore Exports: Vol. 31, No. 40, Oct. 5, 1953, p. 4226.

scale production that was to increase its monthly capacity from 3 metric tons to 10 by June 1954 and to 50 tons by the end of 1954.

Toho Titanium Industry Co., Ltd., 19.—Kaigan-dori 4-chome, Ikuta-ku, Kobe, financially affiliated with Nippon Mining Co., Ltd., operated a pilot plant at 818, Chigasaki, Chagasaki-shi, Kanagawa Prefecture, where experimental production of titanium sponge under the Kroll process was undertaken. The firm intended to start production on a commercial scale in the second quarter of 1954, with a goal of 40 metric tons per month in the third quarter. The company planned to increase the monthly capacity to 100 metric tons at the end of 1954.

Mitsui Mining & Smelting Co., Ltd., 1.—Muromachi 2-chome, Nihonbashi, Chuo-ku, Tokyo, had a monthly output of 0.3 to 0.5 metric ton at its Hibi Smelting Plant, Hibi, Tamano-shi, Okayama Prefecture. Plans to construct a plant to produce 30 to 50 metric tons of titanium sponge-metal per month were underway at the end of 1953.

Kobe Steel Works, Ltd., 36–1.—Wakinohama-cho, 1-chome, Fukiai-ku, Kobe, was engaged in experimental fabrication of titanium mill products at its Nagato factory, Chofu-Minatomachi, Shimonoseki. Production in 1953 is unknown; however, it was reported that output capacity in 1954 was expected to be 10 to 20 metric tons per month.

Sumiomo Metal Industries, Ltd., 31.—Kawara-machi 4-chome, Higashi-ku, Osaka, experimented on the fabrication of titanium mill products and expected to fabricate about 10 to 15 metric tons of titanium in 1954. Production in 1953 was not reported.

Furukawa Electric Co., Ltd., 8.—Marunouchi 2-chome, Chiyoda-ku, Tokyo, operated an experimental titanium fabrication plant at Nikko Electric Copper Refining Works, Nikko-cho, Kamitsugo-gun, Tochigi Prefecture. Production capacity was not reported.

Ishihara Mining & Chemical Co., Ltd., 1.—Tosabori 1-chome, Nishi-ku, Osaka, entered into a technological assistance agreement with the Glidden Co., Cleveland, Ohio, for manufacturing of titanium pigments, and at the end of 1953 was constructing a plant within its premises that was to produce 300 to 400 metric tons of titanium pigments per month upon completion of the plant in the first quarter of 1954. The firm was also experimenting on the production of titanium sponge by electrolysis.

Sakai Chemical Industry Co., Ltd., 142.—Ebisujima 5-cho, Sakai, Osaka Prefecture, experimented on the production of titanium pigments and was expected to produce commercially in 1954 about 250 to 300 metric tons of titanium pigments.[53]

The Nippon Titanium Co. of Tokyo announced, in the first quarter of 1953, the signing of a contract with R. S. Aries & Associates of New York. The agreement provided for stock ownership in the Japanese firm to Aries organization in return for its engineering services in improving and expanding Nippon's titanium-pigment production. A new pigment plant was constructed with an output capacity of 150 metric tons per month at Hiratsuka. Expansion to double the pro-

[53] Trade and Industry News Letter (Tokyo, Japan), Titanium to Play Important Role in Civilian Industry: Vol. 7, No. 2, Dec. 30, 1953, p. 2.
Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 3, March 1954, pp. 23-27.

duction was planned for 1954. Basic material was to be supplied from blast-furnace slag from iron production in Japan.[54]

Malaya.—Ilmenite was produced before World War II in Langkawi Island, a few miles off the coast of the State of Kedah, Federation of Malaya; however, no production has been reported on the island since the end of the war.

On the mainland of the Federation of Malaya, unlike production on Langkawi Island, ilmenite output resulted almost entirely as a byproduct of tin mining. The primary concentration in the treatment of tin-bearing gravels results in the separation of cassiterite (the tin mineral) and other associated heavy minerals. Further concentration of the cassiterite is conducted in the tin-dressing sheds, leaving a residue known as "amang" (the primary constituent of which is ilmenite), which is separated from cassiterite by means of magnetic separators or by washing in sluiceboxes. About 15 to 25 percent of the amang is treated to recover ilmenite; the balance remains on mining dumps. A typical analysis of exported Malayan ilmenite concentrates, in percent, follows: TiO_2, 53.91; FeO, 34.44; MnO, 4.05; P_2O_5, 0.10; SnO_2, 0.17.

The Federation of Malaya Government did not maintain statistics on ilmenite production. In official statistical compilations for ilmenite export figures are inserted in lieu of production. The exportation of ilmenite is handled by the Harper, Gilfillan Co., Ltd., Maran Lead, Ltd., and Oriental Thai Corp. All of these companies have their offices in Kaula Lumpar. From January to June 1952 the price of ilmenite in Malaya was approximately M$35–M$40 ($11.55–$13.20) per ton, f. o. b.[55]

Malayan exports of ilmenite increased from 22,498 long tons in 1952 to 26,570 tons in 1953.

Exports of ilmenite from Malaya, 1952–53 [1]

Destination	1952		1953	
	Long tons	Value, M$	Long tons	Value, M$
United Kingdom	5,194	114,268	10,350	264,600
Belgium	299	6,153	3,220	99,700
Czechoslovakia	3,000	66,000		
France	7,210	158,465	2,300	75,065
Germany	3,995	87,890		
Netherlands			1,300	36,600
Japan	2,800	61,600	9,400	222,800
Total	22,498	494,376	26,570	698,765

1 Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 5, May 1954, p. 28.

United Kingdom.—The Imperial Chemical Industries, Ltd., operated a small pilot plant in 1951 at Merseyside, where annual output was about 18 long tons of sponge titanium; however, larger pilot plants were erected in 1953 in the Widnes and Witton areas, from which production was to be at the rate of 150 tons of sponge titanium per year, commencing in the first half of 1954. The British firm

54 Chemical and Engineering News, Japan Increases Titanium Dioxide Production: Vol. 31, No. 16, Apr. 20, 1953, p. 1668.

55 Rogatnick, Joseph H., Malayan Ilmenite—Quarterly Review for April to June 1952: Consular Rept., Am. Embassy, Singapore, Dispatch 112, July 31, 1952 (unpub.)

announced plans in August 1953 for constructive facilities at Widnes, for the producing of 1,500 long tons of titanium sponge metal annually and for converting sponge titanium into ingot form. The proposed plants, which were expected to be in production midway in 1955, were to be financed wholly by ICI.

The British Government (Ministry of Materials) participation consisted of a contract to purchase up to three-quarters of the company output of titanium sponge metal for the first 4 years of production, if the metal was not otherwise sold for use by Government contractors. The terms of the contract stipulated that the price to be paid for the metal would be equivalent to the world price current at time of purchase. The Ministry also had an option on the full output if needed for defense purposes.[56]

National Titanium Pigments, Ltd., of Hanover House, London, W. I., a wholly owned subsidiary of Laporte Industries, Ltd., reported the completion of a new titanium-pigment plant at Battery Works, Stallingborough, North Lincolnshire. The new facility, having an annual production rate of 8,000 tons of titanium pigment, cost £2.5 million ($7 million). Test runs at Battery Works were underway during June 1953, and full operations were expected at the end of 1953. The British firm also announced on July 20, 1953, that it had changed its name from National Titanium Pigments, Ltd., to Laporte Titanium, Ltd.[57]

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[56] Metal Bulletin (London), No. 3817, Aug. 14, 1953, p. 23.
[57] Chemical and Engineering News, vol. 31, No. 23, June 8, 1953, p. 2364.
Chemistry and Industry, Laporte Titanium ,Ltd.: No. 29, July 18, 1953, p. 754.

Tungsten

By Robert W. Geehan [1] and Mary J. Burke [2]

TRANSITION from shortage to abundance was the keynote of the tungsten industry during 1953. Government controls on distribution, use, and price were removed. Domestic production increased 28 percent, and world production was up 7 percent; foreign prices declined 60 percent. Imports of tungsten concentrates were at an alltime high in 1953. The Domestic Tungsten Program was extended to July 1, 1958, by act of Congress; however, the limit of 3 million units was not changed. General Services Administration announced that 599,893 short-ton units had been delivered through December 31, 1953.[3]

TABLE 1.—Salient statistics of tungsten ores and concentrates in the United States,[1] 1944–48 (average) and 1949–53, in thousand pounds of contained tungsten

Year	Production	Shipments from mines	General imports	Consumption	Industry stocks at end of year		
					Producers	Consumers and dealers	Total
1944–48 (average)	5,377	5,356	10,488	11,287	442	3,523	3,965
1949	2,896	2,632	7,357	4,958	827	4,229	5,056
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	[2] 16,995	8,634	208	2,816	3,024
1953	9,259	9,128	28,994	7,734	363	4,335	4,698

[1] Includes Alaska.
[2] Revised figure.

DOMESTIC PRODUCTION

Domestic production of tungsten concentrates in 1953 exceeded the 1952 output by 28 percent and was near the alltime high established in 1943. Nevada was the leading tungsten-producing State, followed by California and North Carolina. The Hamme, N. C., mine of Tungsten Mining Corp. and the Pine Creek, Calif., mine of United States Vanadium Co. were the most productive domestic tungsten mines.

Production has been obtained from many widely scattered operations in 16 States; but in 1953, as in 1952, over 90 percent of the output came from 4 States—California, Colorado, Nevada, and North Carolina; and 8 operators—Bradley Mining Co., Climax Molybdenum Co., Getchell Mine, Inc., Nevada-Massachusetts Co., Nevada Scheelite, Surcease Mining Co., Tungsten Mining Corp., and United States Vanadium Co.—produced 72 percent of the United States total.

[1] Assistant chief, Ferrous Metals and Alloys Branch.
[2] Statistical clerk.
[3] A short-ton unit equals 20 pounds of tungsten trioxide (WO_3) and contains 15.862 pounds of tungsten (W). A short ton of 60-percent WO_3 contains 951.72 pounds of tungsten.

During 1953, 435 producers reported output; however, many of them utilized custom milling facilities to treat their ore.

Most tungsten ore mined and milled in the United States contains 0.25 to 2.5 percent WO_3 and is beneficiated to a concentrate containing 60 percent or more WO_3. Ores containing scheelite (calcium tungstate) were important sources of tungsten in California, Montana, and Nevada, but in Colorado, Idaho, and North Carolina production was chiefly ores containing hübnerite (manganese tungstate), wolframite (iron-manganese tungstate), and ferberite (iron tungstate).

Many firms benefited from the first full year's operation of facilities completed late in 1952. Several mills designed to treat ore from individual mines were built in 1953; however, custom mills continued to treat large tonnages. The following plants were most active in the custom milling of tungsten ore:

Boulder Tungsten Mines, Inc., Marion mill, Boulder County, Colo.
Getchell Mine, Inc., Getchell mill, Humboldt County, Nev.
Hetzer Mines, Inc., Wolf Tongue mill, Boulder County, Colo.
Kennametal, Inc., Nevada Scheelite mill, Mineral County, Nev.
United States Vanadium Co., Pine Creek mill, Inyo County, Calif.

In addition to treating raw ore, the Pine Creek mill received substantial quantities of low-grade concentrate for treatment by chemical methods to produce highgrade synthetic scheelite. Salt Lake Tungsten Co. completed a chemical plant for the same purpose in Salt Lake City during 1953.

Formation of the Tungsten Institute, an organization of individuals and companies producing tungsten concentrates from domestic mines, was announced.[4] The objectives stated were:

To foster the progress and development of the American tungsten mining industry; to promote the use of tungsten; to afford the means of cooperation between the American tungsten mining industry and the federal government in all matters tending to promote the national defense and other matters of national concern; and to promote the mutual improvement of its members and the study of the metallurgy of and the arts and sciences connected with the tungsten industry.

Brief descriptions covering 1953 activities at the most productive domestic tungsten mines are included below; more detailed accounts are contained in Minerals Yearbook, volume III, in the respective State chapters.

Black Rock Mining Co.—The Lincoln mine in Lincoln County, Nev., produced 58,050 tons of ore which was milled to produce both standard- and low-grade scheelite concentrates. At the Black Rock mine, Mono County, Calif., the output was 63,050 tons of ore; part of it was milled by the producer, and the remainder was shipped to a custom mill.

Bradley Mining Co.—The Ima mine, Lemhi County, Idaho, produced 53,792 tons of ore from which 335 tons of hübnerite concentrates and 16 tons of low-grade scheelite concentrates were produced. Exploration was an important phase of the work, and extensive use was made of drifting and diamond drilling. At the Springfield mine, Valley County, Idaho, a simple gravity plant was used to treat material from a talus deposit. After cleaning at the nearby Stibnite mill 31 tons of standard-grade scheelite concentrates was recovered.

[4] American Metal Market, vol. 60, No. 159, Aug. 15, 1953, pp. 1, 3.

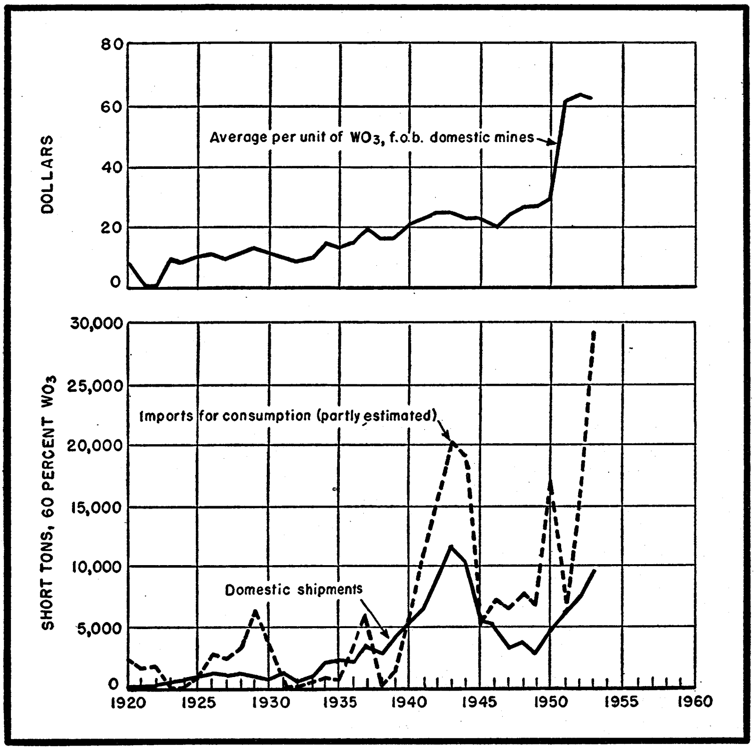

FIGURE 1.—Domestic shipments, imports, and average price of tungsten ores and concentrates, 1920–53.

TABLE 2.—Tungsten concentrates produced and shipped in the United States, 1952–53, by States

	Produced				Shipped from mines			
	1952		1953		1952		1953	
	Tungsten content (1,000 lbs.)	Units	Tungsten content (1,000 lbs.)	Units	Tungsten content (1,000 lbs.)	Units	Tungsten content (1,000 lbs.)	Units
Alaska	7	451	3	171	7	451	3	171
Arizona	73	4,628	128	8,055	68	4,269	128	8,055
California	2,656	167,411	2,277	143,534	2,836	178,779	2,267	142,912
Colorado	649	40,908	708	44,620	595	37,521	777	49,016
Idaho	335	21,144	430	27,132	317	19,986	420	26,461
Montana	----	----	29	1,830	----	----	13	820
Nevada	2,314	145,882	3,603	227,168	2,217	139,760	3,506	221,011
New Mexico	(1)	1	----	----	----	----	----	----
North Carolina	1,188	74,904	2,041	128,645	1,193	75,226	1,974	124,465
Oregon	4	274	(1)	1	4	266	(1)	1
South Dakota	(1)	6	2	136	(1)	6	2	136
Utah	3	163	33	2,078	3	163	33	2,078
Washington	4	236	5	333	4	236	5	322
Total	7,233	456,008	9,259	583,703	7,244	456,663	9,128	575,448

[1] Less than 1,000 pounds.

TABLE 3.—Tungsten concentrates shipped from mines in the United States,[1] 1944–48 (average) and 1949–53

Year	Quantity: Units	Quantity: Tungsten content (pounds)	Reported value f. o. b. mines[2]: Total	Reported value f. o. b. mines[2]: Average per unit of WO_3	Reported value f. o. b. mines[2]: Average per pound of tungsten
1944–48 (average)	337,645	5,355,709	$7,817,697	$23.15	$1.46
1949	165,915	2,631,506	4,377,066	26.38	1.66
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

[1] Includes Alaska.
[2] Values apply to finished concentrates and in some cases are f. o. b. custom mills.

TABLE 4.—Tungsten ore and concentrates shipped from mines in the United States, by States, 1944–48 (average) and 1949–53, shipments for maximum year, and total shipments, 1900–53, in short tons of 60 percent WO_3[1]

State	Maximum shipments: Year	Maximum shipments: Quantity	Shipments by years: 1944–48 (average)	1949	1950	1951	1952	1953: Quantity	1953: Percent of total	Total shipments, 1900–53: Quantity	Total shipments, 1900–53: Percent of total
Alaska	1916	47	10	------	13	10	8	3	0.03	211	0.14
Arizona	1936	489	36	(2)	1	11	71	134	1.40	4,130	2.68
California	1943	3,871	1,505	952	2,025	3,007	2,980	2,382	24.84	47,798	31.00
Colorado	1917	2,707	204	222	196	336	625	817	8.52	27,030	17.54
Connecticut	1916	3	------	------	------	------	------	------	------	11	.01
Idaho	1943	4,648	1,385	66	222	377	333	441	4.60	16,733	10.85
Missouri	1940	13	1	2	(2)	------	------	------	------	37	.02
Montana	1946	84	28	9	------	1	------	14	.15	560	.36
Nevada	1953	3,683	2,018	740	1,123	1,482	2,329	3,683	38.40	46,060	29.89
New Mexico	1915	45	2	------	------	------	------	------	------	103	.07
North Carolina	1953	2,074	426	770	1,240	1,041	1,254	2,074	21.63	8,547	5.54
Oregon	1952	4	------	3	------	1	4	(2)	------	8	.01
South Dakota	1917	270	2	------	------	------	(2)	2	.02	1,298	.84
Texas	1946	1	------	------	------	------	------	------	------	1	(3)
Utah	1953	35	9	1	------	(2)	3	35	.36	277	.18
Washington	1938	303	2	------	------	9	4	5	.05	1,344	.87
Total	1943	11,945	5,628	2,765	4,820	6,275	7,611	9,590	100.00	154,148	100.00

[1] Shipments are credited to the State where final concentrates were produced.
[2] Less than 1 ton.
[3] Less than 0.01 percent.

Climax Molybdenum Co.—Tungsten concentrates were produced as a byproduct from molybdenum ores at the Climax mine, Lake County, Colo. The following is quoted from the company's annual report for 1953.

> The tungsten values contained in that portion of the ore body now being mined on the Storke Level have been much lower than anticipated. With about half the by-product plant feed during 1953 coming from this source, production of tungsten fell to 413,000 pounds contained in concentrate from 524,000 pounds in 1952 despite the higher total tonnage treated. Some slight improvement may be expected in 1954 as a higher proportion of Phillipson Level ore will be present in feed as a result of low grade ore production from that level. Research intended to discover means of increasing recoveries will be continued.

Getchell Mine, Inc.—This firm produced large tonnages by both surface and underground methods at the Getchell-mine group in Humboldt County, Nev. Company ore was milled along with a nearly equal quantity of custom ore from several nearby mines.

Nevada-Massachusetts Co.—Production of 157,600 tons of ore was obtained from the Stank, Sutton No. 1, Sutton No. 2, and Humboldt underground mines and from adjacent open pits, all in Pershing County, Nev. This ore was milled to produce 612 tons of scheelite concentrates.

Nevada Scheelite Division of Kennametal, Inc.—The Leonard mine, Mineral County, Nev., was the source of 268 tons of scheelite concentrate. The shaft was deepened to the 400-foot level and the mill capacity expanded to 100 tons per day.

Surcease Mining Co.—Production of 50,150 tons of scheelite ore from the Atolia mine, San Bernardino County, Calif., was milled with a yield of 170 tons of concentrate.

Tungsten Mining Corp.—The Hamme mine, Vance County, N. C., with an output of 227,400 tons of ore, was the leading domestic producer. The reported recovery was 2,563 tons of concentrate, mostly hübnerite. The Central shaft was deepened 643 feet to the 1,587-foot level, and the Sneed shaft was advanced 635 feet to the 1,520-foot level. Exploration and development included 14,846 feet of underground headings and 13,727 feet of diamond drilling.

United States Vanadium Co.—The Pine Creek mine, Inyo County, Calif., was the second-ranking domestic tungsten mine, and the Pine Creek mill was an important market for custom ores and low-grade concentrate. Work during the year included 671 feet of raising and 4,412 feet of drifting.

GSA announced that 599,893 short-ton units of tungsten trioxide had been delivered, as of December 31, 1953, under the terms of the Domestic Tungsten Program. This program, quoted in full in Minerals Yearbook, 1952, authorizes purchase of 3 million units at a price of $63 per short-ton unit in standard-grade concentrates. The decline in prices for foreign concentrates in 1953 led to delivery of nearly all the domestic output to the Government; this contrasts with 1952, when domestic producers could obtain nearly $2 per short-ton unit more from industry than from the Government.

CONSUMPTION AND USES

During 1953, 7,734,000 pounds, metal content, of concentrates was consumed compared with 8,634,000 pounds in 1952. The distribution of the material used in 1953 is listed in table 5.

Manufacturers of hydrogen-reduced metal powder were the chief consumers of wolframite-hübnerite-type concentrates. High-grade scheelite and synthetic-scheelite-type concentrates were used for direct charging to steel and by manufacturers of all groups of tungsten products; however, the specifications for the various uses were not similar. Manufacturers of metal powder specified material low in molybdenum content; freedom from copper and phosphorus was important to manufacturers of steel.

Consumption of tungsten concentrates reported to the Bureau of Mines was confined to 2 general areas; 75 percent was used in New

York, Pennsylvania, and New Jersey, while nearly all of the remainder was consumed in Ohio, Illinois, and Michigan.

Tungsten is employed in a wide variety of products; however, the most important use, from the standpoint of consumption, is in tools used to cut or machine steels. Both high-speed steel containing tungsten and sintered tungsten carbide are used for this purpose. Another important use is in dies, and again both high-speed steel and tungsten carbide are used. Although accounting for only a small percentage of the total tungsten used, tungsten-wire filaments in light bulbs and radio and television tubes are very important to the general public. The modern shielded-arc method of welding uses tungsten welding electrodes. Many electrical contact points use tungsten.

Table 6 reveals the relationship of steel production to tungsten consumption and the very considerable relative increase during World War II.

Wah Chang Corp. completed three furnaces for hydrogen reduction of tungsten metal powder. In contrast to many existing furnaces, these new units are automatically operated and controlled.[5]

TABLE 5.—Distribution of tungsten concentrates consumed

	Tungsten (pounds)	Net tons (60 percent WO_3)	Percent of total
Manufacturers of steel ingots and ferrotungsten	2,811,000	2,953	37
Manufacturers of hydrogen-reduced metal powder [1]	3,112,000	3,270	40
Manufacturers of carbon-reduced metal powder, tungsten chemicals, and consumption of firms producing several products [1]	1,811,000	1,903	23

[1] Includes the entire consumption of firms that use tungsten concentrates primarily for the purpose listed, except the quantities used to produce ferrotungsten.

TABLE 6.—Tungsten consumed for all purposes as related to steel production, 1916–53

Year	Tungsten consumed from concentrates (million pounds)	Total steel production (million tons)	Pounds of tungsten per ton of steel	Alloy steel production (million tons)	Tungsten per ton of alloy steel (pounds)
1916–19, average	[1] 11.0	46.8	0.24	(2)	(2)
1920–29, average	[1] 3.2	47.8	.07	(2)	(2)
1930–38, average	[1] 3.2	36.1	.09	(2)	(2)
1939	(2)	(2)	(2)	(2)	(2)
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
1941–45, average	17.3	85.4	.20	10.0	1.7
1946–52, average	7.8	87.6	.09	7.3	1.1

[1] Apparent consumption.
[2] Not available.

[5] Business Week, No. 1264, Nov. 21, 1953, pp. 112, 114, 116.

STOCKS

The downward trend in industry stocks that prevailed throughout the second half of 1950 and all of 1951 and 1952 was reversed in 1953; at the end of the year stocks were the highest since 1950.

PRICES

The quoted prices for domestic tungsten concentrates of known good analyses were at the ceiling price of $65 per short-ton unit of WO_3, f. o. b. mine, at the beginning of 1953. After April 2 western high-grade scheelite was quoted at $63, and after June 25 all domestic concentrates that met standard specifications of the Domestic Tungsten Program [6] were quoted at $63. The ceiling price regulations of the Government on tungsten products were terminated on March 18.

Foreign quotations for tungsten concentrates declined sharply during 1953. In January the London price dropped from 410–400 shillings per long-ton unit to 370–360; this was followed by a gradual decline to 300 in late September and then by a sharp decline to 170–155, which was quoted at the end of the year. These prices were equivalent to $51.25 to $19.37 per short-ton unit.

As reported to the Bureau of Mines the average price for domestic concentrates shipped was $62.46 per short-ton unit in 1953.

FOREIGN TRADE [7]

General imports increased to an alltime high in 1953. Korea was the greatest single source; Bolivia, Portugal, and Spain each contributed concentrates with over 3 million pounds tungsten content. The United States received 82 percent of all the tungsten produced in the world except U. S. S. R., China, and North Korea.

Table 7 lists general imports and imports for consumption of concentrates for 1952 and 1953. General imports represent ores and concentrates received in the United States, irrespective of final disposal. Imports for consumption cover ores and concentrates on which duty has been paid and which have thereby entered the domestic commerce of the United States and concentrates that enter duty-free for the United States Government. This classification includes concentrates that are withdrawn from bonded warehouses; actual physical imports of such concentrates may have been included under "general imports" in prior years.

Imports of ferrotungsten are listed on table 8.

Reexports of concentrates totaled 22 tons and exports 13 tons compared with 3 and 11 tons, respectively, in 1952.

Imports for consumption of tungsten metal were 37,600 pounds from United Kingdom and 28,946 pounds from West Germany. Exports of tungsten metal powder totaled 85,473 pounds; countries receiving over 100 pounds included Australia (375), Belgium-Luxembourg (105), Canada (84,818), and Japan (153). Additional tungsten-bearing items imported for consumption during 1953 were tungsten

[6] These specifications were listed in the Tungsten chapter, Minerals Yearbook, 1952.
[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.

carbide (15,509 pounds content), tungstic acid (122 pounds content), ferrochromium-tungsten (83 pounds content), and tungsten-nickel (132,234 pounds content); additional exported items were metals, alloys, and scrap (202,836 pounds gross) and tungsten semifabricated forms not elsewhere classified (42,629 pounds gross).

TABLE 7.—Tungsten ores and concentrates imported into the United States, 1952–53 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
1952					
Argentina	277,075	141,640	277,075	141,640	$509,197
Australia	1,762,874	823,884	1,942,816	905,429	3,336,327
Belgian Congo	66,146	37,330	66,146	37,330	127,402
Bolivia	6,325,189	2,867,947	6,515,656	2,940,931	10,599,924
Brazil	[3] 1,851,201	[3] 1,056,221	[3] 2,517,928	[3] 1,434,681	[3] 4,467,094
British East Africa	22,198	12,098	22,198	12,098	38,483
British Malaya	16,845	8,685	706	367	353
Burma	1,968,741	911,148	579,646	305,168	350,341
Canada	2,958,442	642,655	2,638,001	631,380	2,304,397
China	84,084	42,318	84,084	42,318	169,992
Finland	10,362	4,766	10,362	4,766	13,726
Hong Kong	310,216	159,249	290,631	151,121	468,230
Japan	258	133	9,381	4,088	10,813
Korea, Republic of	7,723,668	3,723,474	8,098,841	3,923,314	14,036,199
Mexico	3,011,723	468,457	3,220,543	585,826	1,660,574
Netherlands	19,918	11,230	19,918	11,230	38,211
Peru	399,827	216,391	703,679	378,052	771,373
Portugal	4,792,206	2,590,840	4,842,011	2,674,062	7,950,761
Spain	3,886,924	2,044,510	3,944,991	2,074,384	7,207,272
Thailand	2,239,160	1,220,867	2,120,964	1,158,183	2,999,734
Union of South Africa	22,400	11,548	------------	------------	------------
Total	[3] 37,749,457	[3] 16,995,391	[3] 37,905.577	[3] 17,416,368	[3] 57,060,403
1953					
Argentina	997,829	513,504	997,829	513,504	1,768,715
Australia	2,916,826	1,439,039	2,664,441	1,308,072	4,296,066
Belgian Congo	519,086	290,060	519,086	290,060	950,140
Bolivia	6,826,538	3,256,566	6,837,122	3,273,147	12,147,453
Brazil	4,866,344	2,743,501	4,848,282	2,734,663	7,977,914
British East Africa	49,959	27,068	49,959	27,068	85,115
British Malaya	118,882	65,650	107,150	59,602	124,719
Burma	3,561,751	1,722,005	3,057,209	1,639,012	2,989,928
Canada	5,984,099	1,874,996	6,205,550	1,903,034	5,193,213
Egypt	35,835	18,057	25,835	13,487	29,987
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
French Morocco	22,046	11,365	------------	------------	------------
Germany, West	228,697	128,743	228,697	128,743	349,447
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
Mexico	2,648,534	824,735	2,627,911	813,260	1,572,678
Netherlands	35,283	19,911	35,283	19,911	56,596
New Zealand	67,690	36,396	67,690	36,396	92,529
Nigeria	5,040	2,844	------------	------------	------------
Peru	1,508,917	818,040	1,404,064	784,060	2,489,967
Portugal	5,477,561	3,007,744	4,854,443	2,712,669	8,054,917
Southern Rhodesia	353,400	193,202	327,331	178,571	434,809
Spain	5,678,566	3,050,911	5,691,853	3,058,630	10,419,754
Thailand	3,352,737	1,882,604	3,010,431	1,704,271	5,450,355
Union of South Africa	298,878	143,386	100,733	51,903	117,627
United Kingdom	65,000	34,083	65,000	34,083	88,882
Yugoslavia	34,943	17,735	34,943	17,735	47,244
Total	59,709,103	28,993,604	57,320,865	27,923,573	91,049,676

[1] Comprises ores and concentrates received in the United States; part went into consumption during year, and remainder entered bonded warehouses.
[2] Comprises ores and concentrates withdrawn from bonded warehouses during year and receipts during year for consumption.
[3] Revised figure.

TABLE 8.—Ferrotungsten imported for consumption in the United States, 1952–53, by countries
[U. S. Department of Commerce]

Country	1952			1953		
	Gross weight (pounds)	Tungsten content (pounds)	Value	Gross weight (pounds)	Tungsten content (pounds)	Value
Germany, West				6,614	5,040	$16,127
Japan	277,214	211,468	$646,168			
Korea, Republic of	181,230	140,564	91,531			
Netherlands				9,921	8,165	21,061
Portugal	121,253	87,934	383,986	461,716	365,868	1,013,397
Sweden	43,593	33,812	21,939	63,582	53,426	142,111
Taiwan	6,537	4,917	7,375			
United Kingdom				211,917	170,800	493,994
Total	629,827	478,695	1,150,999	753,750	603,299	1,686,690

TECHNOLOGY

During 1953 the following technological developments were significant:

Mining.—The trend toward nonselective mining of low-grade ore continued in 1953. The quantity of ore produced by opencut mining increased during the year, but by far the greatest percentage of tungsten ore produced came from underground workings. Mining methods at the Hamme mine, North Carolina, and the Pine Creek mine, California, were described.[8] At the former flatback square-set stopes were used; stopes were 100 feet along the strike, full vein width, and 200 feet high. During 1953 sets were 5 feet square, with 8-foot posts; unframed timbers were used. The Central and Sneed shafts were being sunk to the 1,500-foot level; the deepest operating level in 1953 was the 700 foot. At the Pine Creek mine a contact-metamorphic deposit was mined, and open stopes, with blasting from sublevel ring drilling, were used. The 1,500-foot raise which serves as a working shaft was nearly completed in 1953; all sublevel stations were cut, and the company expected to complete the hoist station early in 1954.

Milling.—Methods in use at the Getchell, Hamme, Nevada-Massachusetts, and Pine Creek mills were described.[9] Table 9 lists equipment and methods that have been reported in use at a group of the larger tungsten mills. This table indicates that rolls, which were formerly very widely used at tungsten mills, are not in use at any of these large mills; that jaw crushers and flotation for removing sulfides are the only items common to all 6 mills; and that the 4 mills treating scheelite ore all use flotation to recover the scheelite. Several typical flowsheets for tungsten mills were published.[10]

[8] Waldron, Howard L., Hamme Mine Doubles Productive Capacity: Min. World, vol. 15, No. 10, September 1953, pp. 47–50, 67.
Behme, Robert L., United States Vanadium's Tungsten Mine in California: Explosives Eng., vol. 31, No. 2, March–April 1953, pp. 39–44, 58–59.

[9] Kunze, Keith, Milling Tungsten Ores at the Getchell Mine: Min. Cong. Jour., vol. 39, No. 1, January 1953, pp. 31–33, 114.
Waldron, Howard L., and Walters, Lewis J., Tungsten Mining Corporation's Expanded Mill: Min. World, vol 15, No. 12, November 1953, pp. 42–46.
Engineering and Mining Journal, Improved Flowsheet Increases Recovery and Mill Capacity: Vol. 154, No. 1, January 1953, pp. 96–97.
Behme, Robert L., United States Vanadium's Tungsten Mine: Explosives Eng., vol. 31, No. 2, March–April 1953, pp. 58–59.
Mining World, Kennametal Develops Nevada Mine to Assure Adequate Source of Tungsten: Vol. 15, No. 13, December 1953, pp. 54–55, 103.

[10] Gisler, H. J., Tungsten Metallurgy and Flowsheets: Deco Trefoil, vol. 17, No. 5, September–October 1953, pp. 7–18.

TABLE 9.—Milling-methods check list

	Getchell, Nevada	Hamme, North Carolina	Ima, Idaho	Nevada-Massachusetts, Nevada	Pine Creek, California	King Island, Australia
Type of ore deposit:						
Vein		x	x			
Contact	x			x	x	x
Wolframite group		x	x			
Scheelite	x	Some	Some	x	x	x
Crushing equipment:						
Jaw	x	x	x	x	x	x
Gyratory				x		
Cone		x		x	x	
Grinding equipment:						
Rod mill	x	x	x			
Ball mill	x			x	x	x
Rolls		[1]				
Gravity section:						
Jigs		x	x			
Tables		x	x	x	x	x
Other		[2]				[3]
Flotation section:						
Tungsten minerals floated	x		[4]	x	x	x
Gangue minerals floated	[5]	Sulfides	Sulfides	Sulfides	Sulfides	Sulfides
Additional treatment for flotation concentrates:						
Roasted						
Acid-leached	x			x		
Dissolved					x	
Gravity cleaning					x	[3]
Sold for cleaning	Some			Some		
Additional treatment for gravity concentrates:						
Roasted				x		x
Acid leached						
Flotation				x		
Dissolved		[6]			x	
Magnetic separation		x	x	x		x

[1] Rolls were used before 1952.
[2] Denver-Buckman tilting tables.
[3] Vanners.
[4] Flotation of tungsten minerals terminated in 1945.
[5] Sulfides floated from concentrates after first acid leach.
[6] Shipped to other plants for treatment.

Tungsten Carbide.—The manufacture of tungsten carbide consumed more tungsten during 1953 than all other tungsten products combined. The uses of tungsten carbide-tipped tools by the mining industry continued to expand. Rock bits of this type were particularly favored for drilling with equipment designed to allow completion of a drill hole without delays for changing drill steel; this included use in long-hole drilling to replace diamond drills.[11]

Industrial uses of tungsten carbide for mold liners in producing silicon carbide and aluminum oxide grinding wheels, for milling gear cases, for wire production, for rolling metals, and for header dies

[11] Hubbell, A. H., Tungsten Carbide Drilling Takes the Lead: Eng. and Min. Jour., vol. 154, No. 2, February 1953, pp. 111–116.
Dobbrodt, A. F., An Understanding of Cemented Tungsten Carbides and Their Applications in Mining: Mines Mag., vol. 43, No. 7, July 1953, pp. 13–14, 30.
Flournoy, E., Blast-Hole Drilling at the Tennessee Copper Co.: Min. Cong. Jour., vol. 39, No. 4, April 1953, pp. 78–80.

were described.[12] Methods for production of tungsten carbide shell cores for armor-piercing projectiles were published; this is one of the important defense requirements for tungsten.[13] Characteristics of tungsten carbide were described by Dobbrodt and by Beardslee.[14]

Welding.—Tungsten is consumed by the welding trade as a component of the following: (1) Hard facing alloys applied by welding, (2) electrodes used in resistance welding, and (3) electrodes used in inert-gas-shielded arc welding. Procedures have been developed for coating metals with tungsten carbide; both gas and electric units are used. Tungsten carbide coatings include massive carbide, carbide fragments in a steel matrix, and very thin carbide flakes. Publications that refer to the use of tungsten in welding during 1951–53 are of special interest.[15]

WORLD REVIEW

Argentina.—Construction of a 500-ton concentrator at the Los Condores mine was begun.

Australia.—King Island Scheelite, Ltd., mined 220,000 tons of ore averaging 0.505 percent WO_3 during the year ended October 31; 1,279 tons of scheelite concentrates was recovered. Ore reserves of the mine, on King Island in Bass Strait, were estimated to be 3,242,000 tons averaging 0.48 percent WO_3. The mine and mill were described.[16] In northeastern Tasmania near Rossarden, Aberfoyle Tin, N. L., produced tin and tungsten; the latter was reported sold to the British Government under a contract terminating in November 1955.[17]

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[12] Materials and Methods, Tungsten Carbide Mold Liners: Vol. 38, No. 4, October 1953, p. 132.
Iron Age, Tungsten Carbide Insert Blades Speed Milling of Gear Cases: Vol. 171, No. 14, Apr. 2, 1953, pp. 187–188.
Iron Age, Knowles Loom Rolls Stainless Steel Wire for Loom Reeds: Vol. 171, No. 15, Apr. 9, 1953, p. 154.
Steel, Carbide Rolls Save: Vol. 132, No. 25, June 22, 1953, pp. 95–96.
Iron Age, Header Dies; Standardized Carbide Nibs Cut Costs, Improve Production: Vol. 171, No. 24, June 11, 1953, pp. 134–135.

[13] Steel, Carbide-Shell Core Production Mechanized: Vol. 132, No. 8, Feb. 23, 1953, p. 92.
Altholz, E., Tungsten Carbide Shell Cores: Machinery, vol. 59, No. 4, April 1953, pp. 159–164.

[14] Beardslee, K. R., Carboloy Cemented Carbide, Hardest Man-Made Metal: Gen. Elec. Rev., vol. 56, No. 5, May 1953, pp. 51–55.
Dobbrodt, A. F., An Understanding of Cemented Tungsten Carbides and Their Applications in Mining: Mines Mag., vol. 43, No. 7, July 1953, p. 30.

[15] Engineering and Mining Journal, Tungsten Carbide Welding Rods: Vol. 152, No. 12, December 1951, p. 123.
King, F. E., Thin, Ductile Carbide Coatings Possible With New Method: Materials and Methods, vol. 36, No. 4, October 1952, pp. 112–114.
Huff, H. A., Jr., 3 Ways to Boost Aluminum-Welding Production: Iron Age, vol. 171, No. 23, June 4, 1953 pp. 146–147.
American Metal Market, Sylvania Develops New Tungsten-Zirconium Alloy Welding Rod: Vol. 60, No. 27, Feb. 7, 1953, p. 1.
Barry, J. J., Carbide Hardfacing by New Inert-Gas-Arc Method: Materials and Methods, vol. 37, No. 7, January 1953, pp. 80–81.
Breslin, A. J., and Harris, W. B., Use of Thoriated Tungsten Electrodes in Inert Gas-Shielded Arc Welding—Investigation of Potential Hazard: Am. Ind. Hygiene Assoc. Quarterly, vol. 13, No. 12, December 1952, pp. 191–195; Nat. Safety News, Abs., vol. 67, No. 4, April 1953, pp. 94–98.
Rose, A. S., and Braun, M. A., Fusion-Welding Techniques for Jet Aircraft Components: Welding Jour., vol. 31, No. 12, December 1952, pp. 1121–1128.
Koopman, K. A., Shielding Arc-Welding Process for Jet-Engine Components: Welding Jour., vol. 32, No. 2, February 1953, pp. 103–115.
Chyle, J. J., and Kutuchief, I., Practical Aspects of Welding Titanium Alloys: Welding Jour., vol. 32, No. 2, February 1953, pp. 65S–72S.
Wooding, W. H., The Inert-Gas-Shielded Metal-Arc Welding Process: Welding Jour., vol. 32, Nos. 4 and 5, April 1953, pp. 299–312; and May 1953, pp. 407–423.

[16] Mining World, Tungsten From "Down Under": Vol. 15, No. 1, January 1953, pp. 34–37.

[17] Mining Magazine (London,) Wolfram Mining: Vol. 88, No. 4, April 1953, p. 229.

TABLE 10.—World production of tungsten ores, by countries, in metric tons,[1] of concentrates containing 60 percent WO_3, 1944–48 (average) and 1949–53

[Compiled by Pauline Roberts and Berenice B. Mitchell]

Country	1944–48 (average)	1949	1950	1951	1952	1953
North America:						
Canada	296	191	215	2	1,128	1,803
Mexico	132	65	67	325	443	682
United States (shipments)	5,105	2,508	4,373	5,693	6,905	8,713
Total North America	5,533	2,764	4,655	6,020	8,476	11,198
South America:						
Argentina	727	[2] 30	[2] 20	100	600	600
Bolivia (exports)	3,805	2,543	2,485	2,718	3,707	3,825
Brazil (exports)	1,702	575	759	1,422	1,784	1,947
Peru	520	455	516	469	584	733
Total South America	6,754	[2] 3,600	[2] 3,780	4,709	6,675	7,105
Europe:						
Finland	[3] 4	49	20	8	47	22
France	306	792	456	765	946	[2] 1,000
Italy	7	3	2	5	5	5
Norway	2	----	----	----	----	----
Portugal	2,162	2,700	2,500	5,148	5,283	5,070
Spain	889	888	850	2,553	5,479	2,950
Sweden	375	468	362	383	337	[2] 350
U. S. S. R.[2]	2,460	6,000	7,500	7,500	7,500	7,500
United Kingdom	143	81	76	61	55	61
Yugoslavia	----	----	----	----	----	120
Total Europe (estimate)	6,354	11,000	11,800	16,400	19,700	[2] 17,000
Asia:						
Burma	843	740	930	1,647	2,200	2,000
China[2]	5,640	9,000	12,000	15,800	20,000	20,000
Hong Kong	----	----	----	23	104	160
India	12	----	2	15	10	[2] 10
Indochina	18	----	----	----	----	----
Japan	171	20	24	166	482	743
Korea:						
Korea, Republic of	3,108 (both Koreas)	1,448	2,000	1,269	3,500	6,800
North Korea		1,000	[2] 1,000	[2] 1,200	[2] 1,200	[2] 1,500
Malaya, Federation of	79	69	27	54	79	147
Thailand	[2] 700	[2] 1,100	[2] 1,200	[2] 1,350	[2] 1,600	1,890
Total Asia (estimate)	10,580	13,400	17,000	21,500	29,000	33,200
Africa:						
Algeria	----	----	----	22	49	30
Belgian Congo[4]	437	355	400	653	1,010	1,273
Egypt	6	----	----	7	21	14
French Morocco	1	----	7	38	18	12
Nigeria	10	5	5	23	23	18
Southern Rhodesia	241	26	64	231	420	380
South-West Africa	29	6	4	33	118	150
Tanganyika (exports)	[3] 1	42	15	15	14	12
Uganda (exports)	109	180	218	167	151	179
Union of South Africa	300	416	96	188	263	386
Total Africa	1,134	1,030	809	1,377	2,087	2,454
Oceania:						
Australia	1,074	1,371	1,235	1,883	2,171	2,300
New Zealand	56	28	24	35	63	[2] 40
Total Oceania	1,130	1,399	1,259	1,918	2,234	[2] 2,340
Grand total (estimate)	31,500	33,200	39,300	52,000	68,000	73,000

1 This table incorporates a number of revisions of data published in previous Tungsten chapters.
2 Estimate.
3 Average for 1 year only, as 1948 was first year of production.
4 Including Ruanda-Urundi.

Bolivia.—The Bolivian Government announced a method for indemnification of the former owners of nationalized tungsten mines. The agreement calls for payment of $10 to the former owners and a like sum to the Export-Import Bank for each short-ton unit of WO_3 sold to the United States Government.[18] The Bank had advanced funds for expanding the capacity of Bolivian tungsten mines. During the first year of nationalized operation, production of tungsten concentrates increased 118 metric tons.

Burma.—The Mawchi mine, long the source of much of the tungsten output of Burma, was retaken from insurgents. Equipment was reported undamaged.[19]

Canada.—The Department of Mines and Technical Surveys, Ottawa, reported the following preliminary data for 1953:

Item:	*Short tons*
Production (shipments), WO_3	1, 192
Imports, gross weight, scheelite	127
Imports, gross weight, ferrotungsten	31
Exports, scheelite, W content	850
Consumption: Scheelite	27
Ferrotungsten	40
Metal carbide, and sodium tungstate	63

Production from the Salmo, B. C., Emerald mine of Canadian Exploration, Ltd., during the year ended August 31, 1953, was reported to be 82,944 short-ton units of WO_3 of which 51,558 was in the form of a 52.03-percent WO_3 table concentrate and 31,356 in a 26.76-percent WO_3 flotation concentrate.[20] Output of the Red Rose mine near Hazelton, B. C., operated by Western Tungsten Copper Mines, Ltd., was listed as 24,417 units of WO_3 obtained from 37,283 tons of ore. A plant designed to produce tungsten carbide and tungsten powder was placed in operation by Kennametal, Inc., at Port Coquitlam, B. C.

China.—No official information on production is available, but it seems probable that the output is set to match Russia's requirements. China, formerly the leading supplier of United States imports, has the largest known reserves of tungsten ore.

France.—A review of French tungsten production was published.[21] Tungsten shipments from France to the United States in 1953 contained 753,472 pounds of tungsten; no shipments were received during 1952.

Korea, Republic of.—An alltime high in production of tungsten was established. The contract of the Utah Construction Co. with the Republic of Korea to provide technical and management personnel was a factor. The two most important tungsten mines are the Sangdong and Dalsung. Tungsten is also produced in North Korea, but no reliable data are available.[22]

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[18] Wall Street Journal, Bolivia, Mine Owners, U. S. Reach Agreement on Wolfram Purchases: Vol. 161, No. 103, May 4, 1953, p. 3.

[19] American Metal Market, vol. 60, No. 229, Nov. 28, 1953, p. 3.

[20] A statement issued by the company reported ore reserves at the Emerald mine to be, as of July 31, 1953: Probable ore, 186,000 tons averaging 1.03 percent WO_3 and prospective ore, 329,000 tons averaging 0.78 percent.

[21] Mining World, vol. 15, No. 13, December 1953, pp. 48–49.

[22] Stroupe, R. M., Korea; How to Dig Out of Rubble: Min. World, vol. 15, No. 2, February 1953, p. 25; Iron Age, vol. 172, No. 14, Oct. 1, 1953, pp. 48–49.

Portugal.—Portugal was again the leading tungsten producer in western Europe, but 1953 output of concentrates was 213 metric tons less than in 1952. A downward adjustment was made in the export tax to compensate in part for the decline in tungsten prices. Much of the 1953 production was from firms having long-term contracts at favorable prices.

Spain.—Output declined 46 percent from the 1952 record. This substantial change indicates the effect of the declining world price in an area where few long-term contracts were in force.

Thailand.—Mining methods at the Pilok mines in Konburi were reported to be placer-type opencuts, with both hydraulic and hand methods in use.[23] A dispute over the origin of certain tungsten concentrates led to suspension of purchase contracts covering tungsten from Thailand by Emergency Procurement Service.[24]

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[23] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 4, April 1953, pp. 23–24.
[24] American Metal Market, vol. 60, No. 232, Dec. 3, 1953, pp. 1, 3.

Uranium, Radium, and Thorium

By John E. Crawford [1]

ACCOMPLISHMENTS in the United States atomic energy program were manifold in 1953. There were indications of increased interest in uranium prospecting; greater supplies of raw materials were made available; expansion of feed and fissionable materials production centers was realized; more powerful and diversified nuclear weapons were tested; and the potentiality of the nuclear reactor as a source of industrial power became more evident.

The first shipment of uranium ore was made from the Utex mine in San Juan County, Utah, early in 1953. Other promising uranium deposits were located on the Colorado Plateau and elsewhere in the West. Imports of foreign uranium ores and concentrates met expectations. Nine ore-processing plants prepared uranium concentrates from material mined.

The Atomic Energy Commission's feed-materials center at Fernald, Ohio, for production of uranium metal and uranium hexafluoride from uranium-ore concentrates, was put into operation during 1953 by the National Lead Co., and expansion of this facility was begun soon after its completion. The Mallinckrodt Chemical Works, St. Louis, Mo., also operated a refinery for the Commission in 1953.

Expansion of fissionable materials production centers at Hanford, Wash., and Oak Ridge, Tenn., continued; and construction of fissionable materials plants near Aiken, S. C., and Paducah, Ky., and in Pike County, Ohio, showed progress during 1953.

Successful nuclear weapons tests and associated studies were conducted by the Atomic Energy Commission at the Nevada proving grounds in the spring of 1953. The Civil Defense Administration and other Government agencies participated.

The potentialities of the nuclear reactor as a source of industrial power received much attention. Four study groups authorized by the AEC reported their findings with regard to the feasibility of certain types of nuclear reactors for power-generation purposes. Other countries in the Free World indicated a desire to develop uranium resources and construct experimental research reactors.

A private organization to foster and encourage peaceful uses of atomic energy was founded in April 1953. Called the Atomic Industrial Forum, Inc., its board of directors includes many prominent industrialists and educators. Headquarters are in New York City.

Industrial and medical applications of radioisotopes increased. Greater exports of radioisotopes were made in 1953 than ever before. Radioactive isotopes, such as cobalt–60, gold–198, and iodine–131, were in competition with radium in some medical therapy treatments; and cobalt–60, strontium–90, and other radioisotopes proved to be

[1] Commodity-industry analyst

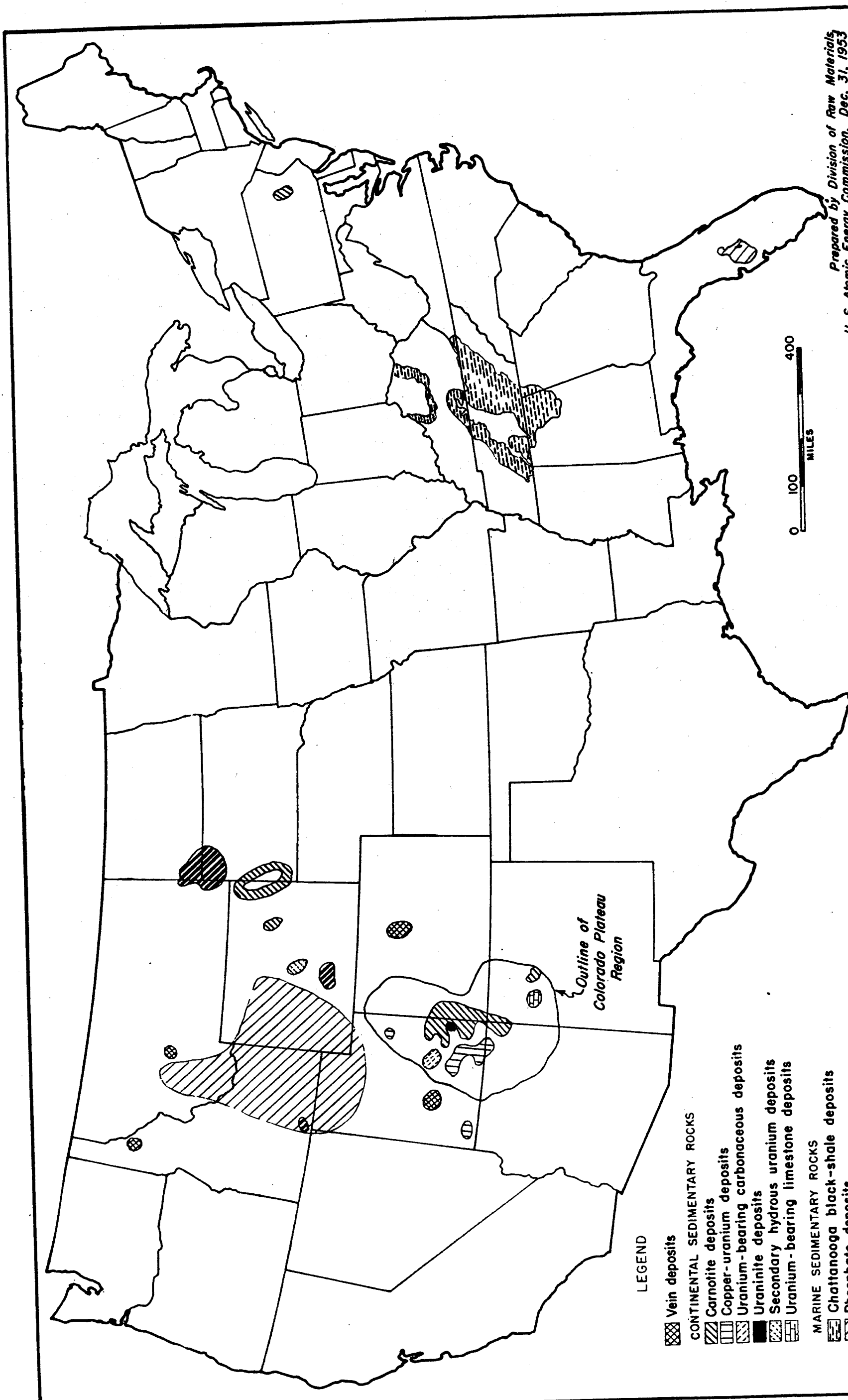

FIGURE 1.—Uranium occurrences in the United States, 1953.

aggressive competitors with radium in industrial fields, such as radiography and luminous markings.

Bureau of Mines engineers were active in exploring for domestic commercial thorium-bearing deposits in 1953. The Lindsay Chemical Co. was in the process of greatly expanding its facilities for producing thorium compounds from monazite. Announcement of the "breeding" of fissionable material in the experimental breeder reactor at Arco, Idaho, gave new life to the hope that thorium may soon be utilized as a source of fissionable uranium–233 on a practicable basis. The new use of thorium as an additive to magnesium alloys to improve qualities of the alloy at ambient and elevated temperatures consumed significant quantities of thorium in 1953.

GOVERNMENT PROGRAMS UNDER THE DEFENSE PRODUCTION ACT OF 1950

Provisions of the Defense Production Act of 1950 with respect to exploration were carried out by the Defense Minerals Exploration Administration (DMEA), and those with respect to procurement by the Defense Materials Procurement Agency (DMPA).

The domestic uranium industry received additional assistance in various forms from Government agencies in 1953. The AEC paid a total of $1,637,698 during the year to uranium miners as a bonus for initial production of uranium, in accord with its Domestic Uranium Program Circular 6, Bonus for Initial Production of Uranium Ores From Domestic Mines (see Uranium, Radium, and Thorium chapter, Minerals Yearbook, 1951); the amount paid compares with a total of $902,551 paid in 1952. Uranium contracts for exploration-project assistance executed by Defense Minerals Exploration Administration in 1953 totaled $537,081 in contract value with $483,373 or 90 percent thereof representing Government participation; these amounts compare with a total contract value of $613,970 and $552,573 or 90 percent thereof in 1952. The exploration contracts executed by DMEA through December 31, 1953, are listed in table 1.

A total of $487,500 was certified for accelerated amortization by the Office of Defense Mobilization in 1953 in connection with facilities for processing uranium ore; the amount compares with $4,119,284 certified for accelerated amortization by the Defense Production Administration in 1952 in connection with the mining of uranium ore and facilities for processing such ore. The certificates of necessity certified by DPA and ODM through December 31, 1953, are listed in table 2.

In 1953 the Bureau of Public Roads completed 497 miles of defense access roads serving uranium mines and was constructing 274 additional miles of such roads; these mileages compare with 160 miles completed and 543 miles under construction in 1952, the year that construction began under the defense program. Detailed statistics of road construction in 1953 and accumulative totals for 1952 and 1953 are presented in table 3.

TABLE 1.—Defense Minerals Exploration Administration contracts involving uranium, by States, through December 31, 1953

Name of contractor	County	Date of contract	Government participation
CALIFORNIA			
Uranium Mines, Inc	Kern	Aug. 11, 1953	$15,867.00
COLORADO			
American Mining Co	Gilpin	Mar. 24, 1953	17,100.00
Anaconda Lead & Silver Co	Eagle	Sept. 15, 1952	9,000.00
Cherokee Mines	Larimer	July 16, 1951	21,600.00
H. C. Gamblin & J. M. Knowles	San Miguel	Oct. 21, 1953	1,159.65
Gateway Mining & Development Co	Mesa	Sept. 26, 1952	46,772.10
Gold Bar Mines, Inc	Clear Creek	Feb. 4, 1953	6,984.00
W. E. Grippe	San Miguel	July 14, 1953	9,225.00
Mack Mining Co	do	May 27, 1953	11,182.50
Moreno-Cripple Creek Corp	Jefferson	May 21, 1952	56,475.00
C. L. Neilson	San Miguel	Oct. 30, 1953	11,362.50
The Realty Co	Gilpin	Oct. 9, 1951	72,000.00
Fred Schwartzwalder	Jefferson	Sept. 2, 1953	20,700.00
J. R. Simplot Co	Montrose	Sept. 8, 1953	50,869.80
Uranium Co. of America	Gilpin	Feb. 25, 1952	22,500.00
Uranium Development Corp	Montrose	Nov. 24, 1952	19,570.00
W. L. Weaver	Garfield	Feb. 12, 1953	1,800.00
Robert Williams	San Miguel	Aug. 27, 1953	22,738.00
MONTANA			
David Nieminen et al	Jefferson	Apr. 17, 1952	13,599.00
Elkhorn Mining Co	do	Aug. 16, 1951	23,125.50
Do	do	Aug. 22, 1951	11,520.00
D. A. McNabb	do	Jan. 16, 1952	20,616.30
NEVADA			
Nevada Uranium Co	Pershing	Dec. 18, 1952	8,230.50
NEW MEXICO			
Black Hawk Consolidated Mines Co	Grant	Apr. 11, 1952	18,000.00
SOUTH DAKOTA			
Mining Research Corp	Fall River	May 14, 1953	47,585.70
C. G. Ortmayer et al	do	May 7, 1953	35,050.50
Oxide Metals Corp	do	Aug. 10, 1953	7,272.00
Urova Co	Custer	Sept. 21, 1953	8,802.00
C. E. Weir	do	June 23, 1953	9,933.30
UTAH			
Beaver Uranium Co	Beaver	Aug. 19, 1953	29,880.00
Boomerang Mining Co	Grand	Nov. 4, 1952	21,705.84
Bullion Monarch Mining Co	Piute	June 23, 1952	24,957.00
Calvin Black et al	San Juan	Dec. 15, 1953	6,480.00
Canary Mining Co	Daggett	Dec. 5, 1951	24,052.50
Abe Day	San Juan	Mar. 17, 1952	9,810.00
J. Walter Duncan, Jr	do	Mar. 4, 1952	38,871.00
Ellihill Mining Co	do	Sept. 4, 1952	17,145.00
Excaliber Uranium Corp	Emery	Jan. 24, 1952	53,363.70
Do	Grand and Emery	Feb. 17, 1953	34,410.00
Gerald Gidwitz	Beaver	Aug. 19, 1953	29,880.00
Glenn Mining Co	Piute	Oct. 15, 1952	29,139.30
R. A. Glenny et al	do	Aug. 19, 1952	22,050.00
Gramlich Minerals, Inc	Emery	Aug. 6, 1953	31,770.00
Kay and Andrew Hunt	do	Apr. 9, 1953	6,631.20
Mineral Uranium Corp	Grand	Aug. 25, 1953	1,215.00
Moreno-Cripple Creek Corp	San Juan	Oct. 29, 1952	19,260.00
Frank and Erma Morgan	Emery	Mar. 23, 1953	2,106.00
Plateau Mining Co	San Juan	Oct. 23, 1951	17,049.60
Red Canyon Mines	do	Nov. 16, 1953	21,600.00
Salina Mining & Smelting Co	Kane	Sept. 10, 1952	15,255.45
Jess and Grant Shumway	San Juan	Feb. 6, 1953	4,050.00
J. R. Simplot	Wayne and Garfield	Dec. 13, 1951	64,340.48
Sunnyside Uranium Co	Piute	Sept. 8, 1952	39,114.00
Thornburg Mining Co	Grand	Nov. 13, 1953	37,719.00
White Canyon Mining Co	San Juan	Feb. 19, 1952	47,138.40
Total			1,269,633.82

TABLE 2.—Certificates of necessity, involving uranium, certified by Defense Production Administration (1951–52) and Office of Defense Mobilization (1953) for assistance through tax amortization, by States, through December 31, 1953

Company	Type of project	Date certified	Percentage of depreciable assets certified	Amount allowed for accelerated amortization
COLORADO				
Climax Uranium Co	Ore-processing facilities	Apr. 16, 1951	90	$817,374.74
Do	Mine buildings and equipment.	May 1, 1951	90	156,329.12
Do	Ore-processing facilities	Nov. 7, 1952	80	226,602.34
Do	Mine buildings and equipment; ore-processing facilities.	Nov. 26, 1952	80	17,698.50
FLORIDA				
Armour & Co	Processing building	Oct. 21, 1953	50	37,500.00
ILLINOIS				
Blockson Chemical Co	Processing equipment	Jan. 13, 1953	75	450,000.00
NEW MEXICO				
Anaconda Copper Mining Co	Ore processing facilities	Jan. , 1952	90	3,197,610.00
UTAH				
Vitro Chemical Co	do	June 5, 1952	80	677,373.32
Total				5,580,488.02

TABLE 3.—Construction in 1953 of defense access roads serving uranium mines and cumulative total for 1952–53

[Bureau of Public Roads]

State	Total work involved			Projects completed			Work accomplished on uncompleted projects		
	Total estimated cost	Access funds	Miles	Total estimated cost	Access funds	Miles	Total estimated cost [1]	Access funds [1]	Miles under contract
Arizona	$513,500	$513,500	90.0	$180,000	$180,000	8.0	$152,085	$152,085	82.0
Colorado	3,137,080	2,787,603	243.8	1,100,965	1,100,695	211.2	398,061	179,682	32.6
New Mexico	159,000	159,000	26.0				4,770	4,770	26.0
South Dakota	110,000	110,000	24.4				108,900	108,900	24.4
Utah	2,069,143	1,920,776	385.9	667,699	624,646	277.3	559,968	519,491	108.6
Total	[2] 5,988,723	[2] 5,490,879	770.1	1,948,664	1,905,341	496.5	1,223,784	964,928	273.6
Cumulative total, 1952–53	[3] 6,360,065	[3] 5,862,221	929.8	2,320,006	2,276,683	656.2	1,223,784	964,928	273.6

[1] Funds based on percentage of work completed.
[3] Difference available from State and county funds.

DOMESTIC PRODUCTION

URANIUM

Raw Materials Program.—Production of domestic uraniferous ores and concentrates under the AEC's Raw Materials Program continued to increase in 1953. Expansion was noted in the uranium-mining industry, and exploration for radio-active materials was unabated during the year.

Ore was produced from more than 525 mines, mostly in the Colorado Plateau area. Some uranium was also recovered in South Dakota, Wyoming, the Colorado Front Range, and the Boulder Batholith area near Boulder, Mont.[2] The first ore shipment from the much publicized Mi Vida claim of Charles A. Steen was made early in 1953, and by December 1953 Utex Exploration Co., the operating company in which Steen holds controlling interest, had shipped over $2,400,000 worth of ore to AEC buying stations. The Mi Vida mine is in the Big Indian Wash district of San Juan County, Utah.[3] The two principal uranium-ore minerals in the Mi Vida mine are the yellow tyuyamunite and soft gray to black, altered uraninite. Owing to the substantial width and thickness of the ore deposit a modified room-and-pillar method of mining was utilized. Little waste has been produced because, except for material from the inclined entry, all mining has been in ore. Thickness of the ore varied from 10 to 23 feet, while drift headings measured about 12 feet in height. No rooms or stopes were started in 1953; all work was still in the development stage. The G & G Mining Co., lessees, recovered ore on part of the Steen property, operated in conjunction with the Utex Exploration Co. Ore shipments by the lessee were about 41 percent of the total shipments from the Mi Vida mine.[4]

In New Mexico the Anaconda Copper Mining Co. outlined a large ore body at the Jackpile mine on the Laguna Indian Reservation west of Albuquerque. The deposit will be mined by open-pit methods.[5] The Santa Fe Railroad and about 20 to 25 other small operators were producing uranium ores from the Grants area of New Mexico.[6]

The Freedom and Prospector mines of the Vanadium Corp. of America yielded most of the uranium ore recovered from the primary vein-type deposits of the Marysvale, Utah, area.[7]

Uranium ore was mined in the vicinity of Pumpkin Buttes, west-central part of the Powder River Basin, Wyo., during 1953. One ore body in the area was mined out, and the ore was shipped to the AEC buying station at Edgemont, S. Dak. The Homestake Mining Co. began to mine carnotite-bearing sandstone near Carlile, Crook County, Wyo., in January 1953. The uranium ore that Homestake Mining Co. recovered was trucked to the AEC buying station at Edgemont, S. Dak. Although there were other uranium occurrences in Wyoming, none were worked for uranium in 1953.[8]

The Kerr-McGee Oil Industries, Inc., of Oklahoma City, Okla., was reported to have planned a major program of exploration and development in northeastern Wyoming. The company conducted an airborne radioactivity reconnaissance and did core drilling in the Pumpkin Buttes area of Wyoming during 1953.

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2 Atomic Energy Commission, Fifteenth Semiannual Report: January 1954, p. 3.
3 Waylett, William J., Uranium: Min. World, Apr. 15, 1954, pp. 47–48.
4 Steen, C. A., Dix, G. P., Jr., Hazen, S. W., Jr., and McLellan, R. R., Uranium-Mining Operations of the Utex Exploration Co. in the Big Indian District, San Juan County, Utah: Bureau of Mines Inf. Circ. 7669, 1953, 13 pp.
Bilyou, Virgil, Mining and Handling Ore in a Large Uranium Operation: Address before meeting of the Colorado Min. Assoc., Denver, Colo., Jan. 29, 1954.
Steen, C. A., Uranium Bonanza: Address before Special Subcommittee on Minerals, Materials, and Fuels Economics, in Salt Lake City, Utah, Nov. 12–13, 1953.
5 Work cited in footnote 3.
6 Mining Record, vol. 64, No. 50, Dec. 10, 1953, pp. 1–2.
7 Work cited in footnote 3.
8 Thomas, H. D., Uranium in Wyoming: Address before meeting of Colorado Min. Assoc., Denver, Colo., Jan. 28, 1954.

Airborne radiometric survey techniques found greater use in 1953. The AEC, the Geological Survey, and industrial concerns such as Kerr-McGee Oil Industries, Inc., Hunt Oil Co., Jenkins & Hand, and Anaconda Copper Mining Co. have made successful airborne radioactivity surveys.[9] Airborne radioactivity surveys were made of the Mauch Chunk, Pa., area by Safair Flying Services, Inc., Teterboro, N. J. The Safair Co. carried out the work under contract with the AEC.[10] The Federal Geological Survey announced in June the results of airborne radioactivity surveys in the Pumpkin Buttes and Devils Tower regions of Wyoming.[11]

New developments in exploration and mining methods on the Colorado Plateau include the use of 36-inch-diameter calyx drill holes for mine shafts and improvement in long-hole wagon drilling. Miners are utilizing crawler tractors, small diesel shuttle cars, small diesel locomotives, and other more conventional mining equipment in underground operations.[12] A comprehensive report on drilling methods and costs on the Colorado Plateau was published in 1953.[13]

An act of Congress (Public Law 250, 83d Cong.), approved August 12, 1953, validated mining claims located between July 31, 1939, and January 1, 1953, on United States lands under Government oil and gas leases, provided the owner of any such mining claim, not later than December 10, 1953, submitted an amended notice of location of claim to the Land Office where the original claim was filed. Passage of the law will materially aid the exploration for uranium in the western United States where prospectors have been unable to obtain title to lands previously leased for oil and gas rights.[14]

During 1953 the Bureau of Mines conducted for the AEC an exploration drilling program of the low-grade uraniferous Chattanooga shale to determine the distribution of uranium in the shale members. On January 30, 1953, it was announced that the Bureau of Mines would open a small mine in the Chattanooga shale to develop satisfactory methods for full-scale mining of the material. Shale process studies were concurrently being carried out at Columbia University, Battelle Memorial Institute, and the Oil Shale Experimental Plant of the Bureau of Mines, Rifle, Colo.[15]

The AEC continued to investigate the feasibility of extracting uranium, phosphate, and alumina from "leached-zone" material of the Florida land-pebble-phosphate field. Principal research contractors of the AEC in this program are International Minerals & Chemical Corp. and the Tennessee Valley Authority.[16]

Ore-processing capacity was expanded to treat the ever-increasing quantities of ore being mined. The new Anaconda Copper Mining Co. processing plant at Bluewater near Grants, N. Mex., was com-

[9] Work cited in footnote 3.
[10] Atomic Energy Newsletter, vol. 8, No. 12, Jan. 27, 1953.
Mining World, vol. 15, No. 8, July 1953, p. 108.
[11] Geological Survey, Airborne Radioactivity Survey in the Devils Tower Region, Wyo.: U. S. Dept. of the Interior Press release, June 1, 1953. Airborne Radioactivity Survey in the Pumpkin Buttes Region, Wyo.: U. S. Dept. of the Interior Press release, June 10, 1953.
[12] Roberts, G. E., The Colorado Plateau Area: Min. Eng., vol. 6, No. 2, February 1954, p. 157.
[13] Ross, A. E., Drilling in the Colorado Plateau: Address before 5th Ann. Symposium sponsored by the University of Minnesota Center for Continuation Study, Minneapolis, Minn., Oct 14, 15, 1954.
[14] Mining Record, vol. 64, No. 35, Aug. 27, 1953, p. 1.
Defense Minerals Exploration Administration, Mining Claims Staked on Lands Under Government Oil and Gas Leases: Memorandum 22, Sept. 14, 1953, 1 p.
[15] Atomic Energy Commission, Major Activities in the Atomic Energy Programs: January–June 1953, p. 8.
[16] Work cited in footnote 2, p. 7.

pleted in September. With completion of the Anaconda plant there were nine facilities in the United States for treating uranium ores. The Western Machinery Co. of San Francisco announced early in 1953 that it will design, construct, and equip a processing mill for the Kerr-McGee Oil Industries, Inc., at Shiprock, N. Mex. The plant was scheduled for completion by December 1954.[17] It will treat uranium ores produced in the Lukachukai Mountain area of northeastern Arizona and other areas on the Navajo Indian Reservation, as well as ore stockpiled at the Shiprock ore-buying station for about 2 years. The capacity of the Vanadium Corp. of America mills at Naturita and Durango, Colo., was enlarged, as were the facilities of the Climax Uranium Co. at Grand Junction, Colo. The AEC is planning to expand the present Government-owned Monticello mill at Monticello, Utah; this mill is operated for the Commission by the Galligher Co. of Salt Lake City. Construction of additional plants is being considered by industry.[18]

A unit for recovering low-grade uranium from Florida phosphate rock was completed in October by Texas City Chemicals, Inc., at Texas City, Tex. Uranium concentrates will be recovered as a byproduct of an operation producing an animal feed-grade dicalcium phosphate and dicalcium phosphate fertilizer material. International Minerals & Chemical Corp. and Virginia-Carolina Chemical Corp. are constructing similar recovery units at their plants in Bartow and Nichols, Fla., respectively. The Blockson Chemical Co. at Joliet, Ill., has been recovering uranium from Florida phosphate rock as a byproduct of its phosphate chemical operations since September 1952.[19]

The AEC opened a new laboratory in Winchester, Mass., for developing and improving processes for recovering uranium from its ores. The American Cyanamid Co. was selected to operate the laboratory under contract with the AEC.[20] Methods for processing uranium ores were described at conventions during the year.[21]

Feed-Materials Program.—The AEC's Feed-Materials Program, which consists of the refining of uranium ores and concentrates, proceeded during 1953 with an expansion of uranium concentrate refining capacity. The $78 million refining plant at Fernald, Ohio, was completed midway in the year and put into operation for the AEC by the National Lead Co. of Ohio.[22] The Fernald plant includes a uranium rolling mill, the first and only one in the United States designed specifically for producing uranium bars. It was built by

17 Mining Congress Journal, vol. 39, No. 12, December 1953, p. 83.
18 Work cited in footnote 2, p. 4 and footnote 3.
Engineering and Mining Journal, vol. 155, No. 1, January 1954, p. 138.
Western Industry, vol. 15, No. 12, December 1953, p. 102.
Nucleonics, vol. 12, No. 2, February 1954, p. 76.
Mining Engineering, vol. 5, No. 10, October 1953, p. 965.
19 Skillings Mining Review, vol. 42, No. 46, Feb. 20, 1954, p. 22.
Mining Engineering, vol. 6, No. 2, February 1954, p. 191.
Chemical Engineering, vol. 60, No. 12, December 1953, pp. 106, 110.
Barr, J. A., Jr., Remarks for Delivery Before the Phosphate Fertilizers Industry Advisory Committee, National Production Authority: Atomic Energy Commission, Sept. 29, 1953.
Work cited in footnote 2, p. 7.
20 Mining World, vol. 15, No. 7, June 1953, p. 88.
Nucleonics, vol. 11, No. 7, July 1953, p. 70.
Industrial and Mining Standard, vol. 108, No. 2750, Sept. 17, 1953, p. 5.
21 Kentro, D. M., Uranium Ore Processing: Address before meeting of Colorado Min. Assoc., Denver, Colo., Jan. 29, 1954.
Swanson, S. J., Methods of Processing Uranium Ores: Address before Am. Min. Cong., Seattle, Wash., Sept. 21–24, 1953.
22 Chemical Engineering, vol. 60, No. 7, July 1953, pp. 101–102.
Chemical and Engineering News, vol. 31, No. 23, June 8, 1953, p. 2404.

Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.[23] The Mallinckrodt Chemical Works operated a refinery for the Commission at St. Louis, Mo. The two feed-materials refineries produced uranium hexafluoride (UF_6) and uranium metal, which was transported to fissionable materials production centers for manufacture of uranium-235 or plutonium.[24]

Fissionable Materials Program.—The production of uranium-235 continued satisfactorily at the Oak Ridge, Tenn., fissionable materials center operated by Carbide & Carbon Chemicals Co., a division of Union Carbide & Carbon Corp. The installation, which was initially constructed at a cost of about $500 million, had undergone a $200 million expansion after World War II, and a second major expansion program now underway will cost an estimated $464 million. The Union Carbide & Carbon Corp. contract with the AEC was modified in 1953 to include more operational responsibilities at facilities already under its management.[25]

Construction of one $500 million unit of the uranium-235 production center at Paducah, Ky., was completed and the unit put into operation early in 1953. A second $458 million unit is under construction and probably will be completed late in 1954.[26]

A third uranium-235 production plant is being constructed in Pike County, Ohio. The plant will cost an estimated $1.2 billion and will be operated by Goodyear Atomic Corp., a subsidiary of the Goodyear Tire & Rubber Co., Inc.[27]

The American Cyanamid Co. began operating a facility for processing used reactor-fuel elements to recover fissionable material at the AEC's National Reactor Testing Station, Arco, Idaho. The plant cost about $34 million to construct.[28]

RADIUM

Refinery Production.—The Canadian Radium & Uranium Corp., New York, N. Y., was the sole domestic producer of radium in 1953. The Canadian Radium & Uranium Corp. refinery is at Mount Kisco, N. Y. Distributors of radium and radium compounds produced elsewhere are Radium Chemical Co., Inc., New York, N. Y., sales agent for the Union Minière du Haut Katanga, and United States Radium Corp., New York, N. Y.

A faster, more efficient method of extracting radium from radium-barium solutions was announced. The process, known as the precipitation from a homogeneous solution procedure, was developed at the

[23] American Metal Market, vol. 60, No. 93, May 15, 1953, p. 1.
E&MJ Metal and Mineral Markets, vol. 24, No. 21, May 21, 1953, p. 7.
Materials and Methods, vol. 38, No. 2, August 1953, p. 164.
Iron Age, vol. 171, No. 22, May 28, 1953, p. 138.
[24] American Society of Mechanical Engineers, Uranium, Plutonium, and Industry: November 1952, p.
[25] Work cited in footnote 24, p. 9.
Steel, vol. 133, No. 10, Sept. 7, 1953, p. 63.
Oil, Paint and Drug Reporter, vol. 164, No. 10, Sept. 7, 1953, p. 5.
Atomic Energy Newsletter, vol. 10, No. 3, p. 2.
[26] Work cited in footnote 15, p. 10.
Atomic Energy Newsletter, vol. 10, No. 2, Aug. 25, 1953, p. 1.
Business Week, No. 1620, Oct. 24, 1953, p. 182.
Chemical Week, vol. 73, No. 7, Aug. 15, 1953, p. 16.
[27] Work cited in footnote 24, p. 9.
[28] Atomic Energy Newsletter, vol. 9, No. 3, Mar. 24, 1953, p. 3.
Mining Congress Journal, vol. 39, No. 6, June 1953, p. 106.

AEC's Mound Laboratory, Miamisburg, Ohio, operated by the Monsanto Chemical Co.[29]

THORIUM

Exploration and Mine Production.—Field investigations for thorium-uranium minerals in alluvial deposits were continued in 1953 by the Bureau of Mines, on behalf of the AEC, in Georgia, Idaho, Montana, North Carolina, Oregon, South Carolina, and Washington. Churn-drilling projects to evaluate promising placers, as indicated from 1952 field investigations, were conducted in Idaho, Montana, North Carolina, and South Carolina. Bureau engineers located several placer areas in central Idaho that contained appreciable quantities of thorite and uranothorite, and these areas will be explored by bulldozer trenching and churn drilling in the summer of 1954 to determine whether the deposits contain sufficient quantities of these minerals to warrant exploitation by private industry.

The monazite lode deposits in Lemhi County, Idaho, first examined by Bureau engineers in 1951, were explored further by a mining company in 1953. A lode deposit of monazite was discovered during 1953 in San Miguel County, N. Mex. Bulldozer trenching is reported to have disclosed massive monazite 6 to 20 inches thick in a veinlike structure. Analyses of this monazite indicate a thoria content of 10 to 12 percent.

The Lindsay Chemical Co., West Chicago, Ill., took over the options on the thorium deposit of the Rare Earth Mining Co. in Gunnison County, Colo., and plans to develop the property and begin mining in 1954.

In Idaho three dredges (operated by Baumhoff-Marshall, Inc., Idaho-Canadian Dredging Co., and Warren Dredging Co., all of Boise, Idaho), recovered monazite from placer deposits. Two companies recovered monazite in Florida; they were Humphreys Gold Corp., Jacksonville, Fla., and the Florida Ore Processing Co., Sharonville, Ohio.[30] Thorium deposits in the western hemisphere were discussed.[31] Methods for analyzing thorium in ores were published or released during the year.[32]

Refinery Production.—Domestic thorium and thorium-compounds production statistics are classified as security information by the AEC and therefore cannot be published. Producers of thorium compounds directly from monazite concentrates in the United States are Lindsay Chemical Co., West Chicago, Ill.; Maywood Chemical Works, Maywood, N. J.; and Rare Earths, Inc., Paterson, N. J.

The Lindsay Chemical Co. during 1953 was constructing additional facilities for producing rare-earth and thorium compounds. The

[29] Chemical Week, vol. 73, No. 12, Sept. 19, 1953, p. 60.
Mining Record, vol. 64, No. 35, Aug. 27, 1953, p. 4.
Materials and Methods, vol. 38, No. 4, October 1953, pp. 238, 240.
Nuclear Science Abstracts, vol. 7, No. 11, June 15, 1953, p. 370.

[30] Mining Engineering, vol. 5, No. 2, February 1953, p. 164.
Carlson, E. J., Minor Metals chapter (section on Rare-Earth Minerals and Metals). Minerals Yearbook, 1953.

[31] Strod, A. J., Thorium and Its Sources in the Western Hemisphere: Ceram. Bull., vol. 32, No. 4, 1953, pp. 122–123.

[32] Barks, C. V., and Byrd, C. H., Spectrophotometric Determination of Thorium in Monazite Sands: Jour. Am. Ceram. Soc., vol. 36, No. 7, July 1, 1953, pp. 115–130.
Audrieth, L. F., and Buyers, A. G., Determination of Thorium in Monazite Ores by Measurement of Radioactivity: Illinois University, December 1947, 45 pp. (Made available from Library of Congress, Publication Board Project ,Washington ,D. C. ,1953.)

expansion program will cost over $2 million. Operation of the new facilities may begin early in 1954. Some of the increased quantity of thorium compounds produced, it is reported, will be sold to the AEC. Lindsay is the largest known producer of thorium compounds in the world.[33]

Commercial facilities for producing thorium metal in the United States are maintained by Metal Hydrides, Inc., Beverly, Mass., and Westinghouse Electric Corp. (Lamp Division), Bloomfield, N. J. Production of thorium metal was negligible in 1953.

A patented process was described for converting massive metallic thorium to powdered thorium.[34]

CONSUMPTION AND USES

URANIUM

Production Reactors.—Probably the greatest part of the uranium metal produced at feed-materials centers was consumed in producing the artificial element plutonium in nuclear reactor systems. The AEC's Hanford, Wash., plutonium-production works, which originally cost about $350 million and had undergone a $200 million expansion program after World War II, was subject to further expansion in 1953. The Kaiser Engineers Division of Henry J. Kaiser Co. progressed on construction of new production facilities costing $110 million, and the Blaw-Knox Construction Co. began work on a $40 million contract to build a new chemical-processing plant. A $2.4 million contract was let to Grove, Shepherd, Wilson & Kreige, Inc., of Seattle to prepare 15 underground storage tanks for radioactive wastes. A $14.2 million laboratory area was completed by L. H. Hoffman, Sound Construction & Engineering Co. of Seattle.[35] The Hanford works are operated by the General Electric Corp.

Construction continued on the Savannah River plutonium-production center near Aiken, S. C., which will cost approximately $1.4 billion when completed. The Savannah River plant will be operated by E. I. du Pont de Nemours & Co.[36]

Propulsion Reactor Systems.—The submarine thermal reactor (STR Mark I), a prototype of the STR Mark II, which will propel the submarine U. S. S. *Nautilus*, began its first phase of operation at the National Reactor Testing Station near Idaho Falls, Idaho. The reactor became "critical" about March 31, 1953. It was to have been tested under full power to determine its operating characteristics and to train the crew of the U. S. S. *Nautilus*. The development of the prototype submarine thermal reactor and of the similar reactor that will be installed in the U. S. S. *Nautilus* was the responsibility of the Argonne National Laboratory and the Atomic Power Division of the Westinghouse Electric Corp.[37]

In September 1953 the keel was laid for the second nuclear-powered submarine, the U. S. S. *Sea Wolf*. The Electric Boat Division of

[33] American Metal Market, Worthington Units to Be Used in New Thorium Nitrate Plant: Vol. 60, No. 161, Aug. 19, 1953, p. 1.
[34] Chemical and Engineering News, vol. 31, No. 22, June 1, 1953, p. 2306.
Atomic Energy Newsletter, vol. 9, No. 6, May 5, 1953, p. 4.
[35] Atomic Energy Newsletter, vol. 9, No. 11, June 30, 1953, p. 2.
Western Industry, vol. 19, No. 1, January 1954, pp. 52, 54.
[36] Work cited in footnote 24, p. 12.
[37] Atomic Energy Newsletter, vol. 9, No. 4, Apr. 7, 1953, p. 4.
Nucleonics, Submarine Thermal Reactor Reaches Criticality: Vol. 11, No. 5, p. 71.

General Dynamics Corp., Groton, Conn., is the contractor in charge of construction of the submarines U. S. S. *Nautilus* and U. S. S. *Sea Wolf*. The prototype of the submarine intermediate reactor (SIR) which will propel the submarine U. S. S. *Sea Wolf* is being constructed at the Knolls Atomic Power Laboratory, West Milton, N. Y., by the General Electric Co. The prototype, Mark A, will be installed in a land-based submarine hull section, inside a steel sphere 225 feet in diameter. The purpose of the sphere is to provide for capture of radioactivity should the reactor fail and radioactive material be released. The submarine intermediate reactor will use medium-speed neutrons for energy and liquid sodium metal as a heat-exchange medium, while the submarine thermal reactor will use slow-speed neutrons for energy and water as the heat-exchange substance. After the submarine intermediate reactor, Mark A, at the Knolls Laboratory has been tested, a similar reactor, Mark B, will be built by General Electric Co. for installation in the U. S. S. *Sea Wolf*.[38]

The Newport News Shipbuilding & Drydock Co., Newport News, Va., will, as a part of its power-reactor study, determine the feasibility of a reactor as a means of ship propulsion. The company previously gained experience in nuclear energy as a subcontractor on the now terminated AEC-Navy program for investigation of a suitable reactor for propelling an aircraft carrier.[39]

The General Electric Co. in 1953 established an aircraft nuclear propulsion department at its Evandale plant, Cincinnati, Ohio. The organization has been active in aircraft nuclear propulsion since 1951.[40] Other AEC research and development contractors in this field are Carbide & Carbon Chemicals Co. at the Oak Ridge National Laboratory and the Pratt & Whitney Aircraft Division of the United Aircraft Corp. at East Hartford, Conn. The Air Force sponsors airframe investigations of three aircraft firms.[41]

Power-Reactor Systems.—The AEC program for designing and developing more efficient nuclear reactors for future power applications advanced in 1953. A project was initiated for construction of the first full-scale, experimental industrial nuclear power plant, and industrial participation in the AEC's nuclear power studies program was enlarged.[42]

The experimental industrial power reactor was authorized by the AEC in July. The Westinghouse Electric Co. will be responsible for the development, design, and construction of the pressurized-water-type reactor, which will have an electrical capacity of at least 60,000 kw.[43]

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[38] Atomic Energy Newsletter, vol. 10, No. 4, Sept. 22, 1953, pp. 1–2.
Chemical and Engineering News, Second Atomic Sub: Vol. 31, No. 33, Aug. 17, 1953, p. 3350.
Engineering News Record, Sphere is Atomic Sub Lab: Vol. 150, No. 15, Apr. 9, 1953, pp. 32, 34–35.
Compressed Air, Subs Will be First: Vol. 59, No. 1, January 1954, pp. 19–20.
[39] Atomic Energy Newsletter, Nuclear Power for Ship Propulsion To Be Studied: Vol. 10, No. 6, Nov. 3 1953, p. 5.
[40] Atomic Energy Newsletter, vol. 10, No. 3, Sept. 8, 1953, p. 1.
[41] Work cited in footnote 2, p. 24.
[42] Work cited in footnote 2, p. 17.
[43] Work cited in footnote 2, p. 18.
Chemical and Engineering News, AEC Gives Go-Ahead for Industry to Build Peacetime A-Power Plant: Vol. 31, No. 44, Nov. 2, 1953, p. 4538.
Scientific American, A Start on Atomic Power: December 1953, p. 48.
Engineering and Mining Journal, AEC Picks Westinghouse to Build Atomic Plant: Vol. 154, No. 11, November 1953, p. 132.
Industrial and Engineering Chemistry, vol. 45, No. 6, June 1953. p. 8–A.

North American Aviation, Inc., announced in May that, under contract with the AEC, it had designed a practical sodium-graphite power reactor. The company indicated that it was willing to plan and build for industry a $10 million, 8,000-kw. prototype reactor based on its designs when conditions permit. The reactor would require slightly enriched uranium metal as fuel, graphite as a moderator, liquid sodium as a heat-transfer agent, and cadmium or boron-steel rods for controlling progress of the reaction.[44]

The Commission authorized five new industrial groups to study reactor technology, make preliminary design and economic surveys, and carry on research and development in the field of nuclear power. The groups, which were authorized in October 1953, are:

1. Duquesne Light Co., Pittsburgh, Pa.
   Walter Kidde Nuclear Laboratory, Inc., New York, N. Y.
2. General Electric Co., Schenectady, N. Y.
3. Newport News Shipbuilding & Dry Dock Co., Newport News, Va.
4. Tennessee Valley Authority, Wilson Dam, Ala.
5. A five-company group consisting of:
   Commonwealth Edison Co., Chicago, Ill.
   Union Electric Co., St. Louis, Mo.
   Bechtel Corp., San Francisco, Calif.
   Pacific Gas & Electric Co., San Francisco, Calif.
   American Gas & Electric Service Corp., New York, N. Y.

The 5-company group contains 4 members of the original 4 teams, American Gas & Electric being the new contractor.

The four original study groups, all active in 1953, are:

1. Detroit Edison-Dow Chemical:
   Allis-Chalmers Manufacturing Co.
   Atlantic City Electric Co.
   Babcock & Wilson Co.
   Bendix Aviation Corp.
   Cincinnati Gas & Electric Co.
   Cleveland Electric Illuminating Co.
   Consolidated Edison Co. of New York
   Consolidated Gas, Electric Light & Power Co.
   Consumers Power Co.
   Detroit Edison Co.
   Dow Chemical Co.
   Ford Motor Co.
   General Public Utilities Corp.
   Gibbs & Cox, Inc.
   Hartford Electric Light Co.
   New England Electric System.
   Niagara Mohawk Power Corp.
   Philadelphia Electric Co.
   Potomac Electric Power Co.
   Public Service Electric & Gas Co.
   Rochester Gas & Electric Corp.
   Southern Services, Inc.
   Toledo Edison Co.
   United Engineers & Constructors, Inc.
   Vitro Corp. of America.
   Wisconsin Electric Power Co.

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[44] Chemical and Engineering News, Plans Drawn Up for Proposed Atomic Power Installation: Vol. 31, No. 23, June 8, 1953, p. 2400.
Steel, North American Lands in Industrial Atom Picture: Vol. 132, No. 26, June 29, 1953, p. 111.
Atomic Energy Newsletter, vol. 9, No. 10, June 16, 1953, p. 2.
Nucleonics, vol. 11, No. 6, June 1953, p. 87.

2. Commonwealth Edison-Public Service:
   American Gas & Electric Service Corp.
   Bechtel Corp.
   Commonwealth Edison Co.
   Pacific Gas & Electric Co.
   Union Electric Co.
3. Foster Wheeler-Pioneer Service & Engineering-Diamond Alkali:
   California-Oregon Power Co.
   Diamond Alkali Co.
   Foster Wheeler Corp.
   Louisville Gas & Electric Co.
   Northern States Power Co.
   Oklahoma Gas & Electric Co.
   Pioneer Service & Engineering Co.
   San Diego Gas & Electric
   Wisconsin Public Service Corp.
4. Monsanto Chemical Co. and Union Electric Corp.:
   Monsanto Chemical Co.
   Union Electric Corp.

In May 1953 surveys prepared by the four original study teams were released. The Commonwealth Edison-Public Service team considered two power-reactor types—a helium-cooled, graphite-moderated design and a heavy-water cooled and moderated design, both employing natural uranium fuel. The Detroit Edison-Dow Chemical team investigated a rapid-breeder power reactor, cooled with liquid sodium and consuming-fluid, uranium-alloy fuels. The Monsanto Chemical-Union Electric team was concerned with modifications of a liquid-sodium-cooled, graphite-moderated power reactor using enriched uranium; and the Bechtel Corp.-Pacific Gas & Electric team studied a heavy-water-moderated power reactor requiring natural uranium fuel and light-water cooling, as well as a rapid-breeder power reactor using enriched uranium with a liquid-sodium cooling system. Although each group investigated a unique reactor design, the significant conclusions reached by all four groups were (1) that nuclear power reactors can be constructed by industry today, with completion in 3 to 5 years, (2) plutonium would have to be produced in the power reactor, processed, and sold to the Government to make the power reactor currently economical, and (3) as technology improves nuclear power will become more competitive with power from conventional fuels.[45]

The Army has undertaken preliminary studies to determine the feasibility of small nuclear reactors to supply electric power for remote military bases like the Thule, Greenland, Air Force station. The objective of the studies is to estimate the costs of power from such small package units and compare them with costs of power from conventional sources.[46]

A small, experimental, homogeneous nuclear reactor at the Oak Ridge National Laboratory was successfully operated during 1953 to produce 1,000 kw. of heat. The heat from the new-design reactor

[45] Atomic Energy Commission, Reports to the U. S. Atomic Energy Commission on Nuclear Power-Reactor Technology: May 1953, 88 pp.
Chemical Engineering, Industry Teams Report on A-Power: Part 1, vol. 60, No. 7, July 1953, pp. 188–192; part 2, vol. 60, No. 8, August 1953, pp. 188–192.
Chemical and Engineering News, AEC Releases Private Industry's Data on Nuclear Power Reactors: Vol. 31, No. 22, June 1, 1953, pp. 2294–2296.
Engineering News Report, vol. 150, No. 23, June 4, 1953, pp. 26-27.
Mining Engineering, vol. 5, No. 7, July 1953, pp. 666–667.
Nucleonics, Nuclear Power Feasibility Studies: Vol. 11, No. 6, June 1953, pp. 49–64.
Western Industry, Atomic Power Report Released: Vol. 18, No. 6, June 1953, pp. 70, 72, 74, 76.
[46] Nucleonics, Army Studies Costs of Small Power Reactors: Vol. 11, No. 10, October 1953, p. 72.
Nucleonics, Market for "Package" Nuclear Power: Vol. 11, No. 4, April 1953, pp. 32–33.

was used to run a turbine-powered generator which produced 150 kw. of electric power. A single homogenous solution serves as a fuel, moderator, and coolant. The heat from the hot, radioactive liquid is removed by pumping the solution through a heat exchanger, the steam from which drives the turbine generator. Operation of this small reactor should provide information regarding the feasibility of the design for similar full-scale power-reactor systems.[47]

In June 1953 it was announced that fissionable plutonium could be produced in a "breeder" reactor at a rate at least equal to the uranium-235 consumed as a fuel in the reactor. The successful experiment was conducted in the experimental breeder reactor (EBR) in Idaho. The significance of the experiment was the demonstration that, in theory, all of the world's supply of minable uranium and thorium can be made to undergo fission.[48]

Major revision of the Atomic Energy Act of 1946 to promote industrial development of nuclear power was proposed in a bill (HR 4687) introduced in Congress by Representative James E. Van Zandt, a member of the Joint Congressional Committee on Atomic Energy. The bill would, among other things, permit private ownership of fissionable materials and reactors, guarantee the supply by AEC of fissionable materials for owners of private power reactors and relax patent restrictions. The AEC had recommended earlier that Congress amend the Atomic Energy Act to permit greater industrial participation in nuclear power investigations.[49]

Many comprehensive articles were published during the year about the potentialities of industrial nuclear power, some of which are listed.[50] Also made public were the results of investigations of materials acceptability in reactor construction.[51]

Research Reactors.—An agreement between the Consolidated University of North Carolina and the AEC provided the North Carolina State College with enough fissionable uranium-235 in 1953

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[47] Atomic Energy Newsletter, vol. 9, No. 3, Mar. 24, 1953, p. 3.
Chemical and Engineering News, Electricity From Atoms: Vol. 31, No. 11, Mar. 16, 1953, p. 1063.
Engineering and Mining Journal, New Homogeneous Reactor Produces Atomic Power: Vol. 154, No. 4, April 1953, p. 129.
Industrial and Engineering Chemistry, vol. 45, No. 4, April 1953, pp. 8-A, 9-A.
Nucleonics, Homogeneous Reactor Generates 150 Kw.: Vol. 11, No. 4, April 1953, p. 66.

[48] Atomic Energy Newsletter, vol. 9, No. 10, June 16, 1953, p. 4.
Bulletin of the Atomic Scientists, vol. 9, No. 5, June 1953, p. 195.
Business Week, More Energy From the Atom: No. 1241, June 13, 1953, pp. 30-31.
Chemical Age (London), Atomic Energy Advance, USA Success in "Breeding" Process: Vol. 68, No. 1770, June 13, 1953, p. 888.
Daily Metal Reporter, New Process Will Speed Civilian Atomic Energy: Vol. 53, No. 108, June 5, 1953, pp. 1-2.
E&MJ Metal and Mineral Markets, Atomic Power Plant Breeds Fuel From Uranium-235: Vol. 24, No. 24, June 11, 1953, p. 10.
Industrial and Engineering Chemistry, vol. 45, No. 7, July 1953, p. 8-A.
Northern Miner (Toronto), New Atomic Pile Makes Own Fuel: Vol. 39, No. 12, June 11, 1953, p. 2.
Nucleonics, An Important Milestone: Vol. 11, No. 7, July 1953, p. 7.
Steel, Atomic Milestone, vol. 132, No. 24, June 15, 1953, p. 55.

[49] Chemical and Engineering News, Industry Seeks Atomic Power: Vol. 31, No. 33, Aug. 17, 1953, p. 3374
Nucleonics, Joint Congressional Committee Begins Hearings on Possibilities of Private Nuclear Power Development: Vol. 11, No. 4, April 1953, p. 66. Congress to Get AEC Plan to Amend Atomic Energy Act; Would Permit Private Ownership of Nuclear Power Plants: Vol. 11, No. 5, May 1953, p. 72. Vol. 11, No. 6, June 1953, p. 88.

[50] Benedict, Manson, What Is Delaying Industrial Nuclear Power: Chem. and Eng. News, vol. 31, No. 10, Mar. 9, 1953, pp. 986-990.
Gray, A. G., Atomic Power in Industry: Steel, vol. 132, No. 9, Mar. 2, 1953, pp. 86-92.
Urey, H. C., Power From Nuclear Fission: Chem. and Eng. News, vol. 31, No. 45, Nov. 9, 1953, pp. 4660-4663.
Mining Journal (London), Use of Atomic Power in Inudstry: Vol. 241, No. 6158, Aug. 28, 1953, p. 245.
Cohen, Karl, The Key to Atomic Power: Nucleonics, vol. 11, No. 5, May 1953, pp. 10-13.
Zinn, W. H., Wanted, an Operating Power Reactor: Nucleonics, vol. 11, No. 11, November 1953, pp. 30-31.

[51] Koenig, R. F., New Tests Prove Materials for Nuclear Power Plants: Iron Age, vol. 172, No. 8, Aug. 20, 1953, pp. 129-133.
Evans, G. E., Materials: Nucleonics, vol. 11, No. 6, June 1953, pp. 18-25.

to fuel the small research reactor that had been constructed on the campus. The reactor is the first university-owned research reactor in the United States and will be used to train students in nuclear engineering.[52]

The Pennsylvania State College submitted to the AEC a proposal to build a 100-kw. light-water cooled and moderated reactor utilizing enriched uranium fuel. The college would construct and operate the reactor at no cost to the Government. The AEC gave preliminary approval for the loan of fuel material.[53]

A list of research and experimental reactors in operation in the United States and others in advanced stages of design or construction is given below:

Reactors in operation

Name:	*Location*	*Fuel*
Bulk Shielding Facility (swimming pool).	Oak Ridge National Laboratory, Oak Ridge, Tenn.	Highly enriched uranium.
EBR, Experimental Breeder Reactor.	National Reactor Testing Station, Idaho Falls, Idaho.	Do.
MTR, Materials Testing Reactor.	-----do-----	Do.
LITR, Low-Intensity Test Reactor.	Oak Ridge National Laboratory, Oak Ridge, Tenn.	Do.
SUPO, Superpower Water Boiler.	Los Alamos Scientific Laboratory, Los Alamos, N. Mex.	Highly enriched uranium nitrate solution.
North American Water Boiler	North American Aviation, Inc., Downey, Calif.	Highly enriched uranyl nitrate solution.
HRE, Homogeneous Reactor Experiment.	Oak Ridge National Laboratory, Oak Ridge, Tenn.	Solution of highly enriched uranium and moderator.
CP–3′, Argonne Heavy-Water Reactor.	Argonne National Laboratory, Chicago, Ill.	Uranium.
TTR, Low-Power Thermal Test Reactor.	Knolls Atomic Power Laboratory, Schenectady. N. Y.	Highly enriched uranium.
Raleigh-------------	North Carolina State College, Raleigh, N. C.	Solution of enriched uranium sulfate.
STR, Submarine Thermal Reactor, Mark I.	National Reactor Testing Station, Idaho Falls, Idaho.	Highly enriched uranium.

Reactor in advanced state of design or construction

SIR, Submarine Thermal Reactor, Mark I.	Knolls Atomic Power Laboratory, Schenectady, N. Y.	---------------------

Isotopes.—Uranium was required to produce radioactive isotopes for research, industrial, and medical purposes during 1953; this is an indirect use of uranium, as reactors presumably are not operated solely for producing isotopic materials. The AEC made 10,679 shipments of radioactive isotopes in 1953, a 17-percent increase over the 9,102 shipments in 1952. The largest single gain was in shipments of nonclassified radioisotopes, showing a 57-percent increase over 1952. There was an 18-percent increase in shipments of iodine–131; and iodine–131 comprised 43 percent of all radioisotope shipments in 1953. (See table 4.)

[52] Atomic Energy Newsletter, vol. 10, No. 4, Sept. 20, 1953, p. 4.
[53] Work cited in footnote 2, p. 35.

Most radioisotopes were produced in the graphite reactor at the Oak Ridge National Laboratory. Brookhaven National Laboratory prepared special radioisotopes, and in October 1953 the low-intensity test reactor (LITR) at Oak Ridge National Laboratory and the materials-testing reactor (MTR) at the National Reactor Testing Station, Arco, Idaho, were also made available for production of special isotopes. The Argonne National Laboratory may produce radioisotopes with the startup of its new CP–5 reactor.

TABLE 4.—Radioisotopes shipped by the U. S. Atomic Energy Commission by kinds, 1946–53, number of shipments

Radioisotope	1946–48 [1] (total)	1949	1950	1951	1952	1953	Total
Iodine–131	1,541	1,537	2,353	3,183	3,867	4,555	17,036
Phosphorus–32	1,486	1,420	1,736	2,112	2,101	2,218	11,073
Carbon–14	279	192	259	342	431	342	1,845
Sodium–24	200	229	286	176	363	335	1,589
Sulfur–35	92	108	125	168	163	204	860
Gold–198 and gold–199	98	36	164	268	431	536	1,533
Cobalt–60	66	64	137	190	147	185	789
Potassium–42	61	75	123	132	107	158	656
Calcium–45	80	68	89	111	104	107	559
Iron–55 and iron–59	79	54	68	67	149	129	546
Strontium–89 and strontium–90	30	19	46	62	94	113	364
Others	530	568	848	1,014	1,145	1,797	5,902
Total	4,542	4,370	6,234	7,825	9,102	10,679	42,752

[1] Shipments in 1946 by Manhattan District, Corps of Engineers, U. S. Army Service Forces.

Bendix Aviation Corp. and Tracerlab, Inc., under contract with the AEC, determined that commercial production and marketing of isotopes by private industry will probably not be feasible for 5 years.

Industry was the largest consumer of isotopic materials, the field of medicine the second largest. By the end of the year 1,858 institutions or organizations had been authorized by the AEC to use reactor-produced radioisotopes.[54]

The Bureau of Mines Bartlesville, Okla., Petroleum Experiment Station made field tests of radioactive iodine (iodine–131) as a water tracer. The tests, conducted in cooperation with Wells Surveys, Inc., indicated that radioactive iodine can be used successfully as a water tracer to determine (1) relative rates and patterns of flow of injected water between water-input and oil-production wells and (2) zones of excessive water entry into oil-production wells.[55] Carbon–14 was also used at Bartlesville in investigations of detergents as additives to water used in the water flooding of oil sands. The Bureau of Mines Rolla, Mo., laboratories used the radioisotope cobalt–60 for (1) a study of defect sensitivity in radiography, (2) production research on high-purity alloys, and (3) zinc die-casting alloy research.

Applications of radioisotopes in metallurgy were discussed. Specifically, the use of radioisotopes was described in the metallurgical field as tracer elements for (1) determining sulfur in coke, (2) quantitative analysis of oxygen in iron, steel, copper, etc., (3) measuring frictional wear, (4) finding solid diffusion of two or more metals, (5) process metallurgy, such as flotation, (6) study of crystal growth,

[54] Work cited in footnote 2, pp. 39–40.
[55] Watkins, J. Wade, and Mardock, E. S., Use of Radioactive Iodine as a Tracer in Water-Flooding Operations: Address before annual meeting of AIME, New York, N. Y., Feb. 13–17, 1954.

(7) determination of whether one atom substitutes for or joins with another in material crystallography, and (8) examination of carbon in carburized steels by autoradiography. Also described was the use of radioisotopes in the metallurgical field as a source of radiation for (1) locating defects in steel and cast iron by radiography, (2) industrial gages, (3) following the flow of liquids in pipelines to determine when changes in liquid types are made, and (4) determining hard-to-locate leaks in pipelines.[56] Tritium as a radioactive tracer isotope in biological and chemical research was explained.[57] Other reports on applications of radioisotopes were published during 1953.[58]

In July 1953 the Isotopes Division of the AEC announced isotope availability and allocation procedures, technical services, and a health safety visitation program and reported on the Federal control of radioisotopes.[59]

A booklet detailing 20 experiments involving the use of radioisotopes and describing how nuclear radiations are detected and measured was made available to the public by the AEC. The booklet was prepared to assist high-school science teachers to illustrate the use of radioactive isotopes.[60] A new catalog containing price list of isotopes and associated services that are available from Oak Ridge National Laboratory was published, effective January 1, 1953.[61]

The radioisotope strontium–90, which gives off no harmful gamma radiation, was reported to have been used by the Navy for personnel markers. The material emits light and will glow in various colors, depending on impurities present in the zinc compound with which it is mixed.

Industrial management personnel of companies interested in incorporating radioisotopes into their research or production activities were invited to attend a symposium on Management Problems in Industrial Application of Radioisotopes, sponsored by the Oak Ridge Institute of Nuclear Studies, Oak Ridge, Tenn.[62]

It was announced that a $6 million isotopic research center and hospital will be constructed at the University of Tennessee about 20 miles from Oak Ridge.[63]

Weapons.—During the spring of 1953, at the Nevada proving grounds of the AEC, a series of atomic weapon tests was made. The 11th and final test explosion of the series was conducted on June 4, 1953. New and improved nuclear weapons performance data essential to military and civil defense studies were collected. The Civil Defense Administration and other Government agencies participated in the tests. Some 18,000 troops from the Army, Navy, Air Force, and

[56] Boynton, H. C., and Kirshenbaum, A. D., Utility of Isotopes in Metallurgy: Steel, vol. 133, No. 19, Nov. 9, 1953.
[57] Chemical and Engineering News, Tritium Finds Increasing Application in Tracer Chemistry: Vol. 31, No. 31, Aug. 3, 1953, pp. 3184, 3186, 3187.
[58] Iron Age, Isotopes: Vol. 172, No. 19, Nov. 5, 1953, pp. 111–112.
Chemical and Engineering News, Potomac Postscripts: Vol. 31, No. 33, Aug. 17, 1953, p. 3348.
Cockcroft, Sir John, Industrial Applications of Radioactive Materials: Atomics (London), vol. 4, No. 10, October 1953, pp. 245–252.
Whitehouse, W. J., and Putnam, J. L., Radioactive Isotopes, Oxford University Press, London, 1953, 424 pp.
[59] Atomic Energy Commission, Isotopics: Vol. 3, No. 3, July 1953, 9 pp.
[60] Atomic Energy Commission, AEC Issues Booklet to Aid Science Teachers: Press release, Sept. 20, 1953, 2 pp.
[61] Oak Ridge National Laboratory, Isotopes—Radioactive and Stable: Catalog and Price list, Oak Ridge, Tenn., Jan. 1, 1953.
[62] American Metal Market, vol. 60, No. 19, Jan. 28, 1953, p. 14.
[63] Business Week, No. 1262, Nov. 7, 1953, p. 150.

Marines engaged in maneuvers in the proving area to ascertain effects of explosions on military actions.[64]

On August 8, 1953, Russia announced that it had produced the hydrogen bomb and on August 20 that it had exploded such a bomb. The United States tests at Eniwetok Atoll in 1951 and 1952 involved similar explosions.[65]

An atomic artillery shell was successfully fired from the United States Army's new 280-mm. self-propelled cannon during the spring tests. The 85-ton weapon can fire either conventional-type artillery shells or those with atomic warheads.[66]

Early in 1953 the AEC indicated that a plant for processing and assembling nuclear explosives was to be erected 18 miles east of Macomb, McDonough County, Ill., on the Spoon River. Later in the year construction of the facility was canceled owing to developments that would allow existing facilities to turn out the production intended for the Spoon River plant.[67]

Nonenergy Uses.—The Atomic Energy Commission authorized the use of 2,581 pounds of U_3O_8 contained in uranium compounds for nonenergy purposes in 1953 as indicated in table 5, a 47-percent reduction from the 4,901 pounds allowed for use in nonenergy fields in 1952. The largest nonenergy use of uranium compounds was in

TABLE 5.—Consumption of uranium and thorium compounds for nonenergy purposes in the United States, 1949–53, in pounds of contained U_3O_8 and ThO_2

[U. S. Atomic Energy Commission]

Industry	1949	1950	1951	1952	1953
URANIUM (U_3O_8 EQUIVALENT)					
Chemical (including catalytic)	2,426	2,835	2,016	3,048	2,539
Ceramic (including glass)	270	938	875	1,627	--------
Electrical	103	33	88	226	42
Total U_3O_8	2,799	3,806	2,979	4,901	2,581
THORIUM (ThO_2 EQUIVALENT)					
Magnesium alloys	--------	--------	--------	--------	3,600
Gas-mantle manufacture	44,621	48,471	31,132	25,427	8,707
Refractories and polishing compounds	1,847	1,889	3,382	1,157	236
Chemical and medical	596	2,097	6,246	11,064	5,179
Electrical	237	314	1,457	277	1,222
Total ThO_2	47,301	52,771	42,217	37,925	18,944

[64] Atomic Energy Newsletter, vol. 8, No. 13, Feb. 10, 1953, p. 1.
Atomic Scientists News, Weapons Development: Vol. 2, No. 6, July 1953, pp. 387–389.
Bulletin of the Atomic Scientists, Nevada Weapons Test: Vol. 9, No. 3, April 1953, pp. 73–75. Nevada Tests Completed: Vol. 9, No. 5, June 1953, p. 195.
Iron Age, A-Bomb Test Blast Echoes Into Industry: Vol. 171, No. 13, Mar. 26, 1953.
Work cited in footnote 2, p. 49.

[65] Atomic Scientists Journal, The Hydrogen Bomb, USA and Russia: Vol. 3, No. 2, November 1953, pp. 106–110.
Chemical Engineering, Tritium, Fuel for the Hell Bomb: Vol. 60, No. 2, February 1953, p. 103.
Atomic Energy Newsletter, vol. 10, No. 1, August 11, 1953, p. 1.
Titterton, E. W., The Development of the Hydrogen Weapon: Atomics (London), vol. 4, No. 10, October 1953, pp. 253–256.

[66] Atomic Energy Newsletter, vol. 9, No. 2, Mar. 10, 1953, p. 1.
Arnold, Rudy, The Shot Heard Round the World: Steelways, April 1953, pp. 12–13.
Metal Progress, The Army's Big Gun: Vol. 63, No. 2, February 1953, pp. 94–95.
Washington (D. C.) Post, Army to Fire First Atomic Artillery Shell From 280-Mm. Cannon in Spring Tests: Mar. 8, 1953.

[67] Work cited in footnote 2, p. 12.
Atomic Energy Newsletter, vol. 8, No. 13, Feb. 10, 1953, p. 2.
Chemical Engineering, New AEC Plant in Illinois Will Process Explosives: Vol. 60, No. 4, April 1953 pp. 125–126.
Industrial and Engineering Chemistry, vol. 45, No. 3, March 1953, p. 8–A.
Metals, vol. 5, No. 12, December 1953, p. 1609.

the chemical industry, but the 2,539 pounds consumed in 1953 was 17 percent less than the quantity used for the same purpose in 1952. Although 1,627 pounds of contained U_3O_8 was authorized for use as a coloring agent in the ceramic and glass industry in 1952, no uranium was consumed in this field in 1953. The use of uranium compounds in the electrical industry receded from 226 pounds of contained U_3O_8 in 1952 to 42 pounds in 1953, a drop of some 81 percent.

RADIUM

Leases of radium for medical and scientific uses increased in 1953, but leases of radium for radiographic purposes decreased slightly. Limited quantities of radium were used in luminous compounds and static elimination equipment; radioisotopes were available for use in certain industrial fields, and their competition with radium was probably most evident in teletherapy medical treatment and radiography work. The use of radium-bearing carnotite slimes as a marking compound in oil-well casing increased significantly in 1953.

The care of radium salts hermetically sealed in suitable containers for scientific or therapeutic purposes was discussed.[68]

THORIUM

Authorizations by the AEC for industrial procurement of thorium compounds for nonenergy purposes in 1953, as indicated in table 5, totaled 18,944 pounds of contained ThO_2, 50 percent less than the 37,925 pounds authorized in 1952. Authorizations for refractories and polishing compounds, for which use only 236 pounds of contained ThO_2 was authorized, were 80 percent less than in 1952; authorizations for chemical and medical uses amounted to 5,179 pounds of contained ThO_2, 53 percent less than in 1952; and authorizations for gas-mantle manufacture amounted to 8,707 pounds of contained ThO_2, 66 percent less than in 1952. The only increase in authorizations in 1953 was in the electrical equipment field; 1,222 pounds of ThO_2 was allowed—341 percent more than in 1952. In the electrical industry thorium oxide is reduced to thorium metal powder, bar, and sheet, some of which is alloyed with tungsten to produce filaments having high resistance to shock.

A new, and apparently significant, use for thorium was recognized in 1953. Some 3,600 pounds of contained ThO_2 was consumed as an additive to magnesium alloys. Although thorium is a relatively expensive alloying element, preliminary research has indicated that as much as 3 percent thorium imparts outstanding mechanical properties to magnesium alloys at ambient and elevated temperatures.[69]

Gordon Dean, Chairman of the Atomic Energy Commission, announced on June 4, 1953, at a meeting of members of the Edison Electric Institute, the successful "breeding" of fissionable material. The experimental breeder reactor at the National Reactor Testing Station in Idaho, it was explained, produced fissionable plutonium in quantities equal to the fissionable uranium-235 consumed as fuel in the reactor. With regard to thorium, Dean indicated that the proof of success in breeding at the Idaho station suggests, in addition, that

[68] Lind, S. C., Care of Radium Salts: Nucleonics, vol. 11, No. 4, April 1953, pp. 56-57.
[69] Steel, Thorium Improves Magnesium Alloys: Vol. 133, No. 14, December 1953, pp. 126, 128.

the other potential atomic fuel, thorium, may also ultimately be utilized. Thorium, however, was not used in this particular experiment, and it was not implied that its susceptibility to breeding has been proved.[70]

PRICES

Uranium Ore.—Prices paid by the AEC in 1953 for domestic uranium ore were the same as in 1952 and in accord with the schedule and bonus plan effective March 1, 1951 (see Uranium, Radium, and Thorium chapter, Minerals Yearbook, 1951). In September 1953 the AEC announced that the expiration date of the guaranteed minimum price schedule for uranium ores of the Colorado Plateau area, as set forth in Domestic Uranium Program Circular 5, Revised, had been extended to cover the period through March 31, 1962, from the previous expiration date of March 31, 1958, and that the expiration date of the bonus plan applying to initial production of uranium ore from new domestic mines, as set forth in Domestic Uranium Program Circular 6, had been extended to cover the period through February 28, 1957, from the previous expiration date of February 28, 1954.[71]

In January 1953 the AEC issued a comprehensive report covering a survey conducted by the Colorado School of Mines Research Foundation of all phases of uranium-ore sampling as practiced at ore-buying facilities on the Colorado Plateau.[72] Improvements effected, as a result of the survey, were announced by the AEC in April 1953.[73]

Acceptable domestic uranium ore was purchased at the following 6 ore-buying stations and 7 qualified uranium mills:

Ore-buying stations

Location:	*Operating company*
Grants, N. Mex	Anaconda Copper Mining Co., on behalf of AEC.
Shiprock, N. Mex	American Smelting & Refining Co., on behalf of AEC.
Edgemont, S. Dak	Do.
Marysvale, Utah	Do.
Monticello, Utah	Do.
Thompson, Utah	United States Vanadium Co. for company account.

Qualified uranium mills

Durango, Colo	Vanadium Corp. of America.
Grand Junction, Colo	Climax Uranium Co.
Naturita, Colo	Vanadium Corp. of America.
Rifle, Colo	United States Vanadium Co.
Uravan, Colo	Do.
Hite, Utah	Vanadium Corp. of America.
Salt Lake City, Utah	Vitro Chemical Co.
Monticello, Utah	Galigher Co., on behalf of AEC.

[70] Luntz, J. T., An Important Milestone: Nucleonics, vol. 11, No. 7, July 1953, p. 7.
E&MJ Metal and Mineral Markets, Atomic Power Plant Breeds Fuel from Uranium-235: Vol. 24, No. 24, June 11, 1953, p. 10.
Chemical Age (London) Atomic Energy Advance: Vol. 68, No. 1770, June 13, 1953, p. 888.
Business Week, More Energy From the Atom: No. 1241, June 13, 1953, pp. 30–31.

[71] Atomic rnergy Commission, Uranium Ore Price and Initial Production Bonus Schedules Extended: Press release, Sept. 23, 1953, 2 pp.
Mining World, vol. 15, No. 11, October 1953, p. 83; vol. 15, No. 12, November 1953, p. 101.
Engineering and Mining Journal, vol. 154, No. 11, November 1953, pp. 128–129.

[72] Atomic Energy Commission, Uranium-Sampling Report Issued: Press release, Jan. 11, 1953, 2 pp.
Mining World, vol. 15, No. 2, February 1953, p. 87; vol. 15, No. 3, March 1953, p. 105.

[73] Atomic Energy Commission, Uranium-Ore Samplers Improve Practices: Press release, Apr. 12, 1953, pp.
Mining World, vol. 15, No. 7, June 1953, p. 111

The AEC announced in May 1953 establishment of a list of certified uranium umpire analysts available to buyers and sellers of uranium ores in the Colorado Plateau area. Three private firms and the National Bureau of Standards comprised the list; the private firms were: Brown Laboratory, Grand Junction, Colo.; Smith's Laboratory, Moab, Utah; and Ledoux & Co., Inc., New York, N. Y.[74]

Uranium.—Small quantities of high-purity uranium metal were available throughout 1953 to AEC licensees at about $50 a pound. The metal, in the form of pencil-size rods about 4 inches long, was produced by Mallinckrodt Chemical Co., St. Louis, Mo., and distributed to all the major chemical companies, from which the metal was available to the licensees in its original rod form, as rolled sheets, or as foil.

Under the date of September 24, 1953, the AEC announced proposed amendments to its licensing regulations that would (1) provide for an extension of the general license to subcontractors of the Commission and to certain private and Government laboratories having continuing requirements for small quantities of refined source material in the course of normal operations and activities, (2) reduce the allowable quantity to a realistic level in accordance with the actual requirements of the group for whom the general licenses were designed, and (3) reflect changes in the designation and address of the organizational unit to which license applications and communications regarding the regulations should be addressed.[75] The regulations were so amended as of January 1, 1954.

Radium.—Radium was quoted by E&MJ Metal and Mineral Markets at $20 to $25 per milligram of radium content, depending on quantity, from January 1 to February 12, 1953, when the quotation was reduced to $16 to $21.50; the latter quotation continued unchanged for the remainder of the year. One source, however, offered radium element throughout the entire year at $16 to $21.50 per milligram, depending on quantity.

Thorium.—Thorium metal, in the form of powder, unsintered bars, sintered bars, sheet—0.005 inch and over, and sheet—0.002 to 0.0049 inch, was quoted in 1953 by 1 producer, f. o. b. producer's plant, in lots of less than 200 grams per item at 45, 50, 65, 75, and 85 cents per gram, respectively; and, in lots of 200 grams or more per item at 35, 40, 50, 60, and 70 cents per gram, respectively.

Average prices in 1953 for thorium nitrate and oxide were reported by a large producer, in 100-pound lots, f. o. b. producer's plant, as follows: Thorium nitrate, mantle grade—domestic price $3.00, export $3.35 per pound; thorium oxide, 97 percent ThO_2—domestic price $6.30 per pound; thorium oxide, photographic-lens grade, 99 percent ThO_2—$7.63 per pound.

Isotopes.—No appreciable change was made in 1953 in the list of isotopic materials available through the Isotopes Division of the AEC.[76] The only significant change in pricing involved a discount, effective July 1, 1953, on quantity purchases of carbon–14, phospho-

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[74] Atomic Energy Commission, Umpire Analysts of Uranium Ore: Press release, May 24, 1953, 2 pp. Mining World, vol. 15, No. 9, August 1953, p. 99.

[75] Federal Register, vol. 18, No. 192, Oct. 1, 1953, pp. 6267–6268.

[76] Atomic Energy Commission (Oak Ridge National Laboratory, Oak Ridge, Tenn.), Isotopes—Radioactive and Stable: Catalog and Price List. Jan. 1, 1953, 123 pp. Nucleonics, vol. 11, No. 6, June 1953, p. 85.

rus–32, and iodine–131 from the Oak Ridge National Laboratory, according to the following schedule:[77]

Carbon–14: A reduction from $36 to $32 per millicurie on single shipments of 200 millicuries or more.

Phosphorus–32: A reduction from $1.10 to $1.00 per millicurie on single shipments of 250 millicuries or more.

Iodine–131: A reduction from 75 cents to 65 cents per millicurie on single shipments of 500 millicuries or more.

The change represents a reduction in prices ranging from 10 to 13 percent on these shipments.

Distribution of radioisotopes for cancer research and therapy at an 80-percent reduction from catalog prices was continued by the AEC in 1953.[78]

FOREIGN TRADE [79]

Belgian Congo and Canada continued, during 1953, to supply the United States with substantial quantities of uranium ores and concentrates. In addition, the Union of South Africa began shipping to the United States uranium concentrates recovered from the Rand gold deposits. The Radium Hill mine and the Rum Jungle deposit in Australia were developed.[80]

The AEC made 713 shipments of radioisotopes to foreign countries during 1953, 73 percent more than in 1952. Recipients of the most shipments were Canada, Cuba, and Japan, with 36, 11, and 13 percent of the total shipments, respectively. Phosphorus–32 and iodine–131 made up 52 percent of all shipments.[81] The Commercial Products Division, Atomic Energy Control Board of Canada made more than 1,000 shipments of radioisotopes during the 12-months period ending March 31, 1953.[82] Great Britain made 12,159 shipments of radioisotopes in 1953 and was the world's largest exporter of radioisotopes.

Table 6 shows United States imports of radium salts and radioactive substitutes in 1953. The 96,750 milligrams of radium salts imported

TABLE 6.—Radium salts imported for consumption in the United States, 1949–53

[U. S. Department of Commerce]

Year	Radium salts			Radioactive substitutes (value)
	Milligrams	Value		
		Total	Average per gram	
1949	98,032	$1,719,656	$17,500	$370
1950	80,969	1,235,511	15,300	6,106
1951	89,805	1,225,564	13,600	5,399
1952	173,711	2,873,688	16,500	85,849
1953	96,750	1,662,106	17,200	175,387

[77] Atomic Energy Commission (Isotopes Division, Oak Ridge, Tenn.), Isotopics: Vol. 3, No. 3, July 1953, p. 1.

[78] Work cited in footnote 77, p. 1.

[79] 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.

[80] Work cited in footnote 2, p. 5.

[81] Work cited in footnote 2, p. 105.

[82] Atomic Energy Control Board of Canada, Seventh Annual Report, 1952–53: Ottawa, Canada, Mar. 31, 1953, p. 9.

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in 1953 was 44 percent less than the quantity imported in 1952, but the average dollar value per milligram of radium salts increased 4 percent from $16.50 in 1952 to $17.20 in 1953. The value of radioactive substitutes imported increased 104 percent in 1953.

WORLD REVIEW

President Eisenhower on December 8, 1953, before the United Nations assembly in New York, proposed that the United Nations create a stockpile of natural uranium and fissionable materials from contributions of all countries possessing atomic raw materials. This stockpile would be used to develop nuclear energy for peaceful purposes for the benefit of all countries of the world.[83]

The Sixth Tripartite Declassification Conference was held at Chalk River, Canada, April 8–10, 1953. In attendance were representatives of the Governments of Canada, United Kingdom, and United States. The subject of the meeting largely concerned the declassification action, consistent with security, required of the three countries for most rapid progress in the development of nuclear power.[84] After the meeting it was declared that the release of additional information on power reactors and related materials technology had been approved by the Governments of Canada, United Kingdom, and the United States. The release of the data is the result of the revision of the Tripartite Declassification Guide.[85]

In October 1953 United States and British representatives conducted a series of conferences in Washington, D. C., regarding the exchange of information on nuclear energy and the possibility of a greater cooperative effort.[86] It was announced in November that an exchange of information on the effects of atomic and hydrogen weapons would be made between the United States, Canada, and Great Britain. No exchange of information about weapons design and development would be allowed, inasmuch as the Atomic Energy Act of 1946 forbids such an exchange.[87]

A. B. Atomenergi of Sweden and the Commissariat a l'Energie Atomique of France collaborated in certain fields of nuclear research. France supplied the Swedish organization with natural uranium fuel rods for the reactor it was constructing in Stockholm, Sweden, and Sweden in return shipped uranium oxide to France.[88]

An international conference on atomic energy for nuclear power was held at Oslo, Norway, in August 1953; scientists from 19 countries were present. The conference unanimously voted to establish an international nuclear energy association open to interested scientists from all nations.[89]

Gordon Dean discussed the progress in atomic research of the United Kingdom, Canada, France, Norway and The Netherlands, Belgium,

[83] Atomic Energy Newsletter, vol. 10, No. 9, Dec. 15, 1953, p. 1.
[84] Atomic Scientists News, vol. 2, No. 6, July 1953, p. 374.
[85] Canadian Chemical Processing, vol. 38, No. 2, February 1954, p. 86.
Nucleonics, vol. 12, No. 1, January 1954, p. 73.
[86] Atomic Energy Newsletter, vol. 10, No. 6, Oct. 20, 1953, p. 1.
[87] Atomic Energy Newsletter, vol. 10, No. 8, Dec. 1, 1953, p. 1.
Business Week, No. 1265, Nov. 28, 1953, p. 34.
[88] Atomics and Atomic Technology, vol. 5, No. 2, February 1954, p. 60.
[89] Atomic Energy Newsletter, vol. 10, No. 2, Aug. 25, 1953, p. 3.
Bulletin of the Atomic Scientists, vol. 9, No. 10, December 1953, p. 387
Nucleonics, vol. 11, No. 10, October 1953, p. 76.

Sweden, Denmark, Germany, Italy, Switzerland, India, Brazil, Australia, and the U. S. S. R.[90]

Research on heavy-water natural uranium power-reactor systems continued satisfactorily at the Joint Establishment for Nuclear Energy Research, Kjeller, Norway; this is a cooperative effort by The Netherlands and Norway. Isotopes produced in the experimental reactor are distributed to organizations in The Netherlands, Norway and other European countries where practicable.[91]

NORTH AMERICA

Canada.—C. J. Mackenzie retired as president of Atomic Energy of Canada, Ltd., effective October 31, 1953. W. J. Bennett, president of Eldorado Mining & Refining, Ltd., was named as his successor by the directors.[92]

Repair of the NRX reactor at Chalk River continued in 1953. On December 12, 1952, a rapid buildup of power in the NRX reactor, combined with an insufficient supply of cooling water, caused rupture and vaporization of uranium fuel rods. The accident released excessive quantities of radioactive gases through the exhaust stack, which, owing to unusual atmospheric conditions, were not dissipated properly, and the area was subsequently contaminated. The station was decontaminated as soon as possible, and the reactor is now being rebuilt.[93]

Construction was begun on the NRU heavy-water reactor. The new installation will probably be completed in 1955 at a total cost of about $30 million.[94]

The Ontario Hydro-Electric Power System announced that it apportioned some $200,000 for a 2-year feasibility study of nuclear energy for power in Ontario. The study received the endorsement and cooperation of Atomic Energy of Canada, Ltd.[95]

Eldorado Mining & Refining, Ltd., was the only producer of uranium in Canada during 1953, with production from the Port Radium properties at Great Bear Lake and some initial production from the Ace-Fay mine in the Beaverlodge region northeast of Lake Athabaska. A 500-ton-per-day-capacity mill will treat ores from the Ace-Fay mine. Cost of Eldorado's new Beaverlodge project is estimated at $17 million.[96]

Eldorado Mining & Refining, Ltd., continued development work on the RA and Bolger group of claims in the Beaverlodge region, as well as exploration work on the Radiore claims in the same area, leased from Radiore Uranium Mines, Ltd.

Also in the Beaverlodge region Gunnar Gold Mines, Ltd., as a result of an extensive drilling program, announced that uranium reserves on its property were estimated to be worth over $65,000,000.

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[90] Dean, Gordon, We Are in a Life-and-Death Atom-Bomb Race: Look (magazine), vol. 17, No. 14, July 14, 1953.

[91] Randers, Gunnar, The Dutch-Norwegian Atomic Energy Project: Bull. Atom. Sci., vol. 9, No. 16, December 1953, pp. 369–371.

[92] Department of Trade and Commerce, Ottawa, Canada, press release, Information Branch, Sept. 19, 1953, 1 p.

[93] Bulletin of the Atomic Scientists, vol. 9, No. 1, February 1953, p. 30.
Nucleonics, vol. 11, No. 3, March 1953, p. 70.
Atomic Energy Newsletter, vol. 9, No. 12, July 14, 1953, p. 4.

[94] Chemistry and Industry (London), New Heavy-Water Reactor for Canada: No. 5, Jan. 31, 1953, p. 108.

[95] Atomic Energy Newsletter, vol. 10, No. 8, Dec. 1, 1953, p. 1.

[96] Engineering and Mining Journal, vol. 154, No. 7, July 1953, p. 140.

Plans are being made by the company for construction of an acid-leaching plant. Open-pit mining may begin in 1955.

Underground exploration was done on (1) the Ace and A. B. C. properties of Nesbitt LaBine Uranium Mines, Ltd., (2) the Smitty zone of Rix-Athabasca Uranium Mines, Ltd., and claims of (1) Beaver Lodge Uranium Mines, Ltd., (2) Beta-Gamma Mines, Ltd., (3) Meta Uranium Mines, Ltd., (4) National Exploration, Ltd., (5) Pitch-Ore Uranium Mines, Ltd., and (6) Strike Uranium Mines, Ltd. Most of these companies, all in the vicinity of the Eldorado Mining & Refining, Ltd., Beaverlodge properties, probably will ship ore to the Eldorado plant for custom milling.

Scattered occurrences of uranium mineralization were explored in other areas of the Beaverlodge region, the Foster Lake region, and the Lac La Ronge region, of Saskatchewan.

In the Northwest Territories mining progressed normally at the Eldorado Mining & Refining, Ltd., properties at Port Radium on Great Bear Lake.[97] The gravity mill, which treated mine ore only, was in continuous operation throughout the year for the first time since the mill was destroyed by fire in 1951. The acid-leach plant, which treated tailings from the gravity mill, plus tailings from earlier operations, was in operation for the full 12 months—the first time in its history; and dredging of old tailings from Great Bear Lake proceeded without undue difficulty. As a result, production in 1953 at the Port Radium operation was the highest in the life of the mine. The mine-development program at Port Radium included 6,398 feet of drifting and crosscutting, 2,339 feet of raising, and 550 feet of shaft sinking. Exploration diamond drilling totaled 1,898 feet on surface and 24,169 feet underground. Footage of holes drilled for grouting was 24,979 by diamond drill and 4,277 by sectional steel and rock drill.[98]

Claims for uranium mineralization were staked and some drilling was done in the Marian River region, Ingray Lake area, Hottah Lake area, Trout Rock region, Stark Lake region, and the Rourangeau Lake area, Northwest Territory.

A radioactive conglomerate bed at the former Breton property in Long Township, Lake Huron region, Ontario, was found. Pronto Uranium Mines, Ltd., developed the deposit. An adit was driven to obtain bulk samples for metallurgical tests.

Algoma Uranium Mines, Ltd., examined uranium occurrences at Quirke Lake, Pecors Lake, and Elliot Lake in the Lake Huron region, Ontario.

In the North Bay region, Ontario, Beaucage Mines, Ltd., did much diamond drilling to explore columbium-uranium discoveries on and near the Manitou Islands in Lake Nipissing.

In the Haliburton-Bancroft region, Ontario, near Wilberforce, Central Lake Uranium Mines, Ltd., did extensive trenching and diamond drilling, which indicated that a large tonnage of material averaging 0.08 to 0.10 percent U_3O_8 may be available. An adit was driven. Croft Uranium Mines prospected and drilled an extension of the zone on adjoining property.

[97] Department of Mines and Technical Surveys, Uranium in Canada in 1953—Preliminary: Ottawa, Canada, p. 4.

[98] Eldorado Mining & Refining, Ltd., Annual Report, 1953: 19 pp.

Newkirk Mining Corp., financing drilling on the Faraday property west of Bancroft, Ontario, is reported to have outlined a uranium-bearing deposit for a width of 28 feet and a length of 320.

In British Columbia during 1953 drilling was continued on the Rexspar property, about 90 miles north of Kamloops. The main zone of mineralization is said to consist of some 160,000 tons of material. An adit was driven for underground exploration and drilling. Similar mineralization was found on the adjoining Deer Horn Mines, Ltd., claims.

Pitchblende was reported to have been found near Fidler Point on Lake Athabaska about 80 miles west of Beaverlodge and at Leggo Lake about 30 miles east of Fitzgerald in the Province of Alberta.

The only uranium exploration in Manitoba in 1953 centered around the Dion Lake property, Herb Lake region. The uranium mineralization was of pegmatitic origin and localized.

There was much staking of claims in the Maniwaki region and in and near Grand Calumet Island and Huddersfield Townships of Quebec. Prospecting and exploration also took place in the vicinity of St. Simeon and Seven Islands; 45 new radioactive properties were reported in Quebec.[99]

The recovery of uranium from Canadian ores was described by the director of research and development, Eldorado Mining & Refining, Ltd.[1]

Mexico.—The National Institute for the Investigation of Mineral Resources asked for an increase in its 1953 budget to intensify its search for uranium and thorium deposits. The request was for 5,000,000 pesos ($570,000); the 1952 allotment was 2,000,000 pesos ($231,000).[2]

The institute examined reported uranium discoveries in Oaxaca, mostly on the Isthmus of Tehuantepec.[3]

SOUTH AMERICA

Argentina.—The National Commission for Atomic Energy announced that the Government of Argentina will purchase all uranium produced in that country. A sliding price scale based on the uranium content of the ore has been developed; the current schedule will be valid for 1 year from the date of issuance. Stockholders of uranium investments have been informed that all stock must be sold to the National Commission of Atomic Energy.[4]

The Argentine Government reportedly made its first purchase of uranium ore—2,750 kilos—from the Santa Ana mine in the State of San Luis.[5] A concentrator for uranium ores will be constructed by the National Commission for Atomic Energy near Malargue in the State of Mendoza, where an important discovery of carnotite was reported.[6]

Bolivia.—Uranium mineralization was purported to have been discovered in an unspecified area of eastern Bolivia.[7]

[99] Work cited in footnote 97, pp. 4–7.
[1] Thunaes, A., Recovery of Uranium From Canadian Ores: Canadian Min. and Met. Bull., vol. 47, No 503, March 1954, pp. 128–130.
[2] Mining World, vol. 15, No. 4, Apr. 1, 1953, p. 67.
[3] Mining World, vol. 15, No. 11, October 1953, p. 98.
[4] Atomic Energy Newsletter, vol. 9, No. 6, May 5, 1953, p. 3.
[5] Atomic Scientists Journal, vol. 3, No. 3, January 1954, p. 152.
[6] Engineering and Mining Journal, vol. 155, No. 1, p. 158.
[7] Mining World, vol. 15, No. 2, February 1953, p. 61.

Brazil.—The Government-controlled Cruzeiro do Sul Airline, with the assistance of Aero Service Corp., will make extensive airborne magnetic and radioactivity surveys of Brazilian territory.[8]

Several uranium occurrences were discovered in the State of Minas Gerais. The Companhia Morro Velho mined uranium ore at a site near its famous Morro Velho gold mine. A deposit of uranium, thorium, and columbium at Araxa appeared significant, and an occurrence containing 2 to 10 percent uranium at São João del Rei was being studied.[9]

The chairman of the Brazilian National Research Council, Admiral Alvaro Alberto, disclosed that Brazil's first uranium-processing plant may be operating by January 1955. The construction in the next 2 or 3 years of several small experimental reactors was also planned.[10]

Chile.—The Chilean Government was planning a comprehensive search for radioactive materials to be conducted by the mining department of the Corporacion de Fomento de la Produccion with the assistance of the Caja de Credito Minero. The Codigo Minero (mining laws) may be amended by the Chilean Congress to reserve radioactive minerals produced by private industry for the use of the Government. A draft of such a bill was prepared by two congressional committees.[11]

Peru.—Geologists of the United States Atomic Energy Commission surveyed prospective uranium deposits in Peru for 3 months in 1953. High-grade radioactive material was discovered in diverse sections of the country.

Private industry and capital will develop the uranium deposits, and the Peruvian Government will be the only purchaser of the ores produced. A guaranteed scale of prices for the purchase of radioactive ores will be established, and marketing of radioactive products will be the responsibility of the Government.[12]

EUROPE

Representatives of the 10 member countries of the European Council for Nuclear Research (see Uranium, Radium and Thorium chapter, Minerals Yearbook, 1952) and representatives of Greece and the United Kingdom assembled in Paris in July 1953 to consider signing a convention for establishing a European Organization for Nuclear Research, which would succeed the Council (Conseil Européen pour la Recherche Nucléaire, or CERN) when 7 nations, including Switzerland, have ratified the signatures of their respective representatives to the convention. By the close of the year representatives of 10 countries—Belgium, France, West Germany, Greece, Italy, the Netherlands, Sweden, Switzerland, the United Kingdom, and Yugoslavia—had signed the convention, and 2 countries—Switzerland and the United Kingdom—had ratified the signatures of their respective representatives.. CERN, a temporary organization, was constituted to plan an international laboratory and organize other forms of cooperation in nuclear research. Construction of the laboratory at

[8] Mining Engineering, vol. 5, No. 2, February 1953, p. 153.
[9] Mining World, vol. 15, No. 9, August 1953, p. 89; vol. 15, No. 10, p. 83.
Canadian Mining Journal, vol. 11, No. 74, November 1953, p. 84.
[10] Atomics and Atomic Technology, vol. 4, No. 12, December 1953, p. 307.
[11] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 3, September 1953, p. 32.
[12] Engineering and Mining Journal, vol. 155 ,No. 1, January 1954, p. 162.

Geneva will be under the direction of the European Organization for Nuclear Research, at an estimated cost of $30,000,000, to be expended over a construction period of 7 years.[13]

Belgium.—The 2,000-kw., nuclear reactor under construction at Moll, in the Campine area of the Province of Antwerp, was nearing completion at the close of 1953.[14]

Early establishment was announced of a research center, either at Moll or at Marche in the Province of Luxembourg, for investigating the application of nuclear energy in the chemical and metal industries.[15]

Bulgaria.—Uranium deposits discovered near Sofia, Bulgaria, were reported under active exploitation in 1953 as a result of pressure exerted by the Soviet Union.[16]

France.—The French Atomic Energy Commission disclosed during the summer of 1953 that a pilot plant to produce 50 to 100 grams of plutonium a day would soon be constructed in the Rhone Valley.[17] Details of the French atomic energy program were published during the year.[18]

Germany, East.—Establishment of an atomic research center at Boehlen, East Germany, to be operated by East Germans with Russian assistance was reported.[19] East Germany would have a share equal to that held by Russia in the reorganized Wismuth Co., according to an announcement attributed to the Prime Minister of East Germany.[20] Control of uranium production in East Germany is held by the Wismuth Co.

Germany, West.—Preparations were said to be under way toward the close of 1953, with Allied permission, to mine uranium ore in West Germany from deposits in the Black Forest and the Fichtel Mountains and to produce uranium at the rate of 9 tons a year.[21]

Netherlands.—The Government of The Netherlands, with participation of Netherlands industry, is attempting to develop a commercial nuclear power reactor. Whether the control of the proposed reactor program will be in public or private hands is unknown.[22]

Norway.—An occurrence of uraniferous graphite was investigated in Glomfjord,[23] and it has been confirmed that uranium is present in granitic deposits at Rendalsvik south of Glomfjord. The economic significance of these deposits has not been announced.[24]

The reactor and nuclear science laboratories of the Joint Establishment for Nuclear Energy Research at Kjeller, Norway, are run jointly by a Norwegian-Netherlands Commission. Radioactive isotopes are produced in the reactor and distributed to qualified European

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[13] Pickavance, T. G., The European Nuclear Physics Laboratory: Atom Sci. Jour., vol. 3 ,No. 2, November 1953, pp. 73–76.
Wentzel, A. L., International Laboratory for Nuclear Research: Bull. Atom Sci., vol. 9, No. 6, July 1953, pp. 223–224.
Chemical and Engineering News, vol. 31, No. 27, July 6, 1953, p. 2745.
Engineering (London), vol. 176, No. 4567, Aug. 7, 1953, p. 179.

[14] Chemical Age (London), vol. 69, No. 1787, Oct. 10, 1953, p. 767.
Atomic Energy Newsletter, vol. 10, No. 10, Dec. 29, 1953, p. 4.

[15] Atomic Energy Newsletter, vol. 10, No. 6, Oct. 20, 1953, p. 4.

[16] Chemical and Engineering News, vol. 31, No. 7, Feb. 16, 1953, p. 687.

[17] Atomic Energy Newsletter, vol. 9, No. 13, July 28, 1953, p. 2; vol. 10, No. 10, Dec. 29, 1953, p. 4.
Bulletin of the Atomic Scientists, vol. 9, No. 9, November 1953, p. 352.

[18] Atomics (London), The French Atomic Energy Project: Vol. 4, No. 8, August 1953, pp. 183–187, 204.

[19] Industrial and Engineering Chemistry, vol. 45, No. 1, January 1953, p. 8–A

[20] Mining Journal (London), vol. 241, No. 6158, Aug. 28, 1953, p. 248.

[21] Chemical Age (London), vol. 69, No. 1794, Nov. 28, 1953, p. 1134.
Bulletin of the Atomic Scientists, vol. 9, No. 10, December 1953, p. 385.

[22] Bulletin of the Atomic Scientists, vol. 9, No. 4, May 1953, p. 145.

[23] Nucleonics, vol. 11, No. 3, March 1953, p. 74.

[24] Atomics and Atomic Engineering, vol. 4, No. 3 March 1953, p. 70.

purchasers. The materials made radioactive included isotopes of cobalt, iodine, sulfur, iridium, and phosphorus.[25] This 300-kw., heavy-water, natural-uranium reactor has been in operation approximately 2 years, and studies were being conducted to determine if heavy-water reactors are technically sound for industrial power purposes.[26]

Spain.—It was reported that geologists, geophysicists, and mining engineers were recruited during the year to develop a uranium deposit underlying the Straits of Gibraltar and outcropping near Algeciras, Spain.[27]

Sweden.—Development of facilities continued for recovering uranium from the oil-shale deposits at Kvarntorp. Operation of the uranium extraction plant near Orebo was begun.[28] The uranium recovered from the kolm-bearing shale is subsequently refined in a special chemical processing plant operated by A. B. Atomenergi, a Government-industry combine.[29]

Construction of an experimental 100-kw. nuclear reactor is expected to be completed early in 1954. The unit will require 3 to 4 tons of uranium and will be moderated with heavy water. It is located underground in Stockholm, and will be operated by A. B. Atomenergi.[30]

The Swedish Government's Atomkommitten, formed in 1945, controls the country's nuclear research program, and it has been estimated that the Government's expenditures on behalf of the program have so far totaled some 42 million kroner, about 8 million dollars in United States currency.[31]

Switzerland.—Geneva will be the site of the European Nuclear Research Center. Construction of the international laboratory will be a 7-year project and at an estimated cost of $30 million. The center is proposed as the headquarters of a 12-European country organization for cooperative nuclear research. (See Europe.)[32]

The Swiss Atomic Energy Commission is planning to build a heavy-water, natural-uranium reactor of 10,000-kw. capacity. The reactor will probably cost about 5 million dollars, funds to be furnished by both the Government and industry.[33]

U. S. S. R.—The Premier of the Russian Government announced on August 8, 1953, that the United States no longer had a monopoly of the hydrogen bomb.[34] In response to requests for comment on the announcement, Lewis L. Strauss, who was appointed Chairman of the United States Atomic Energy Commission July 2, 1953, stated:[35]

> We have never assumed that it was beyond the capability of the Russians to produce such a weapon and that is the reason why, more than 3 years ago, it was decided to press forward with this development for ourselves.

Subsequent statements by the Chairman were to the effect that the Soviet Union had conducted an atomic test on August 12, that the

[25] Chemical Age (London), vol. 68, No. 1764, May 2, 1953, p. 682.
Atomic Energy Newsletter, vol. 9, No. 7, May 19, 1953, p. 3.
South African Mining and Engineering Journal, vol. 64, No. 3151, part 1, July 4, 1953, p. 755.
[26] Atomic Energy Newsletter, vol. 10, No. 10, Dec. 29, 1953, p. 4.
[27] Mining World, vol. 15, No. 7, June 1953, p. 70.
[28] Nucleonics, vol. 12, No. 1, January 1954, p. 76.
[29] South African Mining and Engineering Journal, vol. 64, No. 3140, part 1, Apr. 18, 1953, p. 219.
[30] Atomic Energy Newsletter, vol. 10, No. 10, Dec. 29, 1953, p. 3.
[31] Work cited in footnote 29.
[32] Work cited in footnote 13.
[33] Atomic Energy Newsletter, vol. 10, No. 10, Dec. 29, 1953, p. 4.
[34] New York Times, vol. 102, No. 34,896, Aug. 9, 1953, Sec. 1, p. 1.
[35] Atomic Energy Commission, Press release: Aug. 8, 1953, 1 p.

test involved both fission and thermonuclear reactions,[36] and that on August 23 a fission explosion took place in Russian territory.[37]

The atomic energy program of the Soviet Union was discussed by a former Chairman of the United States Atomic Energy Commission, in part, as follows:[38]

> In any atomic energy program of considerable size, there are four essential ingredients: adequate material resources, including uranium; adequate scientific competence; adequate technological and production capacity; and the determination and ability to unite these three.
>
> * * * the Soviet Union has available to her the uranium ores of the Erzgebirge region of Czechoslovakia and Saxony, one of the world's three historic relatively high-grade sources of this valuable metal, and she is working this region energetically with slave labor. The Erzgebirge region alone could support a sizable atomic energy program. In addition, the geology of the U. S. S. R. is favorable, in a number of areas both east and west of the Urals, to relatively low-grade deposits of uranium ore. Russia should have no more difficulty in working these than we, in the United States, have in working our own relatively low-grade deposits. Taking these two facts together, there is no doubt that the Soviet Union has available sufficient uranium for a large-scale atomic energy program. In addition, in the vast expanses of the Russian Soviet Empire are the fuels, the sources of electric energy, the iron, and the many other natural resources that are essential to a large industrial operation such as an atomic energy program.
>
> Science in Russia today is sponsored and controlled by the government, acting through the Academy of Sciences and the ministries of Higher Education, Health, Agriculture, various industries, and the Armed Services. The Academy is divided into several sections looking after particular fields, such as chemistry, physics, and mathematics. Each section in turn operates a number of institutes. The section on physics and mathematics, for example, has, among others, the Institute of Physical Problems in Moscow, formerly headed by Kapitza, and the Physico-Technical Institute in Leningrad. The institutes work very closely with the universities in the areas where they are located. * * * The total number of people associated with the Academy and its affiliates is probably more than 40,000, including more than 12,000 scientists and technicians. All of this vast scientific machinery can be turned in any direction the government wishes. Much of the work in physics is undoubtedly steered in the direction of atomic energy development * * * The number of higher educational institutions in Russia, most of which nowadays are primarily concerned with producing professional personnel, has increased from about 150 in 1930 to 900 in 1952. During this same period, student enrollments have gone up from about 200,000 to about 1,400,000, including extension-course enrollees, and the annual graduating classes in the Soviet Union now total about 200,000, of which about half are scientific or technical people. This last figure compares with the about 100,000 scientific or technical students who are graduated annually in the United States. About 30,000 engineers were graduated by Russian schools in 1952, and this figure may increase to about 40,000 by 1955. American production of engineers will average about 22,000 annually over the next four years, although the rate is expected to increase substantially thereafter. * * * The quality of professional training in Russia is apparently very good. Admission to Russian institutions of higher learning seems to be largely on the basis of ability, and subsidies by the government make it possible for all individuals of real ability to complete their training.
>
> * * * Russia has the raw materials, including uranium, and the scientific competence necessary to a sturdy atomic energy program. But what of her production and technological capabilities? Is it true, as some GI's returning home from World War II would have us believe, that the average Russian does not even have the mechanical talent to repair a broken jeep? Certainly such an impression prevails widely. And is it true, as some have said, that—while Russia has able scientists and engineers at the top of her industrial structure, and an unlimited supply of labor at the bottom—she is in very short supply of those essential intermediate people, such as skilled craftsmen, shop foremen, and divisional superintendents? There is some truth in this generalization, but it is dangerously misleading. The proof of the pudding, after all, is in the eating,

[36] Atomic Energy Commission, Press release: Aug. 20, 1953, 1 p.
[37] Atomic Energy Commission, Press release: Sept. 1, 1953, 1 p.
[38] Dean, Gordon, Report on the Atom: Alfred A. Knopf, New York, N. Y., 1953, 321 pp.

and Russia during and since World War II has been mass-producing tanks, rockets, artillery, and aircraft of high quality. These are facts, and one hardly needs any more of a current reminder than the behavior of the MIG–15 jet. We have consistently underrated the Russian technological and production achievement, and it is now time we stopped doing it. Her performance during and since World War II is there for us to see, and it is time we started to believe what we see.

The Russian system produces a number of advantages, as well as disadvantages, insofar as the will and ability to accomplish things is concerned. The net result, however, is that there are enough advantages to make it possible for big things to be done in a big way—at a price in human freedom and dignity.

United Kingdom.—Britain's second atomic test series took place on the Woomera rocket range in South Australia during October 1953. What was described as a "utility" bomb, less powerful than that exploded in the Monte Bello Islands on October 3, 1952, was tested on October 15; another explosion was detonated on October 27.[39] Both 1953 explosions were detonated from a steel tower.[40] Woomera rocket range, about 550 miles northwest of Adelaide, was established shortly after the war as a testing ground for new weapons and, reportedly, will eventually cover an immense area extending from Southern Australia to beyond the northwest seaboard, a distance of 1,200 miles on land and a further 1,500 miles out to sea.[41]

Construction of the world's first atomic power station, rated at 50,000 kw., was begun in June 1953 at Calder Hall, Cumberland, England, and scheduled for completion in about 2 years.[42] The reactor is of the thermal type, graphite moderated, and cooled by circulating carbon dioxide under pressure.[43] Selection of a suitable site in Scotland for a second atomic power station was under consideration as the year closed. The large reactor involved would be of the breeder type, also rated at 50,000 kw., and scheduled for completion in about 3 years.[44] The state of atomic energy development in Great Britain and future prospects for atomic power received considerable discussion in 1953.[45]

Shipments of radioisotopes by Britain's Atomic Energy Research Establishment, at Harwell, England, totaled 12,159 in 1953 compared with 9,710 such shipments in 1952.[46] Britain was held to be the world's leading exporter of radioisotopes in 1953.[47]

In November 1953 the British Government announced formation of a new organization, the Atomic Energy Corporation, the function of which would be speedy and economic development of atomic energy for industrial uses in the United Kingdom. Responsibility for atomic

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[39] Bulletin of the Atomic Scientists, vol. 9, No. 10, December 1953, p. 385.
Illustrated London News, vol. 224, No. 5989, Jan. 30, 1954, p. 157.

[40] Atomic Energy Newsletter, vol. 10, No. 6, Oct. 20, 1953, p. 4; vol. 10, No. 6, Nov. 3, 1953, p. 1.

[41] Atlantic, Australia: Vol. 192, No. 2, August 1953, p. 16.

[42] Atomic Energy Newsletter, vol. 10, No. 10, Dec. 29, 1953, p. 4.

[43] Hinton, Christopher, Atomic Energy Developments in Great Britain: Bull. Atom. Sci., vol. 9, No. 10, December 1953, pp. 366–368, 390.

[44] Nucleonics, vol. 11, No. 12, December 1953, p. 70.

[45] Goodlet, B. L., The Outlook for Economic Nuclear Power: Atomics (London), vol. 4, No. 12, December 1953, pp. 311–317.
Hacking, John, The Production and Use of Energy in Great Britain: Address before Fifth British Electrical Power Convention, Torquay, England, June 9, 1953; Mining Journal (London), vol. 240, No. 6147, June 12, 1953, p. 694.
Skinner, H. W. B., Atomic Energy in Postwar Britain: Bull. Atom. Sci., vol. 9, No. 5, June 1953, pp. 156–161.

[46] Atomic Energy Newsletter, vol. 11, No. 4, Apr. 6, 1954, p. 3.
Cockcroft. John. Atomic Energy Research at Harwell: Atom. Sci. Jour., vol. 3, No. 4, March 1954, pp. 182–192.

[47] Iron and Coal Trades Review (London). vol. 167, No. 4461, Oct. 9, 1953, p. 857.
Bulletin of the Atomic Scientists. vol. 10. No. 3, March 1954, p. 109.

energy development was to be transferred from the Ministry of Supply to the new corporation as of January 1, 1954.[48]

ASIA

India.—Discovery of uranium in the Damodar Valley was announced in 1953,[49] and drilling operations were reported in progress on uranium deposits found in the State of Bihar.[50] Construction of a uranium-thorium processing plant at Trombay, about 10 miles northwest of Bombay, was begun. The plant will treat uranium-bearing concentrates from Bihar and other parts of India, as well as uranium- and thorium-bearing residual cake from the Alwaye, Travancore-Cochin, monazite processing plant operated by Indian Rare Earths, Ltd. Expectations were that the new Trombay plant would be completed by the close of 1954 and produce about 215 tons of thorium nitrate annually.[51]

A seven-point program pertaining to the development of atomic energy was prepared by the Atomic Energy Commission of India and announced in March 1953 by the Minister for Natural Resources and Scientific Research, according to reports. The program comprised (1) a survey of India for radioactive mineral deposits, particularly uranium deposits; (2) construction of a nuclear reactor; (3) establishment of a medical and health division of the Commission, to protect the health of workers engaged on the atomic energy program; (4) establishment of a biological division, to make fundamental biological investigations utilizing techniques developed in the field of atomic energy; (5) construction of a pilot plant for the extraction of uranium from tailings produced at copper-ore treatment plants and from low-grade uranium ores; (6) construction of a plant for recovering thorium and uranium from residual cake produced at the Alwaye plant in the course of recovering rare earth chlorides and carbonates from monazite; and (7) construction of a plant for the production of uranium of sufficient purity for reactor purposes.[52]

AFRICA

Belgian Congo.—The Shinkolobwe mine of Union Minière du Haut Katanga, in Belgian Congo, continued in 1953 to be a major producer of uranium for the atomic energy program of the United States.[53] In the course of becoming available to the program, the ore mined at Shinkolobwe [54] is placed in steel drums which are loaded on freight cars at Shinkolobwe for transport over a narrow-gage railway to Jadotville, 20 miles east (see fig. 2), and thence northwest about 900 miles to Port Francqui on the Kasai River, where the railway ends. The drums are transferred at Port Francqui to paddlewheel riverboats

[48] Engineering (London), The Atomic Energy Project: Vol. 176, No. 4582, Nov. 20, 1953, p. 657.
Mining Journal (London), Atomic Energy Corporation Formed in U. K.: Vol. 241, No. 6169, Nov. 13, 1953, p. 556.
Economist (London), Franchise for Atomic Energy: Vol. 169, No. 5751, Nov. 14, 1953, pp. 505–508.
[49] Mining Journal (London), vol. 240, No. 6139, Apr. 17, 1953, p. 446.
[50] Atomics and Atomic Engineering, vol. 4, No. 5, May 1953, p. 121.
[51] United States Embassy, New Delhi, India, State Department Dispatch 2199, Apr. 14, 1953, 2 pp.
Industrial and Mining Standard, vol. 108, No. 2743, June 4, 1953, p. 10.
Chemical Age (London), vol. 69, No. 1783, Sept. 12, 1953, p. 536.
[52] South African Mining and Engineering Journal, vol. 64, No. 3140, Part 1, Apr. 18, 1953, p. 243.
[53] Atomic Energy Commission, Fifteenth Semiannual Report: January 1954, p. 5.
[54] Ruch, J. W., Status of Uranium Recovery From Low Grade Sources: Address before Colorado Min. Assoc., Denver, Colo., Jan. 29, 1954.

that follow the Kasai River to its confluence with the Congo River and then proceed down the Congo to Leopoldville, about 500 miles. At Leopoldville the drums are again loaded on freight cars for transport over another narrow-gage railway. This 230-mile rail line traverses some rugged terrain in passing around Stanley Falls in the Congo and winding down through the Crystal Mountains before terminating at the port of Matadi on the Congo, 80 miles from the Atlantic. At Matadi the drums of ore are transferred to ocean freighters which in due course discharge the drums into lighters in the port of New York.[55]

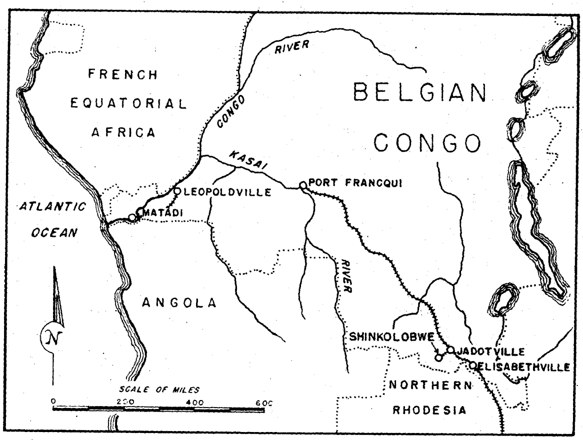

FIGURE 2.—Location of Shinkolobwe mine and ore-transport route to the Atlantic coast.

Details were disclosed in 1953 concerning the initial shipment of Shinkolobwe ore to the United States for atomic energy purposes.[56]

Madagascar.—Processing of uranium ore from the Vinaninkarena mine near Antsirabe, about 100 miles southwest of Tananarive, began in February 1953 at the treatment plant constructed during 1952 at Tananarive, according to reports. Output of the plant is shipped to France.[57]

Mozambique.—A gravity-concentration plant, to treat 100 tons of ore a day, was reported under construction during 1953 at the Mavuzi uranium mines north of Tete. The ore is said to be a disseminated davidite.[58] A pitchblende deposit, apparently the first found in Mozambique, was discovered at the headwaters of the Nhaondoe River, a few miles north of the Zambesi River and at about lat. 15°55′ S. and long. 33°32′ E., according to reports.[59]

Northern Rhodesia.—Pilot-plant investigations were conducted in 1953 at the Nkana copper mine of Rhokana Corp., Ltd., according to reports, with the view of developing a satisfactory flotation process

55 Deindorfer, Robert, The Forbidden Mines of Katanga: World (magazine), vol. 1, No. 7, February 1954, pp. 17–21.
56 Gunther, John, Mystery Man of the A-Bomb: Reader's Digest, vol. 63, No. 380, December 1953, pp. 18–20.
57 Mining World, vol. 15, No. 6, May 1953, p. 75.
58 Mining World, vol. 15, No. 11, October 1953, p. 85.
59 Mining World, vol. 15, No. 12, November 1953, p. 77.

for recovering uranium contained in ore from the Mindola section of the mine.[60]

Southern Rhodesia.—Uranium deposits near Beit Bridge and the southern boundary of Southern Rhodesia, which had been tested by the Atomic Energy Division of the British Geological Survey, were acquired in 1953 by Johannesburg mining interests, and erection of a processing plant was anticipated.[61]

Union of South Africa.—Recovery of uranium as a byproduct of the gold-mining industry on the Witwatersrand increased substantially in 1953. Four new uranium-recovery plants, completed respectively by Blyvooruitzicht Gold Mining Co., Ltd.; Daggafontein Mines, Ltd.; Stilfontein Gold Mining Co., Ltd.; and Western Reefs Exploration & Development Co., Ltd., were placed in operation (see fig. 3), making a total of five such plants operative on the Witwatersrand as the year closed [62] [63]—the plant completed by West Rand Consolidated Mines, Ltd., began operations in October 1952 (see Uranium, Radium and Thorium chapter, Minerals Yearbook, 1952).

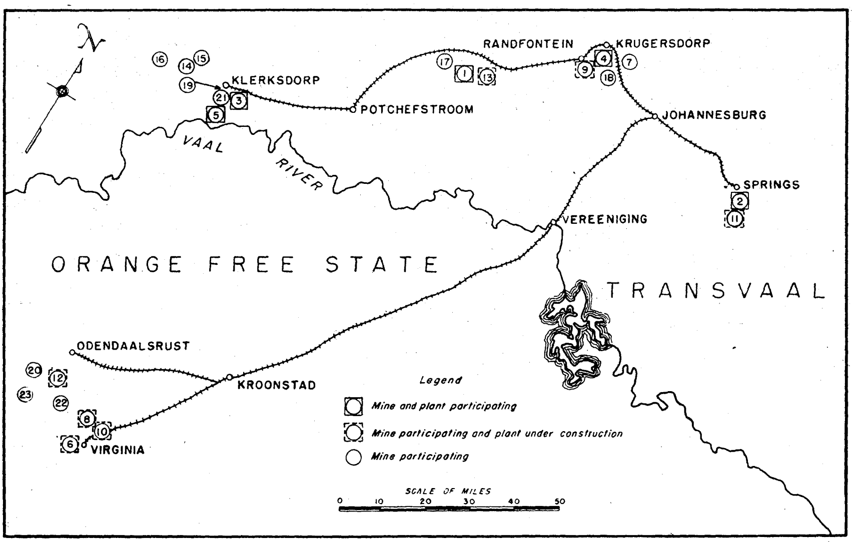

FIGURE 3.—Location of mines and mills participating at the close of 1953 in the South African uranium program.

Companies and the extent of their participation in the uranium-recovery program are shown in figure 3 as follows:

With mines and plants:

1. Blyvooruitzicht Gold Mining Co., Ltd.
2. Daggafontein Mines, Ltd.
3. Stilfontein Gold Mining Co., Ltd.
4. West Rand Consolidated Mines, Ltd.
5. Western Reefs Exploration & Development Co., Ltd.

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[60] Engineering and Mining Journal, vol. 155, No. 1, January 1954, p. 154.
[61] Rhodesia and Nyasaland Newsletter, Uranium Mine for S. R. Likely: Government of Rhodesia and Nyasaland, Federal Information Services, Nov. 6, 1953, p. 9.
[62] Work cited in footnote 53, p. 5.
[63] Atomic Energy Commission, Major Activities in the Atomic Energy Programs, January–June 1953.

With mines, but with plants under construction:
6. Harmony Gold Mining Co., Ltd.
7. Luipaardsvlei Estate & Gold Mining Co., Ltd.
8. President Steyn Gold Mining Co., Ltd.
9. Randfontein Estates Gold Mining Co., Ltd.
10. Virginia (O. F. S.) Gold Mining Co., Ltd.
11. Vogelstruisbult Gold Mining Areas, Ltd.
12. Welkom Gold Mining Co., Ltd.
13. West Driefontein Gold Mining Co., Ltd.

With mines:
14. Afrikander Lease, Ltd.
15. Babrosco Mines (Pty.), Ltd.
16. Dominion Reefs (Klerksdorp), Ltd.
17. Doornfontein Gold Mining Co., Ltd.
18. East Champ d'Or Gold Mining Co., Ltd.
19. Ellaton G. M. Co., Ltd.
20. Free State Geduld Mines, Ltd.
21. New Klerksdorp Gold Estates, Ltd.
22. President Brand Gold Mining Co., Ltd.
23. Western Holdings, Ltd.

Eight additional uranium-recovery plants were being constructed at the end of 1953; 4 in the Transvaal by Luipaardsvlei Estate & Gold Mining Co., Ltd.; Randfontein Estates Gold Mining Co., Ltd.; Vogelstruisbult Gold Mining Areas, Ltd.; and West Driefontein Gold Mining Co., Ltd., respectively, and 4 in Orange Free State by Harmony Gold Mining Co., Ltd.; President Steyn Gold Mining Co., Ltd.; Virginia (O. F. S.) Gold Mining Co., Ltd.; and Welkom Gold Mining Co., Ltd., respectively.[64] [65]

A total of 23 gold-mining companies had received authorization to produce uranium by the close of 1953. In addition to the 15 companies holding such authorization at the end of 1952, the following 8 companies were granted similar authorization in 1953: Afrikander Lease, Ltd.; Babrosco Mines (Pty.), Ltd.; Dominion Reefs (Klerksdorp), Ltd.; Doornfontein Gold Mining Co., Ltd.; East Champ d'Or Gold Mining Co., Ltd.; Ellaton G. M. Co., Ltd.; New Klerksdorp Gold Estates, Ltd.; West Driefontein Gold Mining Co. Ltd.[66]

Production of uranium was held to have an important bearing on the future economy of South Africa, inasmuch as it enhanced the value of the ore and would prolong the life of the gold mines both through the greater value and the fact that lower grade ore can be mined.[67] Capital expenditure under the uranium-production program was expected by the Minister of Mines, Union of South Africa, to reach SA£50 million and gross revenue to exceed SA£30 million a year.[68]

The following conclusions were expressed by Davidson relative to the uraninite in the gold ores of the Witwatersrand:[69]

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[64] Engineering and Mining Journal, Uranium Soars to Prominence in South Africa's Gold Fields: Vol. 154, No. 5, May 1953, pp. 72–76.
Mining Journal (London), vol. 240, No. 6142, May 8, 1953, pp. 550–551.
Mining Survey (Transvaal Chamber of Mines), Uranium in South Africa: Vol. 4, No. 3, March 1953, 32 pp.
Mining World, vol. 15, No. 7, June 1953, p. 70.
South African Mining and Engineering Journal, vol. 63, No. 3127, Jan. 17, 1953, p. 852.

[65] Engineering and Mining Journal, vol. 154, No. 11, November 1953, p. 174; vol. 155, No. 1, January 1954, p. 154.

[66] Mining World, vol. 15, No. 8, July 1953, pp. 72–73; vol. 15, No. 13, December 1953, p. 73.
South African Mining and Engineering Journal, vol. 64, No. 3141, part I, Apr. 25, 1953, p. 261; vol. 64, No. 3164, part 2, Oct. 3, 1953, p. 151; vol. 64, No. 3181, part 2, Jan. 30, 1954, p. 789.
Work cited in footnote 61.

[67] de Kock, P., The Influence of Our Mineral Resources on the Economic Development of South Africa: South African Min. & Eng. Jour., vol. 64, No. 3160, part II, Sept. 5, 1953, pp. 23–25.

[68] Mining Journal (London), vol. 241, No. 6173, Dec. 11, 1953, p. 687.

[69] Davidson, C. F., The Gold-Uranium Ores of the Witwatersrand: Min. Mag. (London), vol. 88, No. 2, February 1953, pp. 73–85.

In the gold-uranium ores of the Witwatersrand the two pay metals vary sympathetically and are clearly derived from the same mineralization. It is widely held in South Africa that the gold is of syngenetic origin; but since the uranium present (as uraninite) is certainly not of placer deposition this view cannot be maintained. The banket reefs differ from modern auriferous placers in possessing a much higher radioactivity than the latter, due to the ubiquitous presence of uraninite, a mineral which has never been recorded as a detrital constituent of any modern sediment. Conversely the refractory uranium and thorium minerals which account for the radioactivity of placers are absent from the South African ores. The distribution pattern of radioactivity throughout the Witwatersrand Series, as determined by radioactivity logging of boreholes, is wholly dissimilar from that found in normal sediments. Lead isotope studies suggest that the uraninite together with galena (and, by inference, the gold and other sulphides) were introduced into the conglomerates by hydrothermal action about 1,700 million years ago.

OCEANIA

Australia.—Marked progress was achieved in Australia during 1953 toward the establishment of a uranium industry, with indications that in 1954 the Commonwealth would be making a substantial contribution to the world's uranium supplies. Regular production of ore was begun from the uranium-copper deposits at Rum Jungle, Northern Territory, and construction was underway at the close of the year of the necessary plant for commercial-scale exploitation of the titanium-uranium (davidite) deposits at Radium Hill, South Australia.[70] [71]

Exploitation activities in the Rum Jungle field, about 40 miles south of Darwin, were well underway toward the close of 1953, with substantial ore reserves blocked out. Shaft sinking had reached a depth of 490 feet, and a concentration plant under construction was scheduled to begin production in the second half of 1954. Ore was produced during 1953 from an opencut 30 feet deep. About 500 persons were employed in the Rum Jungle operation, which is under the direction of Territory Enterprises Pty., Ltd., a subsidiary of Zinc Corp., Ltd.[72] Geologic investigations held promise that exploration in the Rum Jungle area might uncover ore not indicated by surface radiometric surveys.[73]

Under an agreement executed January 8, 1953, uranium from the Rum Jungle deposits will be sold to the Combined Development Agency, an organization through which the United States and the United Kingdom cooperate in the procurement of uranium. The agreement parallels similar action taken in July 1952 whereby uranium from the Radium Hill deposits would be sold to the CDA (see Uranium, Radium, and Thorium chapter, Minerals Yearbook, 1952.)[74]

Progress achieved in bringing the Radium Hill enterprise to fruition was described, in part, as follows by the Director, Department of Mines, South Australia:[75]

> The Radium Hill uranium field is situated 289 miles northeast of Adelaide and 70 miles from Broken Hill. A spur railway line of 11 miles from the main Broken Hill-Port Pirie line will be completed early in October, 1953, thereby providing

[70] Work cited in footnote 57, pp. 5, 6.
Metal Bulletin (London), No. 3785, Apr. 17, 1953, p. 23.
[71] Dickinson, S. B., Uranium and Australia: Address presented July 11, 1953, before the Royal Australian Chemical Institute at Mildura, Victoria, and published in Min. Mag. (London), vol. 89, No. 5, November 1953, pp. 265-272.
[72] Engineering and Mining Journal, vol. 154, No. 12, December 1953, p. 174.
Waylett, W. J., Uranium: Mining World, vol. 16, No. 5, April 1954, p. 47.
[73] Mining Engineering, Rum Jungle: Vol. 5, No. 5, May 1953, pp. 486-487.
[74] Daily Metal Reporter, vol. 53, No. 7, Jan. 10, 1953, p. 1.
Mining World, vol. 15, No. 3, March 1953, p. 59.
[75] Work cited in footnote 71, pp. 268-270.

the field with a direct line of 202 miles with Port Pirie, the site of the chemical extraction plant.

The known uranium deposits comprise a series of lodes adjacent to one another and occupying strong shears in old pre-Cambrian rocks. The lodes are persistent in length and depth, and recent exploration by drilling has revealed promising extensions, especially at the south end of the field. The lodes dip at angles from 30° to 70° and range up to 17 ft. in width; the average width is approximately 4 ft. The deposits are essentially of the vein type and the uranium is present chiefly in an unusual iron-titanium rich mineral which is known as davidite. This mineral also contains a number of other elements—notably, vanadium and rare earths which, together with titanium, may ultimately be recovered as useful byproducts.

The discovery of the occurrence of davidite at Radium Hill actually dates from 1906. It was mistaken for tin ore by the discoverer, Mr. A. J. Smith, a prospector, who sank the first shaft. Its association with a yellow encrustation, a product of weathering, led to its identification by Sir Douglas Mawson as a uranium mineral and eventually as a new uranium mineral to which the name davidite was given after the late Sir Edgeworth David. The original discovery was worked intermittently between 1908 and 1931 for the recovery of radium. It was not until 1947 that the systematic examination of the field was undertaken by the Department of Mines, commencing with geological and geophysical surveys and later with diamond drilling and small exploratory shafts. This testing work revealed a completely new lode system, with the old mine now constituting a very small part of one of the lodes.

The decision to undertake large-scale production was made in March 1952, and at the present time approximately half the approved capital works program has been completed. The establishment, completed for initial production, will cost approximately A£5,000,000 with an annual operating budget of A£2,000,000. The main service shaft has reached a depth of 400 ft. Development work on two levels is well advanced and a third level will be completed before the production date.

For some considerable time the ore from development openings has been treated on the field in a pilot concentrating plant. This plant has provided the basic data for the design of the large-scale concentrator now under construction and has yielded products for chemical extraction studies in Adelaide. The experience and knowledge gained from the operation of this plant will also be most useful in the running in of the new large-scale plant which will treat the full output of the mine. The treatment process combines heavy-medium separation with flotation. The product, a concentrate rich in uranium, will be loaded directly into railway trucks for transport to Port Pirie.

The supply of power to the field by means of a high-voltage transmission line from Morgan on the River Murray, 138 miles distant, is almost complete. It has been constructed by the Electricity Trust of South Australia in a very short time. In October the first power from the Electricity Trust network will be supplied and it will supersede the power from the temporary diesel station now in use.

Probably the most important service to the field is the water-supply pipeline from the Umberumberka Reservoir, 55 miles distant. By arrangement with the New South Wales Government and the Broken Hill Water Board water for the field will come from the Broken Hill water-supply system. A section of the pipeline linking the field with railway dams at Mingary will shortly be completed and by March, 1954, the whole scheme is scheduled for completion.

The uranium extraction plant now being erected at Port Pirie is designed to produce a high-grade uranium salt from the product of the Radium Hill mine—a flotation concentrate containing uranium in association with other minerals—notably titanium, iron, rare earths, vanadium, and numerous minor impurities. The process consists in the main of a leaching circuit with sulfuric acid as the leaching agent. The sulfuric acid dissolves uranium, together with certain other constituents of the concentrates, when heated for a prolonged period at boiling point. After separation from the undissolved material the liquor is subsequently treated for the final extraction of uranium black oxide. The plant is essentially an extension of the concentrating process at the mine. Instead of taking large quantities of chemical reagents required for the final concentration and establishing the plant, together with additional services and highly skilled personnel at the Radium Hill mine, it is more economical to bring the rough concentrates to Port Pirie. Production from the plant is expected in May, 1954. The capital cost is estimated at A£1,500,000 and when in production the average employment will be approximately 200. Its annual operating budget is estimated at approximately A£1,000,000.

The Port Pirie site has many advantages, both economic and strategic. Its establishment will bring another industry of considerable importance to this northern town, already well known and world famous for its lead smelting and refining operations.

Research and development work connected with Radium Hill has been concerned chiefly with the investigation of methods of extraction of uranium. By March 1952 the ore-dressing process had already reached the pilot-plant stage with very satisfactory results. Although utilizing known ore-dressing methods its success largely depends on a number of unique features evolved after much painstaking and systematic work. On the other hand, at that time, the choice of the chemical treatment process remained undecided. A number of lines of inquiry had been followed, but the most promising required chemical reagents not readily available in Australia. After reviewing the results of the research pro-

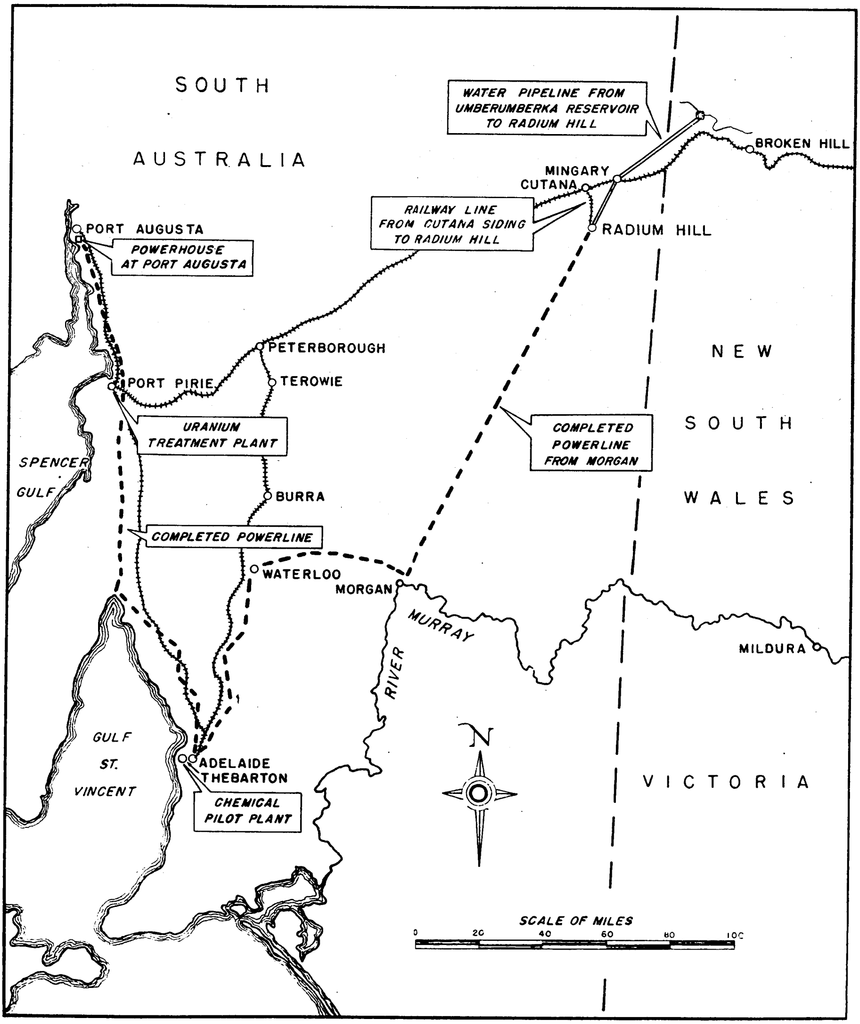

FIGURE 4.—Location of component facilities of the Radium Hill enterprise.

grams, including information made available for the first time from the United Kingdom Ministry of Supply and the United States Atomic Energy Commission, it was decided to use the sulfuric acid leaching technique. While the chemistry of this process was proved, little was known regarding its application in a large-

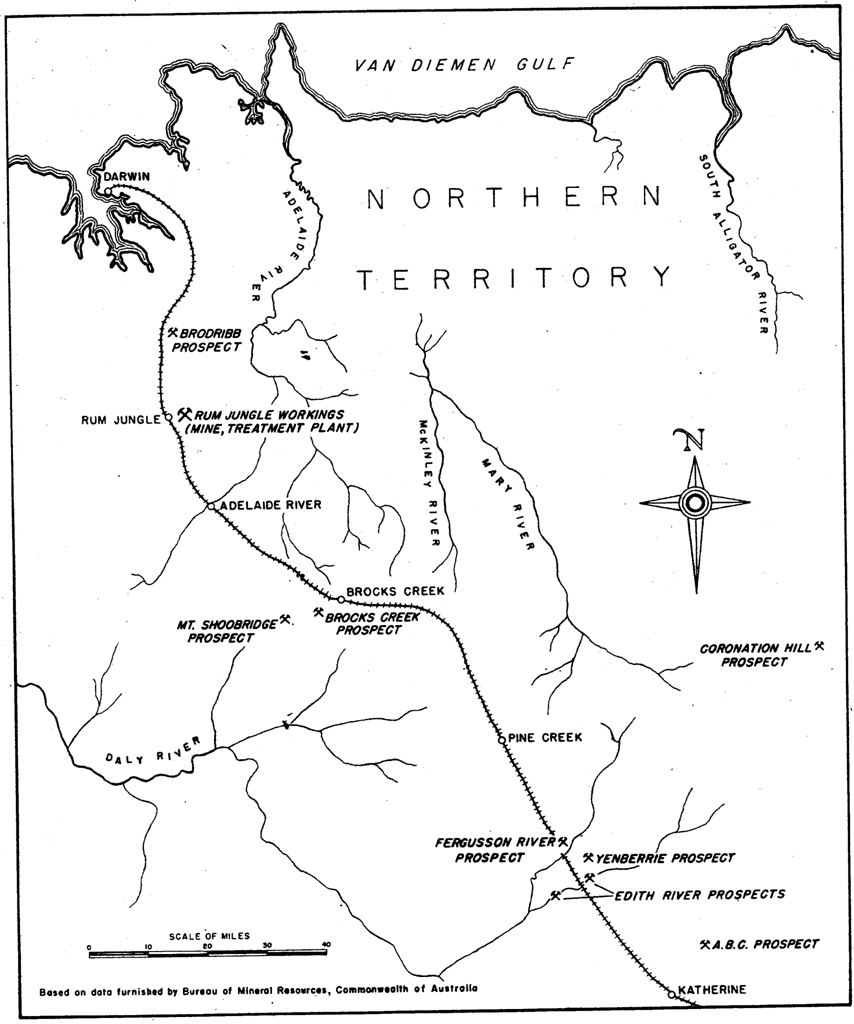

FIGURE 5.—Location of the Rum Jungle area and of nearby uranium discoveries in Northern Territory, Australia.

scale production plant. It was therefore decided to undertake pilot-plant operations with the minimum of delay. In October 1952 the chemical pilot plant at Thebarton commenced operation and has since been running continuously. Several modifications have been found necessary to the original process, but during the early part of 1953 the results have been sufficiently encouraging and adequate to commence the design and construction of the Port Pirie plant.

Two promising uranium discoveries were made in Northern Territory during 1953 according to reports. One, known as the Coronation Hill deposit because it was found on Coronation Day, is situated about 140 miles southeast of Darwin and 55 miles east of Pine Creek; the discovery resulted from an airborne radiometric survey. The other, named the ABC field after A. B. Clarke—a geologist who made the discovery while mapping the area—is situated about 11 miles northeast of Katherine. Drilling was in progress on the Coronation Hill deposit as the year closed.[76]

Other uranium discoveries reported to have been made in Australia during 1953 included three additional deposits in the Crocker's Well area, 40 miles northwest of Radium Hill in South Australia;[77] a discovery of high-grade uraninite ore in biotite schists at Myponga, about 32 miles south of Adelaide;[78] another occurrence along the Edith River in Northern Territory, about 4 miles from the deposit found in 1952;[79] an occurrence discovered along the shore of Lake Dundas in Western Australia, about 350 miles east of Perth and 15 miles south of the town of Norseman, where drilling operations were begun as the year closed;[80] and indications of low-grade uranium deposits in the Broken Hill district, New South Wales.[81]

The Australian Atomic Energy Commission announced a new schedule of prices, effective July 1, 1953, and guaranteed for 5 years, for uranium-bearing ores and concentrates. Designed primarily to encourage the prospecting for and development of uranium deposits, the schedule was applicable up to a limit of 20,000 tons of ore purchased from any 1 producer in any one year. In instances where uranium deposits appeared likely to yield larger tonnages of ore, purchase terms would be subject to negotiation between the producer and the Commission. Purchase points were announced to be Rum Jungle and any other points specified from time to time. Details of the new schedule follow:[82]

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[76] Engineering and Mining Journal, vol. 154, No. 10, October 1953, p. 196; vol. 154, No. 12, December 1953, p. 174.
Mining World and Engineering Record (London), vol. 155, No. 4312, Nov. 21, 1953, p. 304.
[77] Nucleonics, vol. 11, No. 12, December 1953, p. 72.
[78] Gillingham, T. E., Uranium: Min. Cong. Jour., vol. 40, No. 2, February 1954, p. 118.
United States Consulate, Melbourne, Australia, State Department Dispatch 59, Dec. 30, 1953, 2 pp.
[79] Atomics and Atomic Engineering, vol. 4, No. 4, April 1953, p. 99.
[80] Chemical Age (London), vol. 69, No. 1798, Dec. 26, 1953, p. 1332.
United States Consulate, Perth, Australia, State Department Dispatch 16, Dec. 28, 1953, p. 4.
[81] Mining Journal (London), vol. 240, No. 6148, June 19, 1953, p. 731.
[82] Australian Atomic Energy Commission, Schedule of Prices for Uranium-bearing Ores and Concentrates: Circ. 1, June 30, 1953, 3 pp.
Chemical Engineering and Mining Review (Australia), vol. 45, No. 10, July 10, 1953, p. 398.
Atomic Energy Newsletter, vol. 10, No. 5, Oct. 6, 1953, p. 4.

Minimum prices, guaranteed for 5 years from July 1, 1953.

Grade, percent U_3O_8	Price per pound of U_3O_8 in ore	Minimum price per ton of ore, dry weight, at points specified
	A£ s. d.	A£ s. d.
0.25	— 36 —	10 — —
.3	— 36 —	12 — —
.4	— 36 —	16 — —
.5	— 36 —	20 — —
.6	— 36 —	24 — —
.7	— 36 —	28 — —
.8	— 36 —	32 — —
.9	— 36 —	36 — —
1.0	— 36 —	40 — —
2.0	— 37 —	83 — —
3.0	— 38 —	128 — —
4.0	— 39 —	175 — —
5.0	— 40 —	224 — —
10.0	— 45 —	504 — —

Special arrangements will be considered for the purchase of ore of grades lower than those shown in the above schedule, and the price payable will be subject to adjustment in accordance with circumstances. The following are prices which, depending on location, characteristics, and tonnage offered of ores lower than 0.25 percent in grade, might be the basis of negotiation:

Grade, percent U_3O_8	Price per pound of U_3O_8 in ore	Minimum price per ton of ore, dry weight, at points specified
	A£ s. d.	A£ s. d.
0.10	— 14 —	1 10 —
.11	— 16 —	2 — —
.12	— 18 —	2 10 —
.13	— 20 —	3 — —
.14	— 22 —	3 10 —
.15	— 24 —	4 — —
.16	— 25 —	4 10 —
.17	— 27 —	5 — —
.18	— 29 —	6 — —
.19	— 31 —	6 10 —
.20	— 33 —	7 10 —

Vanadium

By Hubert W. Davis [1]

THE VANADIUM INDUSTRY is one of the smaller ferrous metal industries. It ranks last in production and second highest in price among the eight major alloying metals—chromium, cobalt, manganese, molybdenum, nickel, silicon, tungsten, and vanadium.

Since entry of the Atomic Energy Commission into the carnotite region of the Colorado Plateau for the purpose of obtaining uranium, by far the greater part of the vanadium production in the United States became a byproduct or coproduct of uranium. Previously, vanadium production in the United States resulted in byproduct uranium.

Vanadium, although a strategic metal, is the least critical of all the alloying elements used for steel manufacture. Vanadium supply from production in the United States, plus imports from Peru, again exceeded industry requirements, permitting accumulation of the surplus in the National Stockpile.

TABLE 1.—Vanadium in ores and concentrates produced in the United States, 1938–47 [1]

Year	Pounds	Year	Pounds
1938	1,613,155	1943	5,586,492
1939	1,984,068	1944	3,527,054
1940	2,162,916	1945	2,963,913
1941	2,513,051	1946	1,272,148
1942	4,439,130	1947	2,117,962

[1] Data for 1940–47 are receipts at mills and Government purchasing depots.

The center of vanadium-ore mining in the United States continued to be the Colorado Plateau, which comprises chiefly southwestern Colorado and southeastern Utah but extends into Arizona and New Mexico. Some vanadium is also recovered as a byproduct of phosphate rock mined in Idaho. Vanadium is also recovered as a byproduct of chrome ore at Glens Falls, N. Y., and of petroleum residues at Wood-Ridge, N. J.

Imports of vanadium concentrates and ferrovanadium in 1953 were 31 and 19 percent, respectively, less than in 1952. Exports of ferrovanadium in 1953 were 46 percent less than in 1952.

The quotations on vanadium ore and ferrovanadium were unchanged throughout 1953.

For security reasons publication of figures on the production and consumption of vanadium ore in the United States has been suspended since 1947 at the request of the Atomic Energy Commission.

[1] Commodity-industry analyst.

CONSUMPTION AND USES

The first step in processing domestic vanadium ores to a marketable form is conversion of the vanadium to pentoxide, which contains 85 to 92 percent V_2O_5. This product is consumed largely as a raw material in the manufacture of ferrovanadium, which contains 38 to 55 percent vanadium. Peruvian concentrates, which contain about 65 percent V_2O_5, are used directly in the production of ferrovanadium.

TABLE 2.—Producers of vanadium oxide and ferrovanadium in the United States in 1953

Producer	Location of plant	Product
Anaconda Copper Mining Co.	Anaconda, Mont.	Oxide.
Climax Uranium Corp.	Grand Junction, Colo.	Do.
Electro Metallurgical Division, Union Carbide & Carbon Corp.	Columbiana, Ohio	Ferrovanadium.
	Alloy, W. Va.	Do.
Galigher Co., The	Monticello, Utah	Oxide.
Imperial Paper & Color Co.	Glens Falls, N. Y.	Do.
United States Vanadium Co.	Rifle, Colo.	Do.
	Uravan, Colo.	Do.
Vanadium Corp. of America	Cambridge, Ohio	Ferrovanadium.
	Durango, Colo.	Oxide.
	Naturita, Colo.	Do.
Vitro Manufacturing Co.	Canonsburg, Pa.	Do.

About 90 percent of the vanadium used is consumed as ferrovanadium in the manufacture of tool steels, engineering steels, high-strength structural steels, nonaging rimming steels, and special wear-resistant cast irons. Ferrovanadium is also employed in welding-electrode coatings, as a deoxidizer, and in permanent-magnet alloys. Vanadium oxide is also used for the addition of vanadium to steels under certain special conditions. Vanadium oxide and ammonium metavanadate are employed as catalysts, in glass and ceramic glazes, for driers in paints and inks, and for laboratory research. The use of metallic vanadium alone is limited largely to alloying with gold in dental alloys, copper, and bronzes (such as for aircraft propeller bushings) and with aluminum for airframe construction. Some information on the less known mechanical properties of ductile vanadium was made available.[2]

Vanadium is mainly used in steel for its grain-refining and alloying effects. In high-speed steels the vanadium content ranges from approximately 0.50 to 2.50 percent, although still higher percentages are sometimes used. Alloy tool steels, other than high-speed steels, contain 0.20 to 1.00 percent vanadium. The quantity of vanadium added to engineering steels is usually 0.10 to 0.25 percent. Most steels containing over 0.50 percent vanadium have special purposes. Vanadium can be successfully used alone as an alloy of carbon steel; but in a wide variety of engineering and structural steels it is more usually employed in combination with chromium, nickel, manganese, boron, and tungsten. A high-temperature steel, which contains neither cobalt nor columbium but instead employs titanium and small, controlled quantities of vanadium, has been developed. In additions from 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] Steel, Close Look at Vanadium: Vol. 133, No. 3, July 20, 1953, pp. 134, 136, 138.

PRICES

Since March 8, 1951, vanadium ore has been quoted at 31 cents a pound of contained V_2O_5. This quotation, however, disregards penalties based on grade of the ore or the presence of objectionable impurities—matters important to the refiners, inasmuch as impurities vitally affect recoveries. Throughout 1953 vanadium pentoxide (technical grade) was quoted at $1.28 to $1.33 a pound of V_2O_5 and ferrovanadium at $3 to $3.20 a pound of contained vanadium (depending upon the grade of the alloy).

FOREIGN TRADE[3]

Imports of vanadium concentrates (all from Peru) in 1953 were 31 percent less than in 1952 and the smallest since 1949. Flue dust containing 1,010 pounds of vanadium was received from Venezuela in 1953 (939 pounds in 1952). Imports of ferrovanadium were 17,364 pounds (gross weight) valued at $12,584 in 1953 compared with 21,396 pounds valued at $22,132 in 1952. The 1953 imports comprised 12,884 pounds from Japan and 4,480 pounds from United Kingdom. Imports of vanadic acid, anhydride, salts, compounds, and mixtures (all from France) were 3,090 pounds (gross weight) valued at $2,368 in 1953 (none in 1952). Vanadium ore and concentrates enter the United States free of duty; however, the rate of duty on ferrovanadium is 12½ percent ad valorem and on vanadic oxide, anhydride, salts, and compounds and mixtures of vanadium 40 percent ad valorem.

TABLE 3.—Vanadium ore or concentrates and vanadium-bearing flue dust imported for consumption in the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Year	Vanadium ore or concentrates			Vanadium-bearing flue dust		
	Pounds		Value	Pounds		Value
	Gross weight	Vanadium content		Gross weight	Vanadium content	
1944–48 (average)	4,623,445	1,132,337	$546,322	113,314	31,843	$15,280
1949	2,028,980	551,337	272,124			
1950	5,110,403	1,457,010	708,806	9,575	804	2,475
1951	3,893,900	982,878	526,941			
1952	4,338,660	1,043,797	599,203	12,285	939	2,425
1953	2,959,600	716,977	421,091	9,822	1,010	2,237

Exports of ferrovanadium and other vanadium alloying materials containing over 6 percent vanadium totaled 156,952 pounds (gross weight) in 1953 and comprised 65,333 pounds to Canada, 59,124 pounds to Japan, 26,605 pounds to Spain, 4,840 pounds to Belgium-Luxembourg, 1,000 pounds to Mexico, and 50 pounds to Canal Zone. Exports of vanadium pentoxide, vanadic oxide, vanadium oxide, and vanadates totaled 12,319 pounds (contained vanadium) in 1953 and comprised 10,934 pounds to Italy, 945 pounds to France, 333 pounds to West Germany, 73 pounds to the Netherlands, 34 pounds to Brazil,

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

and less than half a pound to Canada. Exports of vanadium flue dust and other vanadium waste materials were 54,211 pounds (contained vanadium) in 1953 and comprised 53,760 pounds to the Netherlands and 451 pounds to France.

TABLE 4.—Exports of vanadium from the United States 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Year	Ore and concentrates [1]		Ferrovanadium		Vanadium metal, alloys, and scrap	
	Pounds (vanadium content)	Value	Pounds (gross weight)	Value	Pounds (gross weight)	Value
1944–48 (average)	29,415	$72,502	378,678	$655,422	5,629	$3,182
1949	13,130	26,266	194,655	350,558	2,754	17,851
1950	963	2,615	82,449	183,307	4,106	2,688
1951	2,817	6,581	122,344	190,346	1,712	6,481
1952	120,367	280,216	293,162	529,360	103,036	12,862
1953	[2] 12,319	[2] 32,141	[3] 156,952	[3] 296,157	(4)	(4)

[1] Probably also includes fused vanadium oxide.
[2] Comprises vanadium pentoxide, vanadic oxide, vanadium oxide, and vanadates.
[3] Comprises ferrovanadium and other vanadium alloying materials containing over 6 percent vanadium.
[4] Beginning Jan. 1, 1953, not separately classified.

TECHNOLOGY

The Bureau of Mines continued research on recovery of vanadium from phosphates and open-hearth slags. A process developed at its Northwest Electrodevelopment Laboratory, Albany, Oreg., for recovering vanadium red cake, sodium phosphate, and chrome yellow from western ferrophosphorus has been described [4] and patented.[5]

At Bureau's Eastern Experiment Station, College Park, Md., work was continued to determine the feasibility of recovering vanadium from an open-hearth slag containing 4.62 percent V_2O_5 by roasting with soda ash, followed by leaching with hot water. Results of research in 1953, however, were largely negative. Increasing the roasting temperature from 800° to 900° and 1,000° C. was found to be ineffectual as a means for increasing vanadium extractability above the 68 percent maximum previously attained. Also attempted, without beneficial results, was admixture of sulfur in the form of iron pyrites in the slag-soda mix before roasting in an effort to break down a possible spinel composed of the oxides of iron, manganese, and vanadium. Likewise, vanadium leachability was not improved by increasing the SiO_2 : CaO ratio of the slag by sintering with silica at a higher temperature, followed by mixing the resulting sinter with soda and roasting at a lower temperature. In an effort to increase the effect of the soda roast on solubility, a series of tests was made in which the slag was sintered with bauxite before the roast. Sintering took place at 1,142° C., with quantities of bauxite varying from 10 to 40 parts per 100 parts of slag. The sinter was then finely ground and roasted with soda ash at 800° C. The same procedure was repeated, using ilmenite at a sintering temperature of 1,156° C. The results of

[4] Banning, L. H., Anable, W. E., and Rasmussen, R. T. C., A Tristage Crystallization Process for Utilizing Western Ferrophosphorus: Jour. Metals, vol. 5, No. 3, March 1953, pp. 423–430.
[5] Banning, L. H., and Anable, W. E. (assigned to the United States of America), Tristage Crystallization and Hydrolysis Process for Recovering Vanadium Phosphorus and Chromium From Ferrophosphorus and Like Materials: U. S. Patent 2,654,655, Oct. 6, 1953.

these tests showed that the bauxite sinter depressed the solubility of vanadium in direct ratio to the quantity of bauxite employed. Sintering with ilmenite increased the solubility of vanadium where smaller quantities of soda ash were used in the roast. The increase, however, was not enough to warrant the addition of this step to the process.

The use of ion-exchange resins in recovering vanadium from acid leach liquors shows technical promise. By complexing a portion of the iron, the vanadium-iron ratio is increased, and a high-grade product may result that will meet specifications. At the Bureau of Mines Salt Lake City Experiment Station methods are being investigated for selectively precipitating ferric vanadate from the upgraded solutions and refining the precipitate by soda ash fusion and water leaching. In initial tests, 94 percent of the vanadium was recovered in a product meeting specifications.

The development of a method for recovering vanadium directly from alkaline solutions, without neutralizing them, has been described.[6]

Patents were issued for a method of recovering vanadates from aqueous solution [7] and a method for treating vanadium and uranium ores.[8]

A report by Armour Research Foundation, summarizing the results of work directed toward development of vanadium-base alloys, has been published.[9]

WORLD REVIEW

World production of vanadium ores is limited almost entirely to four countries—Northern Rhodesia, Peru, South-West Africa, and the United States.

TABLE 5.—World production of vanadium in ores and concentrates, 1944–53, in metric tons

[Compiled by Berenice B. Mitchell]

Country	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953
Argentina	4	3	6	7	(1)	(1)	(1)	(1)	(1)	(1)
Northern Rhodesia	254	219	68	56	173	153	------	87	43	------
Peru	514	688	322	435	511	456	436	449	[2] 437	317
South-West Africa	385	420	430	282	187	163	295	529	624	540
United States (shipments) [3]	1,600	1,344	577	961	(4)	(4)	(4)	(4)	(4)	(4)
Total [5]	2,757	2,674	1,403	1,741	(6)	(6)	(6)	(6)	(6)	(6)

[1] Figure not available.
[2] Revised figure.
[3] Includes vanadium recovered as a byproduct of phosphate-rock mining.
[4] United States figures for 1948–53 withheld at request of Atomic Energy Commission.
[5] Total represents data only for countries shown in table and excludes vanadium in ores produced in French Morocco, Spain, and U. S. S. R., for which figures are not available; the total also excludes quantities of vanadium recovered as byproducts from other ores and raw materials.
[6] Bureau of Mines not at liberty to publish figure.

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

[6] O'Brien, R. N., and others, Precipitation of Vanadium From Aqueous Vanadate Solutions by Reduction With Hydrogen: Canadian Min. and Met. Bull., vol. 46, No. 499, November 1953, pp. 673–676.
[7] Perrin, T. S., and Banner, R. G. (assigned to Diamond Alkali Co.), Method of Recovering Chromates and Vanadates From Aqueous Solution: United States Patent 2,628,154, Feb. 10, 1953.
[8] Burwell, Blair (assigned to Climax Uranium Co.), Method for Treating Vanadium and Uranium Ores and the Like: United States Patent 2,630,369, Mar. 3, 1953.
[9] Rostoker, W., and others, Exploration of Vanadium Base Alloys: Armour Research Foundation (Chicago), May 1953, 66 pp.

collected from the smokestacks of ships and industrial plants, and vanadiferous ashes derived from asphaltites.

Because complete information on the quantity of vanadium recovered as byproducts of iron ore and other raw materials is lacking, it is not possible to determine world production of vanadium from all sources. Consequently, table 5 reflects only the production of vanadium in ores and concentrates for the countries listed, plus the quantity recovered in the United States as a byproduct of phosphate rock.

Argentina.—Vanadium occurs in small deposits widely scattered in the Provinces of Córdoba, Mendoza, and San Luis. A small quantity of ore is mined for the production of 3 to 7 metric tons of vanadium pentoxide annually. Mining of vanadium ore in Argentina was reported as becoming more intensive, particularly because of increasing exportation to such countries as Brazil.[10]

Northern Rhodesia.—The Rhodesia Broken Hill Development Co., Ltd., the only producer of vanadium in Northern Rhodesia, had no output of vanadium oxide in 1953. Production of vanadium oxide was 83 long tons averaging 91.09 percent V_2O_5 in 1952. According to the company:

> All vanadium-bearing ore produced by the mine was stockpiled with the mixed fines tailings, pending the final evolution of a process for recovering both the zinc and vanadium contents of this material. Tests on the problem continue to give encouraging results.

Peru.—The famous Mina Ragra mine of the Vanadium Corp. of America in the Andes near Ricran, Department of Junin, has been an important source of vanadium since 1907, when production was begun. Output in Peru was 566 metric tons of V_2O_5 in 1953 compared with 780 tons of V_2O_5 (revised figure) in 1952.

South-West-Africa.—The Abenab West lead-vanadium mine of the South West Africa Co., Ltd., again was the only producer of vanadium in South-West Africa. Output of concentrates (in terms of recoverable V_2O_5) was 1,064 short tons in 1953 compared with 1,228 tons in 1952; exports of concentrates were 1,166 short tons in 1953 compared with 2,387 tons in 1952. The 1953 exports comprised 1,068 tons to Belgium and 98 tons to United Kingdom. The concentrates shipped to Belgium are processed to fused vanadium oxide for the South West Africa Co., Ltd., which reported that both production and sales of oxide were substantially greater in 1953 than in 1952.

[10] Mining World, vol. 15, No. 12, November 1953, p. 80.

Vermiculite

By Henry P. Chandler[1] and Nan C. Jensen[2]

ALTHOUGH the production of vermiculite declined slightly in 1953, the volume remained at a high level, as this commodity has established a firm market in the building industry.

DOMESTIC PRODUCTION

For the past 5 years the annual production of vermiculite in the United States has averaged about 200,000 short tons. There was a small downward trend in 1953.

Montana and South Carolina are the principal vermiculite-producing States, but smaller quantities are mined in North Carolina and Wyoming. The Zonolite Co., 135 South LaSalle St., Chicago, Ill., operated mines at Libby, Mont., and Travelers Rest, S. C.; American Vermiculite Co. at Woodruff, S. C.; National Vermiculite Co., Inc., at Lanford, S. C.; Variegate Vermiculite Mines at Green Mountain, N. C.; and Mikolite Corp. at Encampment, Wyo.

TABLE 1.—Screened and cleaned vermiculite sold or used by producers in the United States, 1944–48 (average) and 1949–53

Year	Short tons	Value	Year	Short tons	Value
1944–48 (average)	95,067	$956,720	1951	209,008	[1] $2,679,148
1949	168,819	1,686,419	1952	208,906	[1] 2,657,826
1950	208,096	2,122,427	1953	189,535	2,445,381

[1] Revised figure.

Vermiculite is usually mined by opencut methods, followed by concentration, then dried in rotary kilns at low temperatures to avoid exfoliation, and then screened to commercial sizes before shipment to exfoliating plants. Through the development of new processes for treating low-grade ore by one of the larger vermiculite producers, the mine reserves of vermiculite in the United States have been greatly enlarged.[3]

Exfoliation occurs when material that is dry, uniformly sized, and reasonably free from waste matter is fed to furnaces. It usually takes place at temperatures between 1,600° and 2,000° F. The charge is subjected to heat for a few seconds and then cooled rapidly.

[1] Commodity-industry analyst.
[2] Statistical assistant.
[3] Mining World, vol. 15, No. 9, August 1953, p. 107.
Rock Products, Vermiculite: Vol. 56, No. 8, August 1953, p. 101.
Engineering and Mining Journal, vol. 154, No. 9, September 1953, p. 148.

CONSUMPTION AND USES

No canvass of exfoliated-vermiculite production is conducted by the Bureau of Mines; however, assuming a 5-percent tonnage loss in processing, it is estimated that about 185,000 tons of exfoliated vermiculite was produced in 1953. With an average value estimate of $70 a ton f. o. b. plant, the total value of the exfoliated vermiculite produced in the United States may approximate $13,000,000. There are some 50 exfoliating plants in the United States, in 31 States and the District of Columbia.

Expanded vermiculite finds its largest market as an insulating material both thermal and acoustic, which is noncorrosive, nonflammable, and odorless and does not attract rodents and insects. It is extensively used as a loose fill for insulating buildings and also as a concrete aggregate. As an ingredient in plaster its advantages include light weight and acoustical, thermal, and fire-resistant properties. Other uses for expanded vermiculite include application as an extender in certain types of paint, insecticide carrier, filler in plastics, and a soil conditioner. Unexfoliated vermiculite has only a few minor uses. No official figures on the use pattern of vermiculite are available.

PRICES

The E&MJ Metal and Mineral Markets in 1953 reported the following prices: Vermiculite, f. o. b. mine, Montana, $12 to $14 per short ton; South African crude, $30 to $32, c. i. f. Atlantic ports.

FOREIGN TRADE

Nearly all imports of crude vermiculite during 1953 came from the Union of South Africa, particularly from the Palabora district, Transvaal, and were used by exfoliating plants on the eastern seaboard of the United States. Recent exportations from South Africa to the United States, f. o. b. port of shipment, were reported as follows:

Year	Short tons	Value	
		Total	Average per ton
1950	16,531	$256,000	$15.50
1951	9,920	142,000	14.31
1952	7,998	113,000	14.14
1953	6,930	102,000	14.68

Crude vermiculite is imported into the United States free of duty under paragraph 1719 of the Tariff Act of 1930 as material not specifically provided for.

Vermiculite is not produced commercially in Canada, so all its requirements are met by imports from the United States (90 percent of the total) and South Africa (10 percent). The total value was $329,017 in 1953.[4]

[4] Canada Department of Mines and Technical Services, Ottawa, Vermiculite in Canada: 1953, 2 pp.

TECHNOLOGY

A new American Society for Testing Materials specification, C 35–52T, has been written for vermiculite plaster aggregate, detailing density, gradation, and other qualities, the weights ranging from a minimum of 7½ pounds to a maximum of 10 pounds per cubic foot.[5]

Reduction in the heat loss of furnaces by the use of an insulating firebrick made of vermiculite with clay binders was described in a technical publication. Such brick is intended for backup insulation only and not to be exposed to molten slag or metal.[6]

Advantages claimed for air placement of vermiculite concrete over steel, wood, and masonry surfaces for insulation and fireproofing are light weight, improved fire resistance, and fast application.[7] Use of precast roof and wall panels, as well as joists, beams, and columns made with vermiculite, is reported to be increasing. The light weight of these members is one of their advantages.[8]

Insulation of large industrial vats with vermiculite high-temperature cement has been found to reduce heat radiation and minimize fire hazards.[9] By applying vermiculite-gypsum plaster, instead of concrete, the construction industry is able to use much lighter steel columns.[10] The use of vermiculite by the building industry for various types of heat and sound insulation and its comparison with other kinds of insulating and refractory materials were described in trade journals.[11] Vermiculite is used at the United States Department of Agriculture's Bureau of Plant Industry Station at Beltsville, Md., in its experiments for growing plants without soil.[12] It has also been recommended for soil conditioning and other agricultural uses.[13] A trade association announced the publication of a 16-page booklet entitled "Recommended Building-Code Requirements for Vermiculite Plastering, Acoustic Plastering, Fireproofing, and Concrete.[14] New methods for processing vermiculite have been covered by patents.[15]

Vermiculite was the subject of Information Circular 7668, published by the Bureau of Mines. It describes the occurrence, domestic and foreign deposits, mining, milling and exfoliating processes, and uses of this mineral.[16]

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[5] Concrete, New Vermiculite Plaster Aggregate Specifications: Vol. 61, No. 6, June 1953, p. 42.

[6] Chemical Engineering, Vermiculite Firebrick Reduces Heat Loss: Vol. 60, No. 2, February 1953, p. 209.

[7] Concrete Manufacturer, Air-Placed Vermiculite Concrete for Insulating and Fireproofing: Vol. 45, No. 12, June 1953, p. 163.

[8] Castell, L. A., Vermiculite Concrete for Roof and Wall Panels: Rock Products, vol. 56, No. 6, June 1953, pp. 196–197.

[9] Rock Products, New Vermiculite Applications: Vol. 55, No. 7, July 1953, p. 48.

[10] American Metal Market, "Exploded" Vermiculite Helps to Save Steel in Construction Work: Vol. 60, No. 73, Apr. 17, 1953, p. 3.

[11] Cowling, K. W., Vermiculite as a Fuel Saver: Refractories Jour., 29th year, No. 9, September 1953, pp. 371–377.

Hanser, W. C., and Livovich, A. E., Thermal Conductivity of Refractory Insulating Concrete: Jour. Am. Ceram. Soc., vol. 36, No. 11, November 1953, pp. 356–362.

[12] Towe, Emily, Growing Plants Without Soil: Washington Star Pictorial Magazine, Oct. 18, 1953, p. 13.

[13] Sales Management, Zonolite in the Market With Do-It-Yourself Ideas: Vol. 71, No. 6, Sept. 15, 1953, pp. 89–90, 92.

[14] Rock Products, Vermiculite Booklet: Vol. 56, No. 9, September 1953, p. 136.

[15] Stein, H. A., Furnace for Producing Physical and Chemical Changes in Granular Materials: U. S. Patent 2,633,346, Mar. 31, 1953.

Bradford, J. H. (assignor of one-half to Combined Metals Reduction Co., a corporation of Utah), Processing Furnace for Discrete Solids: U. S. Patent 2,639,132, May 19, 1953.

[16] North, O. S., and Chandler, H. P., Vermiculite: Bureau of Mines Inf. Circ. 7668, 1953, 27 pp.

RESERVES

The new methods of concentrating and cleaning vermiculite previously mentioned have greatly increased the commercial reserves of vermiculite in the United States. Exact data are not available on the tonnage of these reserves, but they are considered adequate to take care of domestic requirements for many years.

WORLD REVIEW

India.—A report supplied by the Government of India's Ministry of Works, Housing, and Supply, dated April 2, 1953, contains information on vermiculite deposits known to occur near Gudas in Ajmer-Merwara and in Mysore State. Vermiculite is also reported to occur near Coimbatore in Madras and Bankura in Bengal.[17]

TABLE 2.—World production of vermiculite, by countries,[1] 1944–48 (average) and 1949–53, in metric tons [2]

[Compiled by Helen L. Hunt]

Country [1]	1944–48 (average)	1949	1950	1951	1952	1953
Australia	126	165	122	56	63	29
Egypt	------	------	------	637	60	[3] 100
India	------	------	53	236	22	[3] 100
Kenya	[4] 3	5	4	3	------	74
Southern Rhodesia	[5] 16	962	711	502	------	------
Tanganyika	[6] 17	------	------	------	------	------
Union of South Africa	7,119	21,196	42,423	24,507	36,213	30,703
United States (sold or used by producers)	86,243	153,149	188,781	189,608	189,515	171,942
Total	93,524	175,477	232,094	215,549	225,873	[3] 203,000

[1] In addition to countries listed, vermiculite is produced in Brazil and U. S. S. R., but data are not available, and no estimates are included in the total.
[2] This table incorporates a number of revisions of data published in previous vermiculite chapters.
[3] Estimate.
[4] Average for 1945–48.
[5] Average for 1 year only, as 1948 was the first year of production.
[6] Average for 1946–48.

[17] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 1, July 1953, pp. 61–62.

Zinc

By O. M. Bishop [1] and Esther B. Miller [2]

THE ZINC INDUSTRY of the United States in 1953 was characterized by record consumption of slab zinc, record imports, near record smelter output, and greatly reduced domestic mine production. Industry-held stocks of slab zinc at the year end were the greatest since 1945, and the average selling price of zinc was the lowest since 1947 despite general increases in the cost of production. Elsewhere, mine and smelter production was at higher levels than requirements, a fact that stimulated exports to the United States and accentuated the market problems of domestic miners. The supply of zinc, including newly mined, secondary recovery in all forms, and imports, totaled 1,510,000 tons, whereas that consumed as slab, ore, and secondary metal plus exports was about 1,370,000 tons.

During the year domestic zinc smelters produced 969,000 short tons of slab zinc, exceeding the 1952 output of 960,000 tons and establishing a new peacetime record. Of the 1953 output, 51 percent was from domestic ores, 43 percent from foreign ores, and 6 percent from scrap. Domestic mine production totaled 547,000 tons of recoverable zinc, 18 percent less than in 1952 and the smallest mine output since 1938. Most of the reduced output resulted from mine closings or production curtailments in the second half of the year, particularly in the Tri-State region, New Mexico, Idaho, Colorado, Nevada, Arizona, New Jersey, and the Upper Mississippi Valley region.

Montana, with 80,300 tons, was for the third successive year the chief producing State. Other leading producing States, ranked by output, were Idaho, New York, New Jersey, Tennessee, Colorado, Oklahoma, Washington, Utah, and Arizona.

Imports of zinc in ores and concentrates and imports of slab zinc were 513,000 and 235,000 tons, respectively, compared with 450,000 and 116,000 tons in 1952. Never before were such quantities of slab zinc imported, and only once (in 1943 during the height of World War II) were such quantities of zinc concentrates imported.

Consumption of slab zinc was 986,000 tons, exceeding the World War II peak of 889,000 and the previous alltime high of 967,000 tons in 1950. Stocks at primary and secondary smelters increased from 85,000 tons to 180,000 during the year, while stocks at consumers' plants or in transit thereto declined from about 101,000 tons to 92,000.

The market price of Prime Western zinc, East St. Louis, which was 12.5 cents a pound at the beginning of the year, advanced to 13.0 cents on January 2, but thereafter in 5 successive drops went to 11.0 cents by March 5, where it remained until September 2, when the price dropped to 10.5 cents. Subsequently, on September 11, the

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

price was reduced to 10.0 cents, where it remained the rest of the year. The average price received by producers of slab zinc in 1953 was 11.5 cents a pound compared with 16.6 cents in 1952 and 18.2 cents in 1951.

Because of the widespread mine closings and reduced employment in the zinc- (and lead-) mining industry much thought was given to tariff revision through either new legislation or the invoking of the "escape clause" of the Reciprocal Trade Agreements Act, and various other proposals were made to restrict imports or provide other means of direct or indirect aid to the domestic industry. On July 29, 1953, the Tariff Commission, in response to resolutions of the United States Senate Committee on Finance and the House of Representatives Committee on Ways and Means, instituted a general investigation of the zinc and lead industries to determine relevant facts of production, trade, consumption, and competitive position, including the effect of imports of lead and zinc on the livelihood of American workers. The report of the investigation was published April 20, 1954.[3]

TABLE 1.—Salient statistics of the zinc industry in the United States, 1944–48 (average) and 1949–53

	1944–48 (average)	1949	1950	1951	1952	1953
Production of primary slab zinc:						
By sources:						
From domestic ores .... short tons..	509,753	591,454	588,291	621,826	575,828	495,436
From foreign ores .... do....	280,724	223,328	255,176	259,807	328,651	420,669
Total .... do....	790,477	814,782	843,467	881,633	904,479	916,105
By methods:						
Electrolytic .... percent of total..	37	40	41	38	39	40
Distilled .... do....	63	60	59	62	61	60
Production of redistilled secondary slab zinc .... short tons..	52,931	55,041	66,970	48,657	55,111	52,875
Stocks on hand at primary smelters Dec. 31 .... short tons..	149,895	90,710	7,948	21,343	81,344	176,675
Price:						
Prime Western at St. Louis:						
Average for period ... cents per pound..	9.86	12.15	13.88	17.99	16.21	10.86
Highest quotation .... do....	17.50	17.50	17.50	19.50	19.50	13.00
Lowest quotation .... do....	8.25	9.00	10.00	17.50	12.50	10.00
Yearly average at London .... do....	8.90	14.41	14.89	21.46	[1] 18.53	9.47
Mine production of recoverable zinc:[2] short tons..	635,083	593,203	623,375	681,189	666,001	547,430
Tri-State district (Joplin) percent of total..	21	13	13	13	14	10
Western States .... do....	51	60	59	58	58	56
Other .... do....	28	27	28	29	28	34
World smelter production of zinc short tons..	1,681,000	[1] 2,012,000	[1] 2,172,000	[1] 2,315,000	[1] 2,425,000	2,557,000

[1] Revised figure.
[2] Includes Alaska.

GOVERNMENT REGULATIONS

Government price controls imposed January 26, 1951, under the General Ceiling Price Regulation were terminated February 12, 1953. The last Government control over domestic use—that requiring periodic reports on the quantity of slab zinc stocked and consumed—was revoked in June 1953. Export licenses continued to be required for exports to all countries but Canada.

[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, Parts I, II, III, IV and V.

GOVERNMENT PROGRAMS UNDER DEFENSE PRODUCTION ACT OF 1950

Provisions of the Defense Production Act of 1950 with respect to exploration were carried out by the Defense Minerals Exploration Administration (DMEA) and those with respect to procurement by the Defense Materials Procurement Agency (DMPA).

DEFENSE MINERALS EXPLORATION ADMINISTRATION

Exploration contracts and amendments to existing contracts continued to be made by the DMEA during 1953, but in conformance to a directive issued by the Office of Defense Mobilization no applica-

TABLE 2.—Defense Minerals Exploration Administration contracts involving lead and zinc, by States, executed in 1953

Contractor	County	Government maximum participation
ARIZONA		
Coronado Copper & Zinc Co	Cochise	$49,525.00
French, Gordon R	Pinal	9,750.00
Globe Miami Copper & Zinc Corp	Gila	31,875.00
Yuma Metals, Inc[1]	Yuma	37,500.00
COLORADO		
Blum, Robert F	Clear Creek	1,400.00
Burleson, S. E. and W. E	Saguache	13,300.00
Jones, Myron L., L. M. and Paul R. and Lill, E. M	Dolores	4,130.00
Mariposa Mining Co	San Miguel	10,600.00
Shenandoah-Dives Mining Co	San Juan	105,950.00
Vinson, Mike and Harris, Fred	Summit	18,800.00
IDAHO		
Bunker Hill & Sullivan Mining & Concentrating Co	Shoshone	549,375.00
Day Mines, Inc	do	121,430.00
Golconda Lead Mines	do	45,000.00
Idaho Custer Mines, Inc	Custer	48,868.00
North Fork Mining Co	Shoshone	22,250.00
Pierce, Roger V	Lemhi	31,850.00
Polaris Mining Co	Shoshone	342,977.50
Silver Buckle Mining Co	do	114,750.00
Spokane-Idaho Mining Co	do	71,317.00
MONTANA		
Golden Anchor Mining & Milling Co., Inc	Powell	17,358.00
Neuberg Bros. & Sloan, Inc	Jefferson	22,700.00
Pohl, E. E., Kleinschmidt, H. G., and A. R	Broadwater	6,000.00
NEVADA		
Bullock, Frank	Elko	10,350.00
Consolidated Eureka Mining Co	Eureka	28,525.00
UTAH		
Cleghorn, Willard	Utah	9,177.00
U. S. Smelting, Refining & Mining Co	Salt Lake	74,762.50
VIRGINIA		
Bellville Gold Mines, Ltd	Buckingham	14,125.00
WASHINGTON		
American Zinc, Lead & Smelting Co. Grandview Mines	Stevens	10,500.00
Do	do	18,200.00
Total		[2] 2,068,303.00

[1] Executed in 1952 but not previously listed.
[2] This sum exceeds the total of the listed contracts since it includes sums provided through amendments to contracts previously executed; also includes funds for participation in exploration contracts which were subsequently canceled or terminated upon completion.

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tions were accepted for lead- and zinc-exploration projects after May 15, 1953. The turnabout in lead and zinc supplies from scarcity to plenty in the second half of 1952 and the continued accumulation of stocks in the United States, as well as abroad, in 1953 were considered determining factors in the decision reached by ODM.

The objective of the DMEA—to encourage exploration and increase reserves of strategic and critical minerals and metals, including lead and zinc—was achieved through projects to explore potential domestic ore sources. The Government financed up to 50 percent of the total cost of approved exploration projects for lead and zinc and during the calendar year 1953 entered into 30 contracts involving maximum Government participation of $2,068,303.[4] Through December 31, 1953, 193 lead- and zinc-exploration contracts had been executed, authorizing a maximum Government participation of $7,614,636. Lead-zinc or lead-zinc-copper exploration contracts in 1953 composed 17 percent of all DMEA contracts executed and 40 percent of the funds obligated; through 1953 they represented 32 percent of all contracts and 43 percent of the funds obligated.

DEFENSE MATERIALS PROCUREMENT AGENCY

The Defense Materials Procurement Agency program with respect to lead and zinc was greatly reduced in early 1953 as the supply-requirement ratio increased, and production-expansion programs put in force in 1951 and 1952 were coming to fruition. On August 14, 1953, the remaining function of DMPA—that of servicing contracts and completing those in negotiation—was given to the Emergency Procurement Service of General Services Administration.

Only one contract was approved in 1953 for development of a lead-zinc property in the United States; on June 29, 1953, a development contract with Chief Consolidated Mining Co., Salt Lake City, Utah, was executed. The Government advanced Chief Consolidated $283,373 or 25 percent of proposed expenditures for development of the company Chief No. 1 and Plutus mines in the Tintic district, Juab County, Utah. The contract was a percentage royalty agreement of 3 years duration; the loan was to be repaid on the basis of 5 percent of net smelter returns from ores developed under terms of the contract.

United States assistance in developing foreign zinc resources was negligible in 1953. Foreign Operations Administration, formerly Mutual Security Administration, continued to execute contracts, using counterpart funds, with several foreign companies; tonnages of zinc involved totaled only a few hundred tons, however.

DOMESTIC PRODUCTION

Statistics on zinc production are compiled on both a mine and 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

[4] Includes sums provided through amendments to contracts previously executed; also includes funds for participation in exploration contracts subsequently canceled or terminated upon completion.

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 is utilized directly in making zinc pigments and chemicals.

On April 20, 1954, the United States Tariff Commission released a 553-page report [5] based on its general investigation of the domestic lead and zinc industries and the competitive position of the industry with reference to foreign producers under existing tariff structures. The study, which was based in part on a canvass of domestic lead and zinc mining, milling, smelting, and refining companies, covered employment, wage rates, principal expenses, profit-and-loss experience, and grades and value of ores mined in 1952 and in some part for 1953, making comparisons where possible with figures established by the Census of Minerals for 1939.

One tabulation showed that in 1939 the lead-zinc mines of the United States produced 16,317,000 tons of crude ore with a recoverable metal content of 2.2 percent lead, 2.8 percent zinc, and 0.71 and 0.004 ounce per ton of silver and gold, respectively, utilizing 32,283,000 man-hours of labor at $0.62 per hour. The total value of mine or mill products for that year was $62,652,000. Another similar tabulation, prepared by the United States Tariff Commission from 211 reports covering 89 percent of the 1952 national output of recoverable lead and 90 percent of the recoverable zinc, showed a considerable change in the intervening 13-year period. The 211 reporting firms indicated that in 1952 they produced 22,919,000 tons of crude ore with a recoverable metal content of 1.4 percent lead, 2.5 percent zinc, 0.1 percent copper, and 0.73 and 0.006 ounce of silver and gold, respectively. Man-hours worked by production and related workers in mining and milling this tonnage totaled 43,791,000, paid at an average hourly rate of $1.95. The total mine or mill value of all products was $225,384,000.

On the basis of these figures, it is concluded that in the period 1939 to 1952 wages increased 215 percent, the tons of ore mined and milled per man-hour increased from 0.51 to 0.52, the grade of ores as indicated by the recovery of zinc and lead declined 11 and 36 percent, respectively, and the value of products sold per ton of crude ore increased from $3.84 to $9.83 or 156 percent. The quantity and value of products, principal expenses, hourly earnings, and man-hours worked in lead and zinc mining and milling in the United States are given by States or principal regions in table 3. Table 4 shows the crude ore sold or treated and the recoverable metal content by States, regions, and districts.

Wages, productivity per unit of labor, and grade of ore in 1953 essentially equaled those in 1952, but Bureau of Mines estimated the value of the mine products to have dropped about 31 percent to approximately $6.75 per ton. According to reports to the Tariff Commission which accounted for 92 percent of the mine output of lead and 93 percent of the zinc, the number of employees engaged in

[5] Work cited in footnote 3.

TABLE 3.—Lead and zinc mining and milling: Quantity and value of products, principal expenses, hourly earnings, and man-hours per unit of output in the United States, by principal regions or States in 1952 [1]

[Compiled by the U. S. Tariff Commission]

Item	By principal metal produced				United States total	By principal regions or States					
			All other			States east of the Missisippi River			West Central States		
	Predominantly lead [2]	Predominantly zinc [3]	Chiefly lead [4]	Chiefly zinc [5]		Total	Northern Illinois and Wisconsin	New York, New Jersey, Kentucky, Pennsylvania, Tennessee, and Virginia	Total	Southeastern Missouri	Tri-State (Oklahoma, Kansas, and Southwest Missouri)
Number of reports	30	71	47	63	211	22	13	9	46	3	43
Number of mines covered	38	125	67	83	313	33	16	17	103	8	95
Number of mills covered	10	38	25	40	113	17	8	9	24	6	18
Mine or mill value of all products [6] ...1,000 dollars	37,029	78,869	41,108	68,378	225,384	38,071	7,290	30,781	61,105	35,625	25,480
Ratio of mine or mill value of products to gross market value of recoverable metals produced [7] ...percent	85.7	64.9	69.1	62.8	67.7	64.6	66.5	64.2	79.2	84.3	73.0
Recoverable metals produced:											
Lead ...short tons	124,835	34,235	99,636	87,653	346,359	8,089	3,177	4,912	143,598	122,222	21,376
Zinc ...do	3,744	334,945	53,979	203,517	596,185	173,515	30,573	142,942	89,539	3,602	85,937
Silver ...1,000 fine ounces	398	777	7,910	7,403	16,488	------	------	------	327	327	------
Gold ...fine ounces	189	3,249	31,195	94,903	129,536	------	------	------	------	------	------
Copper ...short tons	1,083	1,800	1,946	8,117	12,946	------	------	------	1,082	1,082	------
Principal expenses designated below, total ...1,000 dollars	24,401	49,424	27,943	53,355	155,123	21,130	4,078	17,052	40,702	23,590	17,112
Salaries and wages, total ...do	14,492	29,758	19,621	35,796	99,667	12,940	2,430	10,510	23,640	13,883	9,757
Paid to production and related workers ...do	12,107	25,369	16,479	31,232	85,187	10,499	2,124	8,375	20,280	11,520	8,760
Paid to other employees ...do	2,385	4,389	3,142	4,564	14,480	2,441	306	2,135	3,360	2,363	997
Cost of supplies, materials, fuels, and purchased electric energy, total ...do	9,909	19,666	8,322	17,559	55,456	8,190	1,648	6,542	17,062	9,707	7,355
Supplies and materials ...do	7,977	16,855	6,788	15,022	46,642	7,257	1,186	6,071	13,870	7,820	6,050
Fuels ...do	104	377	269	402	1,152	143	108	35	280	81	199
Purchased electric energy ...do	1,828	2,434	1,265	2,135	7,662	790	354	436	2,912	1,806	1,106
Ratio of principal expenses to mine or mill value of products, total ...percent	65.9	62.7	68.0	78.0	68.8	55.5	55.9	55.4	66.6	66.2	67.2
Salaries and wages ...do	39.1	37.7	47.7	52.3	44.2	34.0	33.3	34.2	38.7	39.0	38.3
Supplies and materials ...do	21.6	21.4	16.5	22.0	20.7	19.0	16.3	19.7	22.7	21.9	23.8
Fuel ...do	.3	.5	.7	.6	.5	.4	1.5	.1	.4	.2	.8
Purchased electric energy ...do	4.9	3.1	3.1	3.1	3.4	2.1	4.8	1.4	4.8	5.1	4.3
Man-hours worked by production and related workers, total ...1,000 man-hours	6,196	13,951	8,179	15,465	43,791	6,050	1,080	4,970	10,804	5,826	4,978
Per dollar's worth of products	.17	.18	.20	.23	.19	.16	.15	.16	.18	.16	.20
Average hourly earnings of production and related workers	1.95	1.82	2.01	2.02	1.95	1.74	1.97	1.69	1.88	1.98	1.76
Crude ore mined ...1,000 short tons	6,037	9,921	2,113	4,848	22,919	3,889	1,145	2,744	11,697	5,987	5,710

Item	By principal regions or States—Continued									
	Western States									
	Total	Arizona	California	Colorado	Idaho	Montana	Nevada	New Mexico	Utah	Washington
Number of reports	143	21	6	26	22	16	16	13	16	7
Number of mines covered	177	24	6	40	32	16	16	14	20	9
Number of mills covered	72	8	4	11	20	5	4	10	5	5
Mine or mill value of all products [6] ... 1,000 dollars	126,208	9,786	4,196	19,342	28,981	20,180	3,896	10,308	23,404	6,115
Ratio of mine or mill value of products to gross market value of recoverable metals produced [7] ... percent	64.0	57.3	58.5	64.1	62.1	66.5	58.7	54.7	77.8	60.8
Recoverable metals produced:										
Lead ... short tons	194,672	10,959	10,575	25,322	63,866	14,850	5,475	5,711	46,314	11,600
Zinc ... do	333,131	31,866	8,171	50,365	66,050	64,289	12,693	49,944	30,699	19,054
Silver ... 1,000 fine ounces	16,161	1,011	921	2,102	4,500	3,310	537	360	3,371	49
Gold ... fine ounces	129,536	18,006	2,774	62,457	1,548	9,257	4,808	891	29,795	------
Copper ... short tons	11,864	3,259	223	2,969	108	2,695	139	821	1,633	17
Principal expenses designated below, total ... 1,000 dollars	93,291	6,562	2,253	14,777	22,782	17,903	3,382	8,085	13,697	3,850
Salaries and wages, total ... do	63,087	4,474	1,498	8,597	16,400	12,752	2,339	5,242	9,420	2,365
Paid to production and related workers ... do	54,408	4,023	1,251	7,531	14,216	10,728	1,990	4,561	7,993	2,115
Paid to other employees ... do	8,679	451	247	1,066	2,184	2,024	349	681	1,427	250
Cost of supplies, materials, fuels, and purchased electric energy, total ... do	30,204	2,088	755	6,180	6,382	5,151	1,043	2,843	4,277	1,485
Supplies and materials ... do	25,515	1,791	634	5,685	5,289	4,346	824	2,141	3,456	1,349
Fuels ... do	729	119	52	53	234	132	15	29	69	26
Purchased electric energy ... do	3,960	178	69	442	859	673	204	673	752	110
Ratio of principal expenses to mine or mill value of products, total ... percent	73.9	67.0	53.7	76.4	78.6	88.7	86.8	78.4	58.5	63.0
Salaries and wages ... do	50.0	45.7	35.7	44.4	56.6	63.2	60.0	50.8	40.2	38.7
Supplies and materials ... do	20.2	18.3	15.1	29.4	18.2	21.5	21.1	20.8	14.8	22.1
Fuel ... do	.6	1.2	1.2	.3	.8	.7	.4	.3	.3	.4
Purchased electric energy ... do	3.1	1.8	1.7	2.3	3.0	3.3	5.3	6.5	3.2	.8
Man-hours worked by production and related workers, total ... 1,000 man-hours	26,937	2,079	615	4,111	6,689	5,043	1,085	2,259	4,042	1,014
Per dollar's worth of products	.21	.21	.15	.21	.23	.25	.28	.22	.17	.17
Average hourly earnings of production and related workers	2.02	1.94	2.03	1.83	2.13	2.13	1.83	2.02	1.98	2.09
Crude ore mined ... 1,000 short tons	7,333	461	158	1,246	1,760	1,414	250	620	683	741

See footnotes on page 1262.

[1] Represents data from 211 reports covering 313 mines and 113 mills that were engaged during any part of 1952 or 1953 in producing ores valued chiefly for their content of lead plus zinc. The mines covered produced 89 percent of the total 1952 production of recoverable lead and 90 percent of the total output of recoverable zinc from all mines including mines other than lead and zinc mines. Considering only the lead and zinc produced by all lead and zinc mines, the mines covered in this table accounted for 92 percent of the total lead and 93 percent of the total zinc.

[2] Based on reports covering mines producing ores in which the gross market value of the recoverable lead content was 75 percent or more of the total gross market value (at average market prices in 1952) of all recoverable metals contained.

[3] Based on reports covering mines producing ores in which the gross market value of the recoverable zinc content was 75 percent or more of the total gross market value (at average market prices in 1952) of all recoverable metals contained.

[4] Based on reports covering mines producing ores in which the gross market value of the recoverable lead content was greater than the gross market value (at average market prices in 1952) of the recoverable content of any other single metal.

[5] Based on reports covering mines producing ores in which the gross market value of the recoverable zinc content was greater than the gross market value (at average market prices in 1952) of the recoverable content of any other single metal.

[6] Represents value of ores or concentrates produced (and old tailings reclaimed) plus value added in milling (value of concentrates produced minus value of ores, including old tailings, milled).

[7] Gross market value of products used in this ratio was computed by multiplying the quantities of recoverable metals produced by the following average market prices of the refined metals: Lead $329.34 per ton; zinc $324.30 per ton; silver $0.905 per fine ounce; copper $484.00 per ton; and gold $35.00 per fine ounce.

TABLE 4.—Lead and zinc: Grade of ore mined in the United States in terms of recoverable metal content, by States, regions, or districts in 1952

[Compiled by the U. S. Tariff Commission from official statistics of the Bureau of Mines]

State, region, or district	Crude ore sold or treated	Recoverable metal content				
		Lead	Zinc	Silver	Gold	Copper
	Short tons	*Percent*	*Percent*	*Oz. per ton*	*Oz. per ton*	*Percent*
Western States:						
Arizona, total	811,856	1.8	4.1	2.00	0.030	1.0
Big Bug district	196,050	2.1	5.5	2.96	.088	.1
Old Hat district	92,995	3.9	3.5	.77	.009	.2
Warren (Bisbee) district	43,242	4.1	11.0	1.74	.014	.7
California, total	188,712	5.8	4.8	5.21	.020	.3
Coso (Darwin) district	127,235	6.1	4.3	5.63	.006	.1
Colorado, total	1,176,190	2.3	4.5	1.71	.054	.2
Upper San Miguel district	454,469	1.7	2.2	1.68	.077	.5
California (Leadville) district	192,316	2.7	4.4	1.58	.095	.1
Idaho, total	1,862,459	3.5	3.7	2.49	.001	(1)
Couer d'Alene region [2]	1,730,826	3.5	3.8	2.20	.001	(1)
Montana, total	2,350,507	.9	3.4	1.79	.006	.1
Summit Valley (Butte) district	2,264,596	.7	3.4	1.70	.005	.1
Nevada, total	303,498	2.2	5.0	2.27	.018	.1
New Mexico, total	721,005	1.0	7.1	.54	.002	.1
Central district	632,385	.7	7.6	.47	.001	.1
Utah, total [3]	674,825	7.1	4.8	4.85	.042	.2
West Mountain (Bingham) district	432,218	7.9	4.7	4.69	.033	.3
Park City district	62,062	6.8	5.5	5.16	.023	.1
Washington, total [4]	744,622	1.5	2.6	.08	(5)	(1)
Total, Western States [6]	8,834,440	2.4	4.1	2.02	.016	.2
West Central States:						
Southeastern Missouri	6,148,606	1.8	(1)	.08		(1)
Tri-State (Kansas, Oklahoma and Southwestern Missouri)	6,140,155	.4	1.4			
Total, West Central States [7]	12,289,136	1.1	.7	.04		(1)
States east of the Mississippi River:						
Upper Mississippi Valley district (Northern Illinois and Wisconsin)	1,216,655	.3	2.7	(8)		
New York, New Jersey, Tennessee, and Virginia, total	2,719,385	.2	5.1	.01		
Total, States east of the Mississippi River [9]	3,962,857	.2	4.5	.01		
Grand total, United States	25,086,433	1.4	2.5	.73	.006	.1

[1] Less than 0.05 percent.
[2] Data presented at the Tariff Commission hearings indicated that the gross metal content of 1,185,000 tons of ore milled in the Coeur d'Alene district in 1952 was 4.7 percent lead, 5.2 percent zinc, and 2.7 ounces of silver per ton; the average gross metal content of 9,110,000 tons of ore milled during 1946 to mid-1953, inclusive, was 5.2 percent lead, 5.6 percent zinc, and 2.9 ounces of silver per ton.
[3] Data presented at the Tariff Commission hearings from records of the Utah State Tax Commission indicated that lead-zinc mines in that State in 1952 produced 796,592 tons of ore with a gross content of 6.9 percent lead and 5.6 percent zinc; lead-zinc mines in Utah produced 5,393,000 tons of ore during 1946–52 with an average gross lead content of 6.9 percent and an average gross zinc content of 5.6 percent.
[4] Data presented at the Tariff Commission hearings for the Metaline district, which accounts for the bulk of the lead and zinc production in Washington, indicated that the gross metal content of 595,000 tons of ore milled in 1952 was 1.6 percent lead and 2.7 percent zinc; the average gross metal content of 2,834,000 tons of ore milled during 1946 to mid-1953, inclusive, was 1.5 percent lead and 3.2 percent zinc.
[5] Less than 0.0005 ounce per ton.
[6] Including Oregon, South Dakota, and Texas, in addition to the States given above.
[7] Including Arkansas, in addition to the States given above.
[8] Less than 0.005 ounce per ton.
[9] Including Kentucky in addition to the States given above.

NOTE.—This tabulation includes all ores that are classified by the Bureau of Mines as "lead ores," "zinc ores," "lead-zinc ores," and "zinc-lead ores," in addition to such other classes of ores in which the value of the recoverable lead plus zinc content was greater than the value of the recoverable content of other metals. Some "lead-copper," "zinc-copper," and "zinc-lead-copper ores" were excluded because the value of their recoverable lead and zinc content was less than the value of their content of other metals. Old tailings and material from old slag dumps are not included. The mined ores included in this tabulation contained 357,909 tons of recoverable lead and 627,257 tons of recoverable zinc, or 91.7 and 94.2 percent, respectively, of the total United States output from all ores mined and from old tailings, and old slag dumps reclaimed.

mining and milling lead and zinc ores declined from 23,800 in January 1952 to 16,200 in October 1953, or 32 percent.

Employment at primary zinc smelters and refineries (exclusive of construction workers) declined about 3 percent between January 1952 and October 1953 and averaged 12,700 in 1952 and 12,600 for the first 10 months of 1953.

In studying the competitive position of the domestic lead-zinc mining industry, the Tariff Commission obtained reports from certain foreign producers which in 1952 accounted for 80 and 61 percent, respectively, of the lead and zinc mined in Canada, 28 and 45 percent of that mined in Mexico, and 68 percent of that mined in Australia. From these confidential reports the Commission concluded, with relation to Canada, the United States, and Mexico as follows:

> * * * That total principal operating expenses, as well as expenses for wages and salaries, are lower *per ton of crude ore* mined in the United States than in Canada and Mexico. This appears to be the case even though average hourly earnings of workers are much lower for operations in Mexico than for those in either Canada or the United States, and are slightly lower for Canada than for the United States. The data also indicate that taxes other than income taxes *per ton of crude ore* mined in Mexico were much higher than in Canada and very much higher than in the United States.
>
> However, when allowance is made for the differences in the average value of the ores mined in the three countries, as affected by differences in the yield of metals obtained from them, the situation with respect to the foregoing comparison of costs is quite different. Notwithstanding apparently higher operating expenses, and higher expenses for salaries and wages, *per ton of crude ore* mined in Canada and Mexico than in the United States, these expenses are lower *per unit of recoverable metal* in Mexico and Canada than in the United States.

MINE PRODUCTION

Domestic mine production of recoverable zinc (including that recovered as zinc pigments and salts directly from ore) decreased to 547,000 tons, the smallest output since 1938 and 18 percent less than the 666,000-ton mine output of 1952. The decline was the direct result of mine curtailments and closings following the succession of price drops, which between June 2, 1952, and September 11, 1953, amounted to 49 percent for zinc metal and about 59 percent for zinc concentrate.

The zinc mines of the United States are widely dispersed in more than 50 important mining districts, which occur 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 1953 output, Montana, Idaho, Colorado, Washington, Utah, Arizona, New Mexico, Nevada, and California.)

The Western States produced 304,000 tons or 21 percent less than in 1952, the West Central States produced 59,000 tons or 38 percent less, but the States East of the Mississippi River with 184,000 tons produced about the same as in 1951 and 1952. A brief summation of domestic mine production by States, major mines, and districts follows. Information in greater detail is to be found in the State chapters of volume III.

For the third consecutive year, Montana was the chief zinc-producing State, with 80,300 tons or 15 percent of the total. The Butte mines (Summit Valley district) of the Anaconda Copper Co. and zinc recovered from the lead slags of the East Helena smelter supplied about 97 percent of the production. The remainder was derived from the Jack Waite and a few other mines.

Idaho, with an output of 72,200 tons, ranked second among the States. The Coeur d'Alene region, Shoshone County, supplied 95 percent of the State's zinc output, with the Star, Bunker Hill, Page, and Morning mines the major producers. The Triumph mine in Blaine County was also an important zinc producer.

Colorado, with 37,800 tons, ranked sixth among the States, but its output was 29 percent less than in 1952 because of mine closures. The most important producing mines, in order of output, were the Eagle, Treasury Tunnel-Black Bear, Resurrection, Smuggler Union, and Rico Argentine.

Washington increased its zinc production 63 percent as the new Van Stone mine in Stevens County completed its first full year of production. The Pend Oreille, Grandview, and Deep Creek mines were the other major producers.

Utah produced 29,200 tons of zinc in 1953, or 11 percent less than in 1952, largely because the Silver King Coalition mines and Park Utah Consolidated mines (Judge and Keetley) were inoperative throughout 1953. The United States and Lark mines, New Park, Chief Consolidated, and West Calumet were the chief mines, in order of output.

Arizona output declined 42 percent to 27,500 tons owing to the continued idleness of several producers that closed in 1952, plus some additional closings in 1953. The Iron King mine, Yavapai County, was the State's chief producing zinc mine, followed by the Trench property in Santa Cruz County and the Republic-Mammoth in Cochise County.

New Mexico ceased all zinc mine production about October 1; and that, with previous curtailments and closings, decreased output in 1953 by 74 percent to 13,400 tons. Major mines or mine groups producing in early 1953 were the Kearney, Ground Hog, Bayard, and Lynchburg.

Nevada and California zinc output in 1953 declined 62 and 43 percent, respectively, as several mines in each State were forced to curtail by low zinc prices.

Zinc production in the West Central States fell proportionately more than in the combined Western States as output in the major producing area—the Tri-State district—declined from the 91,000 tons of 1952 to 55,700 tons in 1953. Much of the decline resulted from a strike which closed the Eagle-Picher Co. Central mill from June 21 through the remainder of the year. Since mines that normally shipped to the Central mill were unable to have the ores treated, they, too, were forced to close. The leading zinc producers in the Tri-State district were Eagle-Picher Co. (Oklahoma and Kansas), American Zinc, Lead & Smelting Co. (Oklahoma and southwest Missouri), National Lead Co. (Kansas), Dale Mining Co. (southwest Missouri), and Beck Mining Co. (Oklahoma and Kansas). The lead mines of southeast Missouri produced 3,200 tons of recoverable zinc as a byproduct.

TABLE 5.—Mine production of recoverable zinc in the United States, 1944–48 (average) and 1949–53, by States in short tons

State	1944–48 (average)	1949	1950	1951	1952	1953
Western States and Alaska:						
Alaska	9	2	6	1	------	------
Arizona	44,418	70,658	60,480	52,999	47,143	27,530
California	7,199	7,209	7,551	9,602	9,419	5,358
Colorado	39,157	47,703	45,776	55,714	53,203	37,809
Idaho	83,135	76,555	87,890	78,121	74,317	72,153
Montana	35,015	54,195	67,678	85,551	82,185	80,271
Nevada	20,413	20,443	21,606	17,443	15,357	5,812
New Mexico	42,546	29,346	29,263	45,419	50,975	13,373
Oregon	------	6	21	3	1	------
South Dakota	21	------	------	------	------	------
Texas	13	------	------	24	3	------
Utah	37,216	40,670	31,678	34,317	32,947	29,184
Washington	12,273	10,740	14,807	18,189	20,102	32,786
Total	321,415	357,527	366,756	397,383	385,652	304,276
West Central States:						
Arkansas	91	1	8	50	26	------
Kansas	47,375	29,433	27,176	28,904	25,482	15,515
Missouri	20,914	5,911	8,189	11,476	13,986	9,981
Oklahoma	65,037	44,033	46,739	53,450	54,916	33,413
Total	133,417	79,378	82,112	93,880	94,410	58,909
States east of the Mississippi River:						
Illinois	9,485	18,157	26,982	21,776	18,816	14,556
Kentucky	397	935	731	3,457	3,280	489
New Jersey	75,867	50,984	55,029	62,917	59,190	45,700
New York	32,343	37,973	38,321	40,051	32,636	51,529
Tennessee	32,001	29,788	35,326	38,639	38,020	38,465
Virginia	17,063	13,166	12,396	7,332	13,409	16,676
Wisconsin	13,095	5,295	5,722	15,754	20,588	16,830
Total	180,251	156,298	174,507	189,926	185,939	184,245
Grand total	635,083	593,203	623,375	681,189	666,001	547,430

The States east of the Mississippi River produced 184,200 tons to maintain approximately their 1951–52 rate of production. New York, New Jersey, and Tennessee were respectively third, fourth, and fifth among the States in 1953. Zinc output in New York increased 58 percent and was the greatest in the State's history, exceeding the previous record year, 1943, by 12 percent. New Jersey produced 45,700 tons in 1953, a 23-percent decrease from 1952 and 40 percent less than the 1944–48 average.

The principal zinc-producing companies in this group of States were the New Jersey Zinc Co. (Franklin and Sterling Hill mines in New Jersey and Austinville mine in Virginia); St. Joseph Lead Co.

(Balmat and Edwards mines in New York); the American Zinc Co. of Tennessee (Athletic—closed in October, Grasselli, Jarnagin—closed in March, Mascot No. 2, and North Friends Station, all in Tennessee); United States Steel Corp., Tennessee Coal & Iron Division (Davis-Bible group mines in Tennessee); Tennessee Copper Co. (in Tennessee); the Vinegar Hill Zinc Co., Tri-State Zinc, Inc., Calumet & Hecla, Inc., and Eagle-Picher Co. (in northern Illinois and Wisconsin); and the Minerva Oil Co., and Ozark-Mahoning Co. (in southern Illinois and western Kentucky).

The 25 leading zinc-producing mines in the United States in 1953, listed in table 7, yielded 72 percent of the total domestic zinc output; the 3 leading mines 30 percent; and the 6 leading mines 40 percent.

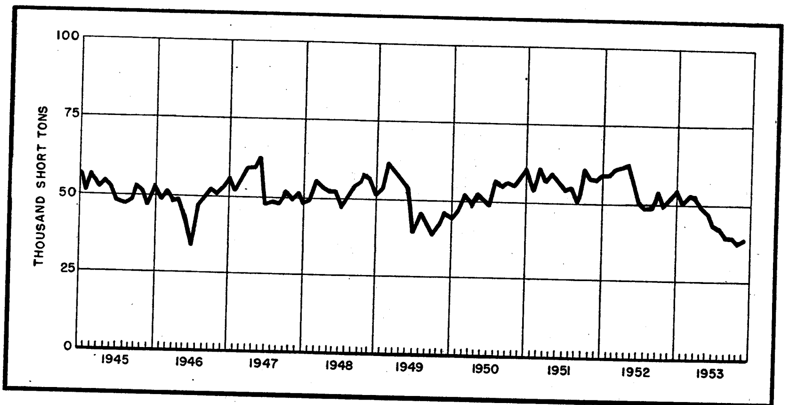

FIGURE 1.—Mine production of recoverable zinc in the United States, 1945–53, by months, in short tons.

TABLE 6.—Mine production of recoverable zinc in the United States,[1] 1952–53, by months, in short tons

Month	1952	1953	Month	1952	1953
January	59,377	54,034	August	49,209	41,677
February	59,145	50,356	September	49,291	39,893
March	60,972	52,726	October	54,243	39,635
April	61,354	52,119	November	49,782	37,699
May	62,751	48,840	December	52,263	39,919
June	57,079	47,310			
July	50,535	43,222	Total	666,001	547,430

[1] Includes Alaska.

TABLE 7.—Twenty-five leading zinc-producing mines in the United States in 1953, in order of output

Rank	Mine	District	State	Operator	Type of ore
1	Butte Hill Mines	Summit Valley (Butte)	Montana	Anaconda Copper Mining Co.	Zinc-lead.
2	Franklin and Sterling Hill	New Jersey	New Jersey	New Jersey Zinc Co.	Zinc.
3	Balmat	St. Lawrence County	New York	St. Joseph Lead Co.	Zinc-lead.
4	United States and Lark	West Mountain (Bingham)	Utah	U. S. Smelting, Refining & Mining Co.	Do.
5	Star	Hunter	Idaho	Sullivan Mining Co.	Do.
6	Eagle Group	Red Cliff (Battle Mountain)	Colorado	Empire Zinc Division, New Jersey Zinc Co.	Zinc.
7	Austinville	Austinville	Virginia	New Jersey Zinc Co.	Zinc-lead.
8	Davis-Bible Group	Eastern Tennessee	Tennessee	United States Steel Corp., Tennessee Coal & Iron Division.	Zinc.
9	Lawyers Group	Tri-State	Oklahoma	American Zinc, Lead & Smelting Co.	Zinc-lead.
10	Mascot No. 2	Eastern Tennessee	Tennessee	American Zinc Co. of Tennessee	Zinc.
11	Page	Yreka	Idaho	American Smelting & Refining Co.	Zinc-lead.
12	Pend Oreille	Metaline	Washington	Pend Oreille Mines & Metals Co.	Do.
13	Iron King	Big Bug	Arizona	Shattuck Denn Mining Corp.	Do.
14	Van Stone	Northport	Washington	American Smelting & Refining Co.	Zinc.
15	Edwards	St. Lawrence County	New York	St. Joseph Lead Co.	Do.
16	Bayard Group	Central	New Mexico	U. S. Smelting, Refining & Mining Co.	Do.
17	Calumet	Wisconsin	Wisconsin	Calumet & Hecla, Inc.	Do.
18	Bunker Hill and Sullivan	Yreka	Idaho	Bunker Hill & Sullivan Mining & Concentrating Co.	Zinc-lead.
19	Old slag dump	Yreka	do.	do.	Zinc-bearing slags.
20	Treasury Tunnel	Upper San Miguel	Colorado	Idarado Mining Co.	Copper-zinc-lead.
21	Morning	Hunter	Idaho	American Smelting & Refining Co.	Zinc-lead.
22	Grandview	Metaline	Washington	American Zinc, Lead & Smelting Co.	Do.
23	Bautsch	Northern Illinois	Illinois	Tri-State Zinc Co., Inc.	Zinc.
24	Grasselli	Eastern Tennessee	Tennessee	American Zinc Co. of Tennessee	Do.
25	Ballard	Tri-State	Kansas	National Lead Co., St. Louis Smelting & Refining Division.	Zinc-lead.

TABLE 8.—Mine production of zinc in the United States in the principal districts [1] of the United States, 1944–48 (average) and 1949–53, in terms of recoverable zinc, in short tons

District	State	1944–48 (average)	1949	1950	1951	1952	1953
Summit Valley (Butte)	Montana	23,337	47,982	63,511	80,500	75,968	75,170
Coeur d'Alene	Idaho	78,748	74,370	86,103	74,989	70,316	68,650
Tri-State (Joplin region)	Kansas, Southwestern Missouri, Oklahoma.	132,552	78,628	80,558	91,553	90,512	55,729
St. Lawrence County	New York	32,343	37,973	38,321	40,051	32,636	51,529
New Jersey	New Jersey	75,867	50,984	55,029	62,917	59,190	45,700
Eastern Tennessee [2]	Tennessee	32,001	29,788	35,326	38,639	38,020	38,465
Upper Mississippi Valley	Northern Illinois, Iowa,[3] Wisconsin.	17,208	17,846	26,793	31,403	34,716	26,286
West Mountain (Bingham)	Utah	16,787	22,311	16,120	18,286	20,395	19,669
Red Cliff	Colorado	17,293	17,450	19,956	29,200	26,000	16,850
Austinville	Virginia	16,766	13,166	[2] 12,396	[2] 7,332	13,409	16,676
Central	New Mexico	37,293	26,376	26,897	41,884	48,043	12,743
Big Bug	Arizona	4,955	8,798	10,416	9,688	10,862	10,476
Upper San Miguel	Colorado	1,960	6,004	8,881	9,228	9,811	10,414
Kentucky-Southern Illinois	Kentucky, Southern Illinois.	5,768	6,541	6,642	9,584	7,968	5,589
Park City region	Utah	9,429	8,359	7,425	10,209	7,746	4,848
Harshaw	Arizona	1,945	2,947	4,193	4,076	3,924	4,186
California (Leadville)	Colorado	6,387	6,455	7,392	8,144	8,487	3,945
Cochise	Arizona	2,048	1,760	1,025	3,243	4,266	3,893
Warm Springs	Idaho	2,659	1,635	1,236	1,860	2,142	3,026
Smelter (Lewis and Clark County).	Montana	6,404	1,463	2,358	2,428	2,807	2,924
Pioneer (Rico)	Colorado	3,705	1,354	1,365	2,527	2,734	2,634
Eureka (Bagdad)	Arizona	712	2,304	1,478	2,504	3,520	2,594
Tintic	Utah	3,547	6,082	5,985	3,410	2,951	2,433
Aravaipa	Arizona	382	783	921	1,404	1,315	1,732
Rush Valley and Smelter (Tooele County).	Utah	5,901	2,188	1,219	1,608	916	1,528
Silver Bell	Arizona	46	1	11	-------	364	1,324
Breckenridge	Colorado	720	362	427	366	620	1,200
Warren (Bisbee)	Arizona	21,747	35,393	20,707	4,511	4,791	1,182
Verde (Jerome)	do	92	4,350	7,800	10,155	4,360	959
Creede	Colorado	22	671	873	892	1,024	858
Animas	do	1,004	1,029	961	1,183	986	541
Magdalena	New Mexico	4,172	2,263	1,677	2,276	2,122	512
Patagonia (Duquesne)	Arizona	688	555	368	601	1,049	257
Pima (Sierritas, Papago, Twin Buttes).	do	4,660	7,177	5,802	5,414	3,472	11
Chelan Lake [4] [5]	Washington	1,902	2,724	2,430	1,879	(6)	(6)
Coso [5]	California	1,501	4,062	5,237	4,720	5,479	(6)
Flint Creek [5]	Montana	63	8	120	392	1,084	(6)
Metaline [5]	Washington	8,091	6,496	11,032	12,753	(6)	(6)
Northport [5]	do	2,139	1,412	1,304	3,496	(6)	(6)
Ophir [5]	Utah	440	1,004	374	341	670	(6)
Pioche [5]	Nevada	16,659	18,651	19,655	14,350	12,493	(6)
Sneffels [5]	Colorado	477	1,053	810	1,094	931	(6)
Cow Creek (Ingot)	California	36	(6)	(6)	(6)	(6)	-------
Heddleston	Montana	1,568	2,026	892	1,395	1,066	-------
Old Hat (Oracle)	Arizona	3,746	5,195	4,603	3,583	3,368	-------
Pioneer (Superior)	do	1,229	-------	2,595	6,240	4,175	-------
Smelter (Cascade County) [5]	Montana	-------	1,278	-------	-------	-------	-------
Ten Mile	Colorado	4,208	9,716	2,925	16	12	-------
Tomichi	do	994	1,456	963	1,011	874	-------
Yellow Pine (Goodsprings)	Nevada	702	447	643	1,332	1,464	-------

[1] Districts producing 1,000 short tons or more in any year of the period 1949–53.
[2] Includes very small quantity produced elsewhere in State.
[3] No production in Iowa since 1917.
[4] Includes Peshastin Creek and Wenatchee River districts.
[5] This district is not listed in order of 1953 output.
[6] Quantity withheld to avoid disclosure of individual company operations.

SMELTER PRODUCTION

During 1953, 18 primary zinc-reduction plants were operating; 9 operated with horizontal retorts exclusively, 4 with vertical retorts exclusively (1 wholly electrothermic and 1 partly so), and 5 with electrolytic methods.

Horizontal-Retort Plants.—The total number of retorts reported at active horizontal-retort primary plants in 1953 was 55,900 compared with 55,800 retorts reported in 1952. Of the total retorts reported, 38,800 (69 percent) were in use at the end of 1953 compared with 51,800 (93 percent) in use at the close of 1952. There were no additional retorts under construction at the end of 1953.

Vertical-Retort Plants.—Four vertical-retort, continuous distilling plants operated during 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 is the resistor. The New Jersey Zinc Co. continued to use its Sterling arc-type electric furnace, which was first put in operation experimentally in 1951. The total number of vertical retorts of all types at the end of 1953, as at the beginning of the year, was 91. Of this number, 71 were in operation at the end of the year.

Electrolytic Plants.—Five electrolytic zinc-reduction plants with a total of 3,692 electrolytic cells were operated in 1953; 3,464 cells were in use at the end of the year. Comparable 1952 figures were 3,370 cells, of which 3,340 cells were operating at the end of that year.

Smelting Capacity.—Irrespective of additions or subtractions of smelter recovery units, statistics on domestic smelting capacity may vary from year to year, owing to changes in metallurgical practices at the various plants. According to reports to the Bureau of Mines, the active zinc-reduction plants in the United States as of the end of 1953 had a reported annual capacity of 1,147,000 tons of slab zinc. This figure indicates that smelter output was 84 percent of capacity. In 1952 smelter production was 86 percent of the reported capacity of 1,112,000 tons. Horizontal and vertical retort plants operated at 83 percent of the 677,000 tons reported capacity (84 percent of a 680,000-ton capacity in 1952), electrolytic plants at 90 percent of a 412,500-ton reported capacity (94 percent of 375,000-ton capacity in 1952), and secondary smelters at 61 percent of 58,000-ton reported capacity (64 percent of 57,000-ton capacity in 1952).

Waelz Kilns.—The following companies operated Waelz kilns in 1953:

Arkansas: Fort Smith—The Residue Co.
Illinois:
- Danville—The Hegeler Zinc Co.
- Fairmont City—American Zinc Co. of Illinois.
- La Salle—Matthiessen & Hegeler Zinc Co.

Kansas: Cherryvale—National Zinc Co., Inc.
Oklahoma: Henryetta—Eagle-Picher Co.
Pennsylvania:
- Donora—American Steel & Wire Division, United States Steel Corp.
- Palmerton—New Jersey Zinc Co.

Slag-Fuming Plants.—The following companies operated slag-fuming plants in 1953 to produce impure zinc oxide, which was further treated to recover the zinc as slab zinc:

California: Selby—American Smelting & Refining Co.
Idaho: Kellogg—Bunker Hill & Sullivan Mining and Concentrating Co.
Montana: East Helena—Anaconda Copper Mining Co.
Texas: El Paso—American Smelting & Refining Co.
Utah: Tooele—International Smelting & Refining Co.

During 1953 these 5 plants treated 656,600 tons of hot and cold slag, which yielded 113,800 tons of oxide fume containing 79,200 tons of recoverable zinc. Corresponding figures for 1952 were 626,200, 104,200, and 73,300 tons, respectively. The new slag-fuming plant[6] at the Selby smelter, which began operation April 20, 1953, was described in the technical press. The plant has capacity to recover 10,000 tons of zinc from lead slags annually.

Active Zinc-Reduction Plants.—During 1953 the Sullivan Mining Co. continued construction of new facilities at its Kellogg, Idaho, plant. These included a second thawing shed for frozen concentrate, 18 concrete storage bins having capacity for 18,000 tons of concentrate, and a pretreatment plant for removing magnesia and lime from concentrates obtained from Metaline Falls, Wash. A new sulfuric acid plant with 250- to 300-ton daily capacity was scheduled for completion in January 1954. Early in 1953 the Kellogg smelter resumed capacity operation following a period of power curtailment, but output was again curtailed 20 percent in April for lack of concentrates. By June the concentrate shortage was overcome, and operations returned to normal. The Henryetta, Okla., smelter of the Eagle-Picher Co. was closed by a strike in early November which continued through the remainder of the year. Other curtailments included an 18-percent reduction in output at St. Joseph Lead Co., Josephtown, Pa., plant announced November 6; a 20-percent reduction at the Fort Smith, Ark., smelter of the Athletic Mining & Smelting Co. in March; and 2 cutbacks of 1,000 tons each, on October 1 and November 1, at the Fairmont City, Ill., smelter and a cutback of one-third at the La Salle, Ill., smelter of the Matthiessen & Hegeler Zinc Co.

A list of zinc-reduction plants operating in the United States in 1953 follows:

Primary Zinc Distillers

Horizontal-retort plants

Arkansas: Fort Smith—Athletic Mining & Smelting Co.
Illinois:
- Fairmont City—American Zinc Co. of Illinois.
- La Salle—Matthiessen & Hegeler Zinc Co.

Oklahoma:
- Bartlesville—National Zinc Co., Inc.
- Blackwell—Blackwell Zinc Co.
- Henryetta—Eagle-Picher Co.

Pennsylvania: Donora—American Steel & Wire Division, United States Steel Corp.
Texas:
- Amarillo—American Smelting & Refining Co.
- Dumas—American Zinc Co. of Illinois.

Vertical-retort plants

Illinois: Depue—The New Jersey Zinc Co.
Pennsylvania:
- Josephtown—St. Joseph Lead Co.
- Palmerton—The New Jersey Zinc Co. of Pennsylvania.

West Virginia: Meadowbrook—Matthiessen & Hegeler Zinc Co.

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[6] Engineering and Mining Journal, Slag-Fuming at Selby: Vol. 154, No. 12, December 1953, pp. 95–97.

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, is chiefly smelted at 12 secondary smelters, although 33 percent is reduced at primary smelters, and much of the sal ammoniac skimmings are processed at chemical plants.

The primary and secondary smelting operations based on zinc-base scrap produced 52,900 tons of redistilled zinc, 6,100 tons of remelt zinc, 25,300 tons of zinc dust, and 11,400 tons of zinc in zinc oxide form, as well as remelt die-cast slab, and zinc pigments and salts.

In addition to secondary zinc and zinc products recovered from zinc-base scrap at primary and secondary smelters and other plants, 161,000 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.
  Philadelphia—General Smelting Co.
West Virginia: Wheeling—Wheeling Steel Corp.

SLAB ZINC

The output of primary slab zinc during 1953 was 916,000 tons, an increase of only 1 percent over the 1952 production and the highest output of primary zinc since 1943. Slab zinc from domestic ores declined 14 percent compared with 1952, but that from foreign ores increased 28 percent.

Production of redistilled slab zinc declined 4 percent to 53,000 tons. Of this total, 33 percent (18,000 tons) was produced at primary smelters and 67 percent (35,000 tons) at secondary smelters.

In addition to primary distilled zinc and redistilled secondary zinc, 2,900 tons of remelted secondary slab zinc was recovered by remelting purchased scrap (3,200 tons in 1952). Zinc rolling mills and other large consumers of slab zinc recovered large quantities of slab zinc from scrap generated in their own plants, but metal so recovered is not measured statistically.

Of the primary slab zinc produced in 1953, 60 percent was distilled and 40 percent produced electrolytically.

Production of Special High Grade, Brass Special, and Prime Western grades increased during 1953, but output of all other grades declined. Of the total 1953 production (comparable 1952 figures in parentheses), 42 (42) percent was Prime Western, 32 (31) percent Special High Grade, 19 (19) percent High Grade, 6 (5) percent Brass Special, 1 (2) percent Intermediate, and less than 0.5 percent (1) Select.

TABLE 9.—Primary and redistilled secondary slab zinc produced in the United States, 1944–48 (average) and 1949–53, in short tons

Year	Primary			Redistilled secondary	Total (excludes zinc recovered by remelting)
	From domestic ores	From foreign ores	Total		
1944–48 (average)	509, 753	280, 724	790, 477	52, 931	843, 408
1949	591, 454	223, 328	814, 782	55, 041	869, 823
1950	588, 291	255, 176	843, 467	66, 970	910, 437
1951	621, 826	259, 807	881, 633	48, 657	930, 290
1952	575, 828	[1] 328, 651	904, 479	55, 111	959, 590
1953	[1] 495, 436	[1] 420, 669	916, 105	52, 875	968, 980

[1] Includes a small tonnage of slab zinc further refined into high-grade metal.

TABLE 10.—Distilled and electrolytic zinc, primary and secondary, produced in the United States, 1944–48 (average) and 1949–53, in short tons

CLASSIFIED ACCORDING TO METHOD OF REDUCTION

Year	Electrolytic primary	Distilled	Redistilled secondary [1]		Total
			At primary smelters	At secondary smelters	
1944–48 (average)	295, 321	495, 156	22, 890	30, 041	843, 408
1949	326, 152	488, 630	22, 782	32, 259	869, 823
1950	342, 085	501, 382	28, 411	38, 559	910, 437
1951	336, 087	545, 546	16, 251	32, 406	930, 290
1952	351, 106	553, 373	18, 861	36, 250	959, 590
1953	370, 870	545, 235	17, 645	35, 230	968, 980

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		
1944–48 (average)	239, 051	202, 102	42, 607	62, 498	14, 605	282, 545	843, 408
1949	230, 576	206, 651	21, 513	56, 388	2, 565	352, 130	869, 823
1950	271, 678	192, 075	21, 571	46, 730	4, 021	374, 362	910, 437
1951	281, 571	175, 499	20, 734	60, 511	13, 494	378, 481	930, 290
1952	295, 801	182, 125	17, 903	48, 817	13, 608	401, 336	959, 590
1953	312, 810	180, 188	14, 720	56, 219	1, 930	403, 113	968, 980

[1] For total production of secondary zinc see chapter on Secondary Metals—Nonferrous.

TABLE 11.—Primary slab zinc produced in the United States, by States where smelted, 1944–48 (average) and 1949–53, in short tons

Year	Arkansas	Idaho	Illinois	Montana	Oklahoma	Pennsylvania	Texas and West Virginia[1]	Total	
								Short tons	Value
1944–48 (average)	22,441	37,674	118,138	199,095	116,769	190,127	106,233	790,477	$158,481,977
1949	17,116	41,854	86,823	216,578	157,650	156,920	137,841	814,782	202,391,849
1950	20,688	53,922	108,301	216,104	145,117	162,539	136,796	843,467	240,050,708
1951	21,776	54,468	108,544	208,482	161,247	189,177	137,939	881,633	321,619,718
1952	21,644	54,340	115,331	214,980	161,242	193,811	143,131	904,479	300,829,715
1953	20,379	54,037	129,904	222,354	134,918	192,279	162,234	916,105	210,154,487

[1] Includes Missouri, 1943–44 and 1947–53.

Montana maintained its position as the largest producer of primary slab zinc in 1953. Pennsylvania and Oklahoma were second and third in rank, respectively. All slab zinc produced in Montana and Idaho was produced electrolytically, that in Illinois and Texas was in part electrolytic and in part distilled, but that produced in all other States was wholly by distillation.

BYPRODUCT SULFURIC ACID

Sulfuric acid is made from sulfur dioxide gases produced in roasting zinc blende (sphalerite) concentrate at all zinc smelters where there is enough demand for sulfuric acid to warrant the plant investment and operation. At several such plants large quantities of elemental sulfur are also burned to increase acidmaking capacity. The production of sulfuric acid at such plants from 1949 through 1953 is shown in table 12.

TABLE 12.—Sulfuric acid (basis, 100 percent) made at zinc blende roasting plants in the United States, 1944–48 (average) and 1949–53

Year	Made from zinc blende[1]		Made from native sulfur		Total[1]		
						Value[1]	
	Short tons	Value[2]	Short tons	Value[2]	Short tons	Total[2]	Average per ton
1944–48 (average)	587,130	$7,722,128	219,358	$2,901,515	806,488	$10,623,643	$10.23
1949	476,932	7,276,481	130,592	1,992,423	607,524	9,268,904	11.85
1950	609,571	8,829,236	243,743	3,530,464	853,314	12,359,700	11.25
1951	635,948	10,218,400	261,106	4,195,451	897,054	14,413,851	12.48
1952	664,714	11,031,494	224,671	3,728,613	889,385	14,760,107	12.89
1953	636,864	11,397,458	229,951	4,115,262	866,815	15,512,720	13.90

[1] Includes acid from foreign blende.
[2] At average of sales of 60° B. acid.

ZINC DUST

Production of zinc dust in 1953 was 25,300 tons compared with 25,100 tons in 1952. The zinc dust reported here is restricted to commercial grades that comply with close specifications as to percentage of unoxidized metal, evenness of grading, and fineness of particles and hence does not include zinc powder and blue powder. The zinc content of the dust produced in 1953 ranged from 95.0 percent to

99.7 and averaged 97.7 percent. Shipments of zinc dust were 24,600 tons, of which 500 tons was for foreign consignees. Producers' stocks of zinc dust rose from 1,400 tons at the beginning of the year to 1,900 tons at the end of 1953.

The average price of all zinc dust shipped in 1953 was 13.3 cents a pound compared with 19.5 cents in 1952. 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 13.—Zinc dust[1] produced in the United States, 1944–48 (average) and 1949–53

Year	Short tons	Value		Year	Short tons	Value	
		Total	Average per pound			Total	Average per pound
1944–48 (average)	28,756	$6,866,817	$0.119	1951	31,695	$13,438,680	$0.212
1949	22,776	6,195,072	.136	1952	25,113	9,794,070	.195
1950	28,922	9,602,104	.166	1953	25,297	6,546,344	.133

[1] All produced by distillation.

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, 176,000 tons of zinc was consumed in these products, of which 118,000 tons were derived from ore (foreign, 39,000 tons), 21,000 tons from slab zinc, and 37,000 tons from secondary materials. Details of the production of zinc pigments and salts are given in the Lead and Zinc Pigments and Zinc Salts chapter of this volume.

CONSUMPTION AND USES

According to reports from approximately 750 plants, 986,000 tons of slab zinc was consumed in 1953, compared with 853,000 tons in 1952 and 967,000 tons in the previous record year of 1950. Slab zinc received at consumers' plants totaled 980,000 tons. In comparing the year's consumption with that of 1952 it must be remembered that the 1952 consumption was reduced by the steel shortage resulting from the nationwide steel strike June 2 to July 25, 1952, and that part of 1953 consumption was to fulfill consumer requirements that were necessarily deferred in 1952.

Galvanizing continued to be the largest field of zinc use, using 407,000 tons or 41 percent of the total slab zinc consumed and 8 percent more than in 1952. Gains were noted in the galvanizing of sheet and strip and in job galvanizing. Two new continuous-strip galvanizing lines were erected at steel plants, bringing the total of such plants to 18 at the year end, with 5 more under construction. The manufacture of zinc-base alloys (chiefly die castings) required

307,000 tons of zinc or 30 percent more than in 1952, owing largely to a 32-percent increase in the 1953 output of automobiles and trucks over that in 1952. Slab zinc consumed in brassmaking increased 15 percent to 178,000 tons, the highest since 1945. In addition to the slab zinc consumed in brassmaking in 1953, 161,000 tons of secondary zinc in the form of copper-base scrap was consumed in making brass and bronze ingots at secondary smelters.

TABLE 14.—Consumption of slab zinc in the United States, 1944–48 (average) and 1949–53, by industries, in short tons [1]

Industry and product	1944–48 (average)	1949	1950	1951	1952	1953
Galvanizing: [2]						
Sheet and strip	120, 818	146, 923	188, 406	144, 329	145, 875	164, 601
Wire and wire rope	46, 746	39, 231	47, 317	51, 792	48, 645	44, 100
Tubes and pipe	67, 041	78, 030	91, 877	79, 221	82, 043	88, 428
Fittings	11, 845	11, 487	15, 948	21, 186	10, 366	10, 330
Other	94, 595	75, 209	98, 138	103, 751	90, 759	99, 529
Total galvanizing	341, 045	350, 880	441, 686	400, 279	377, 688	406, 988
Brass products:						
Sheet, strip, and plate	112, 185	43, 157	68, 737	67, 815	71, 706	94, 826
Rod and wire	51, 677	23, 651	43, 413	46, 056	49, 831	47, 312
Tube	19, 957	12, 816	17, 385	15, 927	17, 057	18, 136
Castings and billets	8, 361	2, 620	4, 170	7, 098	7, 262	8, 145
Copper-base ingots	8, 458	2, 701	4, 081	5, 743	8, 223	7, 659
Other copper-base products	1, 741	589	1, 587	653	1, 529	2, 104
Total brass products	202, 379	85, 534	139, 373	143, 292	155, 608	178, 182
Zinc-base alloy:						
Die castings	169, 123	199, 665	285, 022	282, 812	225, 877	297, 280
Alloy dies and rod	5, 763	2, 024	2, 929	11, 135	9, 235	7, 140
Slush and sand castings	447	492	1, 576	2, 487	1, 577	3, 025
Total zinc-base alloy	175, 333	202, 181	289, 527	296, 434	236, 689	307, 445
Rolled zinc	82, 772	55, 200	68, 444	64, 085	51, 318	54, 649
Zinc oxide	18, 303	10, 292	18, 187	18, 223	17, 205	20, 675
Other uses:						
Wet batteries	1, 686	1, 359	1, 527	1, 749	1, 396	1, 417
Desilverizing lead	2, 254	2, 448	2, 947	2, 186	2, 370	2, 425
Light-metal alloys	1, 158	1, 060	1, 356	3, 132	3, 266	5, 939
Other [3]	4, 325	2, 887	4, 087	4, 591	7, 243	8, 207
Total other uses	9, 423	7, 754	9, 917	11, 658	14, 275	17, 988
Total consumption [4]	829, 255	711, 841	967, 134	933, 971	852, 783	985, 927

[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 2,394 tons of remelt zinc in 1949, 3,035 tons in 1950, 4,505 tons in 1951, 4,144 tons in 1952, and 3,710 tons in 1953.

Slab zinc consumed in rolled-zinc products in 1953 increased 6 percent to 54,600 tons. In addition to slab zinc, the rolling mills remelt and reroll the metallic scrap (home scrap) produced from associated fabricating operations. The scrap so treated totaled 13,100 tons compared with 11,100 tons in 1952. Purchased zinc scrap, in the form of zinc clippings, old zinc scrap, and engravers' plates, totaling 3,600 tons was melted and rolled in 1953 (3,200 tons in 1952). Production of rolled zinc from both slab zinc and purchased scrap was 56,400 tons or 5 percent higher than the 1952 total of 53,500 tons. Stocks of rolled zinc were 1,700 tons at the end of 1953. In addition to shipments of 38,000 tons of rolled zinc in 1953 the rolling mills processed 32,000 tons

TABLE 15.—Rolled zinc produced and quantity available for consumption in the United States, 1952–53

	1952			1953		
	Short tons	Value		Short tons	Value	
		Total	Average per pound		Total	Average per pound
Production:						
Sheet zinc not over 0.1 inch thick	11,906	$7,210,737	$0.303	13,411	$7,416,190	$0.276
Boiler plate and sheets over 0.1 inch thick	1,387	705,111	.254	1,014	473,375	.233
Strip and ribbon zinc [1]	38,750	16,728,827	.216	40,603	14,433,514	.178
Foil, rod, and wire	1,441	905,477	.314	1,359	679,475	.250
Total rolled zinc	53,484	25,550,152	.239	56,387	23,002,554	.204
Imports	47	23,557	.251	196	76,507	.195
Exports	3,031	1,935,410	.319	3,239	1,696,142	.262
Available for consumption	50,688			53,469		
Value of slab zinc (all grades)			.166			.115
Value added by rolling			.073			.089

[1] Figures represent net production. In addition 11,107 tons of strip and ribbon zinc in 1952 and 13,113 tons in 1953 were rerolled from scrap originating in fabricating plants operated in connection with zinc rolling mills.

of rolled zinc in manufacturing 19,400 tons of semifabricated and finished products.

Table 16 shows the six commercial grades of refined slab zinc and purchased remelt zinc consumed by the various industries in 1953. Of the 986,000 tons of domestic and foreign slab zinc consumed, 39 percent was Prime Western, 38 percent Special High Grade, 14 percent High Grade, and 6 percent Brass Special. All grades were used in galvanizing, Prime Western mainly in hot-dip galvanizing and the higher grades for electrogalvanizing. Of the 178,000 tons of zinc used in brass products, 78 percent was Special High Grade and High Grade, as rigid specifications in brass manufacture dictate the use of high-grade metal.

TABLE 16.—Consumption of slab zinc in the United States in 1953, by grades and industries, in short tons

Industry	Special High Grade	High Grade	Inter-mediate	Brass Special	Select	Prime Western	Remelt	Total
Galvanizing	14,702	16,527	8,388	15,338	105	350,008	1,920	406,988
Brass products	40,789	98,349	1,894	8,452	3,664	24,160	874	178,182
Zinc-base alloy	305,155	923	220	38	27	840	242	307,445
Rolled zinc	8,854	20,307	10,361	14,261	47	819		54,649
Zinc oxide	7			16,154		4,514		20,675
Other	5,769	1,510	644	941		8,450	674	17,988
Total	375,276	137,616	21,507	55,184	3,843	388,791	3,710	985,927

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 [7] for the years

[7] For 1940–45, see Bureau of Mines Inf. Circ. 7450, 1948, 30 pp. For more recent years see the Bureau of Mines Yearbooks, beginning with that for 1948.

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 17–22.

Consumption of Slab Zinc for All Uses.—The greatest concentration of slab-zinc consumption, by geographic divisions, was in the region comprising Illinois, Indiana, Michigan, Ohio, and Wisconsin. This area, which has consistently ranked first since before 1940, has used approximately half of the slab zinc consumed in the United States each year. The region of least consumption is the Mountain States group, made up of Arizona, Colorado, Idaho, Montana, and Utah, which used only 0.3 percent of the total. Ohio, which held second place among the 42 zinc-consuming States and the District Columbia from 1945 through 1951, was the leading consuming State in both 1952 and 1953, displacing Illinois, which had held first position from 1940 through 1951. Pennsylvania has held either second or third place since 1940. Connecticut was the second largest consuming State during World War II, when zinc for brassmaking was in greatly expanded demand. From 1945 through 1952 it occupied fourth position but during 1953 dropped to sixth place, being exceeded by both Indiana and Michigan.

TABLE 17.—Consumption of slab zinc in the United States, 1946–50 (average) and 1951–53, by geographic divisions and States [1]

Geographic division and State	1946–50 (average)		1951		1952		1953	
	Short tons	Rank	Short tons	Rank	Short tons	Rank	Short tons	Rank
I. New England:								
Connecticut	59,821	5	69,926	4	65,350	4	73,197	6
Massachusetts	9,982	15	9,745	15	9,872	15	9,395	15
Maine	108	31	95	35	(2)	35	(2)	34
New Hampshire	13	36	(2)	37	(2)	39	(2)	38
Rhode Island	248	29	(2)	28	(2)	28	610	30
Total	70,172	3	80,348	3	75,984	3	83,476	3
II. Middle Atlantic:								
New Jersey	20,889	12	21,517	12	22,975	12	27,565	10
New York	46,442	6	57,809	6	52,738	7	67,081	7
Pennsylvania	123,527	3	137,056	3	126,083	3	135,850	3
Total	190,858	2	216,382	2	201,796	2	230,496	2
III. South Atlantic:								
Delaware	-----	-----	(2)	31	(2)	32	(2)	28
District of Columbia	28	34	(2)	36	(2)	37	(2)	37
Florida	6	37	(2)	33	(2)	33	(2)	33
Georgia	2,300	19	1,689	23	1,479	24	1,556	24
Maryland	25,571	9	28,878	9	29,077	9	36,850	9
North Carolina	-----	-----	-----	-----	(2)	38	-----	-----
South Carolina	45	33	-----	-----	(2)	36	(2)	35
Viginia	247	30	273	32	373	31	702	29
West Virginia	24,540	10	25,616	10	23,655	10	21,340	12
Total	52,737	4	57,032	4	55,350	4	61,810	4
IV. East North Central:								
Illinois	152,504	1	167,937	1	142,516	2	157,765	2
Indiana	60,617	4	58,191	5	53,444	6	74,329	4
Michigan	44,126	7	55,864	7	53,491	5	73,241	5
Ohio	133,562	2	158,685	2	143,350	1	165,062	1
Wisconsin	12,114	14	13,951	14	12,057	14	13,859	14
Total	402,923	1	454,628	1	404,858	1	484,256	1

See footnotes at end of table.

TABLE 17.—Consumption of slab zinc in the United States, 1946–50 (average) and 1951–53, by geographic divisions and States [1]—Continued

Geographic division and State	1946–50 (average)		1951		1952		1953	
	Short tons	Rank	Short tons	Rank	Short tons	Rank	Short tons	Rank
V. East South Central:								
Alabama	23,815	11	25,502	11	23,241	11	25,420	11
Kentucky	8,564	16	(2)	16	(2)	16	8,291	16
Tennessee	1,272	23	(2)	25	(2)	25	1,865	23
Total	33,651	5	35,206	6	32,600	6	35,576	6
VI. West North Central:								
Iowa	6,086	17	4,480	18	4,632	18	5,452	18
Kansas	84	32	(2)	30	(2)	30	(2)	32
Minnesota	3,541	18	3,798	19	(2)	19	3,005	19
Missouri	16,447	13	19,472	13	14,734	13	14,858	13
Nebraska	1,473	22	(2)	24	(2)	23	(2)	25
Total	27,631	7	29,517	7	24,208	7	25,363	7
VII. West South Central:								
Arkansas	------	------	(2)	39	(2)	41	(2)	40
Louisiana	295	28	(2)	27	(2)	26	(2)	26
Oklahoma	912	25	(2)	22	1,921	22	2,229	22
Texas	2,110	20	4,959	17	5,230	17	6,641	17
Total	3,317	8	7,885	8	8,075	8	9,936	8
VIII. Mountain:								
Arizona	------	------	(2)	34	(2)	34	(2)	36
Colorado	1,741	21	(2)	21	(2)	20	2,250	21
Idaho	355	26	(2)	29	(2)	29	(2)	31
Montana	------	------	------	------	(2)	42	------	------
Utah	17	35	(2)	38	(2)	40	(2)	39
Total	2,113	9	3,038	9	2,880	9	2,844	9
IX. Pacific:								
California	28,894	8	41,898	8	39,955	8	45,104	8
Oregon	309	27	1,051	26	767	27	835	27
Washington	1,046	24	2,481	20	2,166	21	2,521	20
Total	30,249	6	45,430	5	42,888	5	48,460	5
Grand total [1]	813,651	------	929,466	------	848,639	------	982,217	------

[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.

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 numerous products. Zinc consumed in coating sheet and strip increased 13 percent in 1953 to 164,600 tons, a quantity exceeded only in 1950. Two additional continuous galvanizing lines were put in operation during 1953, and at the end of the year the rated capacity of the 18 such plants in operation and 5 under construction equaled 75 percent of the demand for quality zinc-coated sheets and strips (coils). Shipments of galvanized-steel sheets, reported by the American Iron and Steel Institute in 1953, totaled 2,291,000 tons compared with 1,961,000 tons in 1952 and 1,985,000 tons in 1951. 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 1953 has held first place. Ohio, Pennsylvania, Illinois, and Indiana used 62 percent of the slab zinc consumed for galvanizing in the period 1946 through 1950 and 58, 59, and 58 percent, respectively, in 1951, 1952, and 1953.

TABLE 18.—Consumption of slab zinc for galvanizing in the United States 1946–50 (average) and 1951–53, by States [1]

State	Geographic division	1946–50 (average)		1951		1952		1953	
		Short tons	Rank	Short tons	Rank	Short tons	Rank	Short tons	Rank
Alabama	V	23,554	6	24,827	6	22,495	8	24,524	7
California	IX	16,214	8	23,756	8	22,516	7	27,116	6
Colorado	VIII	1,684	20	[2]	19	[2]	19	[2]	20
Connecticut	I	3,040	16	3,241	17	2,936	17	3,001	16
Florida	III	6	33	[2]	28	[2]	27	[2]	27
Georgia	III	2,294	18	[2]	22	[2]	22	[2]	22
Illinois	IV	45,523	3	46,510	3	46,633	3	46,605	3
Indiana	IV	27,794	4	31,570	4	30,865	4	35,196	5
Iowa	VI	67	30	294	27	268	28	242	30
Kentucky	V	8,562	9	7,945	9	7,852	9	7,854	9
Louisiana	VII	295	25	[2]	24	[2]	23	[2]	24
Maine	I	105	29	[2]	31	[2]	31	[2]	29
Maryland	III	25,037	5	28,486	5	28,656	5	36,261	4
Massachusetts	I	5,527	11	5,530	13	4,923	13	4,703	14
Michigan	IV	3,628	14	6,481	12	[2]	12	6,810	10
Minnesota	VI	3,541	15	[2]	16	2,939	16	2,944	17
Missouri	VI	4,021	13	6,720	10	3,598	15	4,234	15
Nebraska	VI	241	27	[2]	26	[2]	26	528	26
New Hampshire	I	3	34	------	------	------	------	------	------
New Jersey	II	4,857	12	5,519	14	5,354	11	6,041	12
New York	II	5,762	10	6,619	11	6,292	10	6,356	11
Ohio	IV	82,244	1	79,149	1	77,967	1	83,772	1
Oklahoma	VII	912	23	[2]	20	[2]	20	[2]	19
Oregon	IX	302	24	238	29	238	30	197	31
Pennsylvania	II	71,049	2	73,559	2	65,747	2	67,829	2
Rhode Island	I	242	26	[2]	25	[2]	25	[2]	25
South Carolina	III	44	32	------	------	[2]	32	[2]	32
Tennessee	V	1,014	21	941	23	736	24	1,305	23
Texas	VII	1,981	19	4,431	15	4,413	14	5,170	13
Utah	VIII	58	31	------	------	------	------	------	------
Virginia	III	165	28	[2]	30	[2]	29	[2]	28
Washington	IX	917	22	[2]	21	1,689	21	1,908	21
West Virginia	III	23,394	7	24,701	7	23,260	6	21,069	8
Wisconsin	IV	2,503	17	3,155	18	[2]	18	2,897	18
Total [1]	------	366,580	------	[3] 397,790	------	[3] 375,129	------	[3] 405,068	------

[1] Excludes remelt zinc. Includes zinc used in electrogalvanizing and electroplating, but excludes sherardizing.
[2] Quantity withheld to avoid disclosure of individual company operations.
[3] Includes States not individually shown (footnote reference 2).

Consumption of Slab Zinc for Brass Products.—Slab zinc consumed in brass products during 1953 increased 14 percent to 177,300 tons, the largest quantity since 1945 but well below the annual average of 294,800 tons of zinc used for brassmaking in the war years 1940–45. The concentration of brassmaking facilities in the Connecticut Valley has placed Connecticut first among the States in consuming 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 1953. Michigan was in second place from 1940 through 1942 and again in 1946 and 1947. Wisconsin was in second place in 1943, but in 1944 and 1945 and from 1948 through 1953 Illinois held that position. Third place was held by New York in 1940 through

TABLE 19.—Consumption of slab zinc for brass products in the United States, 1946–50 (average) and 1951–53, by States [1]

State	Geographic division	1946-50 (average)		1951		1952		1953	
		Short tons	Rank	Short tons	Rank	Short tons	Rank	Short tons	Rank
Alabama	V	222	13	(2)	12	(2)	12	(2)	12
California	IX	871	11	1,927	11	3,509	11	3,067	11
Colorado	VIII	56	15	(2)	17	(2)	15	(2)	16
Connecticut	I	50,309	1	60,055	1	56,704	1	63,127	1
Delaware	III	------	------	(2)	15	(2)	14	(2)	14
District of Columbia	III	28	17	(2)	18	(2)	22	(2)	24
Georgia	III	6	22	(2)	26	(2)	25	(2)	25
Illinois	IV	13,616	2	16,460	2	19,173	2	23,944	2
Indiana	IV	2,314	10	4,232	9	7,232	7	13,347	4
Iowa	VI	1	28	(2)	28	------	------	------	------
Kansas	VI	37	16	(2)	23	(2)	18	(2)	20
Kentucky	V	2	25	(2)	16	(2)	16	(2)	19
Maine	I	2	26	(2)	29	(2)	30	(2)	29
Maryland	III	534	12	(2)	13	(2)	13	(2)	13
Massachusetts	I	2,901	9	2,973	10	3,724	10	3,504	10
Michigan	IV	12,475	3	14,649	3	17,869	3	19,259	3
Minnesota	VI	------	------	------	------	(2)	27	(2)	23
Missouri	VI	96	14	43	19	80	19	(2)	15
Nebraska	VI	2	27	------	------	------	------	(2)	30
New Hampshire	I	10	20	(2)	21	(2)	24	(2)	27
New Jersey	II	5,586	7	5,666	8	6,721	8	6,652	9
New York	II	8,891	4	9,390	5	11,100	4	12,655	6
Ohio	IV	8,609	5	10,831	4	10,339	5	13,013	5
Oregon	IX	6	23	(2)	25	(2)	23	(2)	22
Pennsylvania	II	5,438	8	6,483	7	(2)	6	(2)	7
Rhode Island	I	6	24	(2)	24	(2)	29	(2)	26
South Carolina	III	1	29	------	------	------	------	------	------
Tennessee	V	------	------	(2)	20	(2)	28	(2)	31
Texas	VII	19	19	(2)	22	(2)	20	(2)	21
Utah	VIII	1	30	(2)	30	(2)	31	(2)	32
Virginia	III	23	18	(2)	27	(2)	26	(2)	17
Washington	IX	7	21	------	------	(2)	21	(2)	28
West Virginia	III	------	------	(2)	14	(2)	17	(2)	18
Wisconsin	IV	6,467	6	7,461	6	6,519	9	7,305	8
Total [1]	------	118,536	------	[3] 142,360	------	[3] 155,090	------	[3] 177,308	------

[1] Excludes remelt zinc.
[2] Quantity withheld to avoid disclosure of individual company operations.
[3] Includes States not individually shown (footnote reference 2).

1942, by Ohio in 1943, Illinois in 1946 and 1947, and by Michigan all other years through 1953.

Consumption of Slab Zinc for Zinc-Base Alloys.—Slab zinc consumed in zinc-base alloys established a record of 307,200 tons, exceeding 1952 consumption by 30 percent and the previous record year (1950) by 6 percent. The automobile industry uses large quantities of zinc-base alloys for zinc die-cast parts and assemblies, such as fuel pumps, carburetors, radiator grilles, windshield-wiper motors, and much interior and exterior hardware. Passenger-car and truck production in 1953 totaled 7,300,000 units, a quantity exceeded only in 1950, when 8,400,000 units was produced. Not only did demand increase as a result of the requirements of the automobile and automobile-accessory industries, but requirements also rose for zinc die castings in home appliances; office machines, scientific, communications, and photographic equipment; and builders' hardware. Table 20 shows the quantities of zinc consumed in zinc-base alloys by States and the relative rank of each State. Illinois, Indiana, Michigan, Ohio, and Wisconsin, which are the principal producers of automotive parts and many home appliances, consumed over 62 percent of the slab zinc used in zinc-base alloys.

TABLE 20.—Consumption of slab zinc for zinc-base alloys in the United States, 1946–50 (average) and 1951–53, by States [1]

State	Geographic division	1946–50 (average)		1951		1952		1953	
		Short tons	Rank	Short tons	Rank	Short tons	Rank	Short tons	Rank
Alabama	V	10	15	------	------	------	------	------	------
California	IX	11,454	8	15,693	6	13,411	6	14,399	7
Colorado	VIII	------	------	(2)	16	(2)	16	------	------
Connecticut	I	5,095	10	5,044	10	4,400	10	5,737	10
Delaware	III	------	------	------	------	------	------	(2)	15
Illinois	IV	55,687	1	72,740	1	48,944	2	60,613	2
Indiana	IV	14,348	6	11,740	8	8,840	9	15,476	6
Iowa	VI	------	------	------	------	------	------	(2)	17
Kansas	VI	29	13	312	14	(2)	14	(2)	14
Kentucky	V	------	------	(2)	15	(2)	15	(2)	16
Massachusetts	I	11	14	(2)	17	(2)	19	(2)	19
Michigan	IV	27,925	3	34,333	4	30,197	3	46,977	3
Missouri	VI	12,016	7	12,254	7	10,478	7	9,499	9
New Jersey	II	8,609	9	8,448	9	9,622	8	13,531	8
New York	II	26,581	4	35,825	3	29,990	4	41,620	4
North Carolina	III	------	------	------	------	(2)	18	------	------
Ohio	IV	42,417	2	68,321	2	54,623	1	67,094	1
Oregon	IX	------	------	(2)	12	(2)	13	(2)	13
Pennsylvania	II	23,069	5	25,774	5	20,838	5	25,615	5
Texas	VII	109	12	(2)	13	(2)	12	(2)	12
Virginia	III	10	16	(2)	18	(2)	17	(2)	18
Washington	IX	7	17	------	------	------	------	------	------
Wisconsin	IV	3,144	11	3,335	11	(2)	11	(2)	11
Total [1]	------	230,521	------	[3] 295,421	------	[3] 236,147	------	[3] 307,203	------

[1] Excludes remelt zinc.
[2] Quantities withheld to avoid disclosure of individual company operations.
[3] Includes States not individually shown (footnote reference 2).

Consumption of Slab Zinc for Rolled Zinc.—Slab zinc consumed for rolled zinc has continued in the same geographic pattern from 1940 through 1953, but the quantity rolled has ranged from 49,000 tons in 1943 to 98,000 in 1945. During the war years 1940–45, the annual average consumption of slab zinc in this use was 70,000 tons; in the postwar years 1946–49 it averaged 74,000 tons and in 1950–53, 60,000 tons. In 1953 zinc-rolling mills reported the consumption of 54,600 tons of slab zinc in making sheet, strip ribbon, foil, rod, and wire. Illinois ranked first, with 23,000 tons, followed in order by Indiana, Pennsylvania, and New York.

TABLE 21.—Consumption of slab zinc for rolled zinc in the United States, 1946–50 (average) and 1951–53, by States

State	Geographic division	1946–50 (average)		1951		1952		1953	
		Short tons	Rank	Short tons	Rank	Short tons	Rank	Short tons	Rank
Connecticut	I	1,155	7	(1)	6	(1)	7	(1)	7
Illinois	IV	35,833	1	31,471	1	25,353	1	23,066	1
Indiana	IV	15,411	2	(1)	3	(1)	3	(1)	2
Iowa	VI	5,993	4	(1)	5	(1)	5	(1)	5
Massachusetts	I	1,522	6	(1)	7	(1)	6	(1)	6
New York	II	4,772	5	(1)	4	(1)	4	(1)	4
Pennsylvania	II	6,857	3	(1)	2	(1)	2	(1)	3
West Virginia	III	1,136	8	(1)	8	(1)	8	(1)	8
Total	------	72,679	------	64,085	------	51,318	------	54,649	------

[1] Quantity withheld to avoid disclosure of individual company operations.

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 22. The increase in yearly totals, beginning with 1952, is due in large measure to inclusion of slab zinc consumed for zinc oxide.

TABLE 22.—Consumption of slab zinc for other uses in the United States, 1946–50 (average) and 1951–53, by States [1]

State	Geographic division	1946–50 (average)		1951		1952 [2]		1953 [2]	
		Short tons	Rank	Short tons	Rank	Short tons	Rank	Short tons	Rank
Alabama	V	30	15	(3)	27	(3)	25	(3)	25
Arizona	VIII			(3)	17	(3)	16	(3)	19
Arkansas	VII			(3)	26	(3)	26	(3)	28
California	IX	354	6	522	5	519	7	522	12
Colorado	VIII	1	22			(3)	29	(3)	27
Connecticut	I	223	10	(3)	13	(3)	15	(3)	14
Idaho	VIII	356	5	(3)	9	(3)	10	(3)	11
Illinois	IV	94	14	(3)	6	2,413	2	3,537	2
Indiana	IV	98	13	276	14	(3)	14	(3)	13
Iowa	VI	24	16	(3)	16	(3)	8	(3)	8
Kansas	VI	18	18	(3)	21	(3)	27	(3)	22
Louisiana	VII			(3)	25	(3)	30	(3)	23
Maryland	III			(3)	20	(3)	20	(3)	18
Massachusetts	I	21	17	9	23	(3)	18	(3)	20
Michigan	IV	99	12	401	11	(3)	13	(3)	15
Minnesota	VI			(3)	28	(3)	28	(3)	29
Missouri	VI	315	7	455	7	578	6	(3)	7
Montana	VIII					(3)	31		
Nebraska	VI	1,230	3	(3)	3	(3)	4	(3)	6
New Jersey	II	1,838	2	1,884	2	1,278	3	1,341	3
New York	II	436	4	(3)	4	(3)	5	(3)	4
Ohio	IV	292	8	384	12	421	11	1,183	5
Oklahoma	VII			(3)	22	(3)	24	(3)	30
Oregon	IX					(3)	21	(3)	24
Pennsylvania	II	3,193	1	3,240	1	20,770	1	24,863	1
Tennessee	V	258	9	(3)	10	(3)	9	(3)	10
Texas	VII			(3)	19	(3)	19	(3)	17
Utah	VIII	6	20	(3)	24	(3)	22	(3)	26
Virginia	III	2	21	(3)	18	(3)	17	(3)	16
Washington	IX	115	11	(3)	8	(3)	12	(3)	9
West Virginia	III	10	19	(3)	15				
Wisconsin	IV					(3)	23	(3)	21
Total [1]		9,013		[4] 11,587		[4] 30,955		[4] 37,989	

[1] Excludes remelt zinc.
[2] Includes slab zinc used for zinc oxide.
[3] Quantity withheld to avoid disclosure of individual company operations.
[4] Includes States not individually shown (footnote reference 3).

STOCKS

National Strategic Stockpile.—The semiannual Stockpile Report to the Congress for July–December 1953 made no announcements relative to the zinc Stockpile objective or the rate of procurement in 1953, but trade sources and the Tariff Commission indicated that purchases were continued under authority of Public Law 520 of the 79th Congress.

Producers' Stocks.—Slab-zinc stocks on hand at producers' plants at the end of 1953 totaled 180,000 tons, the highest since 1945 and an increase of 95,000 tons over ending stocks in 1952. 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.

TABLE 23.—Stocks of zinc at zinc-reduction plants in the United States at end of year, 1949–53, in short tons

	1949	1950	1951	1952	1953
At primary reduction plants	90,710	7,948	21,343	81,344	176,675
At secondary distilling plants	3,511	936	637	3,677	3,268
Total	94,221	8,884	21,980	85,021	179,943

Consumers' Stocks.—Slab-zinc stocks held by consumers on December 31, 1953 totaled 86,000 tons, a 7-percent decrease from the beginning of the year. This supply, together with 5,000 tons of metal in transit to consumers' plants, represented about 5 weeks' consumption at the average rate established in 1953.

TABLE 24.—Consumers' stocks of slab zinc at plants at the beginning and end of 1953, by industries, in short tons

Date	Galvanizers	Brass mills [1]	Die casters [2]	Zinc rolling mills	Oxide plants	Others	Total
Dec. 31, 1952	[3] 46,151	[3] 18,409	[3] 20,571	[3] 4,837	353	[3] 1,953	[3] [4] 92,274
Dec. 31, 1953	43,569	14,791	20,628	4,684	472	1,903	[4] 86,047

[1] Includes brass mills, brass-ingot makers, and foundries.
[2] Includes producers of zinc-base die castings, zinc-alloy dies, and zinc-alloy rods.
[3] Revised figure.
[4] Stocks on Dec. 31, 1952 and 1953, exclude 583 tons (revised figure) and 475 tons, respectively, of remelt spelter.

PRICES

The market price of Prime Western grade slab zinc, East St. Louis, was 12.5 cents a pound at the beginning of the year and advanced to 13 cents on January 2 but thereafter declined to 12.5 cents on January 14, 12 cents on January 27, 11.5 cents on February 3, 11.25 cents on February 25, and 11 cents on March 5. The 11-cent price remained in effect until July 16. Between July 16 and September 2 the price varied somewhat, owing to efforts to establish a delivered price, but, effective September 2, quotations were reestablished on the f. o. b. East St. Louis basis at 10.5 cents a pound. On September 11 the price dropped to 10 cents a pound at which level it remained for the balance of the year. Thus in a 16-month period starting in June 1952 the price of zinc dropped from 19.5 cents a pound to 10 cents, the widest fluctuation in so short a period since 1916.

The traditional East St. Louis basing-point system for pricing slab zinc was overturned in July, when the American Smelting & Refining Co. announced a series of new prices on a delivered basis. Two prices were established—1 for customers east of the Continental Divide and 1, a quarter of a cent higher, for customers west of the Divide. This pricing system had the effect of lowering the cost of metal to consumers in the East and on the Pacific coast, as formerly sales were made on the basis of East St. Louis delivery, with freight from that

TABLE 25.—Price of zinc concentrates and zinc, 1949–53

	1949	1950	1951	1952	1953
Joplin 60-percent zinc concentrates:[1] Price per short ton dollars	72.28	87.39	120.00	116.10	64.65
Average price common zinc at—					
St. Louis (spot)[1] cents per pound	12.15	13.88	17.99	16.21	10.86
New York[1] do	12.86	14.60	18.75	17.03	11.53
London[2] do	14.41	14.89	21.46	[3] 18.53	9.47
Price indexes (1947–49 average=100):					
Zinc (New York)	101	115	148	134	91
Lead (New York)	96	83	109	103	84
Copper (New York)	93	103	117	117	138
Straits tin (New York)	108	104	139	131	104
Nonferrous metals[4]	99	104	124	124	125
All commodities[4]	99	103	115	112	110

[1] Metal Statistics, 1954.
[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] Revised figure.
[4] Based upon price indexes of U. S. Department of Labor.

point to the consumer's plant paid by the buyer. The new system was abandoned in September owing to difficulties with ore contracts and with differentials on some of the higher grades of zinc. Sellers who had adopted the delivered basis for sales went back to the East St. Louis basing-point system on a slightly modified basis—purchasers to be charged freight but no more than one-half cent a pound.

The London Metal Exchange resumed dealings in zinc on January 2, marking the first time the free zinc market has functioned in Great Britain since August 31, 1939. The price on December 31, 1952,

TABLE 26—Average monthly quoted prices of 60-percent zinc concentrates at Joplin, and of common zinc (prompt delivery or spot) St. Louis and London 1952–53[1]

Month	1952			1953		
	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 4]
January	135.00	19.50	23.56	85.44	12.60	11.21
February	135.00	19.50	23.56	72.08	11.48	10.35
March	135.00	19.50	23.75	67.46	11.03	9.98
April	135.00	19.50	23.75	65.00	11.00	8.99
May	135.00	19.50	22.75	65.00	11.00	8.70
June	109.20	15.74	17.01	65.00	11.00	8.93
July	100.00	15.00	16.12	65.00	11.00	9.24
August	95.96	14.07	15.25	65.00	11.00	9.19
September	94.42	14.00	15.26	57.81	10.18	8.77
October	91.07	13.25	14.77	56.00	10.00	9.22
November	84.00	12.50	13.75	56.00	10.00	9.42
December	84.00	12.50	13.64	56.00	10.00	9.29
Average for year	[5] 116.10	16.21	18.53	64.65	10.86	9.47

[1] Joplin: Metal Statistics, 1954, p. 594. St. Louis: Metal Statistics, 1954, p. 587. London: E&MJ Metal and Mineral Markets and Quin's Metal Handbook.
[2] Conversion of English quotations into American money based on average rates of exchange recorded by Federal Reserve Board.
[3] Revised figures.
[4] Average of daily mean of bid and asked quotations at morning session of London Metal Exchange.
[5] Represents average price realized on total shipments for year.

before the market opened was £110 per long ton (equivalent to 13.75 cents a pound computed at an exchange rate of $2.80 to the pound sterling). By April 23, 1953, the market reached the low of the year at £63¾ (7.97 cents a pound); thereafter prices improved somewhat, closing December 31, 1953, in the range of £74¾ to £75 (9.34 to 9.37 cents). The average monthly quoted price of common zinc is given in table 26. Comparison of the St. Louis and London prices showed that the difference between the two ranged from 0.58 to 2.30 cents a pound but lessened considerably in the last quarter of the year.

TABLE 27.—Average price received by producers of zinc, 1949–53, by grades, in cents per pound

Grade	1949	1950	1951	1952	1953
Grade A:					
Special High grade	12.76	14.30	18.79	17.04	11.81
High grade	12.29	14.16	18.48	16.42	11.40
Grade B: Intermediate	12.94	14.69	18.57	17.76	11.38
Grades C and D:					
Brass Special	12.75	14.47	18.20	17.07	11.72
Select	12.87	17.37	18.00	16.73	11.59
Grade E: Prime Western	12.18	14.11	17.92	16.33	11.21
All grades	12.42	14.23	18.24	16.63	11.47
Prime Western; spot quotation at St. Louis [1]	12.15	13.88	17.99	16.21	10.86

[1] Metal Statistics, 1954, p. 587.

FOREIGN TRADE [8]

Imports.—Total imports (general imports) of zinc in ores and concentrates in 1953 established a peacetime high—513,000 tons—and were exceeded only in wartime 1943, when 539,000 tons was imported. Of the total 33 percent was obtained from Mexico, 32 percent from Canada, and 16 percent from Peru. The remaining 19 percent came chiefly from Bolivia, Union of South Africa, Australia, Yugoslavia, Italy, Spain, and Guatemala.

Imports of slab zinc during the year totaled 235,000 tons, more than double the 1952 total and a new record. Of the tonnage imported Canada supplied 46 percent, Mexico 14 percent, Italy 10 percent Belgium-Luxembourg 9 percent, and West Germany 6 percent. The bulk of the remaining 15 percent came from Peru, Norway, United Kingdom, Netherlands, and Australia.

Exports.—Exports of zinc in zinc ore, concentrate, dross and slab zinc, sheet, scrap and dust totaled 26,900 tons in 1953 valued at $8,338,000 compared with 66,300 tons in 1952 valued at $28,651,000. In addition to the export items listed in tables 30 and 31 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 17,900 short tons were chiefly to United Kingdom (78 percent), Brazil (9 percent), Belgium-Luxembourg (5 percent), and the Republic of Korea (4 percent). The

[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 28.—Zinc imported into the United States, in ores, blocks, pigs, or slabs, by countries, 1944–48 (average) and 1949–53, in short tons [1]

[U. S. Department of Commerce]

Country	1944–48 (average)	1949	1950	1951	1952	1953
Ores (zinc content):						
Algeria						2, 804
Argentina	6, 125		8	5, 546	603	
Australia	12, 546	4, 956	2, 366	2, 825	2, 398	10, 820
Bolivia	12, 242	3, 526	3, 810	7, 849	[2] 14, 603	22, 547
Canada-Newfoundland-Labrador	83, 750	61, 314	77, 525	96, 568	[2] 149, 130	165, 737
Chile	6, 907		40	1, 088	33	3, 247
Guatemala			473	6, 539	[2] 9, 744	6, 477
Honduras	5	221	104	154	316	637
Italy	4, 580					8, 738
Japan	1, 004				1, 389	
Mexico	155, 920	144, 101	155, 283	143, 769	[2] 200, 647	168, 937
Netherlands						3, 009
Peru	40, 113	14, 901	16, 946	29, 136	[2] 44, 337	84, 365
Philippines			42	86	1, 664	2, 104
Spain	2, 485	4, 880	17, 738	4, 392	16, 647	8, 617
Union of South Africa	408	6, 568	3, 794	2, 655	4, 917	13, 356
Yugoslavia				1, 756	2, 512	10, 820
Other countries	382	712	444	512	696	1, 168
Total ores	326, 467	241, 179	278, 573	302, 875	[2] 449, 636	513, 383
Blocks, pigs, or slabs:						
Australia	4, 439	103				3, 951
Belgian Congo						882
Belgium-Luxembourg	229	1, 933	3, 617	612	6, 854	21, 549
Canada	56, 510	109, 708	108, 937	85, 066	[2] 69, 775	107, 925
French Morocco				440		
Germany			1, 637		[2] [3] 7, 619	[3] 13, 906
Italy	316		2, 679		4, 063	23, 972
Japan	4, 323				222	
Mexico	19, 531	14, 191	26, 293	760	18, 686	33, 878
Netherlands			2, 005	254	3, 976	4, 338
Northern Rhodesia						1, 064
Norway	448	960	7, 939	882	110	6, 323
Peru			1, 205	26	1, 600	8, 406
United Kingdom	([4])		555			6, 317
Yugoslavia			485		2, 788	1, 900
Other countries	420	30	622	3	12	165
Total blocks, pigs, or slabs	86, 216	126, 925	155, 974	88, 043	[2] 115, 705	234, 576

[1] Data include zinc imported for immediate consumption plus material entering country under bond.
[2] Revised figure. [3] West Germany. [4] Less than 1 ton.

TABLE 29.—Zinc imported for consumption in the United States, 1944–48 (average) and 1949–53, by classes [1]

[U. S. Department of Commerce]

Year	Ores (zinc content)		Blocks, pigs, slabs		Sheets		Old, dross, and skimmings [2]		Zinc dust		Total value [3]
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	
1944–48 (average)	248, 412	$13, 145, 197	85, 802	$14, 904, 434	27	$7, 176	6, 473	$538, 298	96	$10, 020	$28, 605, 125
1949	109, 535	11, 748, 199	125, 564	29, 340, 620	32	8, 144	3, 732	558, 702	17	4, 397	41, 660, 062
1950	237, 564	24, 313, 625	155, 332	38, 759, 435	211	92, 862	2, 862	688, 176	472	80, 564	63, 934, 662
1951	197, 995	27, 043, 611	88, 043	31, 109, 279	149	84, 044	6, 603	284, 030	154	74, 362	58, 595, 326
1952	[4] 542,314	[4] 105,428, 691	[4] 113,053	[4] 36,219, 619	47	23, 557	[4] 3,489	[4] 535,426	133	38, 932	[4] 142,246, 225
1953	449, 391	47, 918, 150	227, 654	50, 281, 745	196	76, 507	5, 915	556, 592	1, 045	161, 612	98, 994, 606

[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: 1944–48 (average)—4,963 tons, $372,880; 1949—2,668 tons, $335,-283; 1950—1,229 tons, $186,748; 1951—6,457 tons, $242,998; 1952—Revised figures, 3,019 tons, $389,361; 1953—2,925 tons, $250,544.
[3] In addition, manufactures of zinc were imported as follows: 1944–48 (average)—$8,945; 1949—$2,583; 1950—$142,369; 1951—$51,700; 1952—$11,719; 1953—$5,855.
[4] Revised figure.

4,600 tons of sheets, plates, strips, and other forms not otherwise specified was shipped to Canada (50 percent), Brazil (15 percent), and Mexico (12 percent), as well as to several minor purchasing countries listed, with quantities, in table 30.

TABLE 30.—Slab and sheet zinc exported from the United States, by destinations, 1950–53, in short tons

[U. S. Department of Commerce]

Destination	Slabs, pigs, and blocks				Sheets, plates, strips, or other forms, n. e. s.			
	1950	1951	1952	1953	1950	1951	1952	1953
Country:								
Argentina			661			100	305	2
Austria		466	986					
Belgium-Luxembourg	67			840	21	3	(1)	1
Brazil	830	3,967	4,089	1,687	74	310	621	697
Canada	24	1,702	171	7	2,778	2,668	1,686	2,322
Chile	190	466	365	141	18	70	66	31
Colombia	3		1	23	322	369	147	136
Cuba	274	199	33	12	131	176	73	99
Denmark	641	80						
Egypt			385					
France		933	6,689	56	(1)	367		
Germany		215	[2] 607			26	[2] 21	
India	4,588	4,728	2,036		417	807	304	352
Israel and Palestine	105	3	60	34	70	97	55	9
Italy	224							
Japan	374	816				45	3	11
Korea	77		[3] 90	[3] 661				[3] 94
Mexico	349	211	351	457	575	859	532	545
Pakistan		220	111		3	10	3	3
Philippines	4	5	3		54	140	43	104
Switzerland	112	823	498		11	20	23	13
Union of South Africa		1			37	69	45	18
United Kingdom	4,941	20,024	40,423	13,859	98	25	41	9
Yugoslavia		1,244			(1)			
Other countries	114	407	155	82	201	418	263	182
Total	12,917	36,510	57,714	17,859	4,810	6,579	4,231	4,628
Continent:								
North America	652	2,117	558	481	3,544	3,765	2,361	3,013
South America	1,026	4,440	5,189	1,883	481	1,098	1,236	950
Europe	6,035	23,789	49,270	14,789	158	489	152	31
Asia	5,204	5,814	2,309	705	587	1,147	432	616
Africa		5	388	1	40	70	45	18
Oceania		345				10	5	(1)

1 Less than 1 ton.
2 West Germany.
3 Republic of Korea.

Tariff.—The duties on slab zinc (gross weight) and ores and concentrates (zinc content) were 0.7 and 0.6 cent per pound, respectively, from July 23, 1952, throughout 1953. The suspension of the tariff duty on zinc scrap was terminated June 30, 1953, and thereafter duty on such material was 0.75 cent per pound. These and other applicable duties, with changes, are presented in table 32.

The high level of imports established in 1952 was exceeded in 1953; and that, together with the depressed state of the domestic zinc- (and lead-) mining industry, stimulated much study of various protective tariff proposals and other plans whereby the domestic industry might be aided.

TABLE 31.—Zinc ore and manufactures of zinc exported from the United States, 1944–48 (average) and 1949–53

[U. S. Department of Commerce]

Year	Zinc ore, concentrates, and dross (zinc content)		Slabs, pigs, or blocks		Sheets, plates, strips, or other forms, n. e. s.		Zinc scrap (zinc content)		Zinc dust	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1944–48 (average)	1,008	$130,596	49,758	$10,347,463	8,469	$2,961,237	(1)	(1)	706	$198,625
1949	[2] 2,925	[2] 477,718	58,709	18,699,597	7,456	3,496,169	1,570	$224,291	690	261,484
1950	[2] 1,140	[2] 264,907	12,917	3,967,055	4,810	2,322,150	6,212	674,235	506	186,557
1951	[2] 3,090	[2] 792,800	36,510	15,592,994	6,579	4,360,689	4,613	871,302	723	400,656
1952 [3]	[2] 3,370	[2] 899,162	57,714	24,508,568	4,231	2,960,769	972	282,816	(4)	(4)
1953 [3]	[2] 2,953	[2] 758,600	17,859	4,591,792	4,628	2,637,240	1,000	169,517	502	181,055

[1] Not separately classified before Jan. 1, 1949; formerly included with "Other forms, n. e. s."
[2] Effective Jan. 1, 1949, "dross" included with "scrap."
[3] Effective Jan. 1, 1952, zinc and zinc alloy semifabricated forms, n. e. c., were exported as follows: 1952—$191,746 (quantity not available); 1953—236 tons, $151,496.
[4] Effective Jan. 1, 1952, "dust" included with "scrap."

A basic study embodying recommendations on general tariff policy was made by the Foreign Economic Policy Commission (Randall Committee) in a report to the President and the Congress released January 23, 1954. Subsequently the staff papers [9] prepared for use of the Commission in formulating its policy were published.

The Tariff Commission, in response to resolutions of the United States Senate Committee on Finance and the House of Representatives Committee on Ways and Means, undertook a study of the zinc and lead industries, to determine facts relevant to the competitive position of the industry and the effect of imports of zinc and lead on employment at domestic mines and smelters. That report [10] showed that the existing tariff structure restricted imports but slightly and that during the past decade a substantial part of all zinc imports was exempted from duty. It stated that in the postwar period (1946–September 1953) 33 percent of all unmanufactured zinc imported for consumption was entered duty free.

On September 14, 1953, a petition for "escape-clause" relief under section 7 of the Trade Agreements Extension Act of 1951 as amended was filed with the Tariff Commission by an industry group, the National Lead and Zinc Committee. On September 16 the Tariff Commission began the investigation [11] to determine whether lead and zinc imported into the United States under customs treatment or duties reflecting concessions granted under the General Agreement on Tariffs and Trade (GATT) were in such increased amounts as to cause or threaten serious injury to the domestic lead and zinc industries.

[9] Staff Papers Presented to the Commission on Foreign Economic Policy, available from Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.; price $1.75.
[10] Work cited in footnote 3.
[11] The report based on this investigation was transmitted to the President May 21, 1954. The Tariff Commission found that the domestic industry was injured as a result of concessions granted and recommended specific tariff increases.

TABLE 32.—Zinc articles: United States rates of duty imposed under Tariff Act of 1930, in specified years, 1930–54

[United States Tariff Commission]

Item	Tariff rate in— 1930	1945	1948	1951	1954
	Cents per pound; percent ad valorem				
Par. 77:					
Zinc oxide and leaded zinc oxides containing not more than 25 per centum of lead:					
In any form of dry powder	1¾	[1] 1 1/10	[2] 6/10	6/10	6/10
Ground in or mixed with oil or water	2¼	[1] 1½	[2] 1	1	1
Lithopone, and other combinations or mixtures of zinc sulfide and barium sulfate:					
Containing by weight less than 30 per centum of zinc sulfide	1¾	[3] 1½	[2] ⅞	⅞	⅞
Containing by weight 30 per centum or more of zinc sulfide	1¾	1¾	⅞	⅞	⅞
	15%	15%	[2] 7½%	7½%	7½%
	Cents per pound of zinc content				
Par. 393: Zinc-bearing ores of all kinds, except pyrites containing not more than 3 percent zinc	1½	[1, 4] ¾	[2] ¾	[5] 6/10	[6] 6/10
	Cents per pound				
Par. 394:					
Zinc blocks, pigs, or slabs	1¾	[1, 4] ⅞	[2] ⅞	[5] 7/10	[6] 7/10
Old and worn-out zinc, fit only to be remanufactured, zinc dross, and zinc skimmings	1½	[1, 7] ¾	[2, 7] ¾	[7] ¾	[7] ¾
Zinc dust [8]	1¾	[1, 4] ⅞	[2] ⅞	[5] 7/10	7/10
Zinc sheets	2	[1] 1	[2] 1	1	1
Zinc sheets coated or plated with nickel or other metal (except gold, silver, or platinum), or solutions	2¼	[1] 1⅛	[2] 1⅛	1⅛	1⅛

[1] Trade agreement with Mexico, effective Jan. 30, 1943, through Dec. 31, 1950.
[2] General Agreement on Tariffs and Trade (GATT) (Geneva), effective Jan. 1, 1948.
[3] Trade agreement with Netherlands, effective Feb. 1, 1936, through Dec. 31, 1947.
[4] Rate previously reduced in the trade agreement with Canada, effective Jan. 1, 1939, through Dec. 31, 1947, to 1⅕ cents per pound of zinc content on zinc-bearing ores and to 1⅗ cents per pound on zinc blocks, pigs, and slabs, and on zinc dust.
[5] GATT (Torquay), effective June 6, 1951.
[6] Duty suspended from Feb. 12, 1952, to July 23, 1952, inclusive (Public Law 258, 82d Cong).
[7] Duty on metal scrap suspended for practically the entire period from Mar. 14, 1942, to June 30, 1953, inclusive (Public Law 497, 77th Cong.; Public Laws 384 and 613, 80th Cong.; Public Law 869, 81st Cong.; and Public Laws 66 and 535, 82d Cong.).
[8] Since the enactment of Public Law 497 (77th Cong.), effective Mar. 14, 1942, and subsequent amendments (see note 7 above), providing for temporary suspension of duties on metal scrap, quantities of zinc dust have been entered free of duty under this law. No information is available as to the distinction between the zinc dust which has entered free of duty and that which has entered as dutiable.

TECHNOLOGY

Geochemical prospecting of Canadian glacial terrain for zinc and copper was described in a recent issue [12] of Mining Engineering. The paper described the results of testing soil, using "dithizone," over known deposits covered by glacial till.

The geology of the [13] important Friends Station–New Market area of the eastern Tennessee mining district and the ore deposits [14] of the Metaline district, northeastern Washington, were described at the

[12] Bischoff, C. T., Testing for Copper and Zinc in Canadian Glacial Soils: Min. Eng., vol. 6, No. 1, January 1954, pp. 57–61.
[13] Oder, Charles R. L., The Friends Station–New Market Zinc-bearing Area in East Tennessee: Pres. before Soc. Econ. Geol., New York, N. Y., February 1954.
[14] Mills, Hiram F., Productive Ore Deposits of the Metaline District: Pres. before Soc. Econ. Geol., New York, N. Y., February 1954.

annual meeting of the Society of Economic Geologists, New York, N. Y., February 1954.

The technology of mining, metal extraction, and use of zinc in recent years and particularly in 1953 was largely directed toward reducing costs through mechanization and improved extraction techniques.

A recent article [15] described a system of mechanized mining developed and used at the Grandview zinc-lead mine, Washington, since January 1952. The equipment consists of a self-loading, crawler-type transport termed a "Gismo," having a carrying capacity of 5 to 5½ tons of ore, and a second such unit equipped as a 3- or 5-drill jumbo, with a HD5–F Allis-Chalmers diesel tractor modified for the use. Using this equipment to integrate drilling, loading, and transportation with other equipment, the ore output per man-shift was raised from 15 tons in 1950 to 122 in 1953, while labor costs were reduced from $1.57 per ton in 1950 to $0.72 in 1953.

Mechanization and trackless mining at the North Friends Station mine, Tennessee, were described.[16] This operation utilized rubber-tired drilling rigs, tractor-mounted loaders, and 8¼-ton-capacity diesel-powered trucks, the latter hauled the ore from the stope face out of the mine through an 1,100-foot inclined haulageway to surface railway cars.

Trackless mining was used throughout 1953 at the Pend Oreille mine, Washington. It was based on crawler-type, tractor-mounted jumbos, crawler-type, tractor-mounted loaders, and diesel-powered trucks, which are described in detail in still another article.[17] The trackless mining equipment at the Pend Oreille mine increased output per man-shift from the 8 tons obtained by scraper mining methods to 25 tons, at the same time effecting a cost reduction per ton from $2.15 to $1.14.

Somewhat similar equipment and use were described in another technical paper [18] concerning the Tri-State Zinc, Inc., mining operation in northern Illinois.

An unusual open-pit mining technique [19] was used throughout 1953 at the Quick Seven mine in southwest Missouri. Previous mining and drilling indicated that the ore body was a cylindrical mass some 500 feet in diameter and 185 feet in vertical dimension. Management solved the problem of getting the ore from the pit by installing a hammerhead crane with a 131-foot outboard arm and a 10-ton skip at the pit's edge.

The new Van Stone open-pit zinc mine, which was put into production November 1952, operated throughout the year and was described in two technical papers [20] covering mining and milling at

[15] Engineering and Mining Journal, How Mechanized Mining at Grandview Upped Output and Cut Costs: Vol. 155, No. 5, May 1954, pp. 56–59.
[16] Waldron, Howard L., Mechanization and Trackless Mining Slash Costs at North Friends Mine: Min. World, vol. 15, No. 13, December 1953, pp. 38–42.
[17] Kinney, L. M., Trackless Mining at Pend Oreille: Min. Cong. Jour., vol. 29, No. 11, November 1953, pp. 28–29, 105.
[18] Allen, V. C., Mechanization at an Upper Mississippi Valley Zinc-Lead Mine: Bull. Inst. Min. and Met., vol. 63, No. 556, March 1953, pp. 261–269.
[19] Mining World, A New Method of Open Pitting: Vol. 14, No. 10, September 1952, pp. 36–39.
[20] Huttl, John B., A. S. & R.'s Van Stone Mine: Eng. and Min. Jour., vol. 154, No. 4, April 1953, pp. 72–76.
Mining World, Van Stone, American Smelting's Newest Zinc Operation: Vol. 15, No. 4, April 1953, pp. 26–31, 68.

this 1,000-ton-per-day plant. Modern design, to accomplish economy in operation and control, characterized the operation.

Block caving, one of the stoping methods in use at the Bunker Hill mine at Kellogg, Idaho, was reported in a recent issue of Mining World.[21]

The ore body, which contained 716,000 tons of 2.0-percent zinc and 1.0-percent lead ore with 0.5 ounce of silver per ton was block-caved successfully until low zinc and lead prices forced cessation in mid-1953. Total mining and milling costs, including exploration stope preparation and proportionate administrative and service costs, were reported on the basis of the first 10 months of 1952 to be $3.97 a ton.

Other technical articles of interest on zinc mining dealt with reducing drilling costs,[22] the use of steel rail [23] in place of timbered sets, pressure grouting [24] at the Deep Creek mine, Washington, an adaptation of oil-well drilling to mine exploration [25] at the Ruby Hill property, Nevada, and sinking [26] of the Iron King No. 7 shaft, Arizona.

In ore dressing, several articles dealt with recent developments. One of these [27] described the flotation of zinc carbonate and zinc silicate as practiced in Sardinia, Italy, at the San Giovonni and Buggeru mines and also on dump material in France. The authors state:

> Since the beginning of 1953 tests have been underway in Morocco at the Touissit mine of Compagnie Royale Asturienne des Mines and the Zellidja mine of Société des Mines de Zellidja. In spite of the present low price of zinc an attempt will be made to install the process as a commercial operation.

Success in the venture would result in a greatly expanded potentiality in the north African mines, as many Moroccan zinc ores are highly oxidized and hence largely unrecovered in present ore-dressing plants.

Another article [28] described an economically successful flowsheet based on the complex Iron King mine ore (Arizona), which contains lead, zinc, copper, gold, and silver. Close control was exerted to maintain optimum recoveries in terms of smelter returns on the zinc, lead, and pyrite concentrates produced.

Developments [29] in milling practice in southeast Missouri included replacing crushing rolls with wetgrinding rod mills, the installation of short-head cone crushers, the satisfactory retreatment of table and jig tailings by flotation to recover both lead and zinc and the installation of a heavy-medium process at the Hayden Creek mine.

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[21] Mining World, How Bunker Hill "Stair-Step" Block-Caves Low-Dip Lead-Zinc Ore Body in Quartzite: Vol. 15, No. 8, July 1953, pp. 57 and 59. (Describes paper delivered by C. E. Schwab at the 1953 annual meeting of the AIME Inst., Los Angeles, Calif.

[22] Mining World, Are Your Drilling Costs Too High: Vol. 16, No. 3, March 1954, pp. 42–45.

[23] Doyle, Wm. R., Steel Rail Sets at Resurrection: Min. Cong. Jour., vol. 39, No. 10, October 1953, pp. 49–52, 65.

[24] Quine, A. V., Pressure Grouting at Deep Creek: Min. Eng., vol. 6, No. 3, March 1954, pp. 279–281.

[25] Mining World, Eureka Corporation Found It—a Way to Adapt Oil-Well Methods to Mine Exploration: Vol. 15, No. 9, August 1953, pp. 40–43.

[26] Tomkinson, E. R., Sinking Iron King's No. 7 Shaft: Min. Cong. Jour., vol. 39, No. 10, October 1953, pp. 36, 37.

[27] Rey, M., Sitia, G., Raffinot, P., and Formanek, V., Flotation of Oxidized Zinc Ores: Min. Eng., vol. 6, No. 4, April 1954, pp. 416–420.

[28] Mining World, Iron King Uses Close Control: Vol. 15, No. 2, February 1953, pp. 26–29.

[29] Stockett, Norman A., Developments in Milling Practice in Southeast Missouri: Min. Cong. Jour., vol. 39, No. 4, April 1953, pp. 84–87.

During the year the New Jersey Zinc Co. reported[30] the development of a fluid-bed roasting process for sulfide ores, which eliminates sintering before the smelting operation. An experimental unit of commercial capacity was operated at the Palmerton smelter throughout 1953.

FluoSolids roasting of the zinc sulfide to make contact acid at the Aluminum Co. of Canada, Ltd., Arvida, Quebec, was described.[31]

The Blackwell Zinc Co. sintering hearth at Blackwell, Okla., was the subject of a descriptive paper[32] presented at the annual meeting of the American Institute of Mining and Metallurgical Engineers, Los Angeles, February 1953. The sintering hearth is charged with green concentrate and crushed returned sinter fines in the ratio of about 1:5 to produce finished sinter analyzing about 66 percent zinc, 0.3 percent lead, and 0.1 percent cadmium. Lead-cadmium fume is collected in a 9,360-orlon-unit baghouse, and the sinter is retorted in the horizontal retorts, of which 11,200 are operating on a 48-hour cycle.

The installation of a 300-ton-per-day induction furnace at Tadanac, British Columbia, for melting the Consolidated Mining & Smelting Co. electrodeposited zinc sheets was reported[33] recently. The new, Italian-designed furnace is expected to reduce greatly dross formation and eliminate largely the zinc oxide fume, as well as lower melting costs. A second unit is planned as the overall smelter capacity is 520 tons of zinc per day.

Advances were also recorded in numerous areas of zinc use. Many of these dealt with developments in the field of zinc coatings. During 1953, 2 additional continuous galvanizing lines were installed bringing the total at year's end to 18, with 5 more under construction and still others contemplated. The continuous line[34] was described in detail in a recent two-part article in Steel. The importance of improved product and manufacturing processes is emphasized by the fact that galvanized sheet produced in 1953 was worth an estimated $280,000,000. The development of continuous galvanizing in the United States was described by Nelson E. Cook[35] in a paper presented at Oxford, England, July 7, 1954.

Hot-dip galvanizing also received considerable attention in the technical press as work progressed in improving corrosion resistance, workability, and surface quality.[36][37][38]

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[30] Waring, R. K., Research (at New Jersey Zinc Co.): Min. Eng., vol. 5, No. 12, December 1953, pp. 1234, 1235; Am. Met. Market, vol. 61, No. 4, Mar. 20, 1954, page 7.

[31] Anderson, T. T., and Bolduc, R., Fluosolids Roasting of Zinc Concentrates for Contact Acid: Chem. Eng. Prog., vol. 49, No. 10, October 1953, pp. 527–532.

[32] Lee, A. F., Jr., Sintering Zinc Concentrates on the Blackwell 12 by 168 Ft. Machine: Jour. Metals, vol. 5, No. 12, December 1953, pp. 1631–1633.

[33] Canadian Chemical Processing, Electrolytic Zinc at Cominco Expands Facilities: Vol. 37, No. 11, October 1953, p. 72.
Iron Age, Electric Furnace for Zinc Melting: Vol. 172, No. 14, Oct. 1, 1953, p. 47.

[34] McArthur, D. A., Geisgler, A. R., and Upton, John, Jr., New Angles for the Galvanizing Line and Continuous Galvanizing Line: Steel, vol. 134, No. 14, Apr. 5, 1954, pp. 100–102; and No. 15, Apr. 12, 1954, pp. 102–104.

[35] Cook, Nelson E., The Development of Continuous Galvanizing in the United States: Am. Metal Market, vol. 61, No. 134, July 15, 1954, pp. 3–11.

[36] Frazier, K. S., Controlled Hot-Dip Galvanizing: Steel, vol. 134, No. 8, Feb. 22, 1954, pp. 102–103; No. 9, Mar. 1, 1954, pp. 98–99; No. 10, Mar. 8, 1954, pp. 138–139.

[37] Baldwin, Allen T., Electroplating Prior to Hot-Dip Galvanizing for Improved Results: Metal Prog., vol. 64, No. 6, December 1953, pp. 76–81.

[38] Horwick, Ernest W., The New Look in Galvanized Steel· Materials and Methods, vol. 39, No. 3. Mar. 1954, pp. 107–109.

An article on radiant burners[39] set forth the necessity of maintaining uniform galvanizing pot temperature to assure uniform coatings and stressed that overheating speeds up the formation of dross.

The zinc plating of large-caliber steel cartridge cases was described by the officials of a California ordnance plant.[40]

Electrodeposits of zinc-tin alloys are finding wide use for plating radio and television chassis, switch gear, nuts, bolts, and steel, copper, and brass parts for electrical installations, according to Cuthbertson[41] of the Tin Research Institute in England. A summary[42] of recent research on electrodeposition of the alloy was described in Chemical Age.

Zinc-rich paints were marketed under a variety of trade names in 1953, with claims that, unlike ordinary rust protective paints, these can be used effectively over rust and mill scale, because of the sarificial, cathodic protection offered by the zinc dust of the paint.

The vacuum metallizing[43] of die-cast zinc with bright-finish aluminum was described recently as giving a high luster finish at a sixth of the cost of chromium electroplating. The prevention of corrosion by metallizing[44] steel and iron surfaces with zinc was recounted in Metal Progress, and examples of long-term use on barges, lock gates, and tanks were given.

During 1953 the Bureau of Mines published the following Reports of Investigations that relate to zinc:

Browning, J. S., and Clevenger, C. B., Process for Beneficiating Great Gossan Lead Ores, Carroll County, Va.: Rept. of Investigations 4945, 14 pp.

Townsend, J. W., Investigation of Lead-Zinc Deposits at the Harrington-Hickory Mine, Beaver County, Utah: Rept. of Investigations 4953, 2 pp.

Roberts, Edward, Mine Timber Preservation by the Collar Method (injection of chromated zinc chloride): Rept. of Investigations 4980, 14 pp.

Popoff, C. C., Lead-Zinc Deposits of the Dunkelberg District, Granite County, Mont.: Rept. of Investigations 5014, 41 pp.

Publications of the Geological Survey relating to zinc and issued in 1953 are:

Harrison, J. E., and Leonard, B. F., Preliminary Report on the Jo Reynolds Area, Lawson-Dumont District, Clear Creek County, Colo.: Circ. 213, 9 pp.

Agnew, A. F., Flint, A. E., and Allingham, J. W., Exploratory Drilling Program of the United States Geological Survey for Evidences of Zinc-Lead Mineralization in Iowa and Wisconsin: Circ. 231, 37 pp.

Behre, C. H. Jr., Geology and Ore Deposits of the West Slope of the Mosquito Range: Prof. Paper 235, 176 pp.

Gault, H. R., and Fellows, R. E., Zinc-Copper Deposits at Tracy Arm, Petersbury District, Alaska: Bull. 998–A, 13 pp.

Gault, H. R., Rossman, D. L., Flint, G. M. Jr., and Ray R. G., Some Zinc-Lead Deposits of the Wrangell District, Alaska: Bull. 998–B, 43 pp.

Robinson, G. D., and Twenhofel, W. S., Some Lead-Zinc and Zinc-Copper Deposits of the Ketchikan and Wales Districts, Alaska: Bull. 998–C. pp. 59–83.

WORLD REVIEW

World smelter production of zinc established an alltime high in 1953, totaling 2,320,000 metric tons—5 percent above the 1952 out-

[39] Breckenridge, R. M., and Rasmussen, K. E., Radiant Burners Improve Galvanizing Quality, Cut Costs: Iron Age, vol. 172, No. 19, Nov. 5, 1953, pp. 168–171.

[40] Fisher, E. E., and Flatnik, D. F., Zinc Plate on Cartridge Cases Meets Rigid Specifications: Iron Age, vol. 173, No. 10, Mar. 11, 1954, pp. 135–139.

[41] Cuthbertson, J. W., News item—New Plating Alloy: Metal Bull. (London), No. 3888, Apr. 27, 1954, p. 24.

[42] Chemical Age (London), Electrodeposition of Zinc-Tin Alloys, a Summary of Recent Work in Italy: Vol. 68, No. 1752, Feb. 7, 1953, pp. 253–254.

[43] Materials and Methods, Vacuum Metallizing: Vol. 39, No. 2, Feb. 1954, pp. 108–109.

[44] Vanderpool, Howard, Prevention of Corrosion by Metallizing the Surface: Metal Prog., vol. 64, No 5, November 1953, pp. 161–164, 166, 168, 170, 172.

put. World mine production of zinc also established a new record despite a considerable decrease in the output of United States mines. Tables 33 and 34 show the quantity of zinc mined and smelted throughout the world by individual countries. The United States, which consumes over 40 percent of the world zinc, mined about 20 percent and smelted approximately 35 percent of the total.

TABLE 33.—World mine production of zinc (content of ore),[1] by countries,[2] 1944–48 (average) and 1949–53, in metric tons [3]

[Compiled by Pauline Roberts and Berenice B. Mitchell]

Country [2]	1944–48 (average)	1949	1950	1951	1952	1953
North America:						
Canada	266,616	261,506	284,153	309,450	337,291	362,909
Guatemala	-----------	(4)	332	6,500	8,200	6,100
Honduras [5]	5	201	94	140	287	578
Mexico	188,657	178,402	223,530	180,064	227,375	226,538
United States [6]	576,135	538,142	565,513	617,961	604,183	496,618
South America:						
Argentina	15,044	10,921	12,699	15,475	15,396	16,089
Bolivia (exports)	18,444	17,666	19,570	30,535	35,619	23,974
Peru	59,077	72,037	87,961	101,300	127,845	134,127
Europe:						
Austria	2,126	2,694	2,970	3,355	4,986	4,378
Finland [7]	2,200	2,500	2,100	3,000	7,000	3,200
France	4,389	10,907	12,178	13,283	14,600	[6] 12,000
Germany, West	69,565	57,816	70,153	75,294	80,680	91,618
Greece	1,170	3,100	3,184	6,300	7,300	7,500
Ireland	-----------	-----------	762	2,355	3,124	(4)
Italy	38,373	74,562	87,026	100,733	112,914	101,540
Norway	4,631	6,603	5,702	5,469	5,588	5,000
Poland [8]	69,930	85,300	86,200	86,200	95,300	110,000
Spain [7]	38,200	50,000	64,000	74,000	86,000	83,000
Sweden	35,148	35,158	37,121	38,318	47,162	41,538
U. S. S. R. [7, 8]	95,800	110,000	128,800	148,000	186,000	212,000
United Kingdom	2,484	-----------	36	194	1,549	2,891
Yugoslavia	21,054	44,017	38,092	39,420	47,789	59,970
Asia:						
Burma	-----------	-----------	-----------	-----------	750	3,900
India [7]	-----------	-----------	300	1,100	2,000	2,100
Indochina	357	-----------	-----------	-----------	-----------	-----------
Iran	-----------	-----------	-----------	-----------	12,000	5,000
Japan	35,712	44,268	52,032	64,416	87,468	104,670
Korea, Republic of	2,282	-----------	-----------	(4)	500	20
Philippines	-----------	-----------	50	150	1,600	750
Thailand (Siam)	[9] 5	70	270	520	500	(4)
Turkey [7]	608	200	60	500	1,200	(4)
Africa:						
Algeria	3,961	6,863	7,167	9,466	11,192	19,160
Angola	-----------	-----------	-----------	350	40	100
Belgian Congo	33,037	55,420	74,805	88,705	98,948	125,791
Egypt	[10] 60	284	382	1,432	886	200
French Equatorial Africa	224	44	621	518	377	-----------
French Morocco	1,470	2,847	11,412	19,455	28,352	35,460
Nigeria	74	72	-----------	-----------	52	64
Northern Rhodesia [8]	18,334	23,217	23,080	22,953	23,257	25,737
South-West Africa	3,197	12,700	11,300	14,800	15,600	15,800
Tunisia	1,630	3,337	2,932	3,548	3,540	3,650
Australia	176,652	184,919	205,632	197,843	204,380	[6] 204,200
Total (estimate)	1,788,000	1,910,000	2,140,000	2,300,000	2,570,000	2,580,000

[1] Data derived in part from the Yearbook of the American Bureau of Metal Statistics, the United Nations Statistical Yearbook, and the Statistical Summary of the Mineral Industry (Colonial Geological Surveys, London).

[2] In addition to countries listed, Bulgaria, Czechoslovakia, East Germany, North Korea, and Rumania also produce zinc, but production data are not available; estimates by senior author of chapter included in total.

[3] This table incorporates a number of revisions of data published in previous Zinc chapters.

[4] Data not available; estimate by senior author of chapter included in total.

[5] United States imports.

[6] Recoverable.

[7] Estimated.

[8] Smelter production.

[9] Average for 1 year only, as 1948 was first year of production.

[10] Average for 1947–48.

TABLE 34.—World smelter production of zinc, by countries, 1944–48 (average) and 1949–53, in metric tons [1] [2]

[Compiled by Pauline Roberts and Berenice B. Mitchell]

Country	1944–48 (average)	1949	1950	1951	1952	1953
North America:						
Canada	165,535	186,920	185,398	198,290	201,575	224,715
Mexico	49,057	53,496	53,491	58,750	[3] 50,387	[3] 53,053
United States	717,105	739,154	765,176	799,800	820,525	831,072
South America:						
Argentina	1,601	2,651	[4] 7,530	10,629	10,000	11,600
Peru	1,289	1,261	1,262	870	5,216	8,908
Europe:						
Belgium [5]	77,325	176,568	177,326	200,886	186,799	193,427
Czechoslovakia	[6] 2,466	(7)	(7)	(7)	(7)	(7)
France	29,015	58,916	71,531	74,557	80,064	80,938
Germany:						
East	(7)	(7)	(7)	(7)	(7)	(7)
West	[6] 22,983	86,916	122,796	140,640	147,216	148,261
Italy	14,534	26,917	37,925	47,752	54,851	60,033
Netherlands	5,447	15,614	19,752	22,605	25,905	25,202
Norway	25,559	41,090	43,173	40,825	39,232	37,820
Poland	69,930	85,300	86,200	86,200	95,300	110,000
Rumania	[8] 2,533	[4] 3,200	3,000	(7)	(7)	(7)
Spain	18,792	19,551	21,264	21,345	21,358	22,911
Sweden	944					
U. S. S. R.[4]	95,800	110,000	128,800	148,000	186,000	212,000
United Kingdom	68,863	65,144	71,418	70,851	69,839	73,875
Yugoslavia	4,260	9,903	12,315	13,223	14,463	14,549
Asia:						
China [4]	262	180	180	180	180	360
Indochina	[4] 125					
Japan	27,520	32,232	49,008	56,340	70,032	80,112
Africa:						
Belgian Congo						7,801
Northern Rhodesia	18,334	23,217	23,080	22,953	23,257	25,737
Australia	79,158	82,255	84,995	78,246	88,841	91,625
Total (estimate)	1,525,000	1,825,000	1,970,000	2,100,000	2,200,000	2,320,000

[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 3,398 tons in 1952 and 27,477 in 1953.
[4] Estimate.
[5] Includes production from reclaimed scrap.
[6] 1945–48 average.
[7] Data not available; estimate by senior author of chapter included in total.
[8] 1946–48 average.

NORTH AMERICA

Canada.[45]—Mine production of zinc in Canada increased 28,000 tons above 1952 to 400,000 short tons despite lower metal prices and consequent closing of a number of zinc and lead mines.

New properties were explored and developed at a high rate as work continued in the Bathurst area of New Brunswick, the Pine Point area of the Northwest Territories, and elsewhere. An important new copper-zinc discovery was made in the spring of 1953 at Manitouwadge, northern Ontario. On the basis of outcrop studies and surface drilling several million tons of ore was indicated and inferred.

British Columbia was again the leading zinc-producing Province, yielding about 188,000 tons of mine production compared with 174,000 tons in 1952. The Consolidated Mining & Smelting Co., Ltd., operating mines and a smelter in British Columbia, was Canada's largest producer, with a smelter output of 185,900 short tons of zinc in refined

[45] Neelands, R. E., Zinc in Canada, 1953 (Preliminary): Canada Dept. of Mines and Tech. Surveys, Ottawa, pp. 1–7.

and unrefined products (161,400 tons in 1952). The company annual report for 1953 stated:

The major postwar construction program in which your company has been engaged approached completion by the end of 1953. The underground crushing plant at the Sullivan mine, the 3,700-level tunnel and haulageway to the mill, the sink-float plant at the mill, and the new main shaft to the lower levels of the mine were all completed at Kimberley in 1949. In the same year the second slag-fuming furnace was constructed at Trail. The Tulsequah mines came into production in 1951, followed by the Bluebell mine in 1952. Construction at the H. B. mine was virtually completed in March 1953 but, as noted elsewhere, operation has been deferred for the present. Part of the 86-mile transmission line from the Kootenay River power plants to Kimberley was energized in April 1952 to supply the Bluebell mine and the remainder was brought into service in February 1953 * * *. The 66-ton zinc plant extension was completed in 1953.

The construction program resulted in increased production capacity and labor productivity, as well as improved recoveries. During 1953 the Sullivan mine produced 2,643,000 tons of ore compared with 2,700,000 tons in 1952. The Bluebell lead-zinc mine at Riondel, B. C., produced 216,400 tons of ore during 1953, its first full year of operation. In the Atlin district of northern British Columbia the Tulsequah Chief and Big Bull zinc-copper-lead mines produced 173,100 tons of ore compared with 96,000 tons in 1952. The increase was made possible by an expansion of mill capacity to 500 tons a day early in the year. The technical press dealt extensively with the operations of the Consolidated Mining & Smelting Co.[46]

Canadian Exploration, Ltd., completed a large-scale development program at its Salmo, B. C., tungsten-lead-zinc property but owing to declining lead-zinc prices reduced ore to the mill in December from 1,800 tons a day to 1,200 tons.

Sil-Van Consolidated Mining & Milling Co., Ltd., began to produce lead and zinc concentrates at its new 150-ton mill near Smithers.

Sheep Creek Gold Mines, Ltd., built a 450-ton-capacity mill to treat zinc-lead-barite ore from its Mineral King mine west of Lake Windermere. Production is expected in early 1954.

During the year Britannia Mining & Smelting Co., Ltd.,[47] produced 839,400 tons of ore from its Britannia mine on Howe Sound. All zinc-ore production was suspended, however, and such zinc as was produced was a byproduct from copper ores.

Quebec was the second most important zinc-mining Province and produced 100,600 tons of zinc as compared with 94,900 tons in 1952 (revised figure). The open-pit mine of Barvue Mines, Ltd.,[48] near Barville, Barraute township, about 75 miles northeast of the Noranda mining district, operated throughout the year at a rate of 4,000 to 5,000 tons of ore per day. Through the 10-month period ended with October 1,125,500 tons of ore had been mined and milled and another 442,000 tons of waste was mined and removed from the hanging wall of the pit. In that month 5,100 tons of premium grade zinc-silver concentrate was produced, and it was anticipated that production in

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[46] Mine and Quarry Engineering (London), The Sullivan Mine: Vol. 19, No. 10, October 1953, pp. 354–362; The Sullivan Concentrator: Vol. 19, No. 11, November 1953, pp. 386–395.
Canadian Mining Journal, The Consolidated Mines & Smelting Co. issue: Vol. 75, No. 5, May 1954; covers all units, giving history, geology, mining, ore dressing, smelting, refining, power, engineering, research, sales, safety, etc.

[47] Howe Sound Co., Annual Report 1953.

[48] Park, Allen S., Barvue Zinc, The Mine That Started Big: Compressed-Air Mag., January 1954, pp. 10–14.
American Metal Market, Further Progress Achieved in Developing Barvue Mines Project: Vol. 60 No. 240, Dec. 15, 1953, p. 7.

the future would range from 5,000 to 6,000 tons of such concentrate monthly. It is reported that total operating, mining, and milling costs, which were close to $3.00 a ton at the outset, were well below $2.00 and are expected to approximate $1.75 a ton. The concentrate was shipped by rail to Arvida, Quebec, where it is roasted to recover SO_2 fumes. The zinc calcine is then shipped to the United States to the American Zinc, Lead & Smelting Co. for smelting. Ultimate sale is at the rate of 17.5 cents a pound of zinc recovered in the first 175,000 tons of concentrate.

The Quemont Mining Corp., Ltd.,[49] treated 631,600 tons of copper-zinc ore to produce 52,300 tons of copper concentrate (18.12 percent copper) and 22,100 tons of zinc concentrate (51.42 percent zinc). Production would have been greater had not a strike stopped operations from October 2 through the balance of the year to February 16, 1954. All zinc concentrate was shipped to the United States. During the 280-day operation 12,329 feet of development work and 94,059 feet of diamond drilling were accomplished. Indicated ore reserves at the end of the year above the 2,340-foot level totaled 9,528,000 tons averaging 2.76 percent zinc, 1.47 percent copper, 0.159 ounce of gold, 1.07 ounces silver, and 45 percent pyrite.

The Normetal Mining Corp., Ltd., milled 290,800 tons of 6.59-percent zinc and 2.23-percent copper to produce 29,400 tons of 51.75-percent zinc concentrate and 28,100 tons of 20.94-percent copper concentrate. Production was reduced by a labor strike that extended from October 17 until February 17, 1954. Ore reserves at the year end were estimated to be 2,416,100 tons of 8.14-percent zinc and 2.61-percent copper.

Other Quebec producers were the Waite Amulet Mines, Ltd., which milled 372,800 tons of 4.06-percent zinc and 4.33-percent copper ore to recover 15,300 tons of copper and 11,300 tons of zinc before closure October 21 by a strike, and the Weedon Pyrite & Copper Corp., Ltd. West MacDonald Mines, Ltd., has acquired a large zinc pyrite property 7 miles north of Noranda's Horne mine, and Noranda Mines, Ltd., is building a 1,500-ton-per-day mill to treat the ore, which averages about 3 percent zinc and 80 percent pyrite.

The Hudson Bay Mining & Smelting Co., Ltd., operates a large copper-zinc mine, copper smelter, and electrolytic zinc plant at Flin Flon, Manitoba. The ore body lies in both Manitoba and Saskatchewan Provinces, but the major production has been from Saskatchewan for several years. The Flin Flon mine produced 1,497,100 tons of ore containing 48 percent zinc, 2.9 percent copper, and some gold and silver. Of this tonnage 1,478,100 tons was milled to yield 298,100 tons of 12.43-percent copper concentrate containing 4.3 percent zinc and 115,400 tons of 45.4-percent zinc concentrate containing 0.94 percent copper. All copper concentrate and the leached residues from the electrolytic zinc plant are smelted to recover copper, gold, and silver. The zinc content largely accumulates in the copper reverberatory slag, and in 1953, 419,500 tons of reverberatory slag containing 8.2 percent zinc was fumed to recover 42,900 tons of 71.0-percent zinc oxide fume. In 1953, 122,500 tons of zinc concentrates and the 42,900 tons of fume were treated to yield 65,700

[49] Quemont Mining Corp., Ltd., Annual Report: 1953.

tons of slab zinc. As of December 31, 1953, ore reserves, exclusive of subsidiaries, were 17,500,000 tons of 3.9-percent zinc and 3.23-percent copper. In addition 857,000 tons of zinc-plant residues containing 26.6 percent zinc, 1.04 percent copper, 0.143 ounce of gold, and 3.83 ounces of silver were held for re-treatment.

The Buchans Mining Co., Ltd., Newfoundland, milled 346,000 tons of zinc-lead-copper ore, 12,000 tons more than in 1952, although of slightly lower grade, and produced zinc concentrate containing about 32,500 tons of zinc, as well as 11,800 tons of copper concentrate containing some 2,900 tons of copper.

In the Mayo district of Yukon Territory the United Keno Hill Mines, Ltd., increased its milling rate 15 percent and in the year ended September 30, 1953, had milled 156,700 tons of ore to recover concentrates containing 6,252,000 ounces of silver, 13,700 tons of lead, and 10,600 tons of zinc. Ore reserves were increased 40 percent during the year to 612,900 tons averaging 38.4 ounces of silver, 9.1 percent lead, and 8.2 percent zinc.

The Mindamar Metals Corp., Ltd., deepened its Stirling zinc-lead-copper mine on Cape Breton Island, establishing 4 new levels, and treated 189,000 tons of ore to produce 7,700 tons of lead-copper concentrate containing 1,900 tons of lead and 820 tons of copper and zinc concentrate containing about 9,000 tons of zinc.

In New Brunswick the Brunswick Mining & Smelting Corp., Ltd., proceeded with development and construction on the company properties some 20 miles southwest of Bathurst. Two zinc-lead ore bodies estimated to contain 60 million tons of ore averaging 5.3 percent zinc, 1.7 percent lead, and about 0.5 percent copper were outlined to a depth of 1,000 feet. A 150-ton-per-day pilot mill was under construction near the Austin Brook ore body; eventual production was planned at the rate of 5,000 tons a day. Some distance north of Bathurst, Keymet Mines was building a 150-to 200-ton-per-day mill, while mine development went forward. Production was to begin about mid-1954.

During early 1953 a large deposit of copper-zinc-silver ore was discovered near Manitouwadge Lake. Geco Mines, Ltd., was formed to explore and develop the property, and trade journals[50] reported that initial drilling indicated several million tons of ore.

In Northwest Territories, the Pine Point Mines, Ltd. (operated by Consolidated Mining & Smelting Co. of Canada, Ltd., and Ventures, Ltd.), discontinued the exploratory drilling program at Pine Point, Great Slave Lake, in September, after indicating several million tons of ore averaging 10 percent combined lead and zinc. A large tonnage of relatively high grade ore was reported amenable to open-pit mining.

Greenland.—The Mestersvig lead-zinc deposit in East Greenland continued under active development by the Nordic Mining Co., Ltd., throughout 1953. According to the Danish press, the management planned to continue exploration throughout the winter of 1953–54 with a labor force of about 50 men. Work during the summer was primarily surface drilling, which was to be continued until

[50] Wall Street Journal, vol. 143, No. 37, Feb. 24, 1954, pp. 1, 14; Mining Journal (London), vol. 242, No. 6193, Apr. 30, 1954, p. 505; Eng. and Min. Jour., vol. 155, No. 2, Feb. 1954, p. 184.

more knowledge of the extent and value of the mineralization was obtained. The company notified the Danish Government, which owns 27.5 percent of the capital stock, that by the end of 1953 only 2.5 million ($368,000) of the original 15 million kroner ($2,210,000) capital would remain and that, if additional capital is not subscribed, the company must be prepared to discontinue its exploration, despite the considerable tonnage of lead-zinc ore proved to date. Mestersvig is 7 miles from docking facilities on a fjord normally ice-free only 4 to 5 weeks a year, which has, in some years, been icelocked throughout the year.

Mexico.—Mine production of zinc in Mexico was approximately the same as in 1952 (227,000 metric tons), and smelter output increased slightly to 53,000 tons, despite much lower zinc and lead prices. The remarkable uniformity in production is explained by the inflexibility of costs at the large Mexican mines. To reduce costs by closing mines or reduction of 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. A number of small, marginal mines were kept in operation by a Government decree July 28, 1953, which provided 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 producers whose production and export taxes did not exceed 200,000 pesos a month. Nonqualifying lead and zinc mines continued to pay the 2 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, throughout the year, except for a short-lived strike in April and May. The company zinc-fuming plant at its Chihuahua lead smelter operated at approximate capacity to produce deleaded zinc fume, which was shipped to Rosita for reduction to metal. Operating mines in Mexico, owned or leased by the American Smelting & Refining Co.[51] and producing 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; the Angangueo unit, Michoacan; and the Aurora-Xichu unit, Guanajuato. During 1953 the American Smelting & Refining Co. virtually completed construction of the mine plant, mill, power plant, and townsite at the Nuestra Senora lead-zinc-silver property, Cosalá, Sinaloa, which will produce and mill 12,000 tons of ore monthly. Exploration and development of the Rosario lead-zinc property, Rosario, Sinaloa, were continued, and design work for the mine and mill plant was in progress. Limited ore reserves remaining at the Angangueo unit, in combination with a disastrous fire at the Dolores mine, caused the company to apply to the Government to abandon the Angangueo operations, and the Michoacan Railway & Mining Co., Ltd., owner of the property, was notified that the lease would not be renewed after December 31, 1954.

The American Metal Co.,[52] through its Mexican subsidiary, Cia. Minera de Penóles, S. A., produced zinc concentrates at its Avalos

[51] American Smelting & Refining Co., Fifty-fifth Annual Report for the Year Ending Dec. 31, 1953.
[52] American Metal Company, Ltd., Annual Report for the 66th Year, 1953.

unit, Avalos, Zacatecas; Calabaza unit, Etzatlán, Jalisco; and Topia unit, Topia, Durango. The Topia unit completed its first full year of operations with satisfactory technical results. Company zinc concentrates were shipped to its Blackwell, Okla., smelter, but the lead concentrates produced at the same and some other mines were smelted at Torreón, Coahuila. Because of the zinc content of most Mexican lead concentrates smelted at Torreón, the company was considering plans to improve overall zinc and lead recovery by building a slag-fuming plant to treat current and accumulated lead-blast-furnace slags.

The San Francisco Mines of Mexico, Ltd., in the fiscal year ended September 30, 1953, milled 693,000 metric tons of ore to recover 67,000 tons of zinc concentrate (36,300 tons zinc content), 47,900 tons of lead concentrate (29,400 tons lead content), and 6,700 tons of copper concentrate (1,700 tons copper content). Ore reserves at the fiscal year end were 4,506,000 metric tons containing 9.06 percent zinc, 6.28 percent lead, 0.66 percent copper, and about 5.3 ounces of silver per ton.

Other large operations were those of the El Potosi Mining Co. (subsidiary of the Howe Sound Co.), which operated its 1,700-ton-per-day El Potosi mine, Chihuahua, without interruption throughout the year; and the Fresnillo Co., which operated its Fresnillo mine in Zacatecas to produce zinc, lead, and copper concentrates.

The new Waelz plant of Zinc Nacional, S. A., at Monterrey was put in operation in late 1953 to calcine purchased oxidized zinc ores from the Monterrey area.

Guatemala.—Compania Minera de Guatemala, S. A., erected a new 150-ton-per-day concentrator at its Coban mine in northern Guatemala and continued to operate, but the Compania Minera de Huehuetenango, S. A., was reported closed following a fire at the mill.

SOUTH AMERICA

Argentina.—Compania Minera Aguilar, S. A., a subsidiary of the St. Joseph Lead Co. in northern Argentina, produced 31,800 metric tons of zinc concentrate and 19,800 metric tons of lead concentrate compared with 30,400 and 23,100 tons, respectively, in 1952. Most of the zinc concentrate was shipped to Cia. Metalurgica Austral, S. A., Comodora Rivadavia, southern Argentina, for smelting in electrothermic furnaces.

Peru.—During 1953 the Cerro de Pasco Corp. further expanded its facilities for producing zinc, investing in excess of $9,000,000 for that purpose. The company 35-ton-per-day electrolytic plant at Oroya attained full capacity by year end, and the first 35-ton-per-day Sterling-process electrothermic unit was placed in production late in the year. A second Sterling unit was under construction, and plans called for completion of third and fourth units toward the end of 1955, with 2 more to be completed about a year later to give a total annual smelter capacity of 75,000 tons. New milling capacity at the Paragsha concentrator at Cerro de Pasco was put in operation during the year so that gains were made in the producing of zinc, lead, and copper. In all, 128,300 short tons of zinc concentrate was produced. Part of these concentrates contained about 58 percent zinc, but the larger part contained about 49 percent zinc. At existing zinc prices the lower grade could not be sold for export because of high shipping and smelting charges on the recoverable zinc content. Of the total concentrate about 19,000 tons was treated in the electrolytic plant at Oroya, a small part was exported, and the balance was stocked awaiting a more favorable market or completion of Sterling electrothermal furnaces adapted to its treatment. Currently the recoverable zinc content of Cerro de Pasco concentrates was more than twice the lead being produced and almost three times that of copper. Lead-smelter production from the same mines totaled 26,800 tons, and in addition some 38,300 tons of lead was smelted from purchased ores.

A hundred miles south of Lima the Chavin Mines Corp. continued to develop its property and had by the end of 1953 developed 430,000 metric tons of ore containing 15.4 percent zinc, 9.1 percent lead, and 1.3 percent copper in a complex vein pattern. Consideration was being given to construction of a mill and a road to give access to the coast.

The Northern Peru Mining & Smelting Co. (American Smelting & Refining Co. subsidiary) Chilete mine near Pacasmayo was put into operation in May 1952 and throughout 1953 operated its 350-ton-capacity concentrator to produce about 400 tons of lead concentrate and 1,300 tons of zinc concentrate monthly.

EUROPE

Belgium and France.—During 1953 Belgian and French smelters produced about 274,000 metric tons of slab zinc, chiefly from concentrates produced in Belgian Congo (116,000 metric tons), French Africa (69,000), Sweden (47,000), Austria (73,000), and Spain (42,000), as well as Peru, Canada, and other countries. The smelters of Société des Mines et Fonderies de Zinc de la Vielle-Montagne produced 132,000 metric tons of slab zinc, as well as 34,700 tons of rolled zinc and 15,700 tons of zinc oxide. A special French non-ferrous metals issue [53] of the Metal Bulletin (London) reviewed metal mining and smelting operations in France and the French Union, giving map locations of all important units. It also dealt with metal trading, controls, and consumption. No zinc has been mined in Belgium since 1946, when the Vedrin mine closed, but mines of European France yielded about 12,000 metric tons of zinc.

Finland.[54]—In the summer of 1952, Outokumpu Oy. began mining zinc at Metsämonttu, which was concentrated and exported to Belgium for refining. Outokumpu Oy. was preparing to exploit a zinc deposit at Lampinsaari, where 3,000,000 tons of 6-percent zinc ore has been established. Shaft sinking was in progress, and highway and rail facilities to the mine were in operation by December 1953. Production was scheduled for early 1954.

Germany, West.—Despite closings and curtailments at marginal mines, West German mine production of zinc increased 14 percent as a result of recent heavy investments in development and exploitation of zinc and lead ores. The major zinc- (and lead-) producing areas

[53] Metal Bulletin (London), Special French Nonferrous Issue: September 1953, pp. 7-25.
[54] Mining World and Engineering Record (London), Mining in Finland: Vol. 165, No. 4316, Dec. 19, 1953, p. 365.

of West Germany are the Harz Mountains, the Rhineland, and, to a lesser degree, southern Germany. In the Harz area the principal mines were the Erzbergwerk Rammelsberg and Erzbergwerk Grund. Rhineland mines included the important Auguste Viktoria, Ramsbeck, Maubacher Bleiberg, and Leuderich. Zinc and lead concentrates were also produced at the Segen Gettes and Schauinsland mines in southern Germany. During 1953 Germany imported almost 50,000 tons of zinc ores and concentrates, which, with those domestically produced, were smelted at 6 retort plants, 2 of which employed reflux refining columns of the New Jersey Zinc Co. type.

Italy.—Although Italy's smelter output of zinc increased almost 10 percent to 60,000 metric tons, mine production declined 10 percent to 102,000 tons. About 80 percent of the mine production came from Sardinia, where the Montevecchio deposits alone yielded about 36,000 tons of zinc concentrate. A second sink-float plant was being completed at Montevecchio at the year end, and a new lead-zinc flotation plant had been built by the SAPEZ Co. at Agruxau Mount mine, Sardinia, to increase its daily calamine-ore-mill capacity to 200–250 tons. The Italian zinc industry is unique in that a large share (approximately 20,000 tons) of mine and smelter output is based on oxidized ores (calamine) from mines in Sardinia and the Province of Bergamo. The calamine ores are successfully beneficiated by flotation [55] to recover 86 percent of the lead and 73 percent of the zinc content. The calamine concentrates were processed by the Monteponi Co. at its 8,000-ton annual capacity Cagliari electrolytic smelter and by the SAPEZ Co. at its 15,000-ton-capacity electrolytic smelter at Nossa.[56] Sulfide concentrates produced at Oreta, Premola Dassena, and Camerata Cornella, Sardinia, were reduced electrolytically by the Pertusola Co. of Croton (20,000-ton annual capacity), Montevecchio Co. of Venice (20,000-ton), and in a retort plant of the Monteponi Co. at Vado Ligure (12,000-ton).

Spain.—During 1953 the production of zinc concentrate in Spain totaled 150,000 metric tons (156,000 in 1952) and smelter output increased slightly to 22,900 tons. About 40,000 tons of crude concentrates was shipped to France and the United States, 15,600 tons of calcined concentrates to Norway and France, and 26,000 tons to the Netherlands. Chief mine production was in Santander Province, with minor production in Murcia, Lérida, Guipúzcoa and Gerona.

Sweden.—During 1953 Sweden produced almost 70,000 metric tons of zinc concentrate containing 41,500 tons of zinc. Producing companies were the Boliden Mining Co., the Government-owned AB Statsgruvor, Falu Kopparverk, and AB Zinkgrubor. Virtually all of Sweden's zinc concentrates were shipped to Belgium, German, and Norwegian reduction plants. In return, these countries supplied almost all of the 21,000 metric tons of slab zinc imported into Sweden in 1953.

United Kingdom.—Mine production totaled only 2,900 metric tons, but smelter production, based chiefly on imports of Australian ores, was 74,000 tons. Imports of metal, principally from Canada, Belgium,

[55] Rey, M., and Raffinot, P., La Flotation de calamine: Congres des Laveries des Mines Métalliques Française, Paris, September 1953.
[56] Straniero, Diego, Nossa's Unique Electrolytic Plant: Eng. and Min. Jour., vol. 155, No. 5, May 1954, pp. 68–72.

Australia, and the United States, totaled 130,000 tons, while consumption was 270,000 tons (including 76,000 tons of secondary). Exports of slab zinc were about 6,000 tons in 1953.

Major British industry news was the resumption of free trading on the London Metal Exchange January 2, 1953, and the disposal of excess Ministry of Materials zinc stock. At the beginning of 1953 total stocks of zinc in United Kingdom held by consumers and the Government totaled 166,000 in long tons as metal and 52,400 in concentrate. By the year end these quantities were reduced, respectively, to 27,700 and 45,300 tons, plus an undisclosed quantity in strategic stocks. During the year the market dropped from the official opening price of £110 per long ton (13.75 cents a pound) to an average of £74.3 in December (9.29 cents).

Yugoslavia.—In 1953 Yugoslavia produced 1,430,000 metric tons of lead-zinc ore (1,204,000 in 1952) to recover 94,500 metric tons of lead concentrate (92,100) and 71,400 tons of zinc concentrate (65,000). The grade of lead-zinc ore was becoming progressively poorer, but estimates placed the known reserves[57] at 18,000,000 metric tons containing 5 to 6 percent lead and 3 to 4 percent zinc. Approximately half of the reserves are in the Trepca mine and the remainder in such mines as Rudni, Zletovo, Mezica, Lesce, and Suplja Stena or Gradac. Most of the crude ore from the Trepca mines was milled at Svecan, and the Svecan lead smelter had capacity to refine 60,000 to 70,000 metric tons of lead a year, but the zinc concentrate had to be smelted elsewhere. Plans were being made to recover manganese, in the form of rhodochrosite, from the Trepca lead-zinc tailings at the Svecan mill.

A new flotation plant at the Gradac mines near Plevlja was put in operation in September 1953. Efforts were being made to increase smelting capacity, and new equipment was being installed at the 16,000-ton-capacity Celje retort smelter. The new 12,000-ton electrolytic zinc plant at Sabac, in construction in 1952, will when completed give Yugoslavia a total smelter capacity of 28,000 metric tons, a quantity exceeding present 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 expand mine output and rehabilitate the mine and mill, as well as the lead smelter at Namtu. Since the mine was reopened in the summer of 1952, mine production has steadily increased and in 1953 totaled 58,500 tons. Ore was concentrated in the rebuilt Bawdwin mill, and in all about 3,900 metric tons of zinc and 8,000 tons of lead were produced in concentrate form. About 8,700 metric tons of lead and 580,000 troy ounces of silver were refined at Namtu during the year. The company plans to increase its rate of ore production further to about 300,000 tons a year, which is well below the 480,000 tons production in effect immediately before World War II. Reserves

[57] Zimmerman, Joseph, Yugoslavia's Lead and Zinc Industry: Daily Metal Reporter, vol. 53, No. 167, Aug. 27, 1953, pp. 1, 10.

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.

At Lough Keng, southeast of Taunggyi, Shan States, the Burmese Government was conducting exploratory operations on a large zinc deposit.

India.—The Metal Corp. of India, Ltd., is proceeding with its mining and development program at the Zawar lead-zinc mines 25 miles south of Udaipur, Rajasthan. Production data were not available; but output was believed to approximate that of 1952, when 3,900 long tons of 53-percent zinc concentrate and 2,000 tons of 72-percent lead concentrate were produced. The ore mined contained 7 percent zinc and 5 percent lead; and the deposit, according to the Department of Mines and Geology, Government of Rajasthan, is estimated to contain 1 million tons of high-grade, 2 million tons of medium-grade and 6 million to 8 million tons of low-grade ore.

Japan.—Mine and smelter output of zinc in Japan increased 20 and 14 percent, respectively, to establish new records of 104,700 metric tons of mine output and 80,100 tons of slab zinc. The quantities approximate Japanese requirements. During the year the Mitsui Metal Co. completed installing a 6,000-ton-annual-capacity vertical retort plant, and the Mitsubishi Metal Mining Co. installed a fluosolid roaster at one of its smelter. The Kosaka refinery of the Dowa Mining Co. is unique in that during 1953 it produced electrolytic zinc and copper from a single electrolyte.[58] The process was based on concentrate from the Hanaoka mine which contained 10 percent copper, 16 percent zinc, 22 percent iron, and 35 percent sulfur. The concentrate was processed in a Dorrco fluosolids reactor and the resulting calcine leached in tanks followed by countercurrent decantation washing. The solution, after filtration, passed to the copper tankhouse, where the copper was electrolytically deposited as 99.97 percent copper cathodes and 80 percent sponge copper. The electrolyte, which contains 10 percent zinc and about 0.1 percent copper, was neutralized with fine limestone, the gypsum resulting being separated by a battery of centrifuges. The solution was purified further by additions of limestone and manganese oxide, followed by filtration to remove iron. Zinc dust was used to precipitate the remaining copper, nickel, and cadmium, and beta naphthol precipitated the cobalt to prepare the solution for the electrolytic precipitation of 99.99-percent zinc.

AFRICA

Africa produced about 226,000 metric tons or 9 percent of the world mine output of zinc in 1953, an increase of 24 percent over 1952. The chief producing areas were Belgian Congo (126,000 metric tons), French Morocco (35,000 tons), Algeria (19,000 tons), Northern Rhodesia (16,000 tons), South-West Africa (16,000 tons), and Tunisia (4,000 tons).

Belgian Congo.—The first of two sections comprising the new 36,000-metric-ton-annual-capacity electrolytic zinc plant of Société

[58] Jessup, Alpheus W., How Dowa's Plant Extracts Cu-Zn From a Single Electrolyte: Eng. and Min Jour., vol. 155, No. 1, January 1954, pp. 72–74.

Métallurgique du Katanga (Métalkat) was put in service June 1953, began production of slab zinc in late July, and had produced 7,800 metric tons by the end of 1953. All Congo zinc production continued to be from the rich copper-zinc ores of the Prince Leopold mine of Union Miniére du Haut Katanga at Kipushi. In all, 941,000 metric tons of ore was milled at the Kipushi concentrator to produce 242,000 tons (188,000 tons in 1952) of 52-percent zinc concentrate and 305,000 tons of 29-percent copper concentrate. About 75,000 tons of zinc concentrate was roasted at Jadotville to recover sulfuric acid necessary for the company hydrometallurgical treatment of oxidized copper-cobalt ores. Some 22,000 tons of roasted zinc concentrate was shipped to the Métalkat electrolytic plant at Kolwezi. Exports totaled 31,000 tons of roasted concentrate, 94,000 tons of unroasted concentrate and 5,800 tons of slab zinc.

French Africa.—The mine output of zinc in French Africa during 1953 totaled 58,300 metric tons and was made up as follows: Algeria, 19,200 tons; French Morocco, 35,500 tons; and Tunisia, 3,600 tons.

The principal zinc-producing mines of French Morocco were Bou Beker and Touissit lead-zinc mines of eastern Morocco, 25 miles south of Oudjda on the Algerian border. Together these mines supplied 94 percent of the zinc and 63 percent of the lead output of Morocco. The Bou Beker mine is immediately north of the Touissit mine, and together they occupy the center of a mineralized zone that extends 15 miles east-west across the border and 9 miles north-south. Total ore reserves have been estimated to contain 650,000 tons of zinc and 800,000 tons of lead. The Bou Beker mines, owned by Société des Mines Zellidja, were operated by Société Nord Africaine du Plomb, a subsidiary, of which Newmont Mining Corp. and St. Joseph Lead Co. own 49 percent. The crude ore contained 2.5 to 3 percent lead and about 5 percent zinc sulfide and zinc oxide and was concentrated in a modern 3,500-ton-per-day concentration plant of American design and manufacture. During the year the Zellidja mines produced 56,100 tons of 55-percent zinc concentrate and 43,000 tons of 75-percent lead concentrate by flotation.

The Touissit mines, operated by Compagnie Royale Asturienne des Mines, produced 4,400 metric tons of 46- to 51-percent zinc concentrate and 26,400 tons of 69-percent lead concentrate from ore containing about 6 percent lead and 5 percent zinc sulfide and zinc oxides. Other French Moroccan mines, including those of Société des Mines de l'Assifel Mal, Société Miniére des Gundafa, R. Duran, and Société Miniére des Rehamna, produced 4,100 tons of zinc concentrate and some 41,000 tons of lead concentrate. A new 100-ton daily capacity flotation mill was built at the Société Miniére des Gundafa mine at Toundout.

Across the border in Algeria, Société Nord Africaine du Plomb Zellidja mines produced ore containing 15 to 16 percent zinc and 1.5 percent lead, which was concentrated at the rate of 250 tons per day in a 1,000-ton-capacity gravity concentrator at Bou Beker.

The zinc concentrates from the Bou Beker, Touissit, and Zellidja's Algerian mines were shipped to the various smelters of Compagnie Royale Asturienne des Mines in Europe. Most of the Bou Beker and Société Nord Africaine du Plomb Zellidja lead concentrates were smelted at the Qued-el-Heimer Moroccan smelter, a Zellidja subsidiary in which Société Minière et Métallurgique de Pennarroya owns a 49-percent interest.

Tunisian zinc production in 1953 was 3,600 tons compared with 3,500 tons in 1952. Producing mines, listed in order of concentrate output, were the El-Akhouat, the Sakiet Sidi Youssef, and the Djebel Ressas. These mines and about 9 others produced 38,000 tons of lead concentrate containing 24,000 metric tons of lead.

Northern Rhodesia.—The Rhodesia Broken Hill Development Co., Ltd., established new records in mine and smelter output of zinc in 1953. The mine produced 188,400 short tons of 18-percent lead and 29-percent zinc ore, and production of lead and zinc concentrates was, respectively, 19,900 and 39,900 short tons. The electrolytic zinc-reduction plant, which was enlarged in 1952, produced 28,400 short tons of slab zinc during the year compared with 25,600 tons in 1952. The new company lead smelter was put into production in 1953 but owing to various difficulties operated intermittently and produced only 1,300 tons of lead. The old plant produced 11,600 tons of lead, chiefly in the Newman hearths. Ore reserves at the end of 1953 were reported to be 2,520,000 tons of ore containing 17.2 percent lead and 26.7 percent zinc.

New facilities to transfer concentrates from the narrow-gage to the broad-gage railway at Vsakos were completed during the year by South African Railways. The new concentrate[59] storage and shipping facilities at Walvis Bay rail terminal were completed and put in use in early 1953. They permit storage of 20,000 tons of lead, zinc, and copper concentrates and mechanical ship loading at the rate of 300 tons per hour.

The Tsumeb Corp. completed drilling the Hohewarte lead-zinc deposit, east of Windhoeck during the year, and the Del Africain Mining Co. was formed to exploit it when conditions are favorable.

South-West Africa.—The mine output of recoverable zinc increased slightly to 17,400 short tons, although the South-West-Africa Co. at Abenab closed its Berg-Aukas mine south of Grootfontein, which had been producing oxidized zinc ore. The company's Abenab West mine continued to produce, yielding about 7,000 tons of ore per month, from which lead, zinc, and vanadium were produced in concentrate form.

The Tsumeb Corp., Ltd., controlled by Newmont Mining Corp. and the American Metal Co., Ltd., continued to operate its Tsumeb lead-copper-zinc mine to produce a lead-copper concentrate and zinc concentrates, which when smelted yielded approximately 11,600 tons of zinc, 45,000 tons of lead, and 12,000 tons of copper. Sinking the 7-compartment, vertical De Wet shaft, which is to become the main operating shaft, continued, and by midyear it had reached a depth of 3,250 feet. Sinking will be continued to 4,150 feet, while the ore block between the 2,390-foot and 3,150-foot levels is being developed.

AUSTRALIA

Total mine production was essentially unchanged in 1953 at 204,200 metric tons, despite the closing of some marginal cost lead and zinc

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[59] South African Mining and Engineering Journal, The Tsumeb Corp's. £400,000 Storage and Loading Installation Constructed at Walvis Bay: Vol. 64, No. 3137, part 1, p. 123.

producers in Western Australia. Price controls of both zinc and lead, established at A. £ 95 September 4, 1952, were abandoned by Queensland September 13, 1952, but remained in effect in the other five States until April 17, 1953. Thereafter both zinc and lead prices declined, reflecting the changes on the London Metal Exchange and elsewhere. The Commonwealth embargo on export of zinc and lead was removed at the end of March 1953.

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).

In New South Wales the Consolidated Zinc Corp., Ltd., which operates the New Broken Hill Consolidated, Ltd., and the Zinc Corporation, Ltd., mines, milled 542,600 long tons (449,300 tons in 1952) to produce 108,400 tons (87,400) of zinc concentrate and 105,600 tons (77,200) of lead concentrates. Mill heads in 1953 averaged 15.4 percent lead (13.5 percent in 1952), 11.7 percent zinc (11.2), and 3.4 ounces of silver (3.1). The annual report of the Zinc Corp. reports reserves of 8,300,000 long tons of high-grade ore, with yet larger quantities indicated. Other producers in the Broken Hill district were North Broken Hill, Ltd., and Broken Hill South, Ltd.

Lake George Mining Corp., Ltd., operating its complex base-metals mine at Captain's Flat for the fiscal year ended June 30, 1953, milled 178,000 long tons as opposed to 180,000 tons in 1951–52. Metals contained in salable products were 14,300 tons of zinc, 8,200 tons of lead, 900 tons of copper, 183,400 ounces of silver, and 4,000 ounces of gold. Ore reserves of 1,600,000 tons contain 6.4 percent lead, 11.5 percent zinc, 0.62 percent copper, 1.39 ounces of silver, and 0.07 ounce of gold. The annual corporation report states that overall costs per ton of ore milled were A. £10.7 as compared with A. £4.3 in 1947.

Mount Isa Mines, Ltd., milled 623,800 long tons of 6.4-percent zinc and 7.4-percent lead ore in the fiscal year ending June 30, 1953, to recover 41,800 tons of 51.2-percent zinc concentrate and 115,700 tons of 33.8-percent lead concentrate. The lead concentrate is smelted at Mount Isa, but the zinc concentrate is exported. Estimated reserves of lead-zinc-silver ores at the end of the year totaled 9,880,000 tons containing 8.5 percent lead and 6.9 percent zinc and approximately 6 ounces of silver per ton. Diamond drilling in the area of the Northern Prospect indicated an excellent potential, while that below the lower limits of opencut mining showed increased values in lead, zinc, and silver at depth, which will require large-scale underground mining. A new ventilation shaft and air-conditioning plant was being installed.

The Electrolytic Zinc Co. of Australasia, Ltd., operated its Rosebery and Hercules mines and during the fiscal year milled 168,800 tons (162,600 tons in fiscal 1952) of ore averaging 18.0 percent zinc, 5.2 percent lead, 0.44 percent copper, and 6.45 ounces of silver and 0.09 ounce of gold per ton to recover 48,000 tons of 55.3-percent zinc concentrate, 9,300 tons of 58.6-percent lead concentrate, and 4,400 tons of 18.25-percent copper concentrate. The zinc concentrates were shipped to the company Risdon, Tasmania, electrolytic zinc plant, and the lead and copper concentrates were marketed in the United States. Ore reserves were reported at 2,000,000 tons of average grade. Work to increase mine and mill capacity at the west coast operations (Rosebery and Hercules mines) from 160,000 tons to 250,000 annually was continued.

The Risdon electrolytic plant produced 87,400 long tons of refined zinc in the fiscal year ended in June and 91,600 metric tons in the calendar year 1953. About 25 percent of the production was from company concentrates and the remainder from Broken Hill. A portion of the zinc residues produced was shipped to the Broken Hill Associated Smelters, Pty., Ltd., at Port Pirie, South Australia, for the recovery of contained lead, silver and gold. The balance is stocked and will be re-treated in a plant that was being put in operation in the latter half of 1953.

Zirconium and Hafnium

By Robert F. Griffith [1]

ZIRCON is best known as the source mineral for the highly publicized, atomic-age metals zirconium and hafnium, used in the power plant of the atomic-powered submarine, *Nautilus*. Production of these ductile metals, however, represented less than 5 percent of United States zircon consumption in 1953; most of the zircon consumed was used in the refractory, ceramic, and foundry industries. Domestic zircon reserves and mine-production capacity are more than ample to meet requirements. Zirconium is favored as a material of construction in nuclear-reactor plants because of its good strength–weight ratio, corrosion resistance, high melting point, ductility, and low thermal-neutron absorption cross section; that is, zirconium does not readily absorb or waste thermal (slow) neutrons and thus conserves them for their primary function of maintaining a chain reaction. On the other hand, the probability that a hafnium nucleus will absorb or capture a thermal neutron is approximately 550 times greater than the probability that a zirconium nucleus will; consequently, the hafnium must be removed from zirconium used in nuclear reactors. Inasmuch as zircon usually contains 1 to 1.5 percent hafnium and about 50 percent zirconium, several tons of hafnium is produced annually in conjunction with zirconium production. Hafnium also has atomic-energy applications of a classified nature. For most applications of zirconium other than nuclear, the hafnium has no deleterious effects and need not be removed.

Late in 1953 a plant was placed in operation by Carborundum Metals, Co., Inc., Akron, N. Y., under contract to the Atomic Energy Commission for the production of hafnium-free Kroll-process zirconium sponge, thus augmenting the supply formerly furnished entirely by the Electrodevelopment Laboratory of the Bureau of Mines at Albany, Oreg. The Bureau of Mines, with a production capacity nearly double that of Carborundum Metals Co., Inc., continued to be the principal source of hafnium-free zirconium sponge and hafnium sponge. During 1953 the Bureau of Mines produced zirconium ingots and zirconium-alloy ingots from zirconium sponge for the Atomic Energy Commission. Part of this production was assumed by industry toward the close of the year, using a melting procedure developed by the Bureau of Mines, thus allowing the Bureau to devote more time to basic research aimed toward development of improved zirconium-production techniques.

A comprehensive review of zirconium, hafnium, and their alloys was presented in a series of papers before the Western Metal Congress held in Los Angeles, Calif., March 23–27, 1953. The papers were consolidated in book form and published by the American Society for Metals.[2]

[1] Commodity-industry analyst.
[2] American Society for Metals, Zirconium and Zirconium Alloys: Cleveland, Ohio, 1953, 354 pp.

DOMESTIC PRODUCTION

Mine Production.—Domestic production and shipments of zircon in 1953 decreased 9 and 19 percent, respectively, compared with 1952; mine shipments were 11 percent less than production. All marketed zircon of domestic origin was produced in Florida as a byproduct of titanium-mineral mining by the following companies: Florida Ore Processing Co., Palm Bay mine, Brevard County; Humphreys Gold Corp., operating the Trail Ridge mine, Clay County, for E. I. du Pont de Nemours & Co.; National Lead Co., Jacksonville mine, Duval County; and Rutile Mining Co. of Florida, Jacksonville mine, Duval County. A second mine by the Humphreys Gold Corp. was planned on the northern extension of the Trail Ridge deposit near Lawtey, Fla. The heavy-mineral reserves of the National Lead Co. were increased by acquisition of land near Ponte Vedra, Fla.[3] Plans were announced by the American Mining & Development Co.[4] for construction of a heavy-mineral (including zircon) mining and separation plant along the east coast of Florida near St. Augustine. Florida zircon normally contains 1 to 1.5 percent hafnium.

Zircon produced as a result of monazite dredging in Idaho was not marketed because of the lack of western markets and unfavorable freight rates.

Refinery Production.—Manufacturers of zirconium and hafnium products and processors of zircon are:

Producer and plant location:	Products
Manufacturers of zirconium and hafnium products:	
Allegheny-Ludlum Steel Corp., Watervliet, N. Y., and West Leechburg, Pa.	Zirconium ingots and shapes. Melting and rolling mills.
Bureau of Mines, Albany, Oreg. (production consigned to Atomic Energy Commission).	Kroll-process, hafnium-free zirconium sponge; alloy ingots; and hafnium sponge.
Carborundum Metals, Inc., Akron, N. Y. (production consigned to Atomic Energy Commission).	Kroll-process, hafnium-free zirconium sponge and hafnium sponge.
DeRewal International Rare Metals, Co., Philadelphia 5, Pa.	High-purity zirconum-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 Corp. Trafford, Pa., and McKeesport, Pa.	Zirconium ingots and shapes. Melting and rolling mills.
Foote Mineral Co., Philadelphia 44, Pa	Iodide-process zirconium crystal bar, hafnium crystal bar, and zirconium-metal shapes. Refractories, porcelain enamels, compounds, and ground zircon.
Metal Hydrides, Inc., Beverly, Mass	Zirconium-metal powder, zirconium hydride, and zirconium alloys.
Titanium Alloy Manufacturing Division (TAM) of National Lead Co., Niagara Falls, N. Y.	Kroll-process zirconium sponge, briquets, ingots, shapes, and alloys. Ground zircon, compounds, and stabilized zirconia refractories.

[3] Chemical Engineering, vol. 60, No. 3, March 1953, p. 112.
[4] Engineering and Mining Journal, vol. 154, No. 5, May 1953, p. 135.

Manufacturers of zirconium and hafnium products—Continued	Products
Westinghouse Electric Corp., Pittsburgh, Pa.	Zirconium crystal bar and metal shapes.
Processors of zircon:	
Ceramic Color & Chemical Mfg. Co., New Brighton, Pa.	Zirconium porcelains, enamels, refractories, glass, pottery, and compounds.
Corhart Refractories Co., Louisville, Ky.	Refractories.
Kawecki Chemical Co., New York 17, N. Y.	Zirconium fluorides.
Massillon Refractories Co., Massillon, Ohio.	Refractories.
Melberk, Inc., Wood Ridge, N. J.	Zirconium salts and compounds.
Metal & Thermit Corp., New York 17, N. Y.	Zirconium compounds for the pottery industry.
Norton Co., Worcester 6, Mass.	Fused, stabilized-zirconia refractories and granular zirconia.
Orefraction, Inc., Pittsburgh 8, Pa.	Granular and milled zirconium silicate. Porcelains, enamels, refractories, glass, pottery, and compounds.
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 Zirconium Co., Inc., Flemington, N. J.	Zirconium salts and compounds.
Vitro Manufacturing Co., Pittsburgh 4, Pa.	Pottery, enamels, and porcelains.
Zirconium Corp. of America, Solon, Ohio.	Stabilized zirconia. Zirconium compounds.

The zirconium-hafnium sponge-metal plant of Carborundum Metals Co., Inc., was completed and placed in operation the latter part of the year, providing the country with a third source of Kroll-process zirconium sponge (the Bureau of Mines and TAM are the other producers). Production by Carborundum and the Bureau of Mines is consigned to the Atomic Energy Commission. TAM produces zirconium sponge and metal for general industrial use. Allegheny Ludlum Steel Corp., Watervliet, N. Y., and Firth Sterling Corp., Trafford, Pa., installed melting equipment to produce zirconium ingots from zirconium sponge by the consumable-electrode arc-melting process developed by the Bureau of Mines. Processing of the ingots is accomplished by regular mill equipment.[5] The Bureau of Mines continued to produce alloy ingots on a reduced scale for the AEC and was the major source of zirconium sponge. Over 280,000 pounds of clean zirconium sponge and nearly 7,000 pounds of clean hafnium sponge were produced at Albany, Oreg., for the AEC. The Zirconium Corp. of America, Solon, Ohio, was organized the latter part of 1953 to produce various zirconium compounds, stabilized zirconia, and high-purity, monoclinic zirconia for the ceramic industry.

[5] E&MJ Metal and Mineral Markets, vol. 24, No. 37, Sept. 10, 1953, p. 10. Materials and Methods, vol. 38, No. 6, December 1953, pp. 230, 232, 234.

CONSUMPTION AND USES

Zircon consumption in the United States in 1953 was estimated at 45,000 tons. Information furnished by the principal dealers and consumers of zircon indicated that the distribution for 1953, by uses, was as follows: Refractories, 28 percent; foundry facings, foundry sand, and blasting grain, 27 percent; pottery, porcelains, enamels, and glazes, 20 percent; metal and alloys, 12 percent; chemicals and salts, 6 percent; glass, 2 percent; miscellaneous, 5 percent.

Oil-bonded zircon sands were used on an increased scale as core material for foundry applications involving particularly difficult casting conditions. This use was limited for general foundry applications because of the higher cost compared with the commonly used silica sands. For certain special applications zircon sand was preferred because it is of uniform grain size, is more refractory than silica sand, has low thermal expansion, and is not wetted by molten metals. Zircon-sand cores produce sharp definition and smooth surfaces and are removed easily from the casting. The quantity of zircon sand used for many special applications was so small that the higher cost was unimportant compared with the quality of the final product.[6] Zircon was used extensively in manufacturing refractory materials because of its high melting and softening points, good thermal conductivity, low thermal expansion, good abrasion resistance, and striking resistance to certain molten metals, acidic chemicals, slags, and glasses. In the aluminum industry zircon refractories were used in constructing reverberatory or open-hearth furnaces. Stabilized zirconium dioxide capable of withstanding temperatures over 4,000° F. was expected to play an important role in future aircraft developments, such as in rockets and turbojets, and in high-temperature metallurgical research.[7]

Zirconium compounds found wide use as opacifiers in ceramic enamels and glazes because of their high reflectivity of light and thermal stability. Other ceramic uses depended on the chemical inertness, high melting point, and high specific gravity of zircon. In glasses, glazes, and enamels, soluble zirconia was a desirable component because it increases resistance to acids and thermal shock.

Regardless of the publicity given to ductile zirconium metal, the largest tonnage use of zirconium in the metallic industry was in the form of zirconium-ferrosilicon in steel and other alloys. In the manufacture of steel, zirconium acts as a powerful deoxidizer and as a scavenger of nitrogen and sulfur; it also promotes depth-hardenability in the heat-treated engineering steels. A zirconium alloy containing 12–15 percent zirconium and 39–43 percent silicon was commonly used for treating steel. Zirconium briquets containing 11 percent zirconium and 38 percent silicon were used in the manufacture of gray cast iron to improve the machinability. Magnesium-base alloys containing rare-earth metals, thorium, and zinc for jet aircraft-engine castings were improved greatly by zirconium additions. Zirconium acts as a grain refiner and improves the ductility and toughness of magnesium alloys.[8] For this application zirconium was

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[6] Hinchcliffe, M. R., Zircon Sand: Metal Industry (London), vol. 83, No. 22, Nov. 27, 1953, pp. 437-440.
[7] Science News Letter, vol. 64, No. 9, Aug. 29, 1953, p. 136.
[8] Metal Progress, vol. 63, No. 3, March 1953, pp. 75-82.

usually added in the form of the chloride. If experiments with zirconium boride (which can withstand temperatures up to 6,000° F.) prove successful, belief prevailed that considerable use of this alloy would develop in rockets and jets.[9] Zirconium boride and a similar family of cermets were reported to have good possibility as cutting-tool material.[10]

By far the largest use of ductile zirconium in 1953 was as a material of construction in Government-sponsored nuclear-reactor plants. Conceivably, a continuing increase in energy demands would lead to an increased demand for hafnium-free, ductile zirconium in nuclear-reactor plants designed for commercial use. Among the metals only beryllium, bismuth, and magnesium have a lower thermal-neutron absorption cross section than zirconium. The structural properties, high melting point, corrosion resistance, and availability favored the use of zirconium in preference to the other three metals with lower cross section. Absorption cross section refers to the ability of a material to absorb a neutron, the absorption of which is wasteful to the available energy in uranium, thorium, or other fissionable material.[11] Other than nuclear applications, a large future use for zirconium was predicted in the manufacture of corrosion resistant equipment for the chemical industry. Zirconium is especially effective in withstanding hydrochloric acid corrosion and was used in the manufacture of phenol in the plastics industry.[12] Other important uses of zirconium metal were in such diverse applications as photoflash bulbs, surgical equipment, high-power and high-intensity electric arc lamps, and as a getter in radio tubes. This latter use was well established but would apparently not become really extensive unless zirconium alloys with improved high-temperature strength properties could be developed.[13] Contrary to popular belief ductile zirconium metal in the form of bars, rod, sheet, plate, and wire was available for commercial applications during 1951 and 1952, and commercial producers were actively seeking new markets in 1953.

The use of zirconium salts and chemicals expanded rapidly during the 1950–53 period. Zirconium hydroxide in salves exerts a soothing effect on skin eruptions caused by poison ivy; several thousand tubes were sold in 1953. The hydroxide and zirconium lactate were used for personal deodorants. Wax emulsions mixed with zirconium acetate (or ammonium zirconyl carbonate) form good water repellants for textiles, and zirconium salts were used to precipitate either acid or basic dyes on textiles. Zirconium compounds were used for tanning skins.[14] Zirconium oxide was precipitated in the leather fibers in the tanning of white leather.

Little use had been developed for hafnium or its compounds outside of atomic energy and research applications; its future use was considered to depend on special electronic applications and, in its carbide form, on an extremely high melting point.[15] Hafnium was employed for alloying with the tungsten filaments of electric incandes-

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[9] Mining & Contracting Review, vol. 55, No. 5, May 1953, pp. 6, 11.
[10] Iron Age, vol. 171, No. 26, June 25, 1953, p. 63.
[11] Materials and Methods, vol. 37, No. 5, May 1953, p. 174.
[12] Chemical Engineering, vol. 60, No. 6, June 1953, pp. 105–106.
[13] Mining Journal (London), vol. 240, No. 6129, Feb. 6, 1953, pp. 157–159.
[14] Engineering and Mining Journal, vol. 24, No. 34, Aug. 20, 1953, p. 7.
[15] Engineering and Mining Journal, vol. 154, No. 7, July 1953, p. 98.

cent lamps to increase their strength. Possible future use of hafnium in steels comparable to that of zirconium was also foreseen. Other potential applications were in special porcelains, in heat-resisting glasses, as an opacifier in vitreous enamels, and in cast nickel-silicon bronze and other alloys. Predictions prevailed that hafnium might be used in the manufacture of ammunition primers, welding electrodes, flashlight powders, and pyrotechnics. These applications were held to depend largely on the production of the metal in greater quantity and at a lower cost than in 1953; if these conditions were fulfilled the metal would have to compete with zirconium and titanium.[16]

STOCKS

Industry stocks of zircon and other zirconium ores containing more than 65 percent ZrO_2 were about 11,000 short tons at the close of 1953, an increase of about 2,000 tons compared with 1952 year-end stocks. Nearly 1,200 tons of baddeleyite (impure zirconium dioxide) was included in 1953 year-end stocks.

Zirconium ores were included in Group II materials in 1953; such materials are acquired for the National Stockpile only through the transfer of Government-owned surpluses. Stockpile quantitative data are not available for publication.

PRICES

E&MJ Metal and Mineral Markets quoted zircon concentrates (65 percent ZrO_2), c. i. f. Atlantic ports, at $42–$43 per long ton throughout 1953. Since zircon contains a theoretical 67 percent ZrO_2, at least a 97-percent zircon concentrate is necessary to achieve the specified 65 percent ZrO_2 content. Prices for domestic zircon were largely nominal, and individual transactions and contracts were negotiated. No quotations were published for baddeleyite ore and concentrates.

Zirconium-metal powder was quoted in E&MJ throughout 1953 at $7 per pound. Iodide-process ductile zirconium metal, and forms from that stock produced by Foote Mineral Co., were quoted early in 1953, as follows: Zirconium crystal bar $70 per pound for lots of over 100 pounds, $90 per pound for smaller quantities; zirconium wire (annealed), 0.070- to 0.003-inch diameter, $327 to $793 per kilogram; zirconium swaged rod (unannealed), 7/16- to 5/64-inch diameter, $200 to $210 per kilogram; and zirconium sheet, 0.015 to 0.002 inch thick, $289 to $450 per kilogram. Prices for ductile zirconium produced by the Titanium Alloy Manufacturing Division, National Lead Co., and forms fabricated from that stock remained unchanged in 1953. Prices quoted were as follows: Zirconium-metal sponge and briquets, $10 per pound; hot-rolled plate and bars, base price, $27 per pound; hot-rolled strip, base price, $28 per pound; cold-rolled strip, base price, $35 per pound; cold-drawn wire, 0.060- to 0.375-inch diameter, $42.50 to $32.50 per pound, 0.015- to 0.030-inch diameter, $0.08 and $0.15 per foot, respectively. Zirconium tetrachloride, the starting material for Kroll-process zirconium sponge, was quoted at $0.34 per pound in carlots and $0.38 per pound in lots of less than 500 pounds, f. o. b. Niagara Falls, N. Y.

[16] Lomas, J., Hafnium: Canadian Min. Jour., vol. 11, No. 74, November 1953, pp. 80–81.

Zirconium alloys, contract price, were quoted by Electro Metallurgical Co., Division of Union Carbide & Carbon Co., f. o. b. railroad freight cars at destination, as follows: Zirconium-ferrosilicon, 12–15 percent Zr, $0.08 to $0.1075; 35–40 percent Zr, $0.2025 to $0.2525, depending on quantity and size; zirconium briquets (11 percent Zr, 38 percent Si), $0.075 to $0.10 per pound, depending on quantity; and nickel-zirconium (40–50 percent Ni, 25–30 percent Zr) $1.25 to $1.35 per pound, depending on quantity.

A leading producer quoted zirconium compounds, f. o. b. Niagara Falls, N. Y., per pound as follows: Acetate solution, $0.23 to $0.27; carbonate, $0.305; C. P. oxide, $1.50; fused oxide-lump, $0.44 to $0.48; granular zircon, $0.03⅜ to $0.04¼; milled zircon, $0.04⅛ to $0.075; and sulfate, $0.375 to $0.415. The Oil, Paint and Drug Reporter quoted other zirconium compounds, per pound, in large lots, f. o. b. New York, as follows: Hydride, $7.25 to $11.50; and nitrates, $4.50 to $7.00.

DeRewal International Rare Metals Co. quoted hafnium metal and compounds in 1953 as follows: Hafnium metal powder (99 percent), $25 per gram; hafnium oxide, $18 per gram; and hafnium tetrachloride, $17 per gram. A decided drop in hafnium prices is anticipated by this company in the near future as a result of expanded production facilities.

In addition to the principal producers of zirconium products, other buyers and dealers of zircon concentrates include:

New York

New York 17:
- Berkshire Chemicals, Inc.
- Byington & Co.
- International Titanium Corp.
- Metal Traders, Inc.
- Metallurg, Sons & Co.
- C. Tennant, Sons & Co.

Pennsylvania

Philadelphia 7: Frank Samuel & Co.

FOREIGN TRADE [17]

Australia and Brazil were the source countries of all zirconium ore imported for consumption in the United States in 1953. Australia continued to be the only foreign source of zircon; Brazilian shipments were in the form of baddeleyite concentrates. The quantity of zircon imported from Australia was comparable to United States mine production, although domestic mine-production capacity is reported to be capable of meeting domestic requirements. Apparently, a favorable price differential and a tie-in with rutile imports, a mineral in short supply, accounted for the large United States consumption of Australian zircon in preference to the domestic product. The average declared value of zircon imported from Australia in 1953 was $22.50 per long ton of zircon. The average declared value of baddeleyite imports from Brazil was $104 per long ton of concentrate. No transactions were reported for imports of zirconium in other forms during 1953.

[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.

Exports of zirconium ore and concentrates to Canada and Italy in 1953, totaled 1,110 short tons valued at $89,183. Exports of zirconium metal and alloys, in crude form, and scrap to Canada totaled 6,600 pounds valued at $7,047. Semifabricated forms exported to Canada, United Kingdom, and Switzerland amounted to 145 pounds valued at $1,729.

Producers of zirconium products in foreign countries include Dominion Magnesium, Ltd., Toronto, Canada; Electro Metallurgical Co., Ltd., of Canada, Welland, Ontario; Murex Co., Rainham, Essex, England; Blackwell's Metallurgical Works, Ltd., and Imperi alChemical Industries, Ltd., Liverpool, England; Goodlass Wall & Lead Industries, Ltd., Newcastle-upon-Tyne, England; and F. W. Berk & Co., Ltd., London, England. Australia is the principal source of zircon for the English companies.

TABLE 1.—Zirconium ore (concentrates)[1] imported for consumption in the United States, 1944–48 (average) and 1949–53, by countries, in short tons

[U. S. Department of Commerce]

Year	French West Africa	Australia[2]	Brazil	Canada	India	Total	
						Short tons	Value
1944–48 (average)	1	19, 593	2, 746	2	892	23, 234	$609, 296
1949		18, 839	1, 994			20. 833	636, 529
1950		15, 988	697	141		16, 826	431, 107
1951		25. 208	2. 084			27. 292	664, 428
1952		21, 935	1, 972			23. 907	630, 559
1953		23, 461	1, 206			24, 667	571, 783

[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 from 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" concentrate (see Titanium chapter) are estimated as follows: 1949, 14,623 tons; 1950, 15,098 tons; 1951, 24,577 tons; 1952, 21,500 tons; and 1953, 22,875 tons.

TECHNOLOGY

A tremendous quantity of literature dealing with zirconium and hafnium was published in 1953, largely in connection with applications of these metals in the atomic energy program and describing results of research directed toward improved production techniques. Zirconium has been ranked second in importance only to uranium as a vital material in the construction of the nuclear reactor used to power the atomic submarine *Nautilus*.[18] Lighter than steel, zirconium is remarkably corrosion resistant, has a high melting point, and is strong and workable. Its most important asset is that it does not absorb—and thus waste—neutrons to the extend of other potential structural materials. The regenerative efficiency and fuel utilization in thermal reactors depend on neutron economy and thus on the neutron absorption cross section of the structural material.[19] A description of the role played by hafnium in nuclear reactors has not been made available. As the use of zirconium in nuclear-reactor plants became clearly

[18] Modern Metals, vol. 9, No. 4, May 1953, pp. 42, 44.

[19] Miller, Edward C., Zirconium and Nuclear Reactors; chap. in Zirconium and Zirconium Alloys: Am. Soc. Metals, Cleveland, Ohio, 1953, pp. 327–340.

established the demand for the high-purity, ductile metal far exceeded production capacities. The principal limiting factor was in the conversion of Kroll-process sponge, produced by the Bureau of Mines, to iodide-process, crystal-bar zirconium. A large-scale production process was developed by Westinghouse Electric Corp., resulting in an increase in production from several hundred to many thousand pounds per month.[20] The substitution of zirconium carbide for sponge as a feed material for the iodide process has been investigated.[21] The later development of the consumable-electrode arc-melting process by the Bureau of Mines for producing ductile zirconium ingots from Kroll-process sponge has allowed use of this material in future reactor design; operation of the crystal-bar plant is no longer necessary.[22]

The problems involved in the production of zirconium sponge and titanium sponge are similar. Titanium, however, is easier to reduce than zirconium, since its affinities are lower and titanium tetrachloride is easier to handle and keep clean because it is a liquid at room temperature whereas zirconium tetrachloride is a solid.[23] In the manufacture of Kroll-process zirconium sponge zircon is smelted with an excess of carbon to form zirconium carbide, which is chlorinated to crude $ZrCl_4$. For atomic-energy applications the hafnium is removed from the crude $ZrCl_4$ by a classified process and the resultant zirconium oxide is converted to pure $ZrCl_4$ by direct chlorination. Zirconium sponge is produced by reduction of $ZrCl_4$ by magnesium.[24] The separated, hafnium-free zirconium oxide can be produced from zircon for well under $5 per pound of contained zirconium. To this must be added the cost of converting to metal.[25] The Kroll process is a batch process, and the size of the reduction units is limited by the ability to dissipate the high heat of reaction from the units. A major improvement would be development of a continuous process, with continuous withdrawal of arc-melted sponge and recovery of magnesium chloride.[26] Arc reduction of zirconium tetraiodide, a continuous process, was developed by National Research Corp., Cambridge, Mass., for the AEC. This method is not applicable for the cheap tonnage production of zirconium.[27] A method for the production of zirconium ingots from sponge was developed by the Bureau of Mines [28] and adopted by industry for commercial use.[29] The fabrication of zirconium by powder metallurgy methods was described.[30]

Increased interest was shown in 1953 in the use of magnesium-zirconium-rare-earth alloys by the aircraft industry, particularly in

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[20] American Metal Markets, vol. 60, No. 45, Mar. 7, 1953, pp. 1, 12.
[21] Work cited in footnote 13 (p. 157).
[22] Work cited in footnote 20.
[23] Kroll, W. J., Carmody, W. R., and Schlechten, A. W., High-Temperature Experiments With Zirconium and Zirconium Compounds: Bureau of Mines Rept. of Investigations 4915, 1952, 31 pp.
[24] Shelton, S. M., and Dilling, E. Don, The Manufacture of Zirconium Sponge; chap. in Zirconium and Zirconium Alloys: Am. Soc. Metals, Cleveland, Ohio, 1953, pp. 82–119.
[25] Work cited in footnote 19.
[26] Work cited in footnote 13 (p. 158).
[27] Chemical Engineering, vol. 60, No. 6, June 1953, p. 112.
[28] Stephens, W. W., Gilbert, H. L., and Beall, R. A., Consumable-Electrode Arc Melting of Zirconium Metal; chap. in Zirconium and Zirconium Alloys: Am. Soc. Metals, Cleveland, Ohio, 1953, pp. 121–130.
[29] Iron Age, vol. 172, No. 10, Sept. 3, 1953, p. 61.
[30] Materials and Methods, vol. 37, No. 2, February 1953, pp. 101–103.

jet engine parts. Reports describing these alloys were issued [31] and a patent for master-alloy additions was granted.[32]

The successful application of zirconium and certain of its alloys in the chemical industry where severe corrosion problems arise was described as a result of investigations conducted in 1953.[33]

Increased production of zirconium and hafnium has necessitated the development of improved methods of analysis. Spectographic and colorimetric methods were described in 1953.[34]

Interest in applications of zirconium as a substitute for other metals led to descriptions of its mechanical properties and to comparisons with other structural and corrosion-resistant materials, notably titanium and tantalum. Zirconium (density 6.52) is heavier than titanium (density 4.51) and lighter than tantalum (density 16.6). It is more corrosion resistant than titanium but less so than tantalum in extremely thin foil under certain conditions.[35]

Improved methods for producing stabilized zirconium dioxide (zirconia) were developed in 1953; stabilized zirconia is extremely resistant to abrasion and thermal shock.[36] The results of an investigation of zirconium boride ceramals for gas-turbine blade applications were released by the National Advisory Committee for Aeronautics.[37]

Hafnium, a bright metal similar in appearance to stainless steel, has a specific gravity of 13.3 and a melting point of 1,975° C. It has high electron emission and a strong tendency to absorb thermal neutrons. Investigations at Oak Ridge National Laboratory in the winter of 1947–48, determined the thermal-neutron absorption cross section of zirconium to be about 0.18 barn (one barn=10^{-24} cm^2) instead of previously listed values of about 3.5 barns. They further recognized the discrepancy to be caused by 1½–3 percent hafnium (cross section, 115 barns) normally contained in zircon and zirconium metal respectively.[38] The difficult problem of separating hafnium from zirconium on a commercial scale was solved, but details of the process were classified. A report, however, was declassified describing the results of an investigation to purify zircon for subsequent hafnium separation processes employing liquid-liquid extraction.[39] As a result

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[31] Work cited in footnote 19.
Mining Magazine (London), vol. 88, No. 5, May 1953, pp. 273–276.
Mote, M. W., Frost, P. D., and Jackson, J. H., The Investigation of Zirconium-Cerium Master Alloys for Use in Adding Zirconium to Magnesium: Battelle Memorial Inst., Columbus, Ohio, Final Rept., Contract NOas 51–001–c, Jan. 31, 1953, 19 pp.

[32] Saunder, William P., and Strieter, Frederick P. (assigned to Dow Chemical Co.), Zr-Mg Master Alloy: U. S. Patent 2,664,353, Dec. 29, 1953.

[33] Steel, vol. 133, No. 15, Oct. 12, 1953, pp. 248–251.
Industrial and Engineering Chemistry, vol. 45, No. 5, May 1953, p. 1067.
Golden, Lex B., The Corrosion Resistance of Zirconium and Its Alloys; chap. in Zirconium and Zirconium Alloys: Am. Soc. Metals, Cleveland, Ohio, 1953, pp. 305–326.

[34] Chemical and Engineering News, vol. 31, No. 27, July 6, 1953, p. 2767.
Peterson, Maurice J., and Jaffee, Howard W., Visual-Arc Spectroscopic Analysis: Bureau of Mines Bull. 524, 1953, 20 pp.
Mortimore, D. M., and Noble, L. A., Determining Low Concentrations of Hafnium in Zirconium; A Spectrographic Method: Anal. Chem., vol. 25, February 1953, pp. 296–298.
Grimaldi, Frank S., and White, Charles E., Quercetin as Colormetric Reagent for Determination of Zirconium: Anal. Chem., vol. 25, December 1953, pp. 1886–1890.

[35] Metal Industry (London), vol. 83, No. 6, Aug. 7, 1953, p. 111.
Metal Progress, A Comparison of Zirconium With Better Known Commercial Metals: Vol. 63, No. 5, May 1953, pp. 75–81.
Light Metal Age, Mechanical Properties of Zirconium: Vol. 11, Nos. 11, 12, December 1953, pp. 16–19.
Work cited in footnote 33 (Ind. Eng. Chem.).

[36] Materials and Methods, vol. 38, No. 3, September 1953, pp. 199–200.
Industrial and Engineering Chemistry, vol. 45, No. 10, October 1953, p. 42A.
Kistler, S. S. (assigned to Norton Co.), Method of Making Dense, Hard, Abrasion-Resistant Ceramic Material: U. S. Patent 2,624,097, Jan. 6, 1953.
Ballard, Archibald H., and Marshall, Douglas W. (assigned to Norton Co.), Zirconia and Method of Quenching Same and Articles Made Therefrom: U. S. Patent 2,656,278, Oct. 20, 1953.

[37] Hoffman, Charles A., Preliminary Investigation of Zirconium Boride Ceramals for Gas-Turbine Blade Applications: NACA RM E52L 15a (available from NACA, Washington, D. C.), April 1953, 13 pp. (declassified Nov. 12, 1953).

[38] Nucleonics, vol. 11, No. 7, July 1953, p. 28.

[39] Spink, Donald R., and Wilhelm, H. A., Caustic Treatment of Zircon in the Preparation of Pure Zirconium Compounds: AECD–3534; ISC–217, Ames Laboratory, declassified with deletions June 23, 1953, 55 pp.

of the increased availability of hafnium in 1953 a number of papers were published describing the occurrence, properties, and potential applications of this new metal and its compounds.[40]

WORLD REVIEW

Australia.—Australia in 1953 continued to be the world's principal producer of zircon. The average price, f. o. b. main Australian seaport, for 25,465 long tons of zircon exported for the year ended June 30, 1953, was $30 per long ton.[41] Zircon is recovered in conjunction with rutile from beach deposits along the eastern coast of Australia, mainly between Ballina, New South Wales, and Stradbroke Island, Queensland. Australian consumption of zircon is an estimated 1,000 long tons per year, used principally in manufacturing enamel.

Brazil.—The only producer of zirconium ore in Brazil is Cia. Geral de Minas Gerais, São Paulo, from mines in Cascata near Pocos de Caldes. Baddeleyite is the zirconium mineral, and about 3,000 metric tons is exported annually to the United States, United Kingdom, Norway, and Germany. About 200 tons is consumed annually in Brazil.[42]

TABLE 2.—World production of zirconium ores and concentrates, by countries, 1944–53, in short tons

[Compiled by Pauline Roberts]

Country	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953
Australia [1]	15,680	17,002	13,891	24,165	25.017	23.486	24,120	47,006	32,893	[2] 33,200
Brazil (exports)[3]	2,372	836	4,909	4,385	4,011	2,977	3,325	3,854	2,425	1,206
Egypt	13	11	4	-------	104	141	105	4	133	(4)
French West Africa	-------	-------	-------	43	211	270	243	29	-------	992
India	846	1,142	522	(5)	(5)	(5)	(5)	(5)	(5)	(5)
United States [1]	200	2,681	7,946	(5)	(5)	(5)	(5)	(5)	(5)	(5)

[1] Estimated zircon content of all zircon-bearing concentrates.
[2] Estimate.
[3] Chiefly baddeleyite.
[4] Data not available.
[5] Not available for publication.

French West Africa.—Zircon production in 1953 was reported at 992 short tons as a coproduct of ilmenite from beach deposits of Senegal and Casamance.

India.—Zircon is produced along with monazite, ilmenite, rutile, and sillimanite from beach sands on the coast of Travancore.[43]

Tanganyika.—An extensive deposit of orthito (a hydrous calcium, aluminum, rare-earth, orthosilicate) containing up to 8 percent haf-

[40] Lomas, J., Hafnium; Canadian Min. Jour., vol. 11, No. 74, November 1953, pp. 80–81.
Mining Journal (London), The Properties of Hafnium Metal: Vol. 240, No. 6140, Apr. 24, 1953, p. 484.
Roth, H. P., Metallography of Hafnium: Metal Prog., vol. 63, No. 6, June 1953, pp. 84–89.
Journal of Metals, A Study of Some Binary Hafnium Compounds: Vol. 5, No. 9, September 1953, pp. 1119–1120.
[41] Deswal Pty., Ltd., Australian Metal Market and Mineral Sands Report: 60 Hunter St., Sydney, Australia, Bull. 4, Nov. 20, 1953.
[42] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 2, February 1953, p. 30.
[43] American Ceramic Society Journal, vol. 36, No. 6, June 1953, pp. 95–114.

nium was reported in an area recently made accessible to railroad facilities.[44]

United Kingdom.—The consumption of zircon in England, for all purposes, is an estimated 10,000 tons per year. Apparently there was no commercial production of ductile zirconium metal outside the United States and England.[45]

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[44] South African Mining & Engineering Journal vol. 64, No. 3149, June 20, 1953, p. 629; No. 3168, Oct. 31 1953, p. 295.
[45] Work cited in footnote 13 (p. 159)

Minor Metals

By E. J. Carlson[1] and J. D. Sargent[1 2]

CESIUM AND RUBIDIUM[3]

CESIUM, a soft silvery-white metal resembling potassium, is one of the rare elements that has assumed some strategic importance in recent years because of its use in photoelectric cells. It is the heaviest of all known members of the alkali series of metals, the most electropositive, and the softest. The metal is liquid near room temperature and strongly reactive with oxygen and moisture, hence it must be stored in a vacuum or immersed in an inert fluid. Deposits of cesium minerals are uncommon in occurrence. Pollucite, the chief ore mineral, containing 25 to 34 percent Cs_2O, is rarely found in quantity. Cesium may occur with beryl, lepidolite, rhodizite, carnallite and in the mother liquors derived from processing lithium and beryllium.

Rubidium is widely dispersed in the crust of the earth but is recovered principally from lepidolite, the chief source mineral, at an annual rate of a few hundred grams. Other rubidium-bearing minerals are pollucite, cranallite, leucite, and zinnwaldite, which contain quantities of the element ranging from a trace up to 1 percent Rb_2O. The rubidium content of potassium chloride recovered from brines in Michigan is about 0.05 percent. World supply and reserves of lepidolite (1.5 percent Rb_2O) are estimated to be adequate to meet any sharply increased demand for rubidium during an emergency; however, accelerated demands may be developed by the electronics industry.

Domestic Production.—Minor quantities of ores were produced in New England, South Dakota, and Colorado as byproducts from the mining of pegmatites for feldspar, mica, and beryl. Small quantities of cesium and rubidium metals and compounds were produced by Fairmount Chemical Co., Newark, N. J.; DeRewal International Rare Metals Co., Philadelphia, Pa.; Maywood Chemical Works, Maywood, N. J.; and Harshaw Chemical Co., Cleveland, Ohio. The market demands for the metals and compounds increased greatly in 1953 over those of previous years.

Uses.—Cesium and rubidium metals were used principally in the manufacture of photoelectric cells and as getters in the manufacture of vacuum tubes. Both metals were used also in catalytic agents, medicine, radio detector tubes, and infrared signaling devices. Cesium

[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 E. J. Carlson.

was used in scintillation counters and various detecting devices, such as the sniperscope and snooperscope. Information concerning other uses for the metals has been classified by Government agencies.

Prices.—Cesium and rubidium metals, C. P. and double distilled, were quoted at $1.95 and $2.75, respectively, in lots of 10 to 100 grams. The nitrate and chloride of cesium were listed at 30 cents per gram; the carbonate at 35 cents per gram; and the chromate at 43 cents per gram. The salts of rubidium were quoted about 50 percent higher than those of cesium. Crude lepidolite ores from Africa were quoted at $45 per short ton and crude African pollucite at about $500 per short ton, depending upon Cs_2O content.

World Review.—In 1953 South-West Africa continued to be the principal producer of the cesium and rubidium ores, pollucite and lepidolite, and over 60 percent of the domestic demand was imported from that country. Other foreign producers were Belgian Congo, Madagascar, Norway, and Sweden.

GALLIUM [4]

Gallium is widely distributed in the earth's crust, occurring in the same quantity as lead, or about 15 grams per ton of earth. Minor concentrations of gallium are found in ores of tin, zinc, and aluminum, as well as in many coals. Some Bolivian tin ores assay as high as 0.05 percent gallium, while zinc and aluminum ores usually contain small quantities of the element. Flue dusts from certain coals found in England and the United States have been reported to contain up to 0.5 percent gallium. The richest known gallium-bearing mineral is germanite, which contains 0.1 to 1.8 percent gallium. This complex zinc-copper-arsenic-germanium mineral has not been identified in domestic ores.

Domestic Production.—A few thousand grams of gallium was produced in 1953 from liquors of the Bayer aluminum process and from zinc flue dusts and electrolytic plant residues. Producer yearend stocks suffice for several years' supply, based upon present market consumption. Producers of gallium were the Aluminum Co. of America, Pittsburgh, Pa.; and the Anaconda Copper Mining Co., Great Falls, Mont.

Uses.—No new applications for gallium or its compounds were developed in 1953, and market demands continued negligible. Gallium melts at 86° F. This property has permitted some useful application of the metal in high-temperature thermometers or pyrometers. The low melting point of gallium renders it highly suitable for parts of automatic sprinkler systems and other fire-preventing or fire-warning systems. The nontoxic character of gallium has made it of some use in dental amalgams, but its high cost has prevented extensive use in this field. Minor quantities of gallium are used in fluorescent lighting, luminous paints, selenium rectifiers, optical-mirror backings, and medicine.

Prices.—Gallium metal, 99.9 percent pure, was quoted in 1953 at $3.25 per gram in lots less than 1,000 grams and at $3 per gram in 1,000-gram lots.

[4] Prepared by E. J. Carlson.

Technology.—The smelting of germanium-gallium-rich flue dusts, the separation of germanium and gallium, and the recovery and purification of gallium were discussed in detail by J. L. P. Wyndham.[5] The recovery of gallium from zinc blende and standard tests for the metal were described by L. Sanderson.[6]

GERMANIUM [7]

Production of electronic elements containing germanium reached a peak in early 1953. Germanium transistors in hearing aids became available to the public in early 1953, culminating years of research and development. Production difficulties and high-temperature failures plagued the manufacturers of germanium components for electronic equipment. Germanium continued to be the basic raw material for transistors and diodes despite its drawbacks and the development of several other semiconductors. The supply of germanium in 1953 was ample to meet demand.

Domestic Production.—Domestic producers of germanium in 1953 were: The Eagle-Picher Co., Joplin, Mo., and Miami, Okla.; Sylvania Electric Products, Inc., Woburn, Mass., and Towanda, Pa.; American Zinc Co. of Illinois, Fairmont City, Ill.; and the American Steel & Wire Co., Donora, Pa. Experimental production or stockpiling of germanium raw materials was in progress or contemplated in 1953 by American Smelting & Refining Co., Perth Amboy, N. J.; Matthiessen & Hegeler Zinc Co., La Salle, Ill.; National Zinc Co., Inc., New York, N. Y.; International Smelting & Refining Co., Great Falls, Mont.; and the Newmont Exploration Co., Grass Valley, Calif. Other manufacturers abandoned plans to produce germanium when the available supply was revealed to exceed existing demand.

Consumption and Uses.—Sales of germanium diodes reached a peak of about 2½ million units a month in April 1953 and declined considerably during the remainder of the year.[8] Germanium producers reported considerable slackening of demand during the latter half of 1953.

Radioactive phosphorus in a fused mixture of titanium phosphate and germanium dioxide was being used experimentally at the United States Naval Hospital, St. Albans, N. Y., for destroying tumors.

Other experimental uses of germanium were reported in a Geiger counter weighing only 1 pound, closed-circuit television, "Dick Tracy," portable, and automobile radios, the operation of d. c. motors from an a. c. source, electronic computers, a prototype aircraft electronic fuel gage, photocells, pyrometers, and specialized radiation detectors.

Stocks.—Stocks of both refined germanium and germanium raw materials increased during 1953 owing principally to lagging sales of refined germanium.

Prices.—E&MJ Metal and Mineral Markets quoted germanium metal during the first half of 1953 at $340 per pound and germanium dioxide at $142 per pound. The price of germanium dioxide con-

[5] Wyndham, J. L. P., Germanium Is in Demand: South African Min. and Eng. Jour., No. 3150, June 27, 1953, pp. 687–689.
[6] Sanderson, L., Gallium: Canadian Min. Jour., vol. 74, No. 3, March 1953, pp. 81–82.
[7] Prepared by J. D. Sargent.
[8] Statistics supplied by the Radio-Electronics-Television Manufacturers Association.

tinued unchanged throughout 1953; but, effective August 15, 1953, The Eagle-Picher Sales Co. announced a price of $295 per pound for germanium metal, which was unchanged for the remainder of the year.

Technology.—The year 1953 was the fifth anniversary of development of the transistor by Bell Laboratories.[9]

New methods for analyzing germanium were published during 1953.[10]

The Philco Corp. prepared a new type of germanium transistor in 1953 by electroetching germanium with indium salts.

Tetrode and pentode transistors were announced by Sylvania Electric Products, Inc.

Transistors as plug-in replacements for vacuum tubes appeared in 1953.

Perhaps of equal importance but accompanied by less fanfare were developments in germanium power rectifiers. Water-cooled germanium power rectifiers of high efficiency were produced in 1953.

A dozen or more semiconductive materials were investigated as substitutes for germanium, but none was adapted on a production basis during 1953.

The physical properties of germanium metal and germanium compounds and alloys were explored further in 1953.[11]

Minneapolis-Honeywell Regulator Co. developed a power transistor 100 times more powerful than previous models.[12]

A 2,250-card bibliographic index of germanium literature was made available in 1953.[13]

The Hevi Duty Electric Co., Milwaukee, Wis., produced an electric furnace for refining germanium dioxide to high-purity metal.

Trace-element investigation of American coal deposits was continued by the Federal Geological Survey, and a progress report of germanium concentrations was published.[14]

World Review.—Germanium transistors were produced in Europe at Nymegue, Netherlands, by Philips Co. and by Standard Ore & Alloys Corp. in West Germany.

Germaniferous raw materials from Belgian Congo were refined to high-purity germanium at Oolen, Belgium.

INDIUM [15]

Indium, a metal soft enough to be scratched with the fingernail, imparts great hardness and strength to other metals on which it may be plated or surface-diffused or with which it may be alloyed. Besides, the resulting plates and alloys become very resistant to corrosion.

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[9] Bello, Francis, The Year of the Transistor: Fortune, vol. 157, No. 3, March 1953, pp. 128–133, 162–168.
[10] Krause, H. H., and Johnson, O. H., Analytical Methods for Germanium: Anal. Chem., vol. 25, No. 1, January 1953, pp. 134–138.
[11] Bradley, D. C., Kay, L., and Wardlaw, W., Some Esters of Germanium: Chem. and Ind. (London), No. 29, July 18, 1953, pp. 746–747.
Struthers, J. D., Theuerer, H. C., Buehler, E., and Burton, J. A., Distribution of Solute Elements between Liquid and Solid Germanium: Jour. Metals, vol. 4, No. 2, February 1952, p. 149.
Wynne, R. H., and Goldberg, C., Preferential Etch for Use in Optical Determination of Germanium Crystal Orientation: Jour. Metals, vol. 5, No. 3, March 1953, p. 436.
[12] E&MJ Metal and Mineral Markets, vol. 24, No. 47, Nov. 19, 1953, p. 7.
[13] Gmelin Institute of Inorganic Chemistry and Related Sciences, Clausthal-Zellerfeld, West Germany.
[14] Stadnichenko, T., Murata, K. J., Zubovic, P., and Hufschmidt, E. L., Concentration of Germanium in the Ash of American Coals—a Progress Report: Geol. Survey Circ. 272, 1953, 34 pp.
[15] Prepared by E. J. Carlson.

This lustrous, silver-white metal has been used mostly as bearing material in the aviation, automotive, and diesel fields; however, a greater value may be found for it in plating, both for decorative and functional designs, because it provides a permanent finish that will not tarnish and can be highly polished.

Indium has been used increasingly in solders for the production of transistors, as well as in glass, ceramic-to-metal seals, and soldering to thin metal films. Silver-indium alloys are used in brazing materials, and gold-indium alloys and solders are employed extensively in dentistry. The use of graphite and indium for lubrication and wear reduction in moving parts of internal-combustion engines, in dies and molds, in metal disk clutches, and in brakes is becoming of greater importance. Low-melting alloys of tin and indium have important military uses in the sealing of detonators in shells and as a base for machining blades and delicate parts of jet engines. The application of molten indium to glass or ceramic surfaces to produce decorative designs has been described.[16]

Domestic Production.—No known minerals are rich in indium, although some zinc sulfides and some complex sulfides of tin, lead, and antimony have been found to contain up to 1 percent. The principal commercial source of the metal has been the residues and dusts obtained in refining zinc and lead. During 1953 only two companies reported production of indium; these were the American Smelting & Refining Co., Perth Amboy, N. J., and the Anaconda Copper Mining Co., Great Falls, Mont. Shipments of indium in 1953 increased considerably over those of 1951 and 1952.

Prices.—Market quotations on indium metal, electrolytic grade, 99.9 percent, have remained constant from 1946 through 1953 at $2.25 per troy ounce.

World Review.—The Consolidated Mining & Smelting Company of Canada, Ltd., produced and exported in 1953 several thousand ounces of indium from smelter operations at Trail, B. C. Cero de Pasco Copper Corp., which previously produced indium from byproduct materials obtained from its operations in Peru, reported no production for 1953.

RARE-EARTH MINERALS AND METALS[17]

The two principal sources of rare-earth metals[18] and compounds are the minerals monazite and bastnaesite. Some uranium-thorium-columbium-tantalum minerals, such as euxenite, samarskite, and fergusonite, contain appreciable quantities of the rare-earth elements, but to date these relatively rare minerals have not been economically important for their rare-earth-metal content. The minerals allanite and cerite—iron-calcium-aluminum silicates of the rare-metals—have not been found in minable concentrations, and their processing would be difficult and expensive because of the complex nature of the minerals.

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[16] Belser, Richard B., New Methods for Decorative Application of Metal to Glass and Ceramic Surfaces: Ceramic Age, vol. 62, No. 4, October 1953, pp. 17-21, 37.
[17] Prepared by E. J. Carlson.
[18] Lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium and lutetium.

Over 80 percent of both domestic and world production of rare-earth metals is from monazite, a rare-earth phosphate containing thorium. Monazite is principally found in alluvial deposits on ocean beaches such as those in the States of Travancore, India; Rio de Janeiro, Espirito Santo, and Bahía, Brazil; and South Carolina, Georgia, and Florida. Minor beach deposits of monazite have been reported in Ceylon, Indonesia, Australia, Mozambique, Madagascar, and Egypt. Stream alluvial deposits of monazite are found in Burma, Malaya, South Korea, and Idaho, Montana, North Carolina, South Carolina, and Georgia. Lode deposits of monazite have been found in the Union of South Africa, Nyasaland, and in Idaho and New Mexico.

Bastnaesite, a rare-earth fluocarbonate, has been reported in lode deposits in Madagascar, Ruanda-Urundi, Transvaal, Sweden, and U. S. S. R. The Mountain Pass mine of the Molybdenum Corp. of America in San Bernardino Co., Calif., is probably the largest known deposit of rare-earth minerals in the world. Several lode occurrences of bastnaesite have been reported in New Mexico, Wyoming, and Wisconsin. No alluvial deposits of bastnaesite are known.

Domestic Production.—The major domestic producers of monazite in 1953 were Baumhoff-Marshall, Inc., and Idaho-Canadian Dredging Co., Boise, Idaho, and Humphreys Gold Corp., of Jacksonville, Fla. Minor producers of monazite were: Jordan Creek Placers, Idaho City, Idaho; K & D Mining Co. and Winters & White, both of McCall, Idaho; Climax Molybdenum Co., Climax, Colo.; and Florida Ore Processing Co., Brevard Co., Fla. Monazite-production statistics are classified because the mineral contains thorium, a source of fissionable material, and comes under the Atomic Energy Act of 1946. The Molybdenum Corp. of America continued to be the only producer of bastnaesite and reported a substantially larger production for 1953 than for 1952.

The principal processors of rare-earth ores were Lindsay Chemical Co., West Chicago, Ill.; Rare Earths, Inc., Pompton Plains, N. J.; and Maywood Chemical Works, Maywood, N. J. These companies produce only salts or compounds of rare-earth metals.

The following firms produced misch metal and ferrocerium: General Cerium Corp., Edgewater, N. J.; New Process Metals Corp., Newark, N. J.; Matchless Metals Co., Flushing, N. Y.; and American Metallurgical Products Co., Pittsburgh, Pa.

Uses.—Nearly half of the rare-earth ores processed in 1953 were made into rare-earth metal oxides and fluorides for use in carbon-arc electrode cores. These high-luminosity carbon electrodes are used extensively in lighting for high-speed photography in the motion-picture industry and for military searchlights. The use of rare-earth materials for decolorizing glass increased because of a shortage of selenium.

Misch metal, which had a limited application in scavenging impurities and improving the hot-working qualities of alloy steels, was almost entirely replaced by rare-earth compounds in 1953. It is reported that the compounds, which cost only about one-third as much as misch metal, are equally effective for these purposes. Rare-earth compounds in low-carbon steels are reported to minimize bloomingmill cracking, reduce conditioning time, and increase the yield. From 3 to 6 pounds of rare-earth compounds per ton of alloy steel and 1½ to 2½ pounds of compounds per ton of low-carbon steel are used to obtain these desirable properties.

Rare-earth materials have useful applications in aluminum alloys; zirconium-magnesium alloys; glass coloring and decolorizing; lens, mirror, granite, and television-tube polishing; lighter flints; paint driers; textile waterproofing; activators for fluorescent lighting; scavengers in explosive manufacture; catalysts; reagent chemicals; and medicine.

Prices.—Monazite was quoted from January 1, 1953, through December 24, 1953, in the E&MJ Metal and Mineral Markets as follows: Total rare-earth oxide and thorium oxide, f. o. b. mill (domestic), 55 percent, 16½ cents per pound; 64 percent, 18¾ cents per pound; and 65 percent, 19 cents per pound. No prices were quoted for bastnaesite, but the mineral commands a price comparable with that of monazite. Normally, individual contracts are negotiated between producers and buyers, and the price depends on quantity and grade.

Prices for misch metal and ferrocerium remained unchanged at $4.50 and $8 per pound, respectively. High-purity cerium metal was quoted at $18 per pound. Rare-earth chlorides were sold at 42–50 cents per pound, rare-earth fluoride at $1 per pound, rare-earth oxide at $1.50 per pound, cerium oxide at $6 per pound, and lanthanum oxide at $10 per pound. Prices of other compounds were nominal, depending on quantity and quality.

Foreign Trade.—Imports of cerium alloys in 1953, including ferrocerium for consumption in the United States, totaled 4,211 pounds valued at $18,464. Virtually all receipts originated in West Germany and Canada.

Exports totaled 83,659 pounds of cerium ores, metal, and alloys, valued at $277,993 and 11,254 pounds of cerium lighter flints, valued at $70,201. (See the Minor Metals chapter, Minerals Yearbook, 1950, p. 1325, for statistics covering imports of misch metal and ferrocerium, 1924–50; cerium and other rare-earth compounds, 1922-50; and exports of misch metal and ferrocerium, 1942–50).

World Review.—Brazil and India maintained their restrictions on the export of monazite for commercial processing in foreign countries. Both countries processed several hundred tons of monazite to produce rare-earth chlorides for exportation. The lode deposit of the Anglo American Corp. of South Africa, Ltd., began producing large quantities of monazite from its lode deposit near van Rhynsdorp, Cape Province, Union of South Africa. A part of its production was shipped to England, but the major part was exported to United States processors. South Korea produced several hundred tons of low-grade monazite concentrates from placer operations; these were shipped to processors in Japan. Small tonnages of monazite were produced as a byproduct from tin or ilmenite placer mining in Ceylon, Malaya, Indonesia, Egypt, and Belgian Congo. The Karonge bastnaesite mine of Somuki, Ruanda-Urundi, produced a few hundred tons of bastnaesite, which was processed in West Germany.

SELENIUM [19]

Selenium continued in short supply throughout 1953, despite record-breaking production. The goal of 1,100,000 pounds of available selenium by 1955, set by the Defense Production Authority in 1952, was actually exceeded in 1953. Most of the increased production was attributable to improved efficiency in extracting selenium from copper-anode slimes.

Domestic Production.—Producers of primary selenium in 1953 were the American Smelting & Refining Co., Baltimore, Md.; American Metal Co., Ltd., Carteret, N. J.; Kennecott Copper Corp., Garfield, Utah; and International Smelting & Refining Co., Perth Amboy, N. J.

Production of primary selenium in 1953 totaled 923,887 pounds compared with 687,384 pounds in 1952. This 34-percent increase over 1952—the previous record year—was due to improved efficiency in extracting selenium from anode slimes derived from the electrolytic refining of copper and to a full year of selenium production at the new Kennecott Copper Corp. facilities for recovering selenium at Garfield, Utah.

The production of secondary selenium from rectifier scrap and spent catalysts increased 47 percent—from 66,781 pounds in 1952 to 97,948 pounds, reported by American Smelting & Refining Co., Kawecki Chemical Co., and Vickers Electric Division, Vickers Inc., in 1953.

Consumption and Uses.—Apparent domestic consumption [20] increased from 802,033 in 1952 to 1,125,501 pounds in 1953, a 40-percent increase.

National Production Authority Order M–91, initiated in February 1952, allocating selenium to consumers was revoked in February 1953.

Rectifier manufacturers consumed 497,041 pounds of selenium in 1953; two-thirds went into power rectifiers. Most of the remaining third was used in radio and television receiving sets.

One-third of all selenium produced in 1953 was consumed by the chemical industry. Pigments took 68 percent of the chemical consumption of selenium or 22 percent of the total of the selenium produced; pharmaceuticals 12 percent of the chemical or 4 percent of the total; rubber 10 percent of the chemical or 3 percent of the total; and miscellaneous chemicals another 10 percent of the chemical or 3 percent of the total. Much of the selenium in the miscellaneous chemical category was consumed in manufacturing blasting caps.

Glass manufacturers consumed 15 percent of the total selenium output in 1953. Over half of this quantity went into the production of containers, such as milk bottles.

The steel industry utilized 6 percent of the total selenium production in 1953 compared with 9 percent in 1952.

Photographic and xerographic applications of selenium composed only a third of 1 percent of the total selenium production in 1953.

Stocks.—Beginning stocks of refined selenium in the possession of the producers in 1953 totaled 132,948. End stocks of refined selenium

[19] Prepared by J. D. Sargent.
[20] Producers' domestic shipments to consumers plus consumer imports, minus exports.

in 1953 declined 29 percent to 94,660 pounds and represented only a 1-month supply. Stocks of selenium raw materials also dropped 29 percent in 1953. Consumers were able to replenish their depleted inventories by 50 percent, but consumer stocks were still considerably below a satisfactory level by the close of 1953.

Prices.—The Office of Price Stabilization removed price controls from selenium in February 1953.

During the first 2 months of 1953 the producers' price for commercial-grade selenium of 99.5-percent purity was $3 per pound, and the dealers' price was $3.50 per pound. Early in March 1953 producers and dealers raised their prices of commercial-grade selenium to $4.25 and $4.75, respectively. This price level was maintained throughout the remainder of the year. Prices for high-purity selenium, of 99.9-percent purity, were approximately double those of commercial-grade selenium. Prices in the European markets were 2 or 3 times higher than domestic prices.

Foreign Trade.—Imports of selenium and selenium compounds in 1953 totaled 99,865 pounds of selenium content valued at $456,663, a decrease of 19 percent in quantity and value compared with 1952. Canada was the source of all selenium imports except 1,208 pounds valued at $10,268, which was received from Sweden in January 1953. The exportation of selenium was under strict Government control and was limited to approximately 24,000 pounds in 1953.

Technology.—Some vanadiferous black shales of Wyoming and Idaho contain approximately 1 pound of selenium per ton of shale. By fluidized roasting the Bureau of Mines was able to extract 71 percent of the contained selenium as a commercial-grade product. Research was continuing at the close of 1953 to increase recovery rates and improve the purity of the final product. Ninety-two percent of the selenium contained in seleniferous tuffs from Lysite, Wyo., was extracted by a cyclic leaching process. Bureau of Mines research continued throughout 1953 to determine the selenium content of various rock strata, ores, and byproducts and to develop methods of extracting selenium from promising sources.

Battelle Memorial Institute investigated the commercial potentialities of the geobotanical concentration of selenium during 1953.

Titanium dioxide, germanium, silicon, and tellurium rectifiers were used experimentally as substitutes for selenium rectifiers in 1953, but none was expected to relieve the demand for selenium in the near future.

World Review—*Belgium.*—Belgium exported an estimated 75,000 pounds of selenium valued at $957,080 to 15 European and Asian countries in 1953. Most of the Belgian selenium was derived from African ores.

Canada.—Canada was the second ranking producer of selenium, having attained an output of 262,346 pounds of selenium in 1953.

The gross weight and value of selenium and selenium salts exported from Canada in 1953 was as follows: United Kingdom 147,814 pounds, $627,899; India 1,426 pounds, $7,425; West Germany 200 pounds, $1,450; Italy 1,458 pounds, $1,924; United States 102,722 pounds, $428,121.[21]

[21] Dominion Bureau of Statistics, Preliminary Report on Mineral Production, 1954: Ottawa, 1955, pp. 7, 24.

Finland.—The production of selenium in Finland was estimated to be approximately 6,000 pounds during 1953; all was exported to West Germany.

Germany, West.—West Germany was estimated to have produced 15,000 pounds of selenium in 1953.

Japan.—Japan was the fifth ranking producer of selenium in 1953, with an estimated 60,000-pound output. Japan consumed about one-third of the selenium produced domestically and exported the remainder.

Sweden.—Sweden produced an estimated 100,000 pounds of selenium in 1953 and expected an increased selenium output in 1954. Much of the Swedish selenium was of high-purity grade.

TELLURIUM [22]

Reversing a trend of long duration, more tellurium was shipped to consumers than was produced in 1953. Increased demand was reported in the utilization of tellurium in tellurium-lead sheathing for electric power cable.

Domestic Production.—Domestic primary tellurium production declined 63 percent from 189,076 pounds in 1952 to 70,446 in 1953, largely because the leading tellurium producer of former years reported no output. Producers of tellurium in 1953 were the American Metal Co., Ltd., Carteret, N. J.; International Smelting & Refining Co., Perth Amboy, N. J.; Kennecott Copper Corp., Garfield, Utah; and United States Smelting, Refining and Mining Co., East Chicago, Ind. Most of the 70,446 pounds of tellurium production in 1953 was obtained as a byproduct of lead and copper refining.

Consumption and Uses.—Total shipments of tellurium in 1953 decreased 9 percent from 155,251 pounds in 1952 to 141,223 pounds in 1953. Shipments of tellurium in 1953 outstripped production of tellurium in 1953 by a ratio of 2:1. An increase in tellurium consumption was reported in tellurium-lead alloy for sheaths for power cables. Tellurium was also used as an alloy with copper and iron. Minor quantities of tellurium were consumed as pigment, catalyst, vulcanizer, and electronic semiconductor during 1953.

Stocks.—Stocks of refined tellurium decreased 34 percent from 194,703 pounds in 1952 to 127,992 in 1953.

Tellurium-bearing raw-material stocks were not recorded in 1953, but there were indications that they again increased owing in part to the decreased production of refined tellurium. At the 1953 level of shipments, stocks of refined tellurium represented almost a 1-year supply, and tellurium raw-material stocks were believed to be adequate for several years.

Prices.—Throughout 1953, for the 14th consecutive year, tellurium was quoted at $1.75 per pound.

Technology.—New methods of tellurium analysis were published in 1953.[23]

[22] Prepared by J. D. Sargent.

[23] Chemical and Engineering News, Better Procedures Needed for Analysis of Less Common Metals: Vol. 31, No. 27, July 6, 1953, p. 2767.

Issa, I. M., and Awad, S. A., The Potentiometric Determination of Quadrivalent Tellurium by Potassium Permanganate in Weakly Alkaline Solution: Analyst, vol. 78, No. 929, August 1953, pp. 487–491.

Johnson, R. A., Kwan, F. P., and Westlake, D., Spectrophotometric Determination of Tellurium as Hydrosol: Anal. Chem., vol. 25, No. 7, July 1953, pp. 1017–1019.

Kruse, F. H., Santfer, R. W., and Suttle, J. F., Volumetric Determination of Tellurium in Organic Compounds: Anal. Chem., vol. 25, No. 3, March 1953, pp. 500–502.

A method for preparing a tellurium oxide-containing catalyst was patented.[24]

A tellurium-alloy lead sheath for power cable was developed and produced in 1953. The new alloy had a superior combination of bending and creep properties and reacted satisfactorily to extrusion and heat treatments.[25]

Foreign Trade.—No domestic imports or exports of tellurium were recorded in 1953.

World Review.—Canada produced 4,694 pounds of tellurium in 1953.[26] Three thousand pounds of this tellurium was exported to the United Kingdom in 1953.

THALLIUM[27]

The metal thallium is widely distributed in the lithosphere but usually occurs only in minute quantities in rocks and minerals. This element has not been found native; and only in a few rare minerals, such as lorandite, urbanite, hutchinsonite, and crookesite, is thallium one of the major constituents. Sulfides of zinc, lead, copper, and iron often contain traces of thallium, and the roasting or smelting of these sulfides produces dusts and residues from which thallium can be extracted. The principal domestic production of thallium is from cadmium-rich flue dusts and residues obtained from smelting zinc-lead ores.

Domestic Production.—The principal producer of thallium metal and salts continued to be the Globe plant of the American Smelting & Refining Co. at Denver, Colo. The Cerro de Pasco Copper Corp., Brooklyn, N. Y., produced small quantities of the metal and salts in 1953. Shipments of thallium metal and sulfate in 1953 totaled a few thousand pounds.

Uses.—Metallic thallium as such has few if any industrial applications; in conjunction with other metals, however, thallium forms alloys that have valuable properties. The addition of thallium to lead yields harder products with higher melting points than either of these metals alone, and they show increased resistance to atmospheric and anodic corrosion. Silver-thallium alloys resist acids and hydrogen sulfide; silverware made from this alloy has a high luster and does not tarnish or blacken. Thallium-bromide-iodide crystals have been developed for infrared optical instruments used in military equipment for detection and signaling where visible radiation must be absent. Sodium chloride crystals activated by thallium are needed for certain scintillation counters used in the exploration for uranium and thorium ores. Other uses for thallium are in rodent and insect poisons, fungicides, medicines, depilatories, pigments, glass colorizers, signals, and rockets.

Prices.—Thallium metal and thallium sulfate were quoted in 1953 at $12.50 and $10.50 per pound, respectively.

[24] Richter, F. G. (assigned to Socony-Vacuum Oil Co.), Method for Preparing a Tellurium Oxide-Containing Catalyst: U. S. Patent 2,648,638, Aug. 11, 1953.
[25] American Metal Market, New Tellurium-Alloy Sheaths for Power Cable Announced by G. E.: Vol. 61, No. 15, Jan. 22, 1954, p. 7.
[26] Work cited in footnote 21.
[27] Prepared by E. J. Carlson.

Minor Nonmetals

By Joseph C. Arundale[1] and Henry P. Chandler[2 3]

GREENSAND

A TOTAL of 6,457 short tons of greensand (glauconite) was reported produced in the United States in 1953 by the following firms: The Permutit Co., 330 West 42d Street, New York, N. Y.; Zeolite Chemical Co., Medford, N. J.; and Inversand Co., 226 Atlantic Avenue, Clayton, N. J. Production was from open-pit operations in Burlington and Gloucester Counties, N. J. The bulk of the product was sold for water softening and purification and for local soil application as a source of potassium.

The price of greensand ranged to about $121 per short ton f. o. b. shipping point, with an average value of about $28 per ton.

TABLE 1.—Greensand marl sold or used by producers in the United States, 1944–48 (average) and 1949–53

Year	Short tons	Value	Year	Short tons	Value
1944–48 (average)	6,128	$446,882	1951	5,067	$263,944
1949	6,128	276,564	1952	4,600	177,847
1950	3,935	304,321	1953	6,821	193,404

Glauconite is reported to be produced from the Gingin district of Western Australia for domestic use as a water softener and for export. About 1,000 tons annually is said to be the rate of output.

MEERSCHAUM

No production of meerschaum (sepiolite) in the United States was reported in 1953. In the past a small tonnage has been produced from the few domestic deposits. The world's principal source is Turkey,

TABLE 2.—Meerschaum imported for consumption in the United States, 1944–48 (average) and 1949–53[1]

[U. S. Department of Commerce]

Year	Pounds	Value	Year	Pounds	Value
1944–48 (average)	16,495	$31,278	1951	11,289	$13,384
1949	5,844	13,897	1952	10,479	12,344
1950	9,621	18,549	1953	8,568	12,600

[1] 1944–48 (average), all from Turkey; 1949 and 1951, 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, and 1953: Turkey: 8,168 pounds, $11,911; Union of South Africa: 400 pounds, $689.

[1] Assistant chief, Construction and Chemical Materials Branch.
[2] Commodity-industry analyst.
[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.

where it has been mined for centuries. The principal markets are in Europe and the United States. Exports of blocks of meerschaum from Turkey totaled 12 metric tons in 1953 compared with 11 metric tons in 1952.

The principal use of meerschaum is in pipe bowls and in cigar and cigarette holders. The color of these smokers' articles deepens with smoking as ingredients in the smoke and finishing waxes are absorbed into the meerschaum. This use originated over 200 years ago in Europe.

It is said that meerschaum has also been used as a building material, a "soap," and an ingredient in porcelain and in making vases and pottery.

MINERAL WOOL

Mineral wool produced in the United States during 1953 from rock, slag, and glass had a total value of $149,092,000, according to the Bureau of the Census. The production in 1952 was valued at $138,305,000 and in 1951 at $134,128,000. Use statistics are not available for 1953, but the 1947 report of the Bureau of the Census on mineral wool gave the following percentages for the broad classifications of its use: Structural insulation, 56; equipment insulation, 23; industrial insulation, 17; and unspecified, 4.

In 1953 the average number of persons employed by the mineral-wool industry was 10,506 compared with 10,340 and 10,374, respectively, the previous 2 years. The number of production workers in 1953 was 8,661; in 1952, 8,491; and in 1951, 8,583.

Exports of mineral-wool products from the United States during 1953 were valued at $2,029,000 compared with $1,723,000 in 1952 and $1,511,000 in 1951.

The use of mineral wool for insulation purposes, its composition, and its manufacture in Britain are described in an article in a trade journal.[4]

A report which indicates that metaanthracite can be used in producing satisfactory mineral-wool insulation has been published by the Rhode Island Engineering Experiment Station.[5]

Development of mineral wool from Florida minerals was the subject of a report of the State experiment station.[6]

An insulation made from mineral wool with a heavy aluminum foil backing was introduced by one producer.[7]

Production of mineral wool by a newly patented spinning process was announced by a firm in Texas.[8]

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[4] Mining Journal (London), Rock Wool and Its Applications: Vol. 241, No. 6168, Nov. 6, 1953, pp. 535-536.
[5] Mining Congress Journal, Mineral Wool in Rhode Island: Vol. 39, No. 10, October 1953, p. 72.
[6] Greves-Walker, A. F., Welch, A. Philip, Mineral Wool: Florida Eng. and Exp. Sta., February 1953, 28 pp.
[7] Rock Products, New Insulating Material: Vol. 56, No. 4, April 1953, p. 90.
[8] Pit and Quarry, New Rock-Wool Process Used at Baldwin-Hill Co. Plant: Vol. 46, No. 6, December 1953, p. 59.

WOLLASTONITE

The only production of wollastonite on a commercial scale is from a deposit near Willsboro, N. Y. Late in 1951 Cabot Carbon Co. (previously Godfrey L. Cabot, Inc.), 77 Franklin Street, Boston 10, Mass., acquired the property formerly operated by Willsboro Mining Co. A mill on the property was operated on a pilot-plant scale pending completion of a new and larger plant. This new plant was completed in September 1953. The firm plans to manufacture several wollastonite products in a number of mesh sizes and with various physical properties. The market is still in the development stage, but uses are anticipated in the manufacture of ceramic insulators, tiles and glazes, paint, paper coating, and various fillers.

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By Mabel E. Winslow [1]

[1] Editorial and information specialist.

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